Trade Adjustment: Worker Level Evidence*

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Abstract

In the past two decades, China's manufacturing exports have grown spectacularly. U.S. imports from China have surged, while U.S. exports to China have increased more modestly, consistent with the two countries' divergent current account imbalances. Using data on individual earnings by employer from the Social Security Administration, we examine how exposure to import competition affects the long-term earnings and employment trajectory of workers initially employed in manufacturing industries. We find that workers who in 1991 were employed in industries that experienced high subsequent levels of import growth garner lower cumulative earnings over the subsequent sixteen years (1992 through 2007) and are at substantially elevated risk of obtaining Social Security Disability Insurance benefits as the only recorded source of income in a given year. More exposed individuals spend less time working for their initial employers, less time working in their initial two-digit manufacturing industries, and more time working elsewhere in manufacturing and outside of manufacturing. Effects on earnings and employment are larger for individuals whose initial employers were relatively large, whose initial wages where below their firm's average, and who in the pre-sample period worked part time or intermittently. We obtain similar results using alternative measures of trade exposure. Our findings suggest that there is significant worker-level adjustment cost to import shocks and that adjustment is highly uneven across individuals according their conditions of employment in the pre-shock period.

Keywords: Trade Flows, Labor Demand, Earnings, Job Mobility, Social Security Programs

JEL Classifications: F16, H55, J23, J31, J63

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1 Introduction

Among the most significant recent changes in the global economy is the rapid growth of China. Between 1990 and 2009, the share of world manufacturing exports originating in China increased from 2% to 13% (Figure 1). China's expanding role in global trade is fueled by the rapid growth of its manufacturing capacity. Since 1990, China has accounted for over three quarters of the growth in manufacturing value added by low and middle income countries, raising its share of manufacturing output within this group from 15% to 44% (Hanson, 2012).

For the United States, two factors compound the impact of China's expansion. One is that manufacturing still accounts for the majority of U.S. trade. China's emergence as the world's factory presents stiff competition to the labor-intensive industries that remain in the United States. Second is a sharp imbalance between aggregate exports and aggregate imports in the two countries. During the 2000s, China's average current account surplus was 5% of GDP, a figure equal to the average U.S. current account *deficit* over the period. U.S. industries exposed to the increase in China's trade capacity have faced a major shift in global supply, without an offsetting shift in global demand.

In the wake of China's spectacular growth, there has been a spirited if uneven policy debate about how the United States should respond. Whereas trade theory devotes attention to the fact that long-run net gains from trade are expected to be positive, the public debate about globalization frequently centers less on trade's long-run benefits than on the short-run costs of adjusting to import competition. Congress has repeatedly threatened China with trade sanctions for alleged manipulation of its currency, while others have called for an increase in Trade Adjustment Assistance, the primary federal program that assists workers who lose their jobs as a result of imports.[1] Missing in the debate is hard evidence on whether and by how much U.S. manufacturing workers have been affected by trade with China. We know that U.S. factories have closed and employment has declined in apparel, textiles, furniture, children's toys, and other industries in which imports from China have surged (Bernard, Jensen, and Schott, 2006). But we know little about how workers in these industries adjust to trade shocks.

In this paper, we examine the long-run impact of exposure to trade with China on U.S. workers. We define trade exposure as the growth in U.S. imports from China over 1991 to 2007 that occurred in a worker's initial industry of affiliation. Our focus is on the extended consequences of trade shocks based on where a worker is employed in 1991, at the time the shock initiates. By holding the industry constant, we avoid selection problems arising from the post-shock resorting of workers

[1] E.g., Jennifer Steinhauer, "Senate Jabs China over its Currency," *New York Times*, October 11, 2011; Tom Barkley, "Trade Deal Clears Hurdle in Senate," *Wall Street Journal*, August 4, 2011.

across industries. The choice of 1992 to 2007 as the outcome period is dictated on the front end by the availability of disaggregated bilateral trade data and on the back end by the onset of the Great Recession. These years span much of China's export boom as the early 1990s are when the country's trade growth accelerates (Figure 1).[2]

