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Abstract

Imports of manufactured goods from China to Australia grew more than eleven-fold in real US dollar terms between 1991 and 2006. This study uses differences in industry structure between regions to identify the impact of that growth on labour market outcomes in Australia. Overall, the growth in Chinese imports is estimated to have reduced the ratio of manufacturing employment to population by 1.6 percentage points, and manufacturing employment by 221,000 workers. Adjustment to this impact on local manufacturing employment appears to have occurred through labour mobility between regions, but also increased rates of unemployment and non-participation. Growth in manufacturing imports from other Asian countries during this period, by contrast, is found to have had little impact on manufacturing employment in Australia – with the main explanation for the difference being that Chinese imports were weighted more to manufacturing sectors experiencing slower growth in domestic consumption (absorption) and with high labour-intensity. The study concludes by interpreting the estimated impacts of Chinese imports on Australia against estimates for other countries.

JEL classification: J21, J23, J61, F16, F66

Keywords: Manufacturing employment, trade shocks, labour market adjustment, import exposure

1. Introduction

A new era of globalisation has been a major feature of the world economy in the past 50 years. Trade in goods, which was 17.4 per cent of global GDP in 1968, reached a peak of 51.4 per cent in 2008.[1] Integral to this growth was a major shift in the location of manufacturing production: from developed to developing countries. Most notably, China has assumed the position of the 'global factory', using international trade to increase its share of world manufacturing output from below 5 per cent in the late 1980s to above 25 per cent in 2016 (Levinson, 2018).

As a small open economy, Australia has always been sensitive to changes in world trade patterns. The impact of the current era of globalisation has been intensified by substantial liberalisation of Australia's trade policies since the mid-1980s and by its geographic closeness to the countries in Asia which have experienced rapid economic development (Pomfret, 2014; Anderson, 2020). International trade was 26.8 per cent of GDP in Australia in 1968 but by 2009 had reached a peak of 45.8 per cent.[2]

In many developed countries, including Australia, concerns have been expressed about the impact of globalisation on domestic employment and earnings – especially in import-competing sectors and among low-skill workers. A motivation for this concern has been the simultaneous rise in manufactured imports from China and shrinking employment in manufacturing industry in those countries. Figure 1 shows that the share of imports from China in Australian aggregate consumption of manufactured goods increased from 0.7 per cent to 13.5 per cent from 1990 to 2018 (or more than thirty-fold in real USD terms). At the same time, there was a steady decrease in the share of the working-age population employed in manufacturing industry in Australia, from 9.9 to 5.7 per cent.

Our study investigates the effect of growth in manufacturing imports from China on regional labour market outcomes in Australia.[3] We focus on employment in manufacturing, and

[1] https://data.worldbank.org/indicator/TG.VAL.TOTL.GD.ZS. World trade has since declined to 44 percent of GDP in 2019.

[2] https://data.worldbank.org/indicator/NE.TRD.GNFS.ZS?locations=AU. Trade is 45.7 percent of GDP in Australia in 2019.

[3] Analysis of the effect of recent growth in international trade on labour market outcomes in Australia is limited. Most available studies examine periods that end in the late 1980s or early 1990s (for example, Borland and Foo, 1996; Fahrer and Pease, 1994; Murtough et al., 1998; Gaston, 1998; and

examine the period from 1991 to 2006, from the onset of the rise in Chinese imports to Australia to just prior to the Global Financial Crisis (GFC). To undertake the analysis, we divide Australia into 124 local labour markets, and we construct local manufacturing import exposure measures using employment and trade outcomes at the 3-digit industry level (55 manufacturing industries).

In the early stage of the current era of globalisation, in the mid-1990s, a range of studies undertook detailed analyses of the effect of growth in imports on labour market outcomes in the United States and other developed countries. Those studies almost universally concluded that any adverse effect from increased international trade was small (see, for example, Freeman, 1995; Borjas et al., 1997; Berman et al., 1998). In the past decade, a new wave of research has used the continued rise in imports to developed countries in the 1990s and 2000s to investigate the consequences for labour market outcomes. The most influential contribution has been from Autor, Dorn and Hansen (2013) – hereafter referred to as ADH (2013) – which examines the local labour market effects of growth in imports from China in the United States. The major innovation of the study is to use regional-level variation in exposure to Chinese imports to identify the causal effect of growth in imports on labour market outcomes in the US. The increase in imports from China is argued to provide an ideal natural experiment for studying the effect of a rise in international trade, being a large and unanticipated shock deriving from substantial productivity improvement in Chinese manufacturing industry following reform of the economy (Autor et al., 2016, pp.6-7).[4] In our study, we estimate models following the approach from ADH (2013), but importantly, also incorporate recent developments on estimation of models with Bartik-type instruments (including Borusyak et al., 2018; Adao et al., 2019; and Goldsmith-Pinkham et al., 2020).

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for a survey, see Borland, 1999). All these studies find a minor effect of growth in international trade on aggregate employment. However, a larger negative effect on employment is found for a subset of labour-intensive manufacturing sectors (textile, clothing and footwear; and passenger motor vehicles) where substantial decreases in trade protection were implemented in the 1980s. Studies which examine the effects of more recent growth in manufactured imports from China focus on industry-level employment – and do find evidence of a negative impact (Tuhin, 2015; Blanco et al., 2021).

[4] The other main approach to identifying the labour market effect of growth in international trade has been through episodes of trade policy liberalisation – see for example Pierce and Schott (2016) and Dix-Carneiro and Kovak (2017).

Our study provides an extra case study to the existing literature on how increased imports of manufactured goods from China affected employment – for a country where the share and structure of manufacturing employment, as well as labour market institutions, differ from countries already examined;[5] and furthermore a country where growth in imports occurred at the same time as a trade surplus with China due to the large volume of mineral exports from Australia.[6] We also take the analysis a step further by asking: Why China? Australia also experienced increased penetration of manufactured imports from other developing Asian nations during the period we consider (such as Singapore, South Korea, Taiwan, Indonesia and Thailand). We investigate whether the growth in imports of manufactured goods from other countries had the same impact as imports from China; and analyse why the impacts differed.

More generally, our study contributes to establishing the causes of the decline in manufacturing employment. In most developed countries, manufacturing industry was a major source of employment throughout much of the second half of the twentieth century; that, together with the belief that it is important for a country 'to make something', have given the industry an iconic status. A great deal of attention has therefore been devoted to understanding the reasons for its decline. The decline in manufacturing has also been of interest due to its impact on the relative demand for workers by skill level and job polarisation (see for example Charles et al., 2018a and Barany and Siegel, 2018); and because the uneven regional distribution of manufacturing production within countries means that it can be associated with significant adjustment issues and political impacts (see for example

[5] The ADH (2013) approach has been used to estimate the impact of growth in Chinese imports to Germany (Dauth et al., 2014), Norway (Balsvik et al., 2015) and Spain (Donoso et al., 2015).

[6] For example, the situation of manufacturing employment was very different between Australia and the United States at the time when growth in Chinese imports commenced. By the early 1990s, manufacturing employment in Australia had already been decreasing for two decades, whereas in the United States it remained steady over that period. As well, the distribution of employment by industry – and hence the potential impact of import competition – differed between the countries. For example, food processing, relatively protected from trade with China, accounted for 18.4 per cent of manufacturing employment in Australia but only 8.1 per cent in the United States; whereas the trade-exposed industries of electronic and computer equipment and electric machinery were 14.4 per cent of manufacturing employment in the United States compared to 6.1 per cent in Australia

Autor et al., 2020). The decrease in manufacturing employment has been found to have consequences for social outcomes including health and marriage rates (see Charles et al., 2018b, Autor et al., 2019; and for a survey see Autor et al., 2016).

We find that for Australia, an increase in a local labour market's exposure to Chinese imports by US$1,000 per worker decreased the share of that area's working age population employed in manufacturing industry by on average 0.8 of a percentage point over the period from 1991 to 2006. Our estimates imply that the import shock reduced the aggregate Australian manufacturing employment/population rate by 1.6 percentage points and manufacturing employment by 221,000 workers over the same period. The estimated effect on manufacturing employment is found generally to be robust to a range of checks.

Imports from other Asian source countries were not strongly related to local manufacturing decline in Australia in 1991-2006. The contrasting finding to the impact of Chinese imports appears to be because imports from China were weighted more heavily in more labour-intensive industries and industries experiencing slower growth in local consumption (absorption).

Although there was some adjustment to the effect of Chinese imports on manufacturing employment in Australia through regional labour mobility, with no offsetting increase in local non-manufacturing employment, more import-exposed regions experienced relatively higher rates of unemployment and lower labour force participation. For an average region, the proportion of the working age-population who were unemployed was higher by 0.9 of a percentage point for every US$1,000 increase in Chinese imports per worker. We also find evidence of increases in part-time work and reductions in full-time employee income in labour markets more exposed to Chinese imports.

The rest of the paper is organised as follows. Section 2 presents the empirical methodology used. Section 3 describes the data sources and construction of main variables. Section 4 presents descriptive information on changes in imports from China and in manufacturing employment in Australia by local labour market region. Section 5 reports the main results from the empirical analysis of the effect of increases in imports from China on manufacturing employment in Australia. We compare the effects and characteristics of imports from China with those from other developing Asia in section 6. Sections 7 and 8 present extensions and robustness analysis of the results on the impact on manufacturing employment. Section 9 reports results on how increases in imports from China has affected other labour market outcomes such as employment in non-manufacturing industry, labour force participation, unemployment, part-time work prevalence and employee incomes. Section 10 undertakes a comparative analysis of the findings from this study with existing research for other countries. Section 11 concludes.

2. Methodology

Our basic approach to estimate the localised effect of Chinese imports on manufacturing employment in Australia follows ADH (2013). The main equation is:

$$\Delta L_{it} = \gamma_t + \beta_1 \Delta IPW_{ait} + \beta_2 X_{it} + \varepsilon_{it} \qquad (1)$$

where ΔL_{it} is the change between periods *t* and (*t+1*) in the share of the working-age population in region *i* employed in manufacturing industry; ΔIPW_{ait} is the change in exposure of employment in region *i* to imports from China between periods *t* and (*t+1*); γ_t is an indicator for the interval from period *t* to period (*t+1*); and X_{it} is a vector of region controls which may also affect manufacturing employment changes.

The change in exposure of employment in a region to imports from China is specified as:

$$\Delta IPW_{ait} = \sum_j (L_{ijt} / L_{it})(\Delta M_{acjt} / L_{ajt}) \qquad (2)$$

where L_{ijt}/L_{it} is the share of employment in region *i* working in industry *j* at time *t*; ΔM_{acjt} is the change in the value of imports in industry *j* to Australia from China between periods *t* and *(t+1*); and L_{ajt} is total Australian employment in industry *j* at time *t*. ΔIPW_{ait} can be interpreted as the change in the value of Chinese imports per worker to a region, where increases in imports are apportioned to regions based on the local industry structure of employment.

The key coefficient of interest in equation (1) is β_1. It can be interpreted as the effect on the share of a region's working-age population employed in manufacturing industry that results from a US$1,000 per worker increase in the region's exposure to imports from China.

Variation in ΔIPW_{ait} derives from two main sources. First, differences between regions in the share of employment accounted for by manufacturing industry will cause the change in manufacturing imports per worker to vary by region. Second, where growth in Chinese imports is not uniform between sectors within manufacturing industry and sector-level employment is not evenly distributed by region, those intra-industry differences can be a further source of variation in the change in manufacturing imports per worker by region. The relative importance of the two sources can be established by examining how much of the variation in ΔIPW_{ait} is explained by variation in the regional-level share of manufacturing industry in total employment. In a bivariate regression, start-of-period manufacturing employment shares explain only 34 percent of the variation in ΔIPW_{ait} across our local labour markets. In our preferred specification of equation (1), we control for the local start-of-period manufacturing share. The focus of our analysis is therefore on the effect of variation in exposure to Chinese imports stemming from regional differences in the intra-industry composition of manufacturing employment.[7]

A major issue in estimating (1) is that an OLS estimate of the effect of ΔIPW_{ait} on manufacturing employment, β_1, may be biased. The main reasons for growth in imports from China to Australia are likely to have been productivity shocks which in turn lowered prices, and the re-integration of China into the global economy. However, a further possible source is increased demand by Australian consumers whose incomes have increased. In that case, imports to Australia from China would be positively correlated with industry demand shocks, imparting an upward bias to β_1 (Autor et al., 2016, p.17). In addition, supply disruptions in Australia may both lower domestic employment and increase imports from China or elsewhere.

To identify the effect on labour market outcomes of the supply-driven component of the increase in Chinese imports to Australia, ΔIPW_{ait} in (1) is instrumented with ΔIPW_{oit}, which is constructed using changes in Chinese imports to eight other high-income countries:

$$\Delta IPW_{oit} = \sum_j (L_{ijt-1} / L_{it-1})(\Delta M_{ocjt} / L_{ajt-1}) \quad (3)$$

The other high-income countries we use to construct ΔIPW_{oit} are: Denmark, Finland, Germany, Japan, New Zealand, Spain, Switzerland and the United States.[8] Employment outcomes from period (*t-1*) are used to mitigate potential simultaneity bias.

The motivation for this approach is that the rise in manufacturing productivity in China caused increased import penetration to all high-income countries, and therefore using import

[7] This regression is estimated using 124 regions from 1991 to 2006. We describe how we form these regions below.

[8] The choice of high-income countries to create the instrument follows ADH (2013), except that we substitute the United States for Australia.

flows from China to those other countries as an instrument should identify just the effect of increasing Chinese competitiveness on labour market outcomes. For this to hold it is necessary that the increase in Chinese competitiveness has indeed created similar bundles of imports to other high-income countries as Australia, while the increase in imports to the other high-income countries is uncorrelated with shocks to regional-level labour demand in Australia.

Equation (1) is estimated for three five-year intervals, 1991-1996, 1996-2001 and 2001-2006, as a stacked model. The start of the estimation period was chosen to coincide with the rise in Chinese imports to Australia. We end the estimation period in 2006 because the instrument is likely to have its validity undermined after that time. The GFC caused correlated negative demand shocks across high-income countries that in turn contributed to the collapse in global trade in the late 2000s, but Australia was largely immune from this reversal. In 2001-06 the annualised growth in manufacturing imports from China to Australia and from China to our eight instrument countries (in real US dollars) were respectively 44 and 31 per cent; whereas in 2006-11 those rates were 19 and 7 per cent.[9]

Our preferred model specification includes several region-level variables that may affect changes in manufacturing employment: (i) the initial share of employment in manufacturing industry; (ii) the share of employment in routine occupations; and (iii) an index measuring potential offshoring of occupations. The share of employment in routine occupations is intended to capture the effect of technological change, especially computerisation and robotics, on labour demand. The measure of the offshorable potential of occupations captures an alternative dimension of globalisation: the scope for tasks to be removed from a workplace to a different geographic location.

For (ii), routine occupations are defined as those in the top third (employment weighted) for routine task intensity in Australia in 1986 (see Autor and Dorn, 2013; and Coelli and Borland, 2016). For (iii), the measure of potential offshoring of occupations is also defined in Autor and Dorn (2013) and is based on two measures employed by Firpo et al. (2011).

In ADH (2013) and subsequent studies, it has become standard to include three additional regional-level covariates: (iv) the share of the population with a post-school qualification; (v) the share of the population foreign-born; and (vi) the share of working-age females

[9] For 1991-96 those rates were respectively 23 and 28 per cent, and for 1996-2001 were 13 and 11 per cent.

employed. We also include the three additional covariates in our main specifications. In support of (iv), Eriksson et al. (2019) find the resilience of local labour markets to manufacturing shocks (such as the rise of China) depends on local industries' phase in the product cycle and on local education levels. Cadena and Kovak (2016) find that there is greater mobility among immigrants than the native-born population (especially low-skill workers) in response to adverse labour market shocks, motivating (v). As justification for (vi), labour market responses to shocks may also be a function of the labour force participation of females, who have historically been less attached to the labour market (Gregory, 1991). Observations are weighted using each region's share of national working-age population during estimation. Robust standard errors clustered by local labour market region are reported. In our robustness exercises, we also construct standard errors allowing for arbitrary correlations across industries, as recommended by Adao et al (2019) and Borusyak et al. (2018) when using shift-share designs.[10]

3. Data sources and classification of labour market regions

Employment data were obtained from six five-yearly Censuses conducted from 1986 to 2011 in Australia. The industry classification used is the 3-digit level of the Australian and New Zealand Standard Industrial Classification (ANZSIC) 2006, comprising 55 manufacturing industries. Import data were obtained from the United Nations (UN) Comtrade database at the Harmonized System (HS) 6-digit level. Details of concordance of the employment and import data to ANZSIC 2006 over time are provided in the Appendix.

We constructed local labour market regions for Australia in a manner consistent with US commuting zones. The concept of commuting zones uses data on commuting flows to create regions within which most individuals both live and work. We apply data on commuting flows from place of residence to place of work at the ABS SA3 level from the 2011 Australian Census. Areas defined at the ABS's Statistical Area 3 (SA3) level are aggregated to commuting zone regions using the *flowbca* algorithm (Meekes and Hassink, 2018a, 2018b). The algorithm iteratively aggregates a set of disjoint units based on flows between

[10] Given the small number of states and territories in Australia (8), we chose not to cluster standard errors at this very aggregated level. Standard errors are biased down with few clusters. If we did cluster at this level, estimated standard errors were smaller, not larger, than our preferred estimates. We use the method of Borusyak et al. (2018) to construct standard errors that are asymptotically equivalent to those proposed by Adao et al. (2019).

those units. Each stage of aggregation involves two units being merged into a single unit, with the choice of which units to merge at each step depending on the extent of flows between units. A stopping criterion determines when the process of aggregation is terminated.

Our application of this approach yielded 124 clusters (local labour markets) for Australia.[11] Our regions have a minimum containment of 57 per cent, a raw average containment of 89 per cent and a weighted average (or population) containment of 95 per cent. That is, for the 124 regions used in this study, 95 per cent of workers in Australia live and work within the same region.[12]

4. Descriptive information

Growth in imports of manufactured goods from China to Australia between 1990 and 2018 is illustrated in Figure 1. For the period that is the focus of this study, 1991 to 2006, the share of imports from China in consumption of manufactured goods in Australia increased from 0.9 per cent to 6.1 per cent. Further detailed information on the composition of imports from China is presented in Table 1. The 2-digit manufacturing sectors where the largest increases in imports occurred are: machinery and equipment; textile, leather, clothing and footwear; and furniture and other manufacturing.

Changes in the exposure of local labour market regions in Australia to manufactured imports from China are described Table 2 and Figure 2. Table 2 shows changes in imports per worker for selected percentiles in the distribution of changes by region over 1991-2006 and for the three 5-year Census intervals. Figure 2 shows changes in exposure to imports from China per worker at the local labour market level from 1991 to 2006.

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[11] We used bilateral flows of workers from place of residence to place of work between SA3 regions expressed relative to total flows from each region (including internal flows). The stopping criterion we used was minimum containment of 50 percent. This rule was chosen so that the regions we construct for Australia have containment measures close to those of the 2000 US commuting zones. Other studies such as Manning and Petrongolo (2017) and Meekes and Hassink (2018b) allow local labour markets to vary between workers with different characteristics such as gender and education attainment.

[12] These containment measures are close to those reported in Fowler et al. (2018) for the 2000 US commuting zones (62 per cent, 88 per cent and 93 per cent for minimum, average and population containment respectively).

Four main features are evident. First, the increase in exposure to imports is large in magnitude, increasing by US$2,874 per worker from 1991 to 2006 in the median region. Second, growth in exposure to Chinese imports accelerated considerably after China's accession to the World Trade Organisation (WTO) in 2001. Third, there is high dispersion between regions in changes in import exposure. Growth in the region at the 90th percentile of the distribution of changes is consistently four to six times higher than in the region at the 10th percentile. Fourth, the largest increases in exposure to Chinese imports occurred in metropolitan regions in Victoria (VIC), South Australia (SA) and New South Wales (NSW), and in specific regional areas in VIC and NSW.

Figure 3 shows changes in the share of the working-age population in manufacturing industry from 1991 to 2006 at the regional level. It allows a preliminary perspective on the relation between changes in imports from China and local employment in manufacturing industry in Australia. Some regions that have experienced the largest declines in manufacturing employment also had the largest increases in imports from China, for example, metropolitan regions in Victoria and NSW. However, other regions with relatively large decreases in manufacturing employment were not the regions with the highest growth in exposure to Chinese imports. This is the case in Northern Territory (NT), and areas of SA, Western Australia (WA) and Queensland (QLD).

The extent of correlation between growth in imports from China and regional-level changes to manufacturing employment is illustrated more directly in Panel A of Figure 4. It shows predicted changes in exposure to imports from China for each local labour market[13] plotted together with the corresponding changes in the share of the working-age population employed in manufacturing industry for 1991 to 2006. The results from an OLS regression show there is a significant inverse relation between the series, with a US$1,000 increase in predicted Chinese imports per worker related to a 0.755 percentage point decrease in the share of a region's workforce-age population employed in manufacturing industry.

Panel B of Figure 4 shows the strong relation between Chinese imports to Australia and Chinese imports to the eight high-income countries we employ when constructing our instrument for import exposure. This highlights that our instrument is highly relevant in explaining Chinese import exposure in Australia at the regional level.

[13] These predictions are based on Chinese imports at the 3-digit industry level to the set of eight developed countries that we use as instruments in the analysis.

5. Impact on manufacturing employment - main results

Results from the main two-stage least squares (2SLS) analysis of the impact of Chinese imports on manufacturing employment in local labour markets in Australia are reported in Table 3. Each model includes different sets of additional covariates. The first model (column 1) only includes time indicators, the second model (column 2) adds the start-of-period share of manufacturing employment, while the third model (column 3) also adds state fixed effects. The fourth model (column 4) adds the variables for the share of jobs that are highly routine and the index reflecting the potential for occupations to be offshorable. The fifth model (column 5) adds the three extra covariates also included in previous studies. Coefficient estimates on the instrumental variable, an F-test of the statistical significance of the instrument and the partial R-squared from the first-stage models are also reported.[14]

The estimated negative impact of increases in Chinese imports to Australia on the share of manufacturing employment in local labour markets is large and precisely estimated. In the model with no extra covariates, on average a US$1,000 increase in Chinese imports per worker to a region over a 5-year period causes a 1.1 percentage point decrease in the share of the working-age population employed in manufacturing industry. The estimated impact decreases marginally as additional covariates are added but remains precisely estimated. In the final model with all covariates, the estimated impact is -0.83 of a percentage point (p-value < 0.001). For all models, the results from the first stage show that the instrument is highly predictive.

The large size of the estimated impact of a US$1,000 per worker increase in Chinese imports, together with the extent of variation between regions in growth in exposure to Chinese imports, imply substantial dispersion in the impact on manufacturing employment between local labour markets. For example, over the entire sample period from 1991 to 2006, a local labour market at the 90th percentile in the distribution of increases in Chinese imports per worker has a predicted decrease in the manufacturing employment/population rate of 2.5 percentage points; while a local labour market at the 10th percentile has a predicted decrease of only 0.6 of a percentage point.

Aggregated across all regions, our estimates imply an overall reduction in the Australian manufacturing employment/population rate of 1.6 percentage points or 221,000

[14] Summary statistics for the variables we include in our estimated models are provided in Appendix Table A1.

manufacturing workers.[15] This compares to the observed decline in the manufacturing employment/population rate over the 1991 to 2006 period of 1.5 percentage points (see Appendix Table A1). Note however that the estimates cannot be regarded as necessarily equal to the overall effect of Chinese imports on manufacturing employment in Australia. Identification of employment effects is from inter-regional differences in changes to import exposure, and hence cannot capture effects that are common to all regions.

Estimates of the impact of increases in Chinese imports for disaggregated population groups are presented in Table 4. The impact of increased Chinese imports has been slightly more negative for workers whose highest qualification is a diploma or certificate or who do not have a post-school qualification than for workers with a bachelors' degree or higher.[16] The population share of working-age males employed in manufacturing industry is more negatively affected by Chinese imports than for females, although both effects are precisely estimated (p-values < 0.001).[17]

6. China or developing Asia more generally?

While growth in Australian imports of manufactured goods from China since 1991 has been remarkable, growth in imports from other Asian neighbours has also been sizable. In Figure 5, we present trends in manufactured good import penetration from several countries and country groups covering all of Australia's imports. The rise in import penetration from China stands out. Over the period we examine – 1991 to 2006 – Chinese import penetration rose from 0.8% to 6.1%. However, among four Asian Newly Industrialising Nations (NICs: Indonesia, Malaysia, the Philippines and Thailand), import penetration also rose strongly, from 0.8% to 3.2%. It also rose from 2.5% to 5.4% among the Asian "Tigers" (Hong Kong, Singapore, South Korea and Taiwan). Import penetration from the large group of Low-

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[15] To calculate these implied aggregate effects, we first multiply our coefficient of -0.831 by the first-stage partial R-squared value of 0.829 then multiply that by each local labour market's measured change in Chinese import exposure over the period. These are aggregated using end of period working-age population shares / levels.

[16] This difference in effects, however, is not statistically significant.

[17] The more negative impact on males seems likely explained by a larger share of the male than female population working in manufacturing. An equal proportionate decrease in employment of both groups would therefore cause a larger decrease in the population share of males working in manufacturing.

Income Countries[18] has increased recently, but the rise from 1991 to 2006 was quite modest (0.2% to 0.6%).

We now investigate whether local exposure to increased imports from these Asian neighbours also led to reductions in manufacturing employment over the 1991 to 2006 period. We construct import exposure measures using an appropriately modified version of equation (2) and again instrument using imports to our group of eight developed countries.

The results of IV regressions including the extra exposure measures are provided in Table 5. Adding exposure to the large group of low-income countries in column (1) does not change the estimated effect of Chinese imports much. The coefficient on exposure to low-income country imports is very large, -2.4, but is imprecisely estimated.[19] An OLS regression of the same model yielded a coefficient on exposure to low-income country imports of +1.74 (s.e. = 0.982).[20]

In column (2) of Table 5 we add exposure to imports from the Asian NICs to the base model. The coefficient on Chinese import exposure becomes slightly more negative but is less precisely estimated. The coefficient on NIC import exposure is a noisy positive. Exposure to imports from China and the Asian NICs were quite highly correlated at the local labour market level (correlation coefficient of 0.86), making it difficult to identify separate effects precisely.

In column (3) we add exposure to imports from the Asian Tigers to the base model. In this case, the coefficient on Chinese import exposure remains negative and precisely estimated but is of smaller magnitude. The coefficient on Asian Tiger import exposure is a small noisily estimated negative. In column (4), we include combined import exposure from the Asian NICs and Tigers. The coefficient on Chinese exposure again remains a precisely estimated negative while exposure to imports from these other main Asian sources is unrelated to

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[18] This low-income country group comprises all countries (except China) defined as low income in 1989 by the World Bank and is the same group of low-income countries analysed by ADH (2013). It includes several large Asian neighbours: India, Viet Nam, Sri Lanka, Pakistan and Bangladesh.

[19] This is due to the first-stage model for this exposure being on the borderline of weakness. The relationship between LIC imports to our eight developed countries and LIC imports to Australia was positive but not strong, with a first-stage Kleibergen-Paap F-statistic of only 3.86.

[20] The OLS coefficient on Chinese import exposure changes was a significant -0.831 (s.e. = 0.128).

changes in manufacturing employment in Australia at the local level. Adding imports from the LICs to the "other Asia" exposure measure (column (5)) does not alter this finding.

Why did increased local exposure to imports from China result in manufacturing job losses but exposure to imports from the Asian Tigers and NICs did not? In Figure 6, we plot changes in imports at the industry level from China and from these other major Asian source countries against industry changes in (log) employment in Australia over the 1991 to 2006. Panel A includes 54 3-digit industries with positive imports while Panel B excludes Petroleum and Coal Products. This industry is at the far right of the figure in Panel A and reflects large imports of petroleum products, mainly from Singapore. Figure 6 reveals a negative relation between increased imports from China and changes in employment by industry in Australia. The relation with import changes from the Asian Tiger and NIC countries, however, appears positive. These relations are clearer once petroleum products are excluded in Panel B. An OLS regression confirms this, with the coefficient on Chinese imports equal to -0.0049 (s.e. = 0.0013) and the coefficient on imports from the Asian Tigers and NICs equal to +0.0050 (s.e. = 0.0012).[21]

What is specific about the manufactured product imports from China that explains why those imports have led to reductions in manufacturing employment in Australia? To provide structure to our investigation, we employ a simple deconstruction of industry-level employment as follows:

$$L_{jt} = \frac{1}{\alpha_{jt}} DP_{jt} = \frac{1}{\alpha_{jt}} \left[A_{jt} - I_{jt} + E_{jt}\right] \tag{4}$$

In Equation (4), L_{jt} is employment in industry *j* at time *t* while DP_{jt} is domestic (Australian) production of industry *j* output in period *t*. The term α_{jt} simply denotes domestic production per worker, reflecting Australian labour productivity in industry *j* in period *t*. Domestic production DP_{jt} in turn equals absorption A_{jt} in Australia of output of industry *j* in time *t*, minus imports I_{jt} plus exports E_{jt}. This absorption is the "use" of product within Australia as inputs into other industries and as final consumption by households or government.

From Equation (4) we derive the following:

[21] This regression excludes the Petroleum and Coal Products industry and weights industries using 1991 Australian employment.

$$\frac{\Delta L_j}{L_{j0}} = \frac{1}{\alpha_{j0}}\left[\frac{\Delta A_j}{L_{j0}} - \frac{\Delta I_j}{L_{j0}} + \frac{\Delta E_j}{L_{j0}}\right] + \left(\frac{1}{\alpha_{j1}} - \frac{1}{\alpha_{j0}}\right)\frac{DP_{j1}}{L_{j0}} \quad (5)$$

In Equation (5), Δ indicates the change in the associated variable in industry *j* from period 0 to period 1, for example, $\Delta L_j = L_{j1} - L_{jo}$ The proportional change in employment in industry *j* from period 0 to period 1 can thus be broken down into four components scaled by initial industry employment L_{j0}. The first three components are the change in absorption minus the change in imports plus the change in exports, all multiplied by the inverse of initial labour productivity α_{j0}. The final "residual" term denotes changes over the period in labour productivity, appropriately scaled.

Based on Equation (5), we explore three potential explanations as to why imports from China had a negative effect on Australian manufacturing employment while imports from other major Asian source countries did not, by posing the following questions:

1. Were Chinese imports more heavily weighted in industries where absorption A_{jt} in Australia was growing more slowly or even falling? If so, these imports were more likely to replace domestic workers as they are not simply a response to increased local absorption.
2. Were Chinese imports predominantly in industries with low output per worker (α_{j0}), such that for the same increase in the value of imports, a larger displacement in employment in Australia would occur?
3. Were imports from the Asian Tigers and NICs replacing imports from developed countries such as Japan and the US? Such imports would then be less likely to displace Australian workers.

To investigate the first potential explanation, we plot changes in imports at the industry level from China and from the Asian Tigers and NICs against changes in Australian absorption of product by industry per worker. The Australian absorption data is sourced from input-output tables for Australia.[22] These relations are plotted in Figure 7: (i) for all industries in panel A and (ii) excluding the outlier industry of petroleum and coal product in panel B. There is a reasonably clear positive relation between changes in imports from the Asian Tigers and NICs and industry-level Australian absorption. That is, import growth from these countries

[22] Due to differences in the industry detail provided in these input-output tables over time, we combined the 55 ANZSIC 3-digit manufacturing industries into 34 consistent manufacturing sectors.

appears to be responding to increases in domestic absorption.[23] Imports from China, on the other hand, increased across all industries, including those experiencing slow growth in absorption. The correlation is -0.09 across all industries and 0.01 excluding petroleum and coal product.

In Figure 8, we plot changes in imports from China and from the Asian Tigers and NICs against initial (1991) Australian domestic output per worker. Changes in imports from China appear to be marginally more heavily weighted in low output-per-worker (high labour-intensive) industries. Excluding petroleum and coal product, the correlation is -0.15. Changes in imports from the Asian Tigers and NICs, however, are much more heavily weighted in high output-per-worker industries (correlation of 0.55, again excluding petroleum and coal products).[24] There is thus support for our second potential explanation.

Finally, in Figure 9 we investigate whether imports from China, the Asian Tigers or NICs were simply substituting for imports from developed countries. The first thing to note is that imports from developed countries generally grew in most industries. The only notable fall was in textile products, with imports from the Asian Tigers and NICs also falling, and imports from China grew only modestly. The overall correlation between growth in imports from China and from developed countries is essentially zero (0.046). There is a positive correlation between imports from developed countries and from the Asian Tigers and NICs, but this correlation is not particularly strong (0.33). Overall, there is little evidence that increased imports from either China or the Asian Tigers and NICs were simply replacing imports from developed countries. If anything, imports from the Asian Tigers and NICs were adding to increased imports from developed countries, most likely in response to increased domestic absorption for such products (see Figure 6).

To summarise, imports from China appear to have had a more negative effect on Australian manufacturing employment than imports from the Asian Tigers and NICs for two reasons. Chinese imports have been more heavily weighted in industries experiencing slower growth in domestic absorption and that are more labour-intensive. It does not appear that imports

[23] The correlation is 0.96 including all industries and 0.57 excluding petroleum and coal products.

[24] The correlations including petroleum and coal products are -0.15 and 0.94 for imports from China and from the other Asian countries respectively.

from either China or from the Asian Tigers and NICs are simply replacing imports from developed countries.[25]

7. Impact on manufacturing employment – extensions and robustness

Estimates employing alternative methods, models and samples for measuring the impact of trade with China on manufacturing employment are shown in Table 6. First, a net import exposure measure (Australian imports from China minus Australian exports to China by industry) is used to estimate the impact of growth in trade with China.[26] The overall impact of China's growing importance in international trade on manufacturing employment in Australia is likely to be a function of both the increase in imports from China and of any changes in manufacturing exports to China. While manufacturing imports from China far exceed Australian exports to China (the ratio of imports to exports within manufacturing was 5 in 1991 and 6.4 in 2006), the growth in exports, even within manufacturing (let alone mining), has been substantial over the 1991-2006 period, growing over seven-fold in real US dollar terms. In addition, this export growth is distributed across 3-digit manufacturing industries quite differently to the growth in imports, being dominated by growth in basic metals, leather and meat products, rather than by computer and electronic equipment, textiles and clothing. The effect of growth in trade on manufacturing employment at the local level using net imports is however the same as with the import-only measure.

Second, using a measure of increased exposure to Chinese imports generated from a gravity model, we find that a US$1,000 per worker increase in a region's exposure to Chinese imports (stemming from an increase in Chinese productivity or decrease in transport costs) is associated with a 0.9 percentage point decrease in the population share of manufacturing employment. Generating a measure of import exposure from a gravity model is suggested by ADH (2013, pp.2154, 2164-65) as an alternative method to identify the impact of changes to

[25] We also looked at the two remaining components of Equation (5): changes in exports and the "residual" function of changes in labour productivity. Changes in Australian manufactured good exports were uncorrelated with Chinese imports and positively correlated with imports from the Asian Tigers and NICs, likely reflecting increased global demand for those products. The labour productivity "residual" was only weakly related to imports from both sources.

[26] Following ADH (2013), we instrument for net imports using separate measures of imports to the other 8 developed countries from China per local worker (our main instrument in Table 3) and exports from the other 8 countries to China per worker.

productivity or transport costs for Chinese producers relative to Australian producers. We adapt their method to estimate a modified gravity model for the difference between exports from China and Australia to the group of eight high income countries (that were used to construct the instrumental variable) including industry and country fixed effects over our sample period. The gravity model can be used to predict the change in imports from China due to changes in relative productivity and transport costs between Australia and China. This is implemented by interacting the changes over time in the residual from the gravity model regression with industry-level imports from China to Australia.

We end our main estimation period in 2006 due to concerns that the GFC may undermine the validity of the instrument used in the 2SLS estimation. When we include the 2006 to 2011 period in model 4, the estimated impact of Chinese import exposure falls but not appreciably, and the effect remains precisely estimated. Australia significantly reduced tariffs on imported products beginning in the 1980s but also continuing into our main estimation period. Adding a control variable for changes in local tariff rate "exposure"[27] in model 5 does not affect the estimated effect of Chinese import exposure. Several of our "local" labour markets in remote parts of Australia cover extremely large areas. These are defined by just one ABS SA3, the smallest geographical unit we use in this analysis. It is unlikely that these represent truly local labour markets. Excluding the 17 largest of these (each covering more than 100,000 square kilometres) in model 6 had no effect on our main point estimate.

A recent critique of ADH (2013) is that an appropriate specification of equation (1) should include interactions of the start-of-period shares of manufacturing employment and the indicator variables for the separate time periods (Rothwell, 2017). It is suggested that including these interactions is necessary to control for the effect of unobservable shocks to manufacturing employment that could be confounded with the impact of increases to Chinese imports. For the case of Australia, we find that including these interactions (model 7) makes the estimated impact slightly more negative.

Over the period covered in this study, the share of population employed in manufacturing industry was undergoing a secular decline. Specific labour-intensive industries such as textiles, clothing and footwear may have been particularly susceptible to decline. Therefore, it is possible that the increase in imports from China was caused by that decline. To "control"

[27] Changes in tariff rate exposure were measured using the same regional industry share design used to construct changes in import exposure.

for secular declines separately by sub-industry, we replaced our measure of the overall initial share of workers in manufacturing industry in each region with separate employment shares by 2-digit manufacturing sub-sectors (15 in total) in model 8. This change resulted in the estimated effect of Chinese import exposure to become marginally more negative and more precisely estimated.

In this analysis, we measure Chinese import exposure using imports measured in US dollars rather than in Australian dollars. Our decision to do so was due to concerns regarding the large swings in the US-Australian dollar exchange rate over the period. The exchange rate remained relatively stable from 1991 to 1996 at around 77 US cents per Australian dollar, but then it fell appreciably to around 50 cents in 2001 before rising again to 74 cents in 2006.[28] We were therefore concerned that measuring Chinese imports in Australian dollars would undermine our estimation strategy. Changes in imports would reflect both volume changes (as import prices to Australia are generally based on the US dollar) and the large swings in the exchange rate.[29] The effect of measuring Chinese imports in Australian dollars (after transforming into 2006 dollars using a manufactured good import price deflator[30]) – both to Australia and to the 8 high-income countries used in the instrument – is shown in model 9 of Table 6. The estimated effect of Chinese import exposure does become less negative, but the effect remains precisely estimated. A more detailed discussion of the choice of US dollars is provided in Blanco et al. (2021).

A further approach to test the robustness of the two-stage least squares estimates is to exclude selected industries (models 10 to 12). Changes to imports of computers and construction materials may have been caused by correlated demand shocks across high-income countries; and sectors such as textile, clothing and footwear (TCF), in which China became the world's dominant producer, may exert a disproportionate influence on estimates of the impact of

[28] The rate rose even further to 107 cents in 2011 before falling back to 75 cents in 2016.

[29] The US dollar to Chinese Yuan exchange rate was much more stable over the estimation period, as the Chinese government managed the exchange rate to maintain stability and control. The official US dollar to Chinese Yuan exchange rate did increase sharply by nearly 60% in early 1994 (devaluation of the Yuan) as the Chinese government ended its dual exchange rate system, but the exchange rate has remained relatively stable at other times over the 1991 to 2006 period. The Yuan has appreciated since then in a relatively orderly manner.

[30] Changes over time in the import price deflator mirrored changes in the AUD/USD exchange rate, implying that Australia is a price-taker in international manufactured good markets.

imports on manufacturing employment. We are not able to exclude the computing sector on its own.[31] Omitting the broader computers and electronic equipment sector results in a more negative estimate of the import exposure effect.[32] Omitting either construction-related imports or TCF imports does not alter the estimated impact of Chinese imports on manufacturing employment to any notable extent.

A similar concern would arise if shocks to demand for output by manufacturing sector in Australia were correlated with those in another major high-income country used to construct the instrument. That could imply a direct relation between changes in imports from China to one or more of the instrument countries and changes to regional-level manufacturing employment in Australia. This problem is likely to be most severe for countries where consumers' preferences are most highly correlated with Australia, or where correlation in business cycles is strongest. Based on this reasoning we have tested the sensitivity of our results to excluding the US and New Zealand (NZ) from the set of instrument countries (models 13 and 14). Omitting the US causes the estimated impact of Chinese imports to decrease marginally, while omitting NZ has virtually no effect on the estimated impact.[33]

As an additional test of whether reverse causality can explain the correlation between the increase in imports from China and the decrease in manufacturing employment, we conduct a falsification test. This test involves regressing past changes in the population share of manufacturing employment on future changes in imports from China. To implement the test, we use data on the change in the manufacturing employment to population rate by region from 1986 to 1991 and on the change in exposure to imports from China from 1991 to 2006. In a model including covariates, the relation is found to be close to zero (see Appendix Table A2). This falsification test therefore establishes that decreases in regional manufacturing employment do not appear to have driven increases in Chinese imports to Australia immediately prior to the sample period.

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[31] We do not have employment data for the 4-digit Computer sector alone as it was only possible to obtain employment disaggregated to the 3-digit level when also disaggregating by SA3 region.

[32] Computers constitute approximately 21% of the increase in imports in the 3-digit Computer and Electronic Equipment sector over the 1991 to 2006 period.

[33] We also added an extra high-income country, Canada, to the group of countries from which the instrument is derived, but this also had very little effect on the estimated impact.

8. Impact on manufacturing employment – the Bartik instrument

The instrumental variable estimation technique employed here and in related papers uses what is often referred to as a shift-share or Bartik (1991) instrument. In our setting, we are combining local 3-digit manufacturing industry shares with industry-level changes in Chinese imports to predict local exposure. Shift-share instruments have received considerable attention in recent literature. Several studies have provided clarity regarding the underlying variation being used and the assumptions relied upon for identification. Goldsmith-Pinkham et al. (2018) argue that consistent estimation requires the local lagged detailed industry shares to be exogenous. Share exogeneity seems unlikely in our setting, as the prevailing local industry structure is likely to be related to changes in the local manufacturing share of employment over time. Borusyak et al. (2018), however, argue that consistency can be achieved where the industry-level changes in imports from China are numerous random shocks, even if the industry shares are not random. Our analysis relies on such an assumption.[34] Given the identification requirement for the industry-level trade shocks to be both numerous and random, we follow many of the recommendations of Borusyak et al. (2018) by providing additional details on these trade shocks and conducting several robustness checks below.

The shocks are the total real change in Chinese 3-digit industry imports to the eight instrument countries in $1,000 US divided by lagged Australian employment in those 3-digit industries. The mean trade shock is 167.4 with a standard deviation of 500.6 and an interquartile range of 1481.2. These statistics were constructed using average (across local labour markets) industry by period shares s_{jt} as weights and exclude the non-manufacturing sector (the zero-shock "industry"). On face value, there appears to be considerable variation in the shocks.

The total number of industry-by-period observations we have is 165, comprised of 55 3-digit industries by 3 periods. We calculated an "effective" sample size of 93.3, equal to the inverse

[34] We also constructed the Rotemberg weights as recommended by Goldsmith-Pinkham et al. (2018). Summary statistics and a scatter plot based on these weights are provided in Appendix Table A3 and Figure A1 respectively. These "influence" weights were closely correlated with the China import shocks (labelled "growth" in Table A3) at the industry level and less correlated with other key measures, suggesting that the shocks are driving the estimates in our setting. This keeps us comfortable with relying on the exogenous shock assumption here.

of the Herfindahl Index $HHI = 1 \,/\, \sum_{n,t} s_{nt}^2$. The largest industry-by-period share is equal to 0.022. There thus does not appear to be significant concentration of industry employment within manufacturing in Australia. This again suggests that invoking the assumption of many random shocks is justified.

We estimated the intra-class correlations (ICCs) of trade shocks within larger (fifteen 2-digit) and our more detailed 3-digit industries using a random effects model with a hierarchical structure. The estimates (robust standard errors) for the within 2-digit and within 3-digit ICCs are 0.090 (0.032) and 0.308 (0.052) respectively. This implies that there is modest within 2-digit industry correlation in the shocks in our setting. This in turn suggests that clustering at the 2-digit industry level when constructing "exposure-robust" standard errors (further described below) may be appropriate. But with just fifteen 2-digit industries, clustering at this level may yield standard errors that are too small. In practice, clustering at this higher level did yield smaller standard errors in some versions of the estimated model (see Table 7, described below).

We report the results of several of the robustness exercises recommended by Borusyak et al. (2018) in Table 7.[35] We also report standard errors using the equivalent industry-level regression method of Borusyak et al. (2018) that they call "exposure-robust" and show are asymptotically equivalent to the standard errors proposed by Adao et al (2019).[36] These standard errors are valid under arbitrary cross-regional correlation in the regression residuals due to common shocks at the industry level.

In column 1 of Table 7, we replicate estimates based on our main model from column (5) of Table 3 for comparison. The "exposure-robust" standard errors clustered at the industry level for this model are smaller than the region-clustered version we have reported thus far. This contrasts with the finding using US data (Adao et al., 2019; Borusyak et al., 2018), where the exposure-robust standard errors tend to be 10-20% larger.

In settings such as ours where the industry shares being used to construct the shift-share instrument are "incomplete" (do not sum to 1 as only manufacturing industries are included), the estimated model should include the lagged manufacturing share rather than the initial

[35] In some cases, we follow the updated version: Borusyak et al (2020).

[36] The Borusyak et al (2018) version of these standard errors are more straightforward to construct and can be better behaved in settings where industry shares are correlated across locations, as is the case in our setting.

manufacturing share included by ADH (2013). We make this change in model (2) with little effect on the main coefficient of interest or standard errors. To further isolate within-period shocks to industry imports, separate controls for lagged initial manufacturing share by period should be included. We do this in column (3), again with little effect on the main coefficient or standard errors.

Balance tests can also be constructed to further investigate whether the industry shocks can be considered random. We test whether there is any relationship between the China import shocks and the region-level controls or "confounders" in our main specification: % of workers in routine occupations, the offshorability index, % with post-secondary education, % foreign-born and % of working-age females employed. We implemented these tests by regressing each confounder on the import exposure instrument (normalised to have unit variance) and on the period-interacted lagged manufacturing shares and period indicators. In our setting, all five confounders were related to the instrument,[37] which may call into question the orthogonality of the China import shocks in Australia.

In column (4) of Table 7, we construct a sensitivity test to the inclusion of these five controls or "confounders". Their omission does result in a more negative coefficient, but the change is not excessive. The modest effect on our main estimate suggests minimal potential bias, despite evidence of correlation.

In column (5) of Table 7, we estimate a model that strips out the effect of 3 outlier industries: knitted products, computers and electronic equipment and reproduction of recorded media. These 3 industries were subject to large import shocks from China and may have undue influence on our results. Their exclusion, however, does not affect the main coefficient much, although the standard errors do become markedly larger. Finally, in column (6), we add controls for each 2-digit industry, which essentially allows for differential trends in outcomes within each of these sectors. In this case, the main coefficient becomes more negative.

To summarise, our estimates are generally robust to many alternative specifications and sensitivity analyses. One concern is that the trade shocks appear correlated with local labour market characteristics, suggesting that they are not truly random. However, a simple sensitivity test suggested that any bias in our estimates is likely to be small, and that there

[37] These results are available upon request.

remains strong evidence that imports from China have resulted in lower manufacturing employment in Australia at the local labour market level.

9. Other impacts

Differences in exposure to Chinese imports between local labour markets imply differing magnitudes of impact on manufacturing employment. This might create an incentive for regional mobility. Workers displaced from manufacturing industry in a region may move to areas where their job opportunities are better, or industries that subsequently emerge in the regions which have lost manufacturing jobs might attract new workers.

There is evidence of a negative impact of increases in imports from China on a region's aggregate working-age population relative to other regions. Table 8 reports results from two-stage least squares models which estimate the impact of changes in imports from China per worker on the log of population by region. Estimates are provided for the working-age population overall and for the working-age population disaggregated by education attainment and age.. A larger negative effect is estimated when using one of the main models recommended by Borusyak et al (2018). Using that estimate, the predicted change in population from 1991 to 2006 in a region at the 90th percentile of exposure to increased Chinese imports relative to one at the 10th percentile is lower by approximately 10 per cent.[38]

Growth in Chinese import exposure is most strongly related to decreases in a region's share of the working age population with lower levels of education attainment, especially for those whose highest qualification is a diploma or certificate. This relation may reflect differential mobility between regions. But it may also have been due to less people newly acquiring those qualifications; for example, the value of such qualifications may have fallen as manufacturing employment decreased. Increased Chinese import exposure is related to a decrease in a region's shares of the population aged 15 to 34 years and 50 to 64 years.

In regions where the share of population employed in manufacturing has declined, adjustment can also occur in other ways than population outflow: first, through an offsetting increase in the population share of employment in non-manufacturing industries; and second, a rise in the shares of population who are unemployed and/or out of the labour force.

[38] Average regional working-age population growth over the 1991 to 2006 period was approximately 20 per cent.

Table 9 reports estimates of the impact of changes in imports from China per worker on the share of a region's working-age population who are employed in manufacturing and non-manufacturing, who are unemployed, or who are out of the labour force. Note that over the 1991 to 2006 period, the mean non-manufacturing share rose by 8.1 percentage points, the unemployment share fell by 4.5 percentage points and the share not in the labour force fell by 2.1 percentage points (see Appendix Table A1). In aggregate, the shares of working age population employed in manufacturing and non-manufacturing industries both decreased in response to an increase in Chinese imports per worker. There is thus no offsetting increase in employment in non-manufacturing industries locally in response to declines in manufacturing.[39] Adjustment occurs both via higher unemployment and higher shares of the population who are out of the labour force. For example, a $1,000 increase in Chinese imports per worker causes a (relative) 1.03 percentage point increase in the share of the working-age population who are unemployed.[40]

Table 9 also reports estimated impacts on groups of workers disaggregated by education and gender. There is a much larger increase in the share of working-age males who are unemployed in response to growth in Chinese imports than among females. This seems to be explained by larger negative effects on employment of males in both manufacturing and non-manufacturing.

Impacts also differed by education attainment. For the working-age population with a bachelors' degree or above as their highest educational qualification, increases in Chinese imports caused a smaller than average negative impact on manufacturing employment plus a

[39] In Appendix Table A4, we provide estimates using alternative model specifications. Although our negative estimate on the manufacturing share is robust to these alternatives, the negative estimate on the non-manufacturing share is less robust. We are thus cautious in claiming that local exposure to Chinese imports has necessarily also lowered non-manufacturing employment.

[40] Wang et al. (2018) claims that increased exposure to Chinese imports actually led to higher local employment in the US due to increased employment in non-manufacturing downstream industries more than offsetting any negative effect on manufacturing. Their analytical method pays closer attention to the specific effects of Chinese imports on the entire supply chain and argues that lower-price Chinese imports reduced input costs for US firms spurring expansion. Our own analysis for Australia using the main Wang et al. (2018) methodology failed to find any significant positive downstream effect on non-manufacturing employment that offset the negative direct effect on manufacturing. These estimates are available upon request.

sizable offsetting positive impact on non-manufacturing employment. This group still experienced modest growth in the share of working-age population who were unemployed. By comparison, the working-age population whose highest education qualification was a diploma or certificate experienced a large negative (and significant) effect on manufacturing employment and a quite large negative (although not significant) effect on non-manufacturing employment in response to increases in Chinese imports. Hence, the increase in the share of working-age population in unemployment was much larger for this group. Among the working-age population with no post-secondary education, labour market outcomes were the most negatively affected. A negative effect on manufacturing employment was compounded by a larger negative effect on non-manufacturing employment. Both unemployment and labour force exit were markedly higher for this group in affected regions.

An explanation for these patterns by education attainment might be as follows. When manufacturing employment decreases in a region, it is mainly low-skilled workers who become unemployed and they remain living in the region. Contemporaneously, other non-manufacturing industries are then drawn into the region. These industries are likely to employ workers with higher skill levels such as Bachelors' degree graduates.

We have found evidence of considerable labour market consequences at the local labour market level from increased exposure to imports from China. Are these effects likely to add to dispersion (inequality) in labour market conditions across local labour markets in Australia? As background, the standard deviation in unemployment rates across local labour markets fell from 1.25 to 0.78 over the period, while the coefficient of variation (standard deviation divided by the mean) rose from 0.15 to 0.20. The dispersion in NILF rates rose slightly.

Figure 10 plots initial (1991) local labour market unemployment rates (Panel A) and NILF rates (Panel B) for working-age population (15 to 64 years) against changes in predicted[41] exposure to Chinese imports over the 1991 to 2006 period. A marginally negative relation is observed in Panel A, but it is far from a close relationship. If anything, increased exposure to Chinese imports worked towards narrowing differences in local unemployment rates across Australia, but any effect would have been minimal. A more significant negative relation is observed in Panel B, with the most exposed locations starting with lower NILF rates. The rise

[41] Exposure was predicted by imports to our eight developed countries using simple "first-stage" regressions over the entire 1991 to 2006 period as in Figure 4.

of China in manufacturing exports thus may have worked towards a narrowing of dispersion in NILF rates over the period even as dispersion in NILF rates increased slightly.

In Table 10, we provide estimates of the effect of increased Chinese imports on the proportion of the employed working part-time and on the log of real average income[42] of full-time employees. We provide these estimates in aggregate and broken down by gender and education attainment. In aggregate, the proportion of the employed working part-time rose in response to increases in Chinese import exposure at the local level. The effect was similar for males and females but was essentially non-existent among those with a bachelor's degree or higher. The effect was largest among those with no post-secondary education.[43]

Real average income of full-time employees (the cleanest proxy of wage rates available in the Census data) was negatively affected by increased exposure to Chinese imports at the local level, predominantly among males. These negative effects were larger among those with post-secondary education. The lack of response among those with no post-secondary education may be related to Australian wage-setting institutions which provide a floor for real wages.

10. Cross-country comparisons

How does the way that regional labour markets in Australia have adjusted to increased exposure to imports from China compare with other countries? Table 11 summarises results on patterns of adjustment for Australia and other countries for which evidence is available. Some caution is necessary in using this evidence to make comparisons, since the studies differ in their approaches. Nevertheless, several main patterns emerge. First, in all countries an increase in exposure to imports from China caused a decrease in the share of population employed in manufacturing industry. The size of the negative impact is quite strongly related

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[42] The income data we use is taken from the Australian Censuses is reported in 10-13 categories. We first calculate average income within each local labour market and demographic group using interval regressions.

[43] The estimates in Table 10 are again based on a model specification consistent with ADH (2013). Estimates based on the model recommendation of Borusyak et al. (2018) are provided in Appendix Table A5. These alternative estimates are broadly consistent with those provided in Table 10, but the standard errors are often considerably larger in size such that fewer estimates appear statistically significant.

to the extent to which a country's composition of manufacturing production by sector was correlated with the composition of growth in Chinese imports.[44] Second, impacts on non-manufacturing employment differ widely between the countries. Australia is notable for the large negative effect of Chinese imports on non-manufacturing employment[45] – which in turn is a reason for larger responses in unemployment and non-participation than in, for example, the United States. Whereas Spain, where Chinese imports had the largest negative effect on the share of population working in manufacturing, had substantial growth in non-manufacturing, sufficient to cause a decrease in unemployment.[46] Third, adjustment in wages/income seems broadly similar between the countries, with a smaller negative adjustment in Norway being the exception, but is consistent with the muted effect of exposure on employment in that country

11. Conclusion

Massive growth in imports of manufactured goods from China to Australia occurred from the early 1990s onwards. This study examines the impact of that growth on local labour market outcomes in Australia from 1991 to 2006. We find increased exposure to Chinese imports caused a relatively large negative impact on the share of the working-age population in a region employed in manufacturing industry. The adjustment to this negative impact on employment mainly came via similar increases in the shares of the population who were unemployed and out of the labour force. Differences between local labour markets in their extent of exposure to imports from China meant that the growth in imports had quite different impacts across those regions. Overall, these impacts tended to narrow the dispersion in labour market outcomes across regions.

An important aspect of this study has been the focus on manufacturing industry. This has been done to enable comparisons with other countries where there has been similar growth in

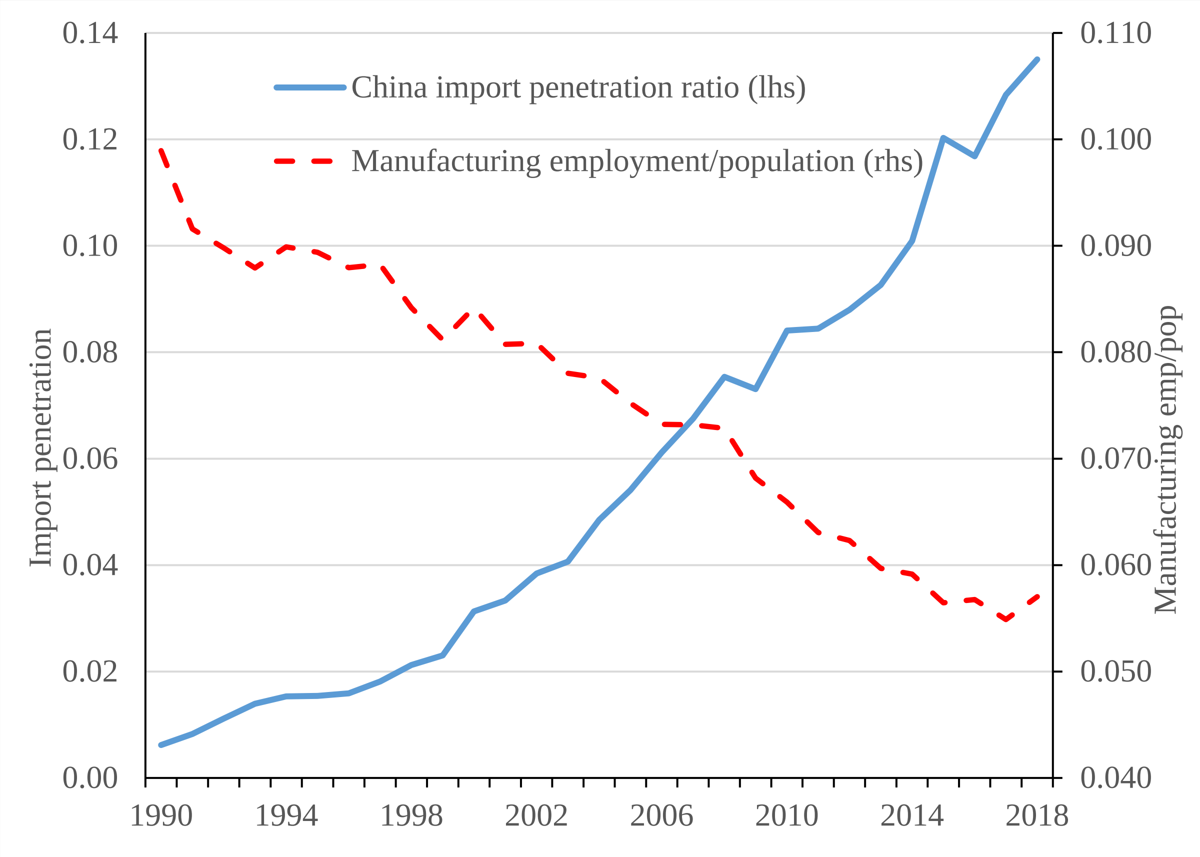
[44] The correlation between (i) the estimated effect on the share of population in manufacturing employment (Table 11) and (ii) the correlation between a country's manufacturing industry employment shares and total exports from China from 1996-2007 (Balsvik et al., 2015, Figure 2) is -0.48.

[45] Note again that this estimate is not fully robust to alternative specifications (see Appendix Table A4).

[46] Donoso et al (2015) attribute this growth in non-manufacturing employment to the construction boom in that country.

Chinese imports. For countries such as the United States, examining the impact of imports from China may be enough to tell the whole story of the consequences of trade with China. For Australia, which also had large growth in its exports to China over the same period (particularly mining exports), that is unlikely to be the case. Therefore, in other work-in-progress we are exploring in more detail how the impact of increases in imports from China on employment may have been offset by higher levels of exports from Australia to China.

Figure 1: **Manufacturing employment share and China manufacturing import penetration, Australia, 1990 to 2018**



Notes: (i) Chinese import penetration to Australia equals (Manufacturing imports to Australia from China)/(Gross manufacturing output in Australia plus imports minus exports).

Data for the denominator are from ABS, Australian National Accounts: Input-Output Tables, catalogue no.5209.0.55.001 for 1989/90, 1992/93 – 1994/95, 1996/97, 1998/99, 2001/02, 2004/05 – 2009/10 and 2012/13 – 2017/18. Missing yearly values are imputed using linear interpolation. Data for the numerator are from the UN Comtrade database https://comtrade.un.org/data/ for manufacturing commodities only).

(ii) Share of manufacturing employment in working age population (15-64): numerator from ABS, Labour Force, Australia, Detailed, Quarterly, catalogue no. 6291.0.55.003, data cube EQ12 (average over year); denominator from ABS, Australian Demographic Statistics, catalogue no. 3101.0, table 59 (June estimate).

Table 1: **Changes in imports of manufactured goods from China to Australia by 2-digit industry, 1991 to 2006** (2006 USD)

	Per working age person		Per industry employee		
Manufacturing industry	Level	Rank	Level ($000s)	Rank	Employment
Food	26.6	10	2.1	14	142,573
Beverage and tobacco	2.1	15	1.0	15	22,302
Textile, leather, clothing and footwear	305.6	2	37.9	2	89,402
Wood products	9.9	13	2.5	13	44,547
Pulp, paper and converted paper	22.2	11	10.4	7	23,706
Printing (inc. reproducing recorded media)	20.9	12	5.1	11	44,959
Petroleum and coal	2.2	14	3.6	12	6,714
Basic chemical and chemical products	59.6	6	18.4	5	35,852
Polymer and rubber products	73.6	5	19.2	4	42,610
Non-metallic mineral products	34.8	9	8.8	9	43,922
Primary metal and metal products	48.3	7	9.4	8	57,289
Fabricated metal products	83.5	4	12.3	6	75,006
Transport equipment	45.9	8	6.3	10	81,006
Machinery and equipment	726.9	1	79.8	1	101,027
Furniture and other	144.9	3	36.7	3	43,725

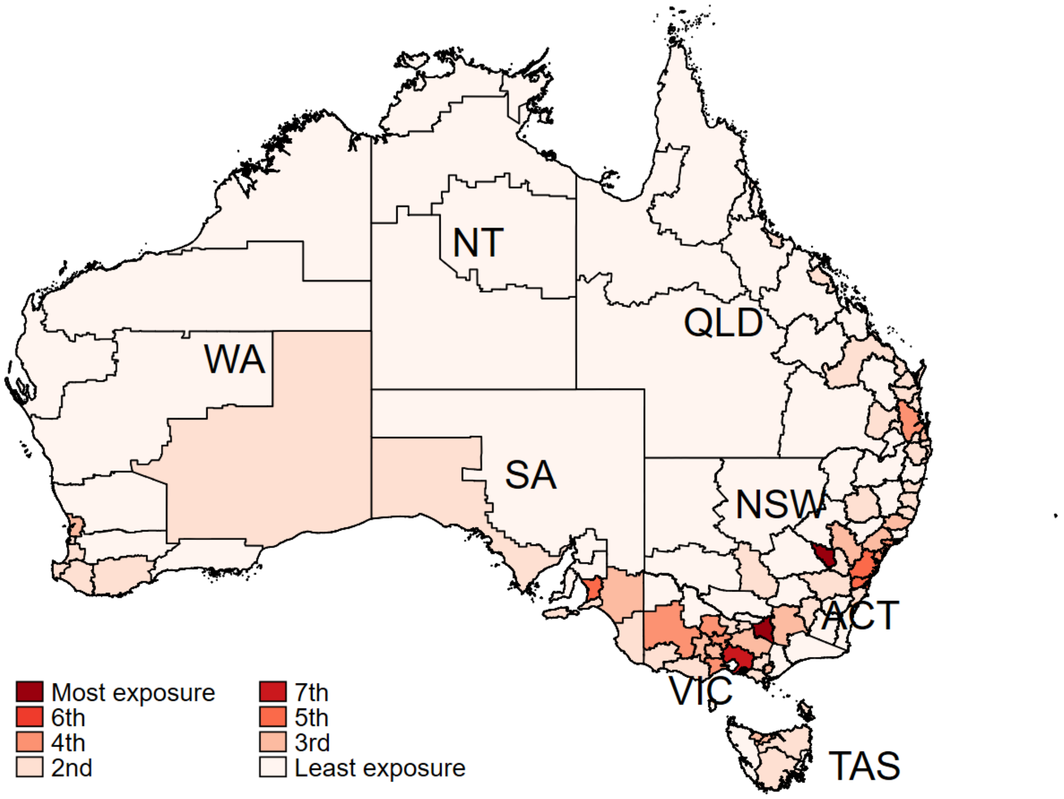
Source: Chinese imports data were taken from the UN Comtrade database (https://comtrade.un.org/) and were deflated using the US Personal Consumption Expenditure (PCE) Deflator sourced from FRED (https://fred.stlouisfed.org/). Australian employment (workers) by industry data for 1991 provided directly by the ABS (https://www.abs.gov.au/) in customised tables.

Table 2: **Changes in local labour market exposure to Chinese imports per worker** (2006 USD; '000s)

percentile	1991-1996	1996-2001	2001-2006	1991-2006
10^{th}	0.083	0.091	0.666	1.260
25^{th}	0.183	0.171	0.978	2.060
50^{th}	0.271	0.268	1.585	2.874
75^{th}	0.406	0.430	2.303	4.025
90^{th}	0.524	0.572	2.554	4.470

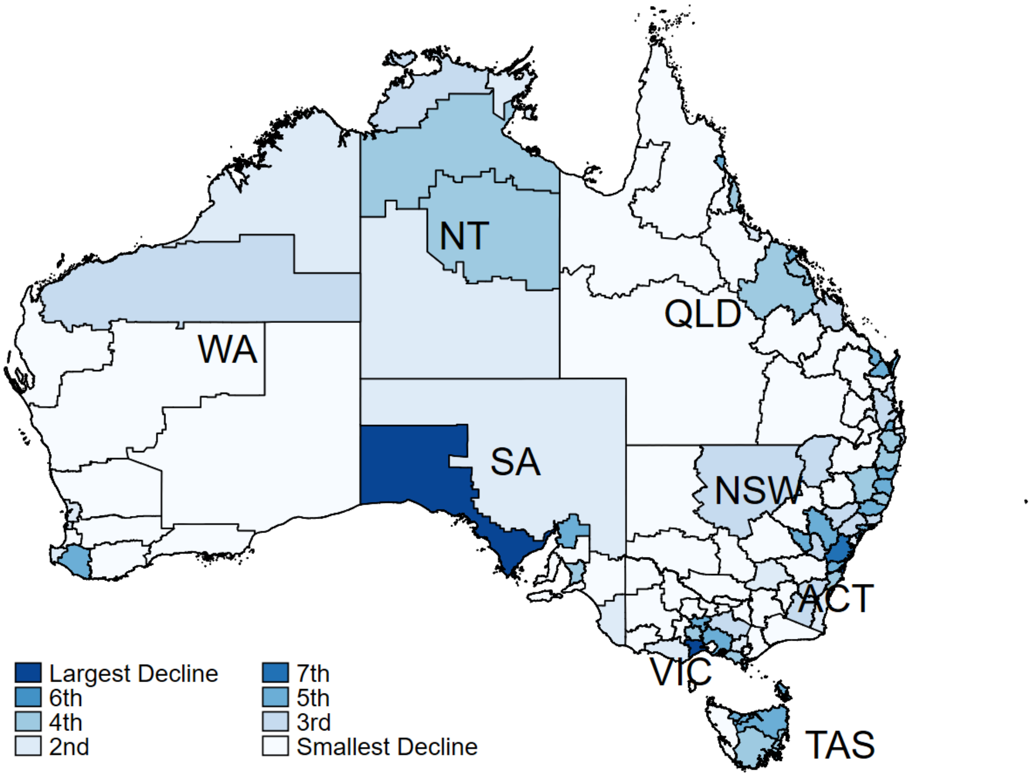
Sources: Authors' calculations using Equation (2). Employment data provided directly by the ABS in customised tables. Trade data downloaded from the UN Comtrade Database. Imports deflated using the US PCE deflator from FRED. See text for details. Local labour markets (N=124) are weighted by their start-of-period share of national working-age population.

Figure 2: **Changes in local exposure to Chinese imports per worker, 1991-2006**



Sources: Authors' calculations using equation (2), Australian Census data at the sub-regional level and commodity import data provided directly by the ABS in customised tables.

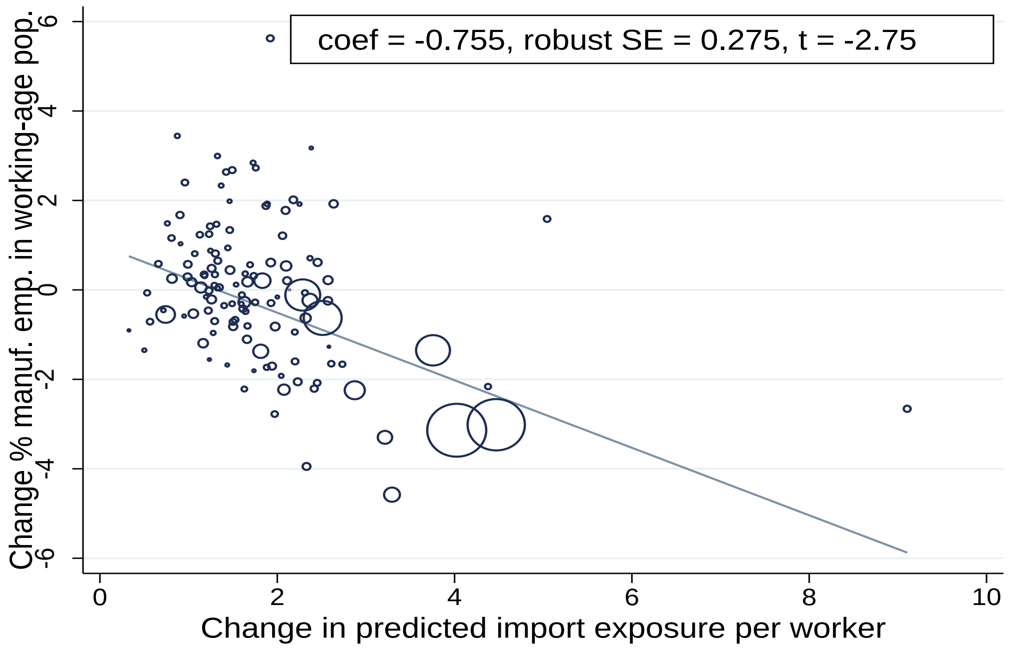
Figure 3: **Changes in local share of working-age population employed in manufacturing, 1991-2006**



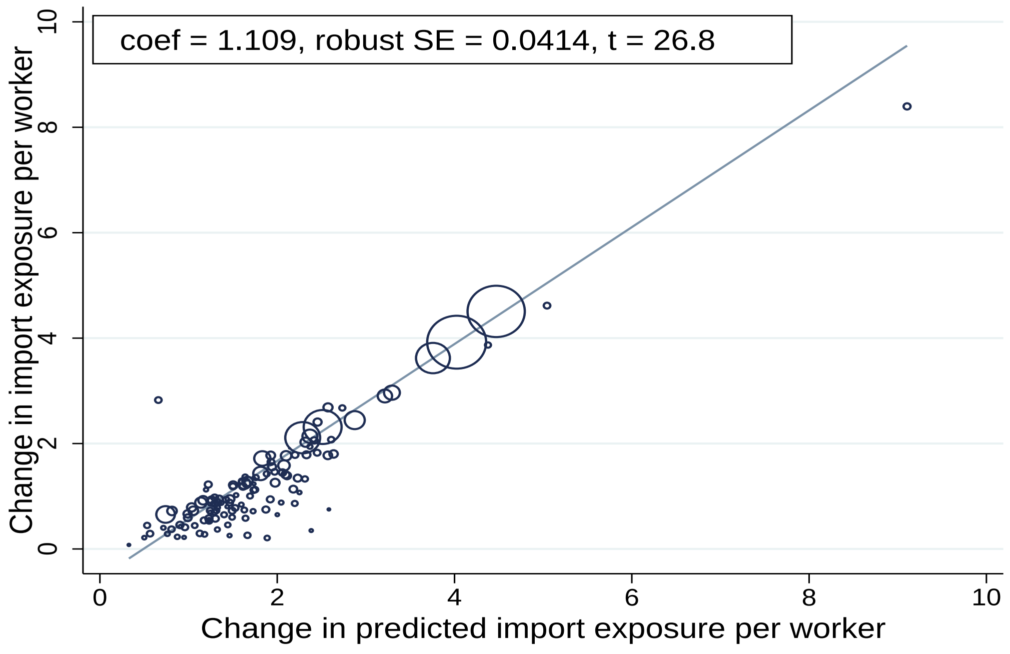
Source: Authors' calculations using Australian Census data from 1991 to 2006 provided at the sub-regional level directly by the ABS in customised tables.

Figure 4: **Changes in local import exposure per worker and manufacturing employment 1991 to 2006** (2006 USD, '000s)

Panel A: **OLS reduced form regression, full sample**



Panel B: **2SLS first stage regression, full sample**



Notes: Authors' calculations with $N = 124$ local labour markets. The estimated regression lines control for the start-of-period share of employment in manufacturing industries in the local labour market. Regression models are weighted by each local labour market's start-of-period share of national working-age population. The circle sizes represent the initial working-age population in each local labour market.

Table 3: **Relation between Chinese import exposure and manufacturing employment by local labour market, Australia, 1991 to 2006, 2SLS estimates**

Dependent variable: 5 x annual change in share of manufacturing employment in working-age population (percentage points)

	(1)	(2)	(3)	(4)	(5)
Change in Chinese imports to Australia per worker (US$1,000, 2006)	-1.131*** (0.080)	-0.980*** (0.126)	-0.907*** (0.107)	-0.860*** (0.117)	-0.831*** (0.128)
Percentage of employment in manufacturing		-0.028** (0.015)	-0.057*** (0.016)	-0.066*** (0.020)	-0.059*** (0.020)
Percentage of employment in routine occupations				0.057* (0.031)	0.029 (0.041)
Average offshorability index of occupations				-0.047 (0.052)	0.122 (0.133)
Percentage of population with post-secondary education					-0.022 (0.027)
Percentage of population foreign-born					-0.012 (0.008)
Percentage of working age females employed					0.013 (0.013)
State fixed effects	No	No	Yes	Yes	Yes
First-stage regression					
Change in Chinese imports to other high-income countries per worker	0.0316*** (0.0019)	0.0316*** (0.0026)	0.0319*** (0.0029)	0.0302*** (0.0041)	0.0301*** (0.0042)
F-statistic	280.3	143.8	118.7	54.0	52.4
Partial R-squared	0.923	0.888	0.881	0.833	0.829

Notes: All regressions include a constant term and period indicators. Robust standard errors clustered at the local labour market level are provided in parentheses. Observations are weighted by a local labour market's start-of-period share of national working-age population. Number of observations is 372 (124 local labour markets by 3 time periods). *, ** and *** denote statistical significance at the 10%, 5% and 1% levels respectively.

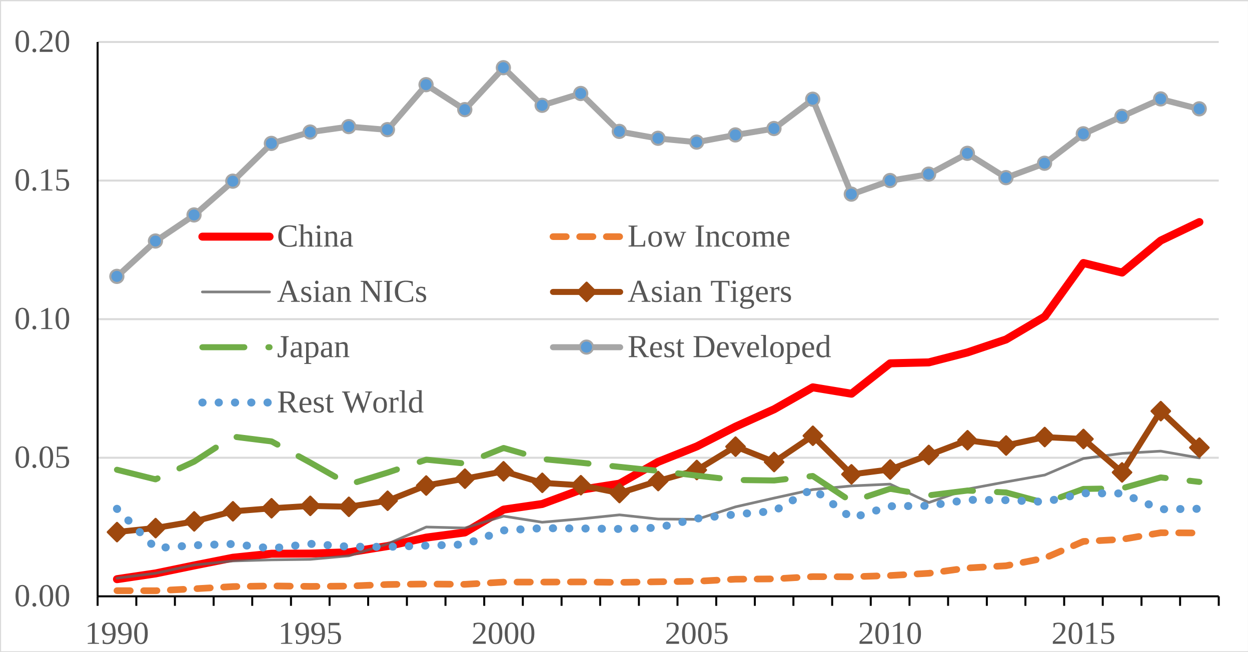
Table 4: **Breakdown of relation between Chinese import exposure and manufacturing employment by local labour market: Education and Gender, Australia, 1991 to 2006, 2SLS estimates**

Dependent variable: 5 x annual change in share of manufacturing employment in working age population (percentage points)

Model	Population	Change in Chinese imports to Australia per worker (US$1,000, 2006)	Obs.
1	All	-0.831*** (0.128)	372
2	Bachelors' degree or higher	-0.648*** (0.147)	372
3	Diploma or certificate	-0.834*** (0.309)	372
4	No post-school qualification	-0.798*** (0.126)	372
5	Males	-1.199*** (0.236)	372
6	Females	-0.483*** (0.066)	372

Notes: All estimated models include the vector of covariates from column (5) in Table 3. Robust standard errors clustered at the local labour market level are provided in parentheses. Observations are weighted by a local labour market's start-of-period share of national working-age population. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels respectively.

Figure 5: **Manufactured Good Import Penetration to Australia by Country Group**



Notes: See Figure one for details of how import penetration is constructed.

Low Income: Afghanistan, Albania, Angola, Armenia, Azerbaijan, Bangladesh, Benin, Bhutan, Burkina Faso, Burundi, Burma, Cambodia, Central African Republic, Chad, China, Comoros, Republic of the Congo, Equatorial Guinea, Eritrea, Ethiopia, Gambia, Georgia, Ghana, Guinea, Guinea-Bissau, Guyana, Haiti, India, Kenya, Laos, Lesotho, Madagascar, Maldives, Mali, Malawi, Mauritania, Moldova, Mozambique, Nepal, Niger, Pakistan, Rwanda, Saint Vincent and the Grenadines, Samoa, Sao Tome and Principe, Sierra Leone, Somalia, Sri Lanka, Sudan, Togo, Uganda, Vietnam and Yemen.

Asian NICs: Indonesia, Malaysia, the Philippines and Thailand.

Asian Tigers: Hong Kong, Singapore, South Korea and Taiwan.

Rest Developed: All original OECD members except Japan and Australia.

Rest World: All other countries covered by the UN Comtrade data.

Table 5: **Relation between Asian and LIC import exposure and manufacturing employment by local labour market, Australia, 1991 to 2006**

Dependent variable: 5 x annual change in shares of working age population by labour force status (percentage points)

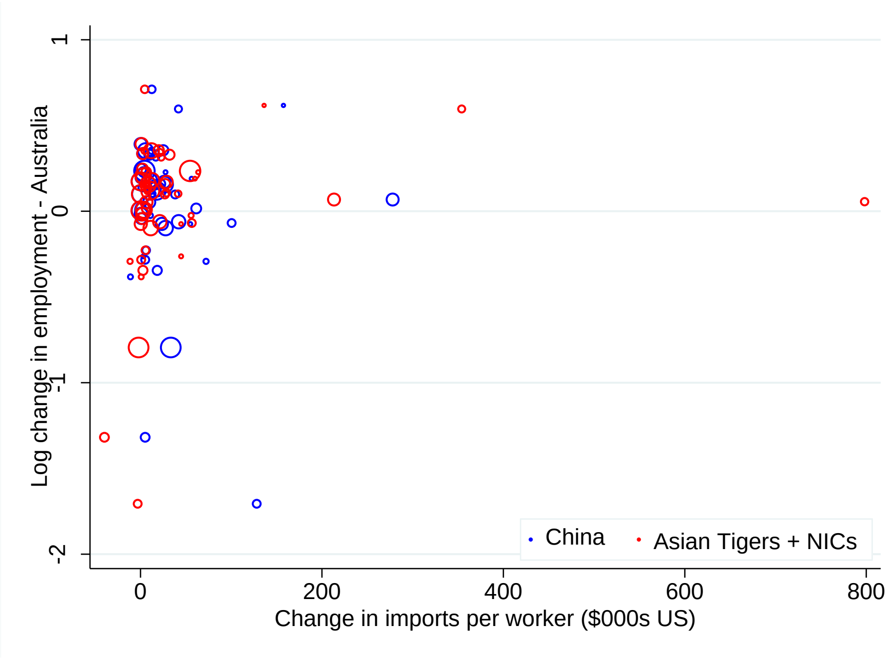
Explanatory variable: Change in imports from country / country group to Australia per worker (US$1,000, 2006)

Import exposure	(1)	(2)	(3)	(4)	(5)
China	-0.764*** (0.137)	-0.929** (0.460)	-0.765*** (0.178)	-0.789*** (0.222)	-0.789*** (0.224)
Other low-income Countries (LICs)	-2.418 (6.852)				
Asian NICs		0.365 (1.598)			
Asian Tigers			-0.155 (0.316)		
Asian NICs + Tigers				-0.062 (0.267)	
Asian NICs + Tigers + LICs					-0.059 (0.260)

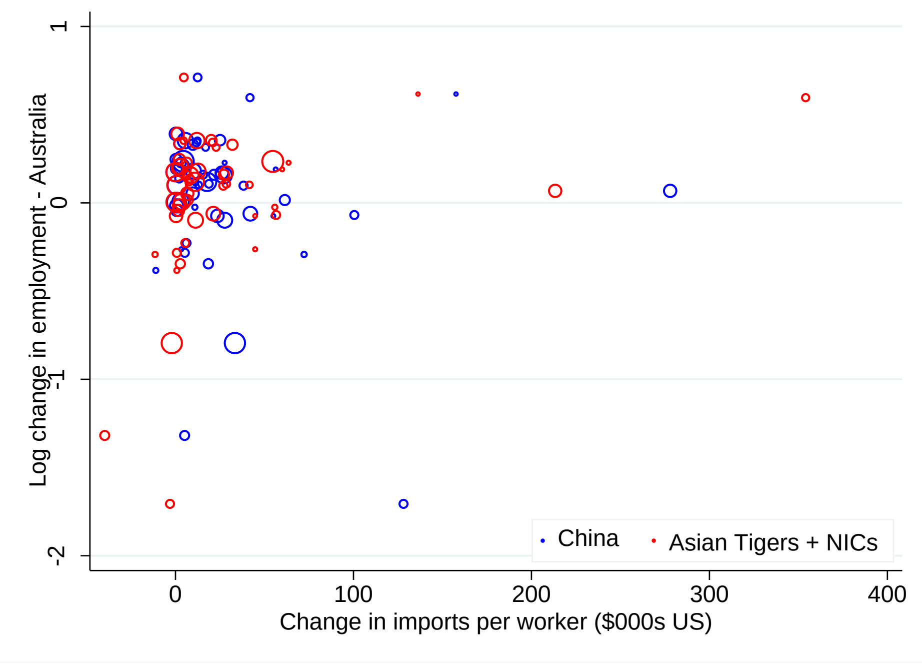
Notes: All regressions include the vector of covariates from column (5) in Table 3. Robust standard errors clustered at the local labour market level are provided in parentheses. Observations are weighted by each local labour market's start-of-period share of national population. N = 372 for all regressions. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels respectively.

Figure 6: **Industry-level Import Penetration and Changes in Employment, 1991-2006**

Panel A: All industries



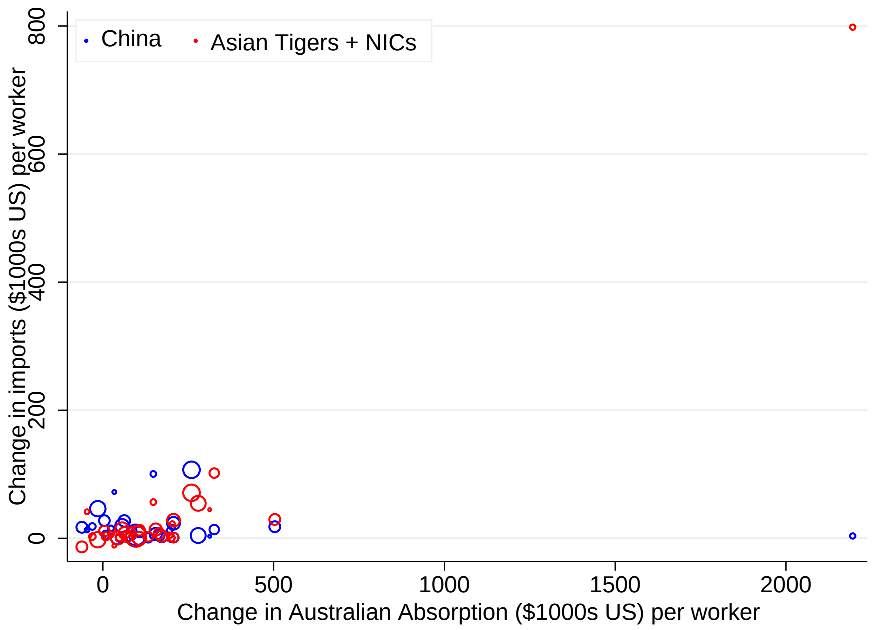
Panel B: Excluding petroleum and coal product



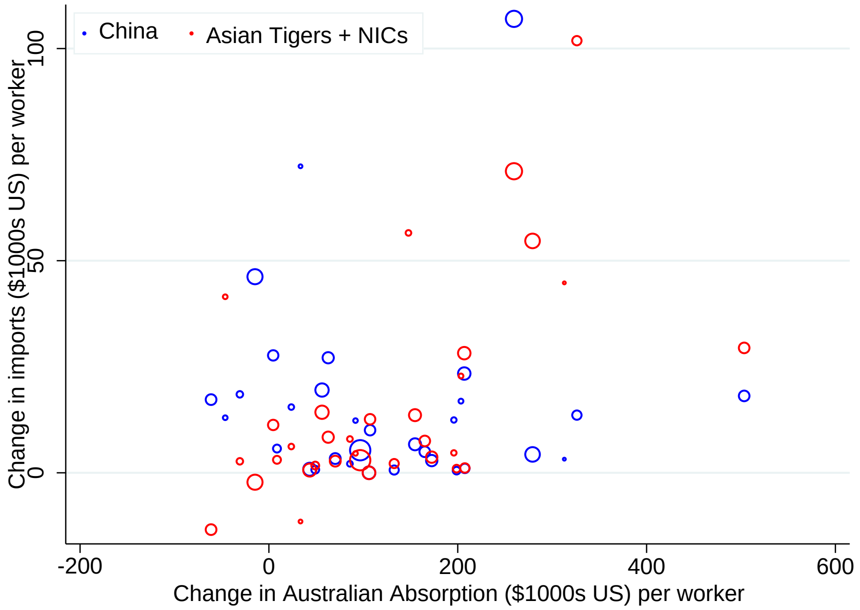
Notes: Employment by industry data from 1991 and 2006 Australian Censuses. Import data from UN Comtrade. Imports deflated using the US PCE deflator. Size of circles reflect industry employment in 1991.

Figure 7: **Industry-level Changes in Imports and Australian Absorption, 1991-2006**

Panel A: All industries



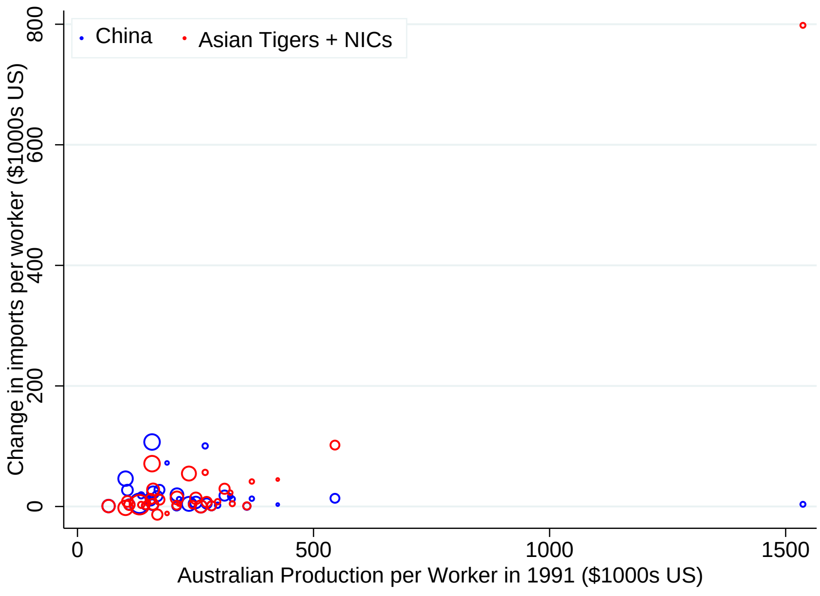
Panel B: Excluding petroleum and coal product



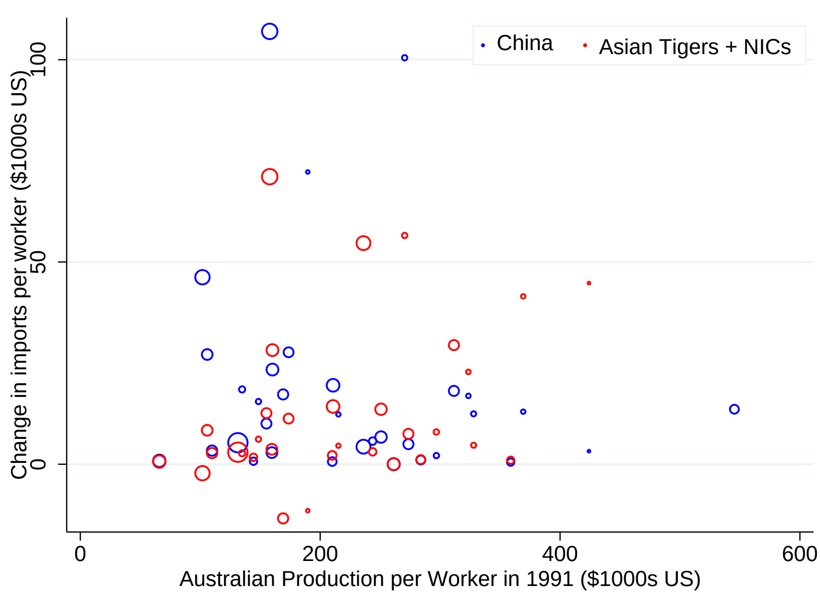
Notes: Import data from UN Comtrade. Absorption data from ABS Australian input-output tables (see notes to Figure 1). Initial employment (1991) data from the Australian Census. Imports deflated using the US PCE deflator. Size of circles reflect initial Australian industry employment in 1991.

Figure 8: **Industry-level Changes in Imports (1991-2006) and 1991 Australian Output per Worker**

Panel A: All industries

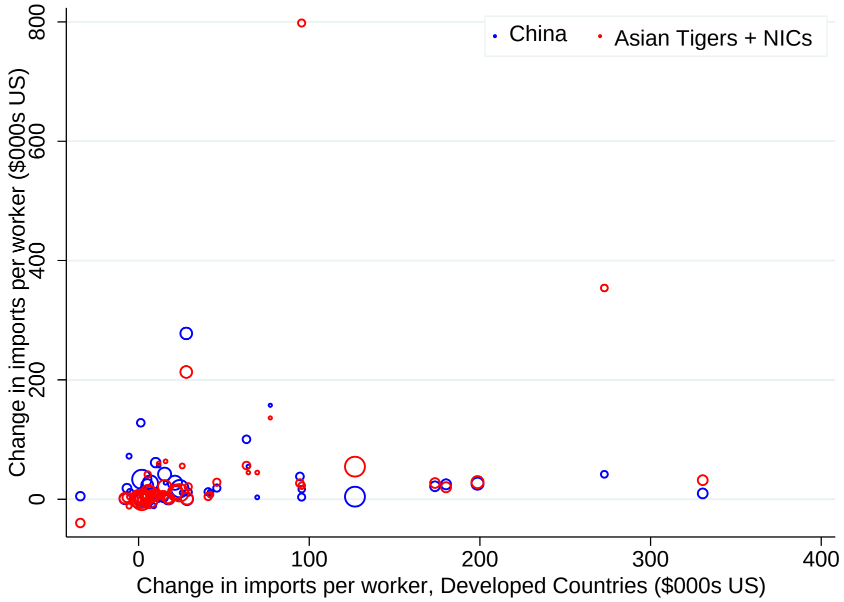


Panel B: Excluding petroleum and coal product



Notes: Import data from UN Comtrade. Australian production data from ABS Australian input-output tables (see notes to Figure 1). Initial employment (1991) data from the Australian Census. Imports deflated using the US PCE deflator. Size of circles reflect Australian industry employment in 1991.

Figure 9: **Industry-level Changes in Imports from Asia and Developed Countries, 1991-2006**



Notes: Import data from UN Comtrade. Initial employment (1991) data from the Australian Census. Size of circles reflect Australian industry employment in 1991.

Table 6: **Checking robustness of relation between Chinese import exposure and manufacturing employment by local labour market, Australia, 1991 to 2006, 2SLS estimates**

Dependent variable: 5 x annual change in share of manufacturing employment in working-age population (percentage points)

Main regressor[a]: Change in Chinese imports to Australia per worker (US$1,000, 2006)

Model	Description	Coefficient on main regressor	Model	Description	Coefficient on main regressor
1	Main estimates	-0.831*** (0.125)	2	Net imports	-0.833*** (0.123)
3	Gravity Model	-0.920*** (0.204)	4	Including 2006-2011 period	-0.795*** (0.142)
5	Controlling for tariff rate changes	-0.883*** (0.114)	6	Exclude remote labour markets	-0.834*** (0.139)
7	Initial manuf. share interacted with year indicators	-0.928*** (0.166)	8	Initial manuf. share separately by 2-digit industries	-0.973*** (0.111)
9	Imports in AU$ deflated using import price index	-0.735*** (0.118)			
	Excluding:				
10	Construction-related imports	-0.828*** (0.119)	11	Apparel, footwear and textile imports	-0.855*** (0.165)
12	Computers and electronic equip.	-1.061*** (0.214)			
13	United States from instrument group	-0.752*** (0.136)	14	New Zealand from instrument group	-0.831*** (0.128)

Notes: Observations N = 372 except model 4 (N = 496) and model 6 (N=321). All models include the vector of covariates from column (5) in Table 3. Robust standard errors clustered at the local labour market level are provided in parentheses. Observations are weighted by each local labour market's start-of-period share of national working-age population except model 11. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels respectively.

[a] Dependent variable differs in models 2 and 3 (see text for details).

Table 7: **Shift-share Instrument Robustness Exercises and Exposure-robust Standard Errors, Australia, 1991 to 2006**

Dependent variable: 5 x annual change in shares of working age population by labour force status (percentage points)

Explanatory variable: Change in imports from country / country group to Australia per worker (US$1,000, 2006)

Import exposure	(1)	(2)	(3)	(4)	(5)	(6)
Coefficient	-0.831	-0.847	-0.925	-1.049	-0.886	-1.240
Region-clustered	(0.128)	(0.117)	(0.147)	(0.164)	(0.278)	(0.313)
Industry-clustered	(0.039)	(0.095)	(0.130)	(0.098)	(0.380)	(0.116)
Industry-level robust	(0.083)	(0.110)	(0.186)	(0.100)	(0.363)	(0.169)
2-digit industry clustered	(0.058)	(0.115)	(0.069)	(0.084)	(0.284)	(0.130)
ADH (2013) controls	✓	✓	✓		✓	✓
Initial mfg. share	✓					
Lagged mfg. share		✓	✓	✓	✓	✓
Period-specific lagged mfg. sh.			✓	✓	✓	✓
Lagged exposure outlier inds.					✓	
Lagged 2-digit industry shares						✓
First-stage F-statistics:						
Region-clustered	52.35	54.21	20.12	71.61	107.5	11.23
Industry-clustered	13.39	10.80	22.33	12.88	13.24	30.16
Industry-level robust	19.87	18.33	24.34	15.79	19.52	49.01
2-digit industry clustered	34.31	25.94	37.12	16.06	6.73	26.61

Notes: Observations are weighted by each local labour market's start-of-period share of national population. All regressions also include period indicators. The ADH (2013) controls are the set of regional-level controls included in model (5) of Table 3: % routine occupations, offshorability index, % with post-secondary education, % foreign-born and % working-age females employed. Number of regions × periods = 372, number of industries × periods = 165 except in model (1) = 168 (it includes the large non-manufacturing sector with a zero shock to imports). The outlier industries controlled for in model (5) are knitted products, computers and electronic equipment and reproduction of recorded media.

Table 8: **Population responses: Relation between Chinese import exposure and working age population by local labour market, Australia, 1991 to 2006**

Dependent variable: Change in the log of working-age population within each demographic group.

Explanatory variable: Change in imports from China to Australia per worker (US$1,000, 2006)

Model	Sample	Full set of controls		BHJ version
		Coefficient	R^2	Coefficient
1	All	-0.0186* (0.0098)	0.510	-0.0442*** (0.0088)
2	Bachelors' degree or higher	-0.0024 (0.0120)	0.653	-0.0219 (0.0136)
3	Diploma or certificate	-0.0623*** (0.0211)	0.642	-0.112*** (0.0195)
4	No post-school qualification	-0.0048 (0.0063)	0.523	-0.0216*** (0.0074)
5	15-34 years of age	-0.0237** (0.0107)	0.575	-0.0507*** (0.0107)
6	35-49 years of age	0.0002 (0.0099)	0.656	-0.0152 (0.0096)
7	50-64 years of age	-0.0262*** (0.0096)	0.676	-0.0637*** (0.0089)

Notes: All 2SLS regressions include a constant term and period indicators. The two columns titled "Full set of controls" also include the vector of covariates from column (5) in Table 3. The final column titled "BHJ version" also includes the vector of covariates from column (3) of Table 7, as recommended in Borusyak et al (2018). Robust standard errors clustered at the local labour market level are provided in parentheses except in the final column titled "BHJ version" where robust standard errors are provided and were constructed using equivalent industry-level regressions, as described in Borusyak et al (2018). Observations are weighted by each local labour market's start-of-period share of national working-age population. N = 372 for the first two regressions and N=165 in the "BHJ version". *, ** and *** denote statistical significance at the 10%, 5% and 1% levels respectively.

Table 9: **Relation between Chinese import exposure and labour force status by local labour market, Australia, 1991 to 2006**

Dependent variable: 5 x annual change in shares of working age population by labour force status (percentage points)

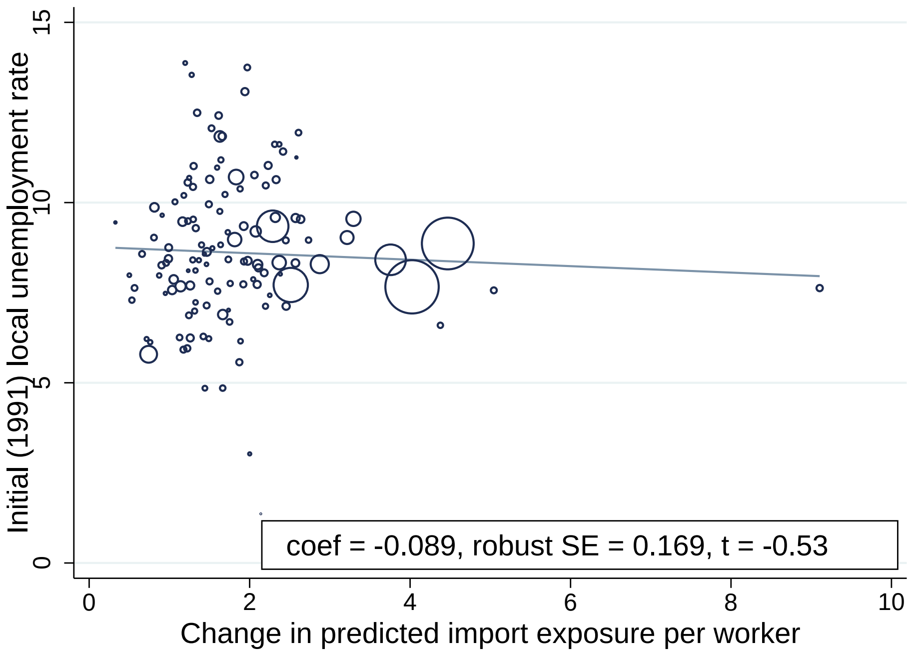
Explanatory variable: Change in imports from China to Australia per worker (US$1,000, 2006)

Demographic group	Manufacturing Employment	Non-manuf. Employment	Unemployment	Not in the labour force
All	-0.831*** (0.128)	-1.129*** (0.376)	1.030*** (0.229)	0.923*** (0.234)
Bachelors' degree or higher	-0.648*** (0.147)	0.439*** (0.167)	0.361*** (0.109)	-0.122 (0.175)
Diploma or certificate	-0.834*** (0.309)	-0.594 (0.393)	1.121*** (0.252)	0.326* (0.189)
No post-school qualification	-0.798*** (0.126)	-1.518*** (0.443)	1.129*** (0.260)	1.178*** (0.297)
Males	-1.199*** (0.236)	-1.307*** (0.435)	1.413*** (0.291)	1.093*** (0.267)
Females	-0.483*** (0.066)	-0.883*** (0.330)	0.662*** (0.174)	0.698*** (0.230)

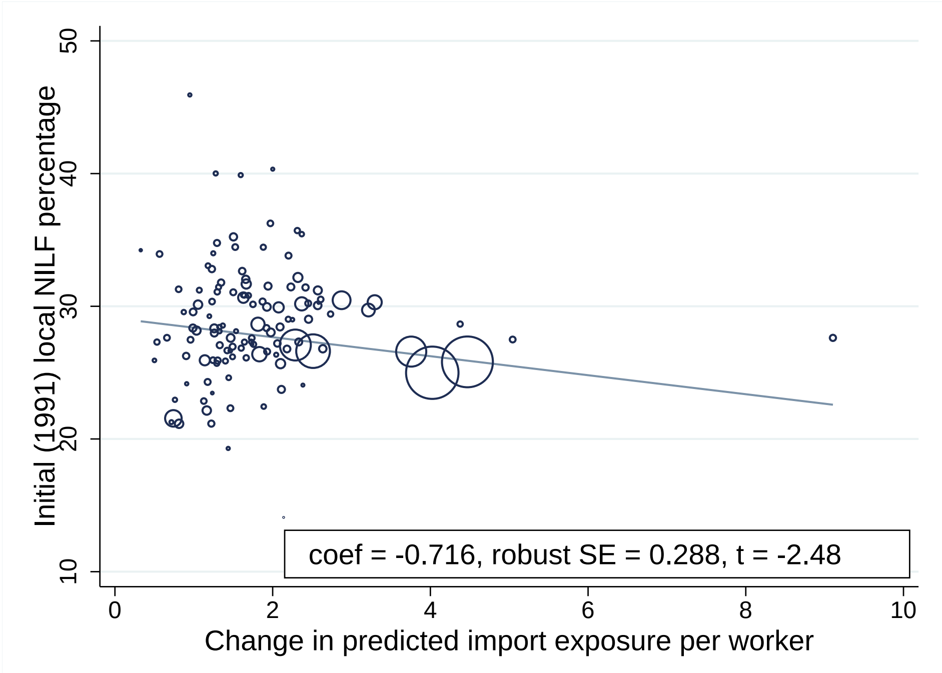
Notes: All regressions include the vector of covariates from column (5) in Table 3. Robust standard errors clustered at the local labour market level are provided in parentheses. Observations are weighted by each local labour market's start-of-period share of national population. N = 372 for all regressions. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels respectively.

Figure 10: **Initial (1991) local unemployment and NILF rates of the working-aged and changes in predicted exposure to Chinese imports**

Panel A: **Unemployment rates**



Panel B: **Not in the labour force (NILF) rates**



Notes: Authors' calculations with *N* = 124 local labour markets. The regression model is weighted by each local labour market's start-of-period share of national working-age population. The circle sizes represent the initial working-age population in each local labour market.

Table 10: **Relation between Chinese import exposure, part-time work status and full-time employee income by local labour market, Australia, 1991 to 2006**

Explanatory variable: Change in imports from China to Australia per worker (US$1,000, 2006)

	part-time employment	full-time income		
		persons	males	females
All	1.090*** (0.289)	-0.0134*** (0.0027)	-0.0174*** (0.0037)	-0.0046 (0.0057)
Bachelor's degree or higher	0.156 (0.111)	-0.0223*** (0.0055)	-0.0360*** (0.0037)	-0.0112 (0.0090)
Diploma or certificate	1.007** (0.438)	-0.0288*** (0.0053)	-0.0341*** (0.0073)	-0.0219*** (0.0081)
No post-school qualification	1.167*** (0.320)	-0.0081** (0.0034)	-0.0077* (0.0045)	-0.0053 (0.0040)
Males	0.951*** (0.335)			
Females	1.034*** (0.201)			

Notes: All regressions include the vector of covariates from column (5) in Table 3. The dependent variable in the "part-time employment" column is the change in the share of workers who are working part-time within each designated group. The dependent variable in the final three columns is the change in the mean of the log real income of full-time employees (adjusted using the Australian CPI) within each designated group. Robust standard errors clustered at the local labour market level are provided in parentheses. Observations are weighted by each local labour market's start-of-period share of national population. N = 372 for all regressions. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels respectively.

Table 11: **International comparison of labour market impacts of a $1,000 2006 USD per worker increase in imports from China**

Country	Period interval	Share in manufacturing employment	Share in non-manufacturing employment	Share unemployed	Share not in the labour force	Wages / Income % change
Australia	5 years	-0.831 (0.128)	-1.129 (0.376)	1.030 (0.229)	0.923 (0.234)	-0.013 (0.003)
United States	10 years	-0.596 (0.099)	-0.178 (0.137)	0.221 (0.058)	0.553 (0.150)	-0.008 (0.003)
Germany	10 years	-0.113 (0.061)	-0.100 (0.061)	0.007 (0.015)		-0.0122 (0.015)
			100 × log non-manufacturing employment	100 × log unemployed	100 × log not in the labour force	
Norway	11 years	-0.079 (0.022)	0.262 (0.094)	0.907 (0.535)	0.071 (0.099)	-0.003 (0.001)
Spain	4 years	-2.055 (0.441)	5.38 (2.27)	-13.77 (11.36)	1.80 (2.71)	-0.0123 (0.0089)

Sources: (i) Australia – Impact on working-age population shares and log real income of full-time employees, 1991 to 2006; Tables 9 and 10 above:

(ii) United States – Impact on population shares and log mean wage, 1990 to 2007: ADH (2013, Tables 5 and 6);

(iii) Germany – Impact on population shares and log median wages, 1988 to 2008: Dauth et al. (2014, Tables 3 and 5). Estimated impact on manufacturing employment is for imports from China. Estimated impact for other outcomes is for imports from China and Eastern Europe. Effects in Euro converted into USD using an exchange rate of 0.76.

(iv) Norway – Impact on population share in manufacturing but for 100 × log population counts for non-manufacturing (private) employment, unemployed and not in the labour force, and log mean earnings (private sector), 1996 to 2007: Balsvik et al. (2015, Tables 3, 4 and 5). Effects in Krone converted into USD using an exchange rate of 5.7.

(v) Spain – Impact on population share in manufacturing but for 100 × log population counts for non-manufacturing (private) employment, unemployed and not in the labour force, and log mean wages, 1999 to 2007: Donoso et al. (2015, Tables 2, 8 and 9, Specification D);

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Appendix: Concordance of employment and trade data to ANZSIC 2006 industry classification system over time

Employment: The original methods of industry classification were: (i) 1986 and 1991 – Australian Standard Industrial Classification (ASIC); (ii) 1996 and 2001 – ANZSIC 1993; and (iii) 2006 and 2011 – ANZSIC 2006. Data were mapped from ASIC to ANZSIC 1993 using an ABS ASIC to ANZSIC 1993 concordance (see ABS, Information Paper: Revisions to Historical ANZSIC Industry Data, 2011, catalogue number 6259.0). Data were mapped from ANZSIC 1993 to ANZSIC 2006 using a concordance constructed using the ABS's Census Tablebuilder
(see http://www.abs.gov.au/websitedbs/censushome.nsf/home/tablebuilder).

Imports: (i) Data are mapped from the HS commodity code system used internationally to the three-digit level of ANZSIC 2006 using an ABS concordance (see ABS, International Merchandise Trade, Australia: Concepts, Sources and Methods, 2015, Appendix 6.2, catalogue number 5489.0; accessed at:
http://www.abs.gov/AUSSTATS/abs@.nsf/Lookup/5489.0Main+Features12015?OpenDocument)

Appendix Table A1: **Summary statistics**

Panel A: **Variables in levels**

	1991	1996	2001	2006
Chinese imports to Australia per working-age population	0.271	0.514	0.767	2.260
	(0.146)	(0.283)	(0.349)	(0.905)
Percentage of working-age population employed in manufacturing	9.197	8.640	8.458	7.665
	(2.799)	(2.522)	(2.342)	(1.897)
Percentage of working-age population employed in non-manufacturing	55.31	57.14	59.05	63.45
	(4.178)	(4.398)	(3.987)	(3.871)
Percentage of working-age population unemployed	8.504	6.671	5.390	3.974
	(1.248)	(1.408)	(1.102)	(0.779)
Percentage of working-age population not in the labour force	26.95	27.54	27.09	24.90
	(2.663)	(2.668)	(2.980)	(2.817)
Percentage of employment in manufacturing	14.26	13.15	12.51	10.79
	(4.264)	(3.822)	(3.345)	(2.654)
Percentage of employment in routine occupations	31.96	30.57	29.47	28.27
	(1.671)	(1.529)	(1.310)	(1.328)
Average offshorability index of occupations	0.000	0.159	0.308	0.280
	(1.000)	(0.974)	(0.975)	(0.977)
Percentage of population with post-secondary education	32.10	36.39	42.03	45.58
	(3.804)	(4.634)	(5.108)	(4.887)
Percentage of population foreign-born	26.67	26.76	26.58	27.03
	(11.24)	(11.42)	(11.54)	(11.81)
Percentage of working-age females employed	55.61	58.13	61.09	65.12
	(4.169)	(4.073)	(3.816)	(3.415)

Notes: N = 124 local labour markets. Statistics are weighted by the local labour market share of national working-age population in the same year.

Panel B: **Variables in changes**

	1991-96	1996-01	2001-06
Chinese imports to Australia per working-age population	0.305 (0.156)	0.322 (0.171)	1.695 (0.728)
Percentage of working-age population employed in manufacturing	-0.521 (0.749)	-0.197 (0.494)	-0.799 (0.903)
Percentage of working-age population employed in non-manufacturing	1.788 (1.358)	1.906 (1.196)	4.376 (1.387)
Percentage of working-age population unemployed	-1.851 (0.881)	-1.285 (0.682)	-1.409 (0.926)
Percentage of working-age population not in the labour force	0.618 (1.016)	-0.419 (0.881)	-2.169 (1.020)
Change in log of working-age population			
All	0.0687 (0.0582)	0.0528 (0.0461)	0.0687 (0.0381)
Bachelor's degree or higher	0.382 (0.0807)	0.270 (0.0648)	0.253 (0.0520)
Diploma or certificate	0.0884 (0.0615)	0.150 (0.0508)	0.0451 (0.0753)
No post-school qualification	-0.0075 (0.0611)	-0.0410 (0.0399)	-0.0127 (0.0305)
15-34 years of age	0.0049 (0.0732)	-0.0128 (0.0582)	0.0246 (0.0462)
35-49 years of age	0.129 (0.0514)	0.0448 (0.0434)	0.0522 (0.0429)
50-64 years of age	0.116 (0.0595)	0.191 (0.0541)	0.161 (0.0427)

Notes: *N* = 124 local labour markets. Statistics are weighted by start-of-period labour market share of national working-age population.

Appendix Table A2: **Pre-exposure test of the relation between Chinese import exposure over 1991 to 2006 and manufacturing employment by local labour market over 1986 to 1991, 2SLS estimates**

Dependent variable: 15 x annual change in share of manufacturing employment in working age population (percentage points)

	(1)	(2)	(3)	(4)	(5)
Change in Chinese imports to Australia per worker (US$1,000, 2006)	-0.529*** (0.057)	-0.181 (0.113)	-0.145 (0.090)	-0.052 (0.132)	0.027 (0.110)
Percentage of employment in manufacturing		-0.111*** (0.029)	-0.131*** (0.022)	-0.130*** (0.022)	-0.128*** (0.023)
Percentage of employment in routine occupations				0.005 (0.046)	-0.005 (0.067)
Average offshorability index of occupations				-0.141 (0.143)	-0.012 (0.314)
Percentage of population with post-secondary education					0.019 (0.051)
Percentage of population foreign-born					-0.026* (0.014)
Percentage of working- age females employed					-0.004 (0.018)
State FE	No	No	Yes	Yes	Yes
2SLS first-stage regression					
Change in Chinese imports to other high-income countries per worker	0.0353*** (0.0011)	0.0338*** (0.0012)	0.0340*** (0.0011)	0.0327*** (0.0010)	0.0317*** (0.0011)
F-statistic (first stage)	1031	788	919	1017	874
Partial R-squared	0.979	0.980	0.983	0.983	0.984

Notes: Robust standard errors are provided in parentheses. Observations are weighted by a local labour market's start-of-period share of national population. N = 124 for all regressions. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels respectively.

Appendix Table A3: **Summary of Rotemberg weights for main estimates**

Panel A: Negative and positive weights

	sum	mean	share
Negative	-0.0242	-0.0017	0.25
Positive	1.0242	0.0250	0.75

Panel B: Correlations

	weight	growth	beta	F-stat	V(share)
weight	1				
growth	0.8473	1			
beta	0.0299	0.0494	1		
F-statistic	-0.0006	0.0166	0.0420	1	
V(share)	-0.0910	-0.1458	-0.0427	-0.0878	1

Panel C: Variation across years in weights

	sum	mean
1991-1996	-0.1231	-0.0022
1996-2001	-0.1242	-0.0023
2001-2006	1.2473	0.0227

Panel D: Top 5 Rotemberg weight industries

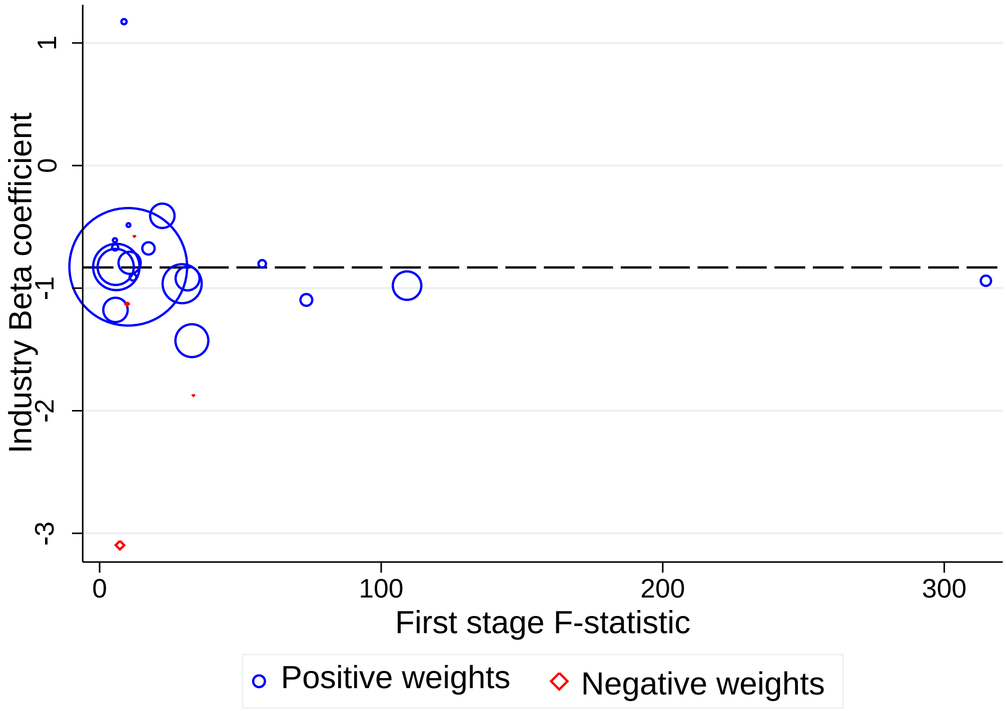
	weight	growth	beta	share
Computer & Electronic Equipment	0.541	8,107	-0.826	0.021
Electrical Equipment	0.084	1,402	-0.827	0.027
Knitted Product	0.059	1,579	-0.964	0.009
Domestic Appliance	0.051	1,957	-0.827	0.009
Clothing and Footwear	0.042	651	-1.428	0.058

Panel E: Estimates of beta for positive and negative weights

	R-weighted sum	share of overall beta	mean
Negative	-0.048	0.046	-13.13
Positive	-0.879	0.954	-0.539

Notes: Growth numbers refer to change in imports to the eight high-income countries per lagged Australian industry worker.

Figure A1: **Heterogeneity of estimates of import exposure effect by industry**



Notes: Industry beta coefficients only displayed if the first stage F-statistic exceeds 5.

Appendix Table A4: **Relation between Chinese import exposure and labour force status by local labour market, alternative specifications**

Dependent variable: 5 x annual change in shares of working age population by labour force status (percentage points)

Explanatory variable: Change in imports from China to Australia per worker (US$1,000, 2006)

Specification	Manufacturing Employment	Non-manuf. Employment	Unemployment	Not in the labour force
Main	-0.831***	-1.129***	1.030***	0.923***
	(0.128)	(0.376)	(0.229)	(0.234)
Unweighted	-0.525***	0.359	0.030	0.158
	(0.200)	(0.327)	(0.148)	(0.219)
No covariates	-1.131***	-0.115	0.473***	0.774***
	(0.080)	(0.251)	(0.147)	(0.177)
Borusyak et al (2018)	-0.925***	-1.226***	1.152***	1.000***
	(0.186)	(0.432)	(0.255)	(0.320)

Notes: The Main and Unweighted specifications include the vector of covariates from column (5) of Table 3. The No covariates specification includes time indicators only. The Borusyak et al (2018) specification includes the vector of covariates from column (3) in Table 7. Robust standard errors clustered at the LM level provided in parentheses except for the Borusyak et al (2018) specification, where the errors were constructed using equivalent industry-level regressions (N = 165) as recommended by Borusyak et al. (2018) are provided in parentheses (errors clustered at either the 3-digit or 2-digit industry levels were generally smaller). Observations are weighted by each local labour market's start-of-period share of national working-age population except for the Unweighted specification. Estimates cover the period from 1991 to 2006. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels respectively.

Appendix Table A5: **Relation between Chinese import exposure, part-time work status and full-time employee income by local labour market, Borusyak et al. (2018) versions**

Explanatory variable: Change in imports from China to Australia per worker (US$1,000, 2006)

	part-time employment	full-time income		
		persons	males	females
All	0.863* (0.466)	-0.0083 (0.0086)	-0.0136 (0.0109)	0.0020 (0.0055)
Bachelor's degree or higher	0.329 (0.293)	-0.0208* (0.0115)	-0.0346** (0.0155)	-0.0073 (0.0087)
Diploma or certificate	0.325 (0.400)	-0.0262** (0.0113)	-0.0321** (0.0125)	-0.0265** (0.0119)
No post-school qualification	0.907 (0.566)	-0.0010 (0.0059)	0.0000 (0.0073)	0.0015 (0.0039)
Males	0.619 (0.426)			
Females	0.981** (0.449)			

Notes: All regressions include the vector of covariates from column (3) in Table 7. The dependent variable in the "part-time employment" column is the change in the share of workers who are working part-time within each designated group. The dependent variable in the final three columns is the change in the mean of the log real income of full-time employees (adjusted using the Australian CPI) within each designated group. Robust standard errors constructed using equivalent industry-level regressions (N = 165) as recommended by Borusyak et al. (2018) are provided in parentheses (errors clustered at either the 3-digit or 2-digit industry levels were generally smaller). Observations are weighted by each local labour market's start-of-period share of national working-age population. Estimates cover the period from 1991 to 2006. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels respectively.