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

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**Abstract**

We study the relationship between increased trade with China and the decline of manufacturing jobs in US local labour markets. We exploit value added decomposition of bilateral trade flows in order to distinguish the effects of Chinese and third country drivers of the trade shock, as well as to identify the groups of industries driving the adjustment based on revealed comparative advantage. Our identification and instrumentation strategy follows closely the nascent literature on local labour market trade exposure. We find evidence for Chinese value added driving adverse relative employment effects in the 2000-2008 period, contrary to an assembly hub or GVC integration explanation. However, these effects have greatly diminished by the 2008-2015 period, as labour market adjustment has largely concluded. This obviates labour market related justifications for bilateral trade policy interventions. The negative effects that persist in the latter period are found to be driven by recently-gained Chinese comparative advantage industries. As a methodological contribution we improve on the local trade exposure measure by calculating it using value added industries, as doing so based on exporting industries obscures the exposure faced by upstream suppliers.

**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 pattens which provide a unique opportunity to examine how predictions of classic trade theory hold up. Trade liberalisation is expected to be on the whole welfare improving, but it also necessitates adjustments in factor markets which will not always be favourable to all groups, be it the owners of a specific type of capital or workers in a specific industry. Without government intervention, some groups are left worse off than before, and individuals face significant adversities in transitioning from job to job. Recent research has largely corroborated the view that aggregate gain and localised pain are two sides of the same coin. For instance, Amiti et al. (2017) estimate that China's WTO entry has caused consumer price of manufacturing goods to fall 7.6% in between 2000-2006. On the other hand, highly influential research by Autor et al. (2013) shows that US local labour markets more exposed to increased import competition from the Chinese manufacturing sector, what is commonly referred to as the China shock, have seen significant losses in jobs and earnings. They find that over a decade a $1000 increase in per worker exposure to Chinese imports leads to a 0.6 percentage point reduction in the share of manufacturing in total employment. Although recent research by Magyari (2017) suggests that these negative effects are not present at the national industry level, and that the costs savings made possible by trade with China have actually helped US manufacturing industries retain workers on aggregate, this does not diminish the significance of the fact that in many location US manufacturing industries have suffered. Autor et al. (2016) present a historical overview of the rise of China and the subsequent adjustment in 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). What is special about the China shock, however, is its scale. 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.

Given these developments it is important to clarify the implications of the China shock research agenda for trade policy. Firstly, it is well known that changes in trade patterns lead to adjustment costs during the transition to a new equilibrium. Such costs are important and should be addressed by policy makers, but they do not outweigh net gains from trade such as the reduction of prices faced by consumers and increases in productivity.[1] It is clear that a policy response to these concerns should not come in the form of barriers to trade but rather as policies that facilitate adjustment and attenuate adjustment costs.

In this paper, we use value added decomposed trade flows to shed light on two aspects of adjustment to the China shock. The first is to distinguish between the impact of Chinese drivers of

[1] Further evidence on temporary adjustment costs are provided by Trefler (2004) and Dix-Carneiro and Kovak (2015) for Canada and Brazil respectively, while evidence on gains from trade with China is presented in Handley and Limão (2017) and Bloom et al. (2016).

the trade shock and that of third countries who use China in final stages of their production but provide much of the value added. Autor et al. (2016) discuss extensively the domestic reforms which took place in China that finally enabled it to take its place in the globalised economy as a major manufacturing powerhouse. On the other hand, Johnson and Noguera (2016) and Koopman et al. (2012) research the proliferation of Global Value Chains (GVCs) and in particular the participation of China. Implication for US policy response are different depending on the extent to which employment effects are driven by (i) China increasing its productivity and moving up the value chain as a result of successful development policies, and (ii) third countries such as Japan and Korea gaining a cost advantage and competing indirectly with US manufacturers by making use of China's comparative advantage in labour intensive stages of production. In the former case, given the structural reasons for the differences in comparative advantage between the US and China, it would make little sense to protect or subsidise those manufacturing sectors in which China has a clear comparative advantage. The priority should be on using transfers financed by the gains from trade to facilitate workers' adjustment out of these industries. In the latter case, it is competition between structurally similar advanced economies that is behind the negative employment effects, however, adjusting bilateral trade policy towards China would have a limited impact as GVCs would increasingly shift to rely on alternative low-wage countries for the final stages of production. Instead, policy should focus on findings ways to improve the competitiveness of US manufacturers in the industries affected. Facilitating the GVCs integration of these industries would permit them to benefit from the cost advantage afforded by Chinese or Mexican inputs and compete on equal terms with their Japanese or Korean counterparts.

The other main contribution of this paper is to explore the length of adjustment and how changes in Chinas comparative advantage over time may have prolonged the employment effects. Autor et al. (2016) show that the negative effects of the China Shock on US local labor markets have been fairly persistent. For designing appropriate policies, it is important to understand if the negative effects of Chinese import competition are temporary but prolonged due to the large size of the new trading partner or if the China shock is unique in that it has a permanent effect. We aim to answer the question, to what extent has the US labour market successfully adjusted by now? If adjustment has already concluded, there is no case for policies aimed at limiting import exposure.

We address these two points 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 Autor et al. (2013) 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.

First, it allows us to create a more precise measure of local labour market exposure by taking into account input-output linkages on the supply side. The reason is that 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 labor markets which depend on plastics or fabricated metal products. By looking at the value added content of US imports from China, we can correctly assign the imports to the local labour markets that are ultimately affected. Furthermore, we can remove the portion of export value due to double counting, since a part or component crossing the US border more than once due to ever lengthening value chains has no significance for its potential to displace local production.

Second, it 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 it causes a mechanical correlation between import exposure and employment in manufacturing. Moreover, it is problematic for the instrumentation strategy 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 and can reduce the bilateral trade deficit between China and the US by up to 40%, which highlights that this adjustment is quantitatively meaningful and relevant.

We find that in the period 2000-2008 increased exposure to Chinese value added is associated with a decline in local manufacturing employment, whereas exposure to foreign value added in Chinese exports has a positive effect, albeit not robustly statistically significant. This means that the China shock is indeed caused by China-specific changes as suggested by Autor et al. (2013) and not by indirect imports consistent with a GVC-driven explanation. It also shows that the results by Autor et al. (2013) are robust to a specification that takes into account input-output linkages at the local labor market level. 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 stems from 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.

We also find that in the period from 2008-2014 the negative effects of local exposure to Chinese value added are greatly diminished. The corresponding coefficients suggest that the magnitude of the effect has decreased by 66% implying that the China shock today only plays a minor role. We further split our DVA exposure along three industry groups to determine if the remaining negative impact of DVA in the second period 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 DVA from the first two groups is associated with negative effects on local manufacturing employment. However, in 2008-2014 only the second group shows a significant, although smaller, effect. This implies that while adjustment is still taking place in some industries in which China has only relatively recently gained a competitive edge, it has mostly 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. We conclude that the China shock is not special in that it has no permanent negative effects. While the adjustment period estimated by Autor et al. (2013) of about 10 years from the mid-1990s to 2007 is fairly long, this can be explained by the concurrent evolution of China's comparative advantage to encompass more complex and skill intensive manufacturing industries.

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

## 2 Related Literature

Our work is directly related to the seminal paper by Autor et al. (2013) and papers that replicate their methodology. Our methodological contribution to this line of research is to improve upon the precision of the exposure measure by considering also the upstream industries 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 (2016). Rather than studying the value added decomposition of bilateral gross trade flows as does the present paper, 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 consider 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 theirs employs forward linkages. They ask whether all the absorbed Chinese value added taken together has a negative labour market impact, and find that it does not. A potential reason for this is that using forward linkages, their measure of Chinese value added is often embedded in goods that will go through several additional production stages after leaving China, that is, upstream goods. Most of these goods, such as rare earths or other raw materials, do not compete with US goods but are rather complementary, or even necessary inputs to US production processes. As such, the presence of this type of value added might attenuate the effects of more downstream, substitutable value added found in bilateral exports which directly competes with US production. Indeed, their paper finds that it is the downstreamness of industries that is associated with negative labour market consequences. Ultimately their decomposition is not suited to study implications of bilateral trade policy and it prevents a direct comparison to the results by Autor et al. (2013) who, like us, look at bilateral trade flows. Instead, they study the overall (direct and indirect) impact of the rise of China including its participation in third countries' production chains.

More recent work on the impact of Chinese imports emphasises the importance of input-output linkages. Acemoglu et al. (2016) use industry level data to study the effects of direct industry exposure, exposure which propagate downstream from a given industry's suppliers, and exposure which propagate upstream from a given industry's buyers. As one would expect, direct and upstream effects of exposure are found to be negative, however downstream effects are statistically insignificant. The key difference to our approach is that they generate upstream and downstream exposure by using US national input-output tables to create a weighted average of what is direct Chinese import exposure measured by exporting industry. In contrast, we use data on the value added industry content of each exporting industry generated from inter country input-output tables to correctly allocated exposure to the affected industries, which encompasses both direct exposure, i.e coming from the value added by the exporting industry itself, and upstream exposure industries.

Like Autor et al. (2013), we are interested in precisely identifying the negative employment effects of Chinese import exposure which necessitate labour market adjustment, so we do not seek to simultaneously include a treatment variable for downstream exposure which would have to be constructed using US national input-output tables. Industries which are downstream from the imported product presumably benefit, so the expected effect identified here would be positive. This hypothesis is consistent with Topalova and Khandelwal (2011), who 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.

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 labor 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 overall 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 Empirical Strategy

## 3.1 Identification and Instrumentation

Our empirical approach builds on the methodology developed by Autor et al. (2013) with the aim to extend and deepen our understanding of the local labour market effects of the US-China trading relationship. 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 will 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. In order to identify differential effects of exposure to domestic and foreign value added, it must be the case that the two are sufficiently different in their industry composition, that is, the proportion of value added contributed by each manufacturing industry.

We use a measure of CZ trade exposure created in the spirit of Autor et al. (2013) with several key differences. As a useful reference point, let us first describe their exposure measure, which is based on gross imports of Chinese goods to the US:

$$\Delta EXP_{it} = \frac{1}{L_{it}} \sum_{s} \frac{L_{ist}}{L_{st}} \Delta IMP_{st}. \tag{1}$$

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.

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 this exposure measure with an analogous one where employment is lagged by one period and US imports from China are replaced by imports by a group of other developed countries.

In contrast to the gross imports used by Autor et al. (2013) our trade data originates from ICIOs and has additional layers of richness that we exploit in our analysis. Trade flows are decomposed according to the bilateral trade accounting framework proposed by Koopman et al. (2014) and adapted to bilateral-sector level by Wang et al. (2013). In particular our bilateral trade flows are net of double counting, which is important, since whether an intermediate good passes through customs more than once at various stages of production is irrelevant from a labour displacement perspective. Using backwards linkages, we can decompose trade flows based on source country and industry of value added.[2] Therefore, we are able to create separate exposure measures based on the distinct sources of exposure and evaluate their relative importance. As discussed above, this is how we evaluate competing hypotheses as to the drivers of the China shock.

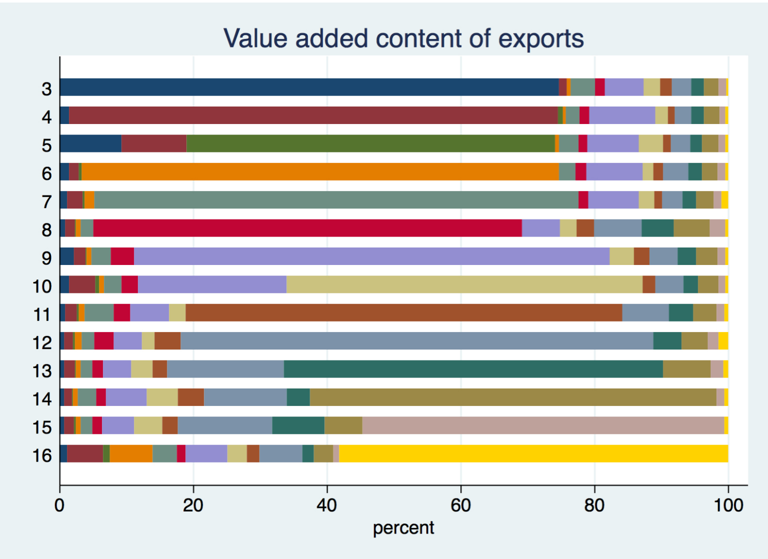
$$\Delta MANUF_{it} = b_1 + b_2 \Delta EXP_{it} + b_3 \Delta EXP_{it} \times D_t + \mathbf{X'}_{it} b_4 + e_{it} \tag{2}$$

In our general specification shown above we regress the share of manufacturing employment in the working-age population by CZ on its trade exposure. We depart from Autor et al. (2013) in that we allow time interactions rather than using their stacked first differences model in order to test whether adjustment is taking place so that the effects of exposure differ in the two time periods analysed. In the example specification (2) above this means that the effects of exposure are captured by $b_2$ in the first period and $b_2 + b_3$ in the second period.

## 3.2 Value Added Exposure

We make a methodological contribution to the growing literature that employs this style of identification strategy. Our richer trade data enables us to improve upon the way local exposure is calculated. We provide a measure which more accurately reflects the threat of displacement to workers in various manufacturing industries. First, we want to draw attention to the fact that the value added content, and hence the labour content, of exports does not generally originate from the exporting industry. This point is well illustrated by Figure 1 below, where different colours represent the manufacturing value added industry content for each exporting manufacturing industry (in the same order). The industry (colour) 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 industries.

Figure 1: Industry-level value added content of exports



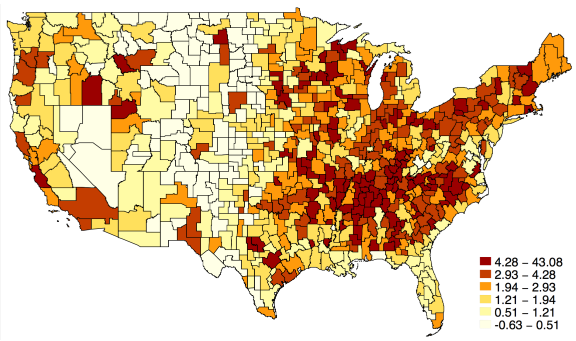

[2] See Baldwin and Lopez-Gonzalez (2015) for a general discussion on value-added trade.

We therefore calculate our exposure measure described in equation (1) with $s$ representing value added industries, in contrast to previous work where local exposure is calculated using exporting industries. While this has been made possible due to more detailed data, note that using exporting industries obscures the true set of industries affected by the increase in trade and thus skews the correct attribution of trade shocks to CZs. For example, if a third of motor vehicle imports' value added increase comes from the steel sector and these domestic industries are located in different CZs, one should allocate a third of the trade shock to the CZ where iron and steel are prominent.

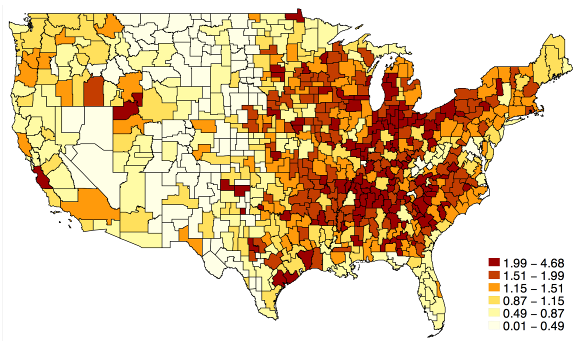
Figure 2 provides a graphical representation of how the geographic distribution of exposure differs when it is calculated based on the two different methodologies. In Washington, Oregon, and California we observe several CZs that display high exporting industry exposure and much lower value added exposure. Their industry structure is such and even though they appear directly exposed to import competition, it is actually jobs located elsewhere that are at risk. Since manufacturing employment losses have been less severe in these areas, misallocating exposure to them leads to underestimating its effect on employment. Therefore, we hypothesise that our exposure measure will yield a negative coefficient much greater in magnitude than Autor et al. (2013). This expected difference is moderated by the fact that upstream industries to a given manufacturing industry are not uniformly distributed across the country but exhibit patterns of geographic clustering. (Ellison and Glaeser, 1997) In terms of causal inference, our methodology yields a more precise estimate of the ideal treatment variable (true exposure to import competition) and is thus better at identifying the true effects of import competition at a local labour market level. It bears repeating that we do not claim to identify any other effects of Chinese imports, such as beneficial downstream effects of cheaper inputs, or more aggregate industry or economy wide employment effects which propagate in general equilibrium though the price-demand channel. As such, this methodology is well suited to studying the labour market adjustment process following a trade shock, but poorly suited to study aggregate welfare implicated that should guide trade policy.

Figure 2: Comparison of import exposure measures for 2000-2007

(a) Exposure in Autor et al. (2013)




(b) Value added exposure



# 4 Data Description

We use value added decomposed trade flow data covering the years 2000, 2008, and 2015 which has been 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. The decomposition uses the accounting framework proposed by Koopman et al. (2014) and further disaggregated to a bilateral-sector level by Wang et al. (2013). For some robustness exercises we also use equivalent data from the 2016 release of the World Input-Output Tables (WIOT 2016). For future research we plan to run value added decompositions also on the OECD/WTO Trade in Value Added database (TiVA). The ADB-MRIO is our preferred source because compared to WIOD 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. It should be noted that ICIOs rely on exporter reporting rather than importer reporting, so while we maintain the terminology of Autor et al. (2013) when referring to import exposure, in Table 1 which makes a direct comparison with their results we apply a scaling correction based on the import/export discrepancy in the UN Comtrade Database.

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[3]. Data on working-age population used to compute the dependent variables is 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[4].

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

# 5 Econometric Results

## 5.1 Comparison with Autor et al. (2013)

We begin our analysis by conducting a comparison and validation exercise where we fit the model of Autor et al. (2013) using our value added data and value added exposure measure but without splitting it into its foreign and Chinese value added components and without extending the analysis to the most recent time period. We evaluate at this stage only whether the results of Autor et al. (2013) are robust to redefining import exposure using the value added origins of imports and the differences between the two. The specification we use is given by equation (3) and is equivalent to the preferred specification of Autor et al. (2013) with the full set of controls.

[3]http://www.ddorn.net/

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

$$\Delta MANUF_{it} = b_1 + b_2 \Delta EXP_{it} + \mathbf{X'}_{it} b_3 + e_{it} \tag{3}$$

For ease of comparison we use data for the time period 2000-2008 and adjust variables to be 10-year equivalent. We use data and code made available by Autor et al. (2013) to run an equivalent regression for the 2000-2007 period, as single period analyses are not reported in their paper.[5] 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. The export exposure measure is instrumented according to the strategy described in Section 3.

Table 1 focuses exclusively on the time period of overlap between our data and that of Autor et al. (2013). In columns 1-6 we replicate their Table 3 and in column 7 we use their data to replicate column 6, since they only publish results for a stacked first differences specification involving also the prior time period. Table 1 shows qualitatively similar findings to Autor et al. (2013) on export exposure with our novel data sources and exposure methodology, with some differences in the significance of controls. We observe a clear difference in the coefficients of exposure depending on the methodology used. From column 7 we see that over the decade in question a \$1000 increase in per worker exporting industry based exposure to Chinese imports leads to a 0.47 percentage point reduction in the share of local manufacturing employment, whereas column 6 shows that a \$1000 increase in per worker value added exposure leads to a 0.96 percentage point reduction. We posit that this difference is due to our exposure measure more accurately identifying the causal effect of imports. We also conclude that our data and methodology are validated and we can have confidence in further results to follow.

[5] Autor et al. (2013) report results from a stacked first differences specification using two time periods, the earlier of these does not overlap with out data.

Table 1 — Comparison with Autor et al. (2013) using 2000-2008 trade flows
Dependent Variable: 10-year equivalent change in manufacturing employment / working-age population in % pts

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| Local exposure to Chinese exports / worker | -2.142*** | -1.683*** | -1.436*** | -1.145*** | -1.017*** | -0.958*** | -0.469*** |
| | (0.225) | (0.380) | (0.363) | (0.296) | (0.295) | (0.285) | (0.123) |
| % manufacturing employment t-1 | | -0.0481 | -0.0680** | -0.132*** | -0.126*** | -0.138*** | -0.083*** |
| | | (0.0380) | (0.0347) | (0.0392) | (0.0331) | (0.0358) | (0.025) |
| % college educated population t-1 | | | | -0.0319 | | -0.00726 | -0.000 |
| | | | | (0.0246) | | (0.0204) | (0.021) |
| % foreign born t-1 | | | | -0.0470*** | | -0.000 | 0.057*** |
| | | | | (0.0112) | | (0.0214) | (0.013) |
| % employment among women t-1 | | | | -0.0268 | | 0.0349 | -0.064 |
| | | | | (0.0396) | | (0.0414) | (0.039) |
| % employment in routine occupations t-1 | | | | | -0.229*** | -0.220*** | -0.142*** |
| | | | | | (0.0742) | (0.0739) | (0.093) |
| avg offshorability of occupations t-1 | | | | | -0.511 | -0.628 | -0.670* |
| | | | | | (0.351) | (0.519) | (0.344) |
| Constant | 0.0651 | 0.204 | -0.364 | 4.608** | 7.334*** | 5.152 | -1.182 |
| | (0.334) | (0.364) | (0.516) | (2.066) | (2.385) | (3.798) | (3.270) |
| Observations | 722 | 722 | 722 | 722 | 722 | 722 | 722 |
| R-squared | 0.437 | 0.453 | 0.532 | 0.589 | 0.638 | 0.642 | 0.532 |
| Census division dummies | NO | NO | YES | YES | YES | YES | YES |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

## 5.2 Extending the analysis until 2014

We proceed to analyse the persistence of local labour market effects in the more recent period 2008-2014. We use a two period setup with each period adjusted to 8-year equivalent period lengths. Instead of using the stacked first differences technique as in Autor et al. (2013) we include a time interaction term with a dummy variable for the second period $D_t = \mathbf{1}_{\{t=2008\}}$ because we do not want to ex-ante restrict the exposure impact coefficients to be identical in both periods. The coefficient of exposure will thus be $b_2$ in the first period and $b_2 + b_3$ in the second. This is done because we hypothesise that the latter period is fundamentally different. It is far enough from the start of the China shock for local labour market adjustment to have potentially taken place, and additionally there may be an interaction with the after-effects of the 2008 global financial crisis.

$$\Delta MANUF_{it} = b_1 + b_2 \Delta EXP_{it} + b_3 \Delta EXP_{it} \times D_t + \mathbf{X'}_{it} b_4 + e_{it} \tag{4}$$

Column 1 in Table 2 is equivalent to column 6 in Table 1 without the necessary adjustments for quantitative comparability with Autor et al. (2013). From column 2 we learn that the interaction of exposure with time is significant, so we may reject that hypothesis that exposure has equal effects in both time periods. Furthermore, we cannot reject that this effect is zero in the second period. This is consistent with our hypothesis that the manufacturing industries most vulnerable to import competition have on the most part already adjusted, leaving behind an industry structure that is more resilient to increasing volumes of import competition.

Bloom et al. (2015) posit that firms accelerate technological and organisational innovation to inoculate themselves against import competition, which could explain our findings. In some 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 some degree of reorganisation response in the prior period, persistent effects can be expected to be diminished in the latter period presuming the the industry composition of increased import competition does not change significantly. We later show that the industry composition does evolve over time, which may account for the persistent of negative effects from some components once trade flows are decomposed in subsequent analysis.

Table 2 — Results using trade data from 2000-2015

Dependent Variable: 8-year equivalent change in manufacturing employment / working-age population in % pts

| | (1) | (2) |
|---|---|---|
| Local exposure to Chinese exports / worker | -1.219*** | -1.905*** |
| | (0.363) | (0.321) |
| Time Dummy * Local exposure to Chinese exports / worker | | 1.425*** |
| | | (0.305) |
| t | | -0.568** |
| | | (0.281) |
| Coefficient + Time Interaction for Chinese Export Exposure | | -0.480 |
| | | (0.378) |
| % manufacturing employment t-1 | -0.111*** | -0.0629*** |
| | (0.0286) | (0.0224) |
| % college educated population t-1 | -0.00581 | 0.000820 |
| | (0.0163) | (0.00990) |
| % foreign born t-1 | -7.28e-05 | 0.00460 |
| | (0.0172) | (0.00726) |
| % employment among women t-1 | 0.0279 | 0.0239 |
| | (0.0331) | (0.0158) |
| % employment in routine occupations t-1 | -0.176*** | -0.121*** |
| | (0.0591) | (0.0300) |
| avg offshorability of occupations t-1 | -0.502 | -0.487** |
| | (0.416) | (0.230) |
| Constant | 4.121 | 2.067 |
| | (3.038) | (1.663) |
| Observations | 722 | 1,444 |
| R-squared | 0.642 | 0.574 |
| Census division dummies | YES | YES |

Robust standard errors in parentheses

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

## 5.3 Trade flows decomposed

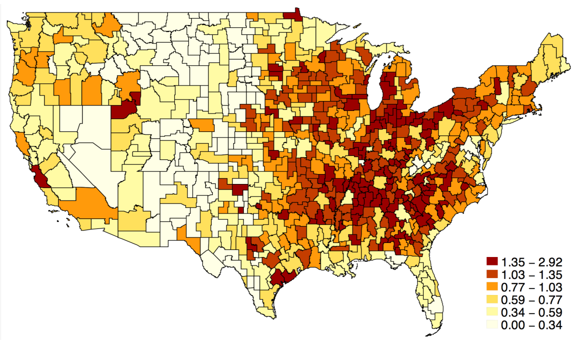
In this section our aim is to shed light on the drivers of China shock by decomposing our exposure measure based on the origin of the value added. DVA represents Chinese domestic value added and FVA represents foreign, third-country value added, with the US excluded. Figure 3 presents two maps contrasting the geographic distribution of DVA and FVA. The specification used in this section is described in equation (5).

$$\Delta MANUF_{it} = b_1 + b_2 \Delta DVAEXP_{it} + b_3 \Delta DVAEXP_{it} \times D_t + b_4 \Delta FVAEXP_{it} + b_5 \Delta FVAEXP_{it} \times D_t + \mathbf{X'}_{it} b_6 + e_{it} \quad (5)$$

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. Even though DVA exposure is generally much greater in magnitude, we can confirm from Figure 3 that the geographic pattern of these two exposures is sufficiently different to allow identification. 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, strategic consideration by the Chinese government to facilitate the growth of certain sectors, or a combination of factors. We further note that the exposure pattern of FVA changes significantly from the first period to the second reflecting both changes in the industry composition of FVA and changes in the US local industry composition. The exposure pattern of DVA remains fairly stable.

Figure 3: Comparison of DVA and FVA exposure 2000-2008

(a) DVA exposure




(b) FVA exposure

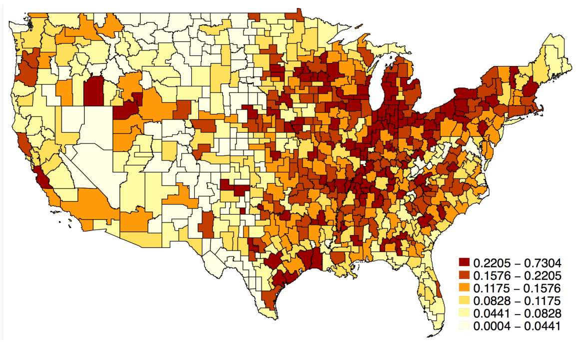


Table 3 — Local labour market exposure by origin of value added for periods 2000-2008 and 2008-2015
Dependent Variable: 8-year equivalent change in manufacturing employment / working-age population in % pts

| | (1) | (2) |
|---|---|---|
| Local exposure to the Chinese value added content of Chinese exports / worker | -4.298*** | -4.801*** |
| | (1.314) | (0.856) |
| Local exposure to the Foreign value added content of Chinese exports / worker | 7.609** | 8.356*** |
| | (3.591) | (2.741) |
| Time Dummy * Local exposure to the Chinese value added content of Chinese export | | 3.189*** |
| | | (0.618) |
| Time Dummy * Local exposure to the Foreign value added content of Chinese export | | -5.334 |
| | | (5.035) |
| Coefficient + Time Interaction for Chinese value added content | | -1.613*** |
| | | (0.626) |
| Coefficient + Time Interaction for Foreign value added content | | 3.022 |
| | | (3.782) |
| t | | -0.558* |
| | | (0.290) |
| % manufacturing employment t-1 | -0.0307 | -0.00661 |
| | (0.0413) | (0.0256) |
| % college educated population t-1 | -0.0129 | -0.00355 |
| | (0.0161) | (0.0104) |
| % foreign born t-1 | 0.000785 | 0.00536 |
| | (0.0181) | (0.00770) |
| % employment among women t-1 | 0.0211 | 0.0166 |
| | (0.0346) | (0.0170) |
| % employment in routine occupations t-1 | -0.140** | -0.0962*** |
| | (0.0638) | (0.0315) |
| avg offshorability of occupations t-1 | -0.554 | -0.518** |
| | (0.458) | (0.255) |
| Constant | 3.622 | 1.837 |
| | (3.247) | (1.711) |
| Observations | 722 | 1,444 |
| R-squared | 0.645 | 0.583 |
| Census division dummies | YES | YES |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3 reports results from the first period in column 1 and with time interactions in column 2. We see that the coefficient of DVA exposure is negative in both periods, although significantly smaller in the latter period, reflecting local labour market adjustment to the domestic component of the trade shock. The coefficient of FVA exposure is positive and we cannot reject that there it is constant across the two periods. However, in robustness exercises using ICIO tables from WIOD 2016 the coefficient of FVA is positive but no longer significant. We may conclude that there are no negative local labour market effects from this component of the trade shock.

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, and we can discount the hypothesis that it is driven by other advanced economies rerouting production through China via global value chains. In fact, the negative effect of DVA indicates that manufacturing has shrunk the most in CZs whose industry structure corresponds to industries in which China has expanded, highlighting a degree of substitutability. However, manufacturing has expanded 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 in response to increased import competition from other sectors. It is also the case that the FVA component does not necessitate new adjustment as countries such as the US have been previously exposed to direct imports from Japan and Korea in these industries which are now rerouted via China. The hypothesis that the US had already adjusted to competition from these industries prior to the China shock is supported by Wang et al. (2017) who describe how Japan and the four Asian Tigers constituted 75% of the US trade deficit in manufactured goods in 1990, but this share declined to just 13% by 2015.

## 5.4 Comparative advantage sectors

Recent work by Hanson et al. (2015) has shown evidence for comparative advantage industries changing dynamically over time. It is well known that since the early 1990s China has expanded its set of comparative advantage manufacturing industries rapidly. We investigate the impact of Chinese value added exposure coming from exporting industries grouped by the dynamics of their revealed comparative advantage.[6]

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 has had a comparative disadvantage between 1995 and 2008.

$$\begin{aligned}\Delta MANUF_{it} = b_1 + b_2\Delta DVA1EXP_{it} + b_3\Delta DVA1EXP_{it} \times D_t \\ + b_4\Delta DVA2EXP_{it} + b_5\Delta DVA2EXP_{it} \times D_t \\ + b_6\Delta DVA3EXP_{it} + b_7\Delta DVA3EXP_{it} \times D_t \\ + b_8\Delta FVAEXP_{it} + b_9\Delta FVAEXP_{it} \times D_t + \mathbf{X'}_{it}b_{10} + e_{it} \quad (6)\end{aligned}$$

[6] We compute comparative advantage industries using the methodology of Balassa (1965) based on value added exports provided by TiVA.

Table 4 — Local labour market exposure by origin of value added for periods 2000-2008 and 2008-2015
Dependent Variable: 8-year equivalent change changes in manufacturing employment / working-age population in % pts

| | (1) | (2) |
|---|---|---|
| Local exposure to the Chinese G1 industry value added content of Chinese exports | -3.189** | -4.020*** |
| | (1.351) | (1.068) |
| Local exposure to the Chinese G2 industry value added content of Chinese exports | -4.882*** | -5.718*** |
| | (1.364) | (0.998) |
| Local exposure to the Chinese G3 industry value added content of Chinese exports | 1.275 | -1.510 |
| | (5.022) | (4.498) |
| Local exposure to the Foreign value added content of Chinese exports / worker | 9.075** | 10.50*** |
| | (3.535) | (3.058) |
| Time Dummy * Local exposure to the Chinese G1 | | 2.861*** |
| | | (0.609) |
| Time Dummy * Local exposure to the Chinese G2 | | 4.313*** |
| | | (1.204) |
| Time Dummy * Local exposure to the Chinese G3 | | 3.086 |
| | | (6.046) |
| Time Dummy * Local exposure to the Foreign value added content of Chinese export | | -8.132* |
| | | (4.685) |
| Coefficient + Time Interaction for Chinese G1 value added content | | -1.159 |
| | | (0.866) |
| Coefficient + Time Interaction for Chinese G2 value added content | | -1.405* |
| | | (0.796) |
| Coefficient + Time Interaction for Chinese G3 value added content | | 1.577 |
| | | (4.813) |
| Coefficient + Time Interaction for Foreign value added content | | 2.369 |
| | | (3.721) |
| t | | -0.568* |
| | | (0.300) |
| % manufacturing employment t-1 | -0.0634 | -0.0275 |
| | (0.0475) | (0.0337) |
| % college educated population t-1 | -0.00755 | -0.00102 |
| | (0.0173) | (0.0115) |
| % foreign born t-1 | 0.000393 | 0.00519 |
| | (0.0177) | (0.00744) |
| % employment among women t-1 | 0.0203 | 0.0176 |
| | (0.0343) | (0.0173) |
| % employment in routine occupations t-1 | -0.162*** | -0.107*** |
| | (0.0584) | (0.0301) |
| avg offshorability of occupations t-1 | -0.432 | -0.458* |
| | (0.424) | (0.234) |
| Constant | 4.075 | 2.021 |
| | (3.148) | (1.636) |
| Observations | 722 | 1,444 |
| R-squared | 0.656 | 0.592 |
| Census division dummies | YES | YES |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

We find in Table 4 that in the first period 2000-2008 exposure to DVA from the first two groups is associated with negative effects on local manufacturing employment. However, in 2008-2014 only the second group shows a significant, although smaller, effect. The effects of FVA exposure are qualitatively similar to the previous specification. We take these results as evidence that adjustment has largely taken place to exposure to China's original comparative advantage industries, and is still taking place due to some industries in which China has only relatively recently gained a competitive edge. This type of rolling adjustment necessitated by China's concurrent development and movement up the value chain could explain why it has taken a several decades for US labour markets to adjust to the rise of China. It is furthermore evidence that this adjustment is winding down despite the growth in imports.

# 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 averting or reversing the aforementioned local labour market effects, there is no case for limiting trade with China. Using recent trade data, we show that rising US local labor market exposure to Chinese imports in the recent period 2008-2014 has significantly smaller effects than in the period 2000-2008 and is driven exclusively by industries in which China has gained a comparative advantage only recently. This suggests that US local labour market adjustment to the China shock has largely concluded.

Furthermore, by exploiting value added decomposition of trade flows, we can analyse the relative impact on US local labour markets of value added components of Chinese imports originating from China and from third countries. We provide evidence that confirms the thesis 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.

Moreover, we contribute an important methodological innovation that complements the empirical strategy of Autor et al. (2013) with a cleaner identification of the causal effects of import exposure. We show that the results of Autor et al. (2013) are qualitatively robust to using our value added based exposure measure, but that more precisely identifying treated local labour markets yields a quantitatively larger effect of trade exposure on local manufacturing employment.

We leave for future research to attempt to identify at a local labour market level the downstream effects of exposure to imports of intermediate products from China, which are predicted to be positive. 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 necessitate 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 evaluation of policy should take into account both sides of the coin. While the China shock was a unique historical event, we can expect future disruptive technology shocks to be of similar magnitude and therefore, lessons from the China shock and how it has affected various countries around the world could potentially inform 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)).

$$
\begin{aligned}
E^{kl} =& \left(V^k B^{kk}\right)^T * F^{kl} + \left(V^k L^{kk}\right)^T * \left(A^{kl} B^{ll} F^{ll}\right) \\
&+ \left(V^k L^{kk}\right)^T * (A^{kl} \sum_{t \neq k,l}^{G} B^{lt} F^{tt}) + \left(V^k L^{kk}\right)^T * (A^{kl} B^{ll} \sum_{t \neq k,l}^{G} F^{lt}) \\
&+ \left(V^k L^{kk}\right)^T * (A^{kl} \sum_{t \neq k}^{G} \sum_{l,u \neq k,t}^{G} B^{lt} F^{tu}) + \left(V^k L^{kk}\right)^T * \left(A^{kl} B^{ll} F^{lk}\right) \\
&+ \left(V^k L^{kk}\right)^T * (A^{kl} \sum_{t \neq k,l}^{G} B^{lt} F^{tk}) + \left(V^k L^{kk}\right)^T * \left(A^{kl} B^{lk} F^{kk}\right) \\
&+ \left(V^k L^{kk}\right)^T * (A^{kl} \sum_{t \neq k}^{G} B^{lk} F^{kt}) + \left(V^k B^{kk} - V^k L^{kk}\right)^T * \left(A^{kl} X^l\right) \\
&+ \left(V^l B^{lk}\right)^T * F^{kl} + \left(V^l B^{lk}\right)^T * \left(A^{kl} L^{ll} F^{ll}\right) + \left(V^l B^{lk}\right)^T \\
&* \left(A^{kl} L^{ll} E^{l*}\right) + (\sum_{t \neq k,l}^{G} V^t B^{tk})^T * F^{kl} + (\sum_{t \neq k,l}^{G} V^t B^{tk})^T \\
&* \left(A^{kl} L^{ll} F^{ll}\right) + (\sum_{t \neq k,l}^{G} V^t B^{tk})^T * \left(A^{kl} L^{ll} E^{l*}\right),
\end{aligned} \tag{7}
$$

Here $E^{kl}$ represents exports from country $k$ to $l$, $F^{kl}$ is the final demand in $l$ for goods of $k$, $L^{ll}$ 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 (7), 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_fin*, 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_ intrexf*, 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 (*pdc*, 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.