Using individual level data from the U.S. Social Security Administration, we estimate the impact of exposure to China trade on cumulative earnings, employment, movement across sectors, and receipts of Social Security benefits over the sixteen year outcome window. The data permit us to decompose worker employment spells by firm and industry and to examine variation in trade impacts according to worker and firm characteristics. To account for possible correlation between industry imports and industry domestic demand or productivity shocks, we instrument for the change in U.S. imports from China using import growth in other high income countries.[3] Key to our analysis is that China's growth over the period appears to be due to improvements in domestic productivity arising from the dismantling of central planning, looser restrictions on rural-to-urban migration, and the liberalization of trade and investment (Naughton, 2007; Hsieh and Ossa, 2011). Hsieh and Klenow (2009) report that during the 1990s and the 2000s, the median Chinese manufacturing plant had average annual TFP growth at the astounding pace of 15%. To account for the possible correlation between workers' potential earnings and their initial industry affiliation, we draw on the longitudinal structure of the data to control flexibly for workers' employment histories, tenure at initial employer and years of work experience, as well as sex, age, race and country of birth.

Our work adds to the literatures on labor markets, trade impacts, and their interactions. A first strand of literature to which we contribute is research on job displacement. Because employment relationships often endure for many years, labor economists have long been concerned with the consequences of losing one's job (Farber, 1999). A challenge in this line of research is to distinguish involuntary from voluntary worker separations from their employers. In pioneering work, Jacobsen, LaLonde, and Sullivan (1993) draw on administrative data to identify episodes in which plants let go a substantial fraction of their employees within a short span of time.[4] To ensure that separations

[2]While China's initial opening to trade occurred in the 1980s, its emergence as an export powerhouse came in the 1990s. Naughton (1996) identifies 1984 as the year in which China's export growth began to take off. However, the government initially maintained many restrictions on imports, exports, and foreign direct investment. In Figure 1, China's share of world manufacturing exports rose unevenly from 1% in 1984 to 2% in 1991. It was not until 1992, following Deng Xiaoping's famous "southern tour"—in which Deng and his reformist clique wrested power back from hardliners who had risen in prominence following a surge in inflation in 1988 and the events at Tiananmen Square in 1989—that the country began to welcome FDI by encouraging the expansion of Special Economic Zones in southern coastal cities (Naughton, 2007). The SEZs, which were later expanded nationally, lured foreign firms to set up export operations in China. Between 1991 and 1994, alone, inward FDI in China grew from 1% to 6% of GDP.

[3]Our identification strategy is related to Bloom, Draca, and Van Reenen (2011) and Autor, Dorn, and Hanson (2012).

[4]A second approach to study job loss uses the CPS Displaced Workers Survey (DWS), which asks workers who

occurring during such mass layoffs are truly involuntary, their analysis and subsequent work further restrict the sample to individuals who at the time of job loss were full-time workers and who had more than five years of tenure with their employer. Workers subject to mass layoffs suffer an immediate sharp decline in earnings and a smaller decline that persists over time. Wage loss is greater for workers with higher tenure but is otherwise similar across groups by age, gender, or skill.[5]

Following the job-displacement literature, we use administrative data on earnings and employment, which allows us to see the long-run effects of trade shocks on worker outcomes. We break from tradition by focusing on a specific type of shock, namely one related to China's export growth.[6] By identifying the source of the shock, we are able to examine worker adjustment along four margins: the change in earnings at the initial employer (the intensive margin), the change in earnings associated with job loss (the extensive margin), the change in earnings associated with uptake of government benefits (the transfer margin), and the change in earnings associated with moving between employers and/or industries (the reallocation margin). We are thus able to identify where in the adjustment process workers experience income loss and which types of losses are more persistent. Because most prior studies analyzing the impact of firm and industry-level shocks on worker outcomes focus exclusively on displaced workers, that work either combines the four margins of adjustment that we analyze here (intensive, extensive, transfer and reallocation) or considers only a subset.[7] A further advantage of our approach is that we are able to include part-time workers and workers with low initial tenure, allowing us to consider how the impact of trade exposure varies across individuals according to their labor market attachment.

Our work also relates to literature on trade and labor markets.[8] An earlier strand of work embraces general equilibrium trade theory, which shows how trade shocks affect wages in national labor markets, with shocks in one industry being transmitted to other industries through labor mobility (Feenstra and Hanson, 1999; Harrigan, 2000; Robertson, 2004; Blum, 2008). This approach

recently left their jobs if the separation was involuntarily. The DWS covers all types of job loss, but for each worker only records a single separation and only those within the last three years (Farber, 2005), which prevents one from investigating long-run consequences. See Addison, Fox, and Ruhm (1995) and Kletzer (2000) for work using the DWS to examine the correlation between job loss and import competition.

[5]See Sullivan and von Wachter (2009), von Wachter, Song, and Manchester (2009), and Couch and Paczek (2010) for recent work that uses administrative data and see Kletzer (1989), Ruhm (1991), Neal (1995), Parent (2000), Chan and Stevens (2001), and Farber (2005) for representative work on job loss using survey data (including the DWS and the Health and Retirement Survey). Hummels, Jorgensen, Munch, and Xiang (2011) apply the Jacobsen-LaLonde-Sullivan (1993) approach to examine the displacement effects of trade shocks in Denmark.

[6]Menezes-Filho and Muendler (2011) also track worker adjustment to trade shocks over a comparable period of time, in their case for formal-sector workers in Brazil following a reduction in import tariffs.

[7]In a similar vein, Walker (2012) studies the impact of environmental regulations on worker adjustment by focusing on workers who are initially employed by industries newly regulated by the Clean Air Act. Walker's analysis considers three of the four margins above, excluding transfer benefits.

[8]For discussion of recent research, see Harrison, McLaren, and McMillan (2010).

is informative about how trade affects equilibrium wages but does not account for any transitional costs in worker adjustment. Moving between industries may take time or may involve a loss in firm or industry-specific human capital, either of which would imply a reduction in lifetime earnings (Neal, 1995; Parent, 2000; Polataev and Robinson, 2008; Gathmann and Schönberg, 2010). Recent literature introduces explicit labor-market frictions into general equilibrium trade models. Helpman, Itskhoki, and Redding (2010) allows for costly worker search, which produces equilibrium variation in earnings and employment across individuals and equilibrium unemployment at the industry level.[9] Helpman, Itskhoki, Muendler, and Redding (2012) apply this framework to data on Brazil. Coşar (2011), Dix Carneiro (2011), and Coşar, Guner and Tybout (2011) also examine the Brazilian context in general equilibrium settings that allow for costly intersectoral labor mobility or costly firm entry/exit. Our work is similar in spirit to this literature but imposes less structure on the data, allowing us to examine a wide variety of sources of heterogeneity in adjustment costs across workers and in the uptake of government benefits that may accompany adjustment.

Another body of trade literature estimates the short or medium run effects of trade by exploiting barriers to the mobility of workers. Where it is costly for workers to change employers, switch occupations, or move to another location, trade shocks may affect wages differentially—at least in the short to medium run—at the firm, industry, or region level.[10] While this approach uncovers the transitory effects of trade shocks, it may miss impacts that persist *after* an individual leaves his firm, abandons his industry, or relocates geographically. An additional complication is that wage effects estimated at the industry or region level may be contaminated by compositional changes resulting from worker exit. If low-wage workers are those most likely to lose their jobs after an import shock, the estimated impact of trade on industry wages may be biased upwards (i.e., toward zero), as exiting low-wage workers push up the industry average.[11] By utilizing the long-run panel structure of the SSA data, our work is able to capture the post-shock change in earnings that workers experience at the same firm, after moving to a different firm in the same industry, or after moving to a new industry altogether. Our focus in this paper is not on identifying changes in equilibrium wages but

[9]See also Davis and Harrigan (2007) and Helpman and Itskhoki (2010).

[10]See Bernard, Jensen, and Schott (2006), Verhoogen (2008), Amiti and Davis (2011), and Hummels, Jorgensen, Munch, and Xiang (2011) on trade shocks at the firm level; Goldberg and Pavcnick (2003), Artuc, Chaudhuri, and McLaren (2010), McLaren and Hakobyan (2010), Ebenstein, Harrison, McMillan, and Phillips (2011), and Menezes-Filho and Muendler (2011) on trade shocks at the industry and occupation level; and Chiquiar (2008), Kovak (2011), Topalova (2010), and Autor, Dorn, and Hanson (2012) on trade shocks at the region level.

[11]Using data on U.S. commuting zones, Autor, Dorn, and Hanson (2012) estimate large negative effects of import shocks on regional manufacturing employment but not on regional manufacturing wages. Using the Current Population Survey, Ebenstein, Harrison, McMillan, and Phillips (2011) find no effect of imports on wages at the industry level though they do find effects for occupations. Both sets of results suggest workers may be non-randomly selected out of employment in trade-impacted industries.

on capturing the changes in earnings and employment that individual workers in exposed industries encounter when adjusting to the shock.

To preview the results, we find that workers more exposed to trade with China have lower cumulative earnings, lower cumulative employment, and higher receipts of Social Security Disability Insurance over the sample window of 1992 through 2007. After including an extensive set of controls, the difference between an individual at the 75th percentile of industry trade exposure and one at the 25th percentile of exposure amounts to reduced earnings equal to 56% of initial yearly income and to one-third of an additional month where payments from Social Security Disability Insurance are the only recorded source of income. Trade exposure increases churning across firms, industries, and sectors. More exposed workers spend less time working for their initial employer, less time working in their initial two-digit industry, and more time working elsewhere in manufacturing and outside the manufacturing sector. The consequences of trade exposure vary across demographic groups. Losses in earnings are larger for workers whose initial wage is below the median of their cohort, workers whose initial employer's average wage is below its industry's average, and workers with relatively weak attachment to the labor force. Perhaps surprisingly it is workers in larger firms who are most likely to see employment disruptions in response to trade, a finding that goes against the Melitz (2003) model in which larger, more productive firms are better positioned to confront increased competition from abroad.[12]

We interpret these results to mean that greater exposure to the China trade shock is associated with a loss in lifetime income and a greater likelihood of changing jobs and of receiving government transfers. These adjustment costs appear to be larger for individuals whose position in the labor market is more tenuous. The data do not allow us to say whether these effects are due to employers being more likely to fire these types of workers or to workers with these characteristics being more likely to leave their jobs when employment prospects worsen. Our finding that lower wage workers suffer more from adverse shocks is consistent with the literature on job displacement but our findings that younger workers suffer more is distinct from this literature (e.g., Chan and Stephens, 2001; von Wachter and Bender 2006; Couch and Placek, 2010). It may be that within affected industries, younger, newly hired workers perform tasks that are more substitutable with Chinese imports.

We begin in Section 2 by describing our empirical approach to estimate the effects of exposure to trade shocks. Section 3 provides a brief discussion of the data. Section 4 provides our primary OLS and 2SLS estimates of the impact of trade shocks on cumulative earnings, employment, and benefit receipts. Section 5 examines variation in the consequences of trade shocks by individual

[12] Our results on large firms are not anomalous. See von Wachter and Bender (2006), Bernard, Jensen, and Schott (2006), Biscourp and Kramarz (2007), and Holmes and Stevens (2010).

characteristics and conditions of initial employment. Section 6 expands the inquiry to explore alternative measures of trade exposure. Section 7 concludes.

2 Empirical approach

The global context for our analysis is one in which China experiences growth in its productivity and reductions in its trade costs, which lead it to expand its exports. General equilibrium trade theory predicts how such shocks affect wages in China, the United States, and the rest of the world (e.g., Hsieh and Ossa, 2011; di Giovanni, Levchenko, and Zhang, 2011). Our focus here is partial equilibrium: we seek to capture the changes in earnings and employment that individual workers in exposed industries encounter when adjusting to the shock.

2.1 Industry Trade Shocks

To consider how productivity growth in China may affect U.S. industries, we apply the Eaton and Kortum (2002) model of trade.[13] Using their framework, total output by U.S. industry j, (Q_{uj}), can be written as as the sum in demand for U.S. goods across destination markets:

$$Q_{uj} = \sum_n \frac{T_{uj} \left(w_{uj}\tau_{nuj}\right)^{-\theta}}{\Phi_{nj}} X_{nj}, \tag{1}$$

which depends on the technological capability of U.S. industry j, (T_{uj}), unit production costs in U.S. industry j, (w_{uj}), bilateral trade costs between the United States and country n in industry j, (τ_{nuj}), expenditure in country n on industry j, (X_{nj}), and the "toughness" of competition in country n's market for outputs of industry j, $\left(\Phi_{nj} = \sum_h T_{hj} \left(w_{hj}\tau_{nhj}\right)^{-\theta}\right)$, which in turn is a function of productivity, production costs, and trade costs in the other countries (indexed by h) that export to country n, including China.[14] As China experiences productivity growth in industry j or a reduction in its production or trade costs, U.S. firms face stiffer competition in the markets that they and China both serve. Totally differentiating (1), we obtain the direct effect of China productivity and cost shocks on the demand for outputs of U.S. industry j,

$$\hat{Q_{uj}} = -\sum_n \left[\frac{X_{nuj}}{Q_{uj}}\right] \left[\frac{X_{ncj}(\hat{A}_{cj} - \theta\hat{\tau}_{ncj})}{X_{nj}}\right], \tag{2}$$

[13]Other models of trade that have a "gravity" structure, as defined in Arkolakis, Costinot, and Rodriguez-Clare (2010), would produce a similar specification.

[14]The parameter θ captures the dispersion in productivity across firms in the industry.

where $\hat{x} \equiv d\ln x$, $\hat{A}_{cj} \equiv \hat{T}_{cj} - \theta\hat{w}_{cj}$, and X_{nuj} is initial sales by U.S. industry j in country n.[15] In (2), the first term in brackets is the share of country n in U.S. sales for industry j and the second term in brackets is the change in the import penetration ratio for industry j in country n that is mandated by changes in China's productivity, production costs, and trade costs. Supply-driven changes in China's exports will tend to reduce demand for U.S. industrial production. In the empirical analysis, we initially focus on import penetration in the U.S. market, as the United States is the dominant destination market for most U.S. industries (Bernard, Jensen, Redding, and Schott, 2009). We later incorporate changes in import penetration in other destination markets as well.

Turning to the data, our baseline measure of trade exposure is the change in the import penetration ratio for a U.S. industry over the period 1991 to 2007, defined as,

$$\Delta IP_{j,\tau} = \frac{\Delta M^{UC}_{j,\tau}}{Y_{j,91} + M_{j,91} - E_{j,91}}, \tag{3}$$

where for U.S. industry j, $\Delta M^{UC}_{j\tau}$ is the change in imports from China over the period 1981 to 2007 and $Y_{j0} + M_{j0} - E_{j0}$ is initial absorption (measured as industry shipments, Y_{j0}, plus industry imports, M_{j0}, minus industry exports, E_{j0}). We choose 1991 as the initial year as it is the earliest period for which we have disaggregated bilateral trade data for a large number of country pairs.[16] The quantity in (3) will mirror that in (2) if the growth in U.S. imports from China is primarily the result of domestic supply shocks in China or changes in its trade costs. Over the period we consider, China underwent enormous changes in industrial productivity associated with TFP growth, human and physical capital accumulation, migration to urban areas, and improvements in the country's infrastructure that followed the country's transition from a centrally planned economy to a more market-oriented one, all of which contributed to its export surge (Naughton, 2007; Hsieh and Klenow, 2009; Bloom, Draca and Van Reenen, 2011; Hsieh and Ossa, 2011).

One concern about (3) as a measure of trade exposure is that observed changes in the import penetration ratio may in part reflect domestic shocks to U.S. industries. Even if the factors driving China's export growth are internal supply shocks, U.S. industry import demand shocks may still contaminate observed bilateral trade flows. To capture the China supply-driven component in U.S. imports from China, we instrument for trade exposure in (3) with the variable,

[15] In (2), we do not consider the general equilibrium effect of the China shock on global wages and expenditures. Our empirical approach implicitly allows for such effects by using the observed changes in imports from China in measuring trade exposure.

[16] Our empirical approach requires data not just on U.S. trade with China but also on the countries' trade with other partners.

$$\Delta IPO_{j\tau} = \frac{\Delta M^{OC}_{j,\tau}}{Y_{j,88} + M_{j,88} - X_{j,88}} \tag{4}$$

where $\Delta M^{OC}_{j,\tau}$ is the growth in imports from China during the period 1991 to 2007 in eight other high income countries excluding the United States , based on the industry in which the worker was employed three years prior to the base year, in 1988.[17] We use industry of employment in 1988, rather than 1991, to account for possible worker sorting across industries in anticipation of future growth in trade with China (or other low-income countries). The denominator in (4) is initial absorption in the 1988 industry. The motivation for the instrument in (4) is that high income economies are similarly exposed to growth in imports from China that is driven by supply shocks in the country. The identifying assumption is that industry import demand shocks are weakly correlated across high-income economies.

Figure 2 plots the value in (3) against the value in (4) for all workers in our main sample, as defined below, which is equivalent to the first-stage regression in the estimation without detailed controls. The coefficient is 0.713 and the t-statistic and adjusted R squared are 8.55 and 0.41, respectively, indicating the strong predictive power of import growth in other high income countries for U.S. import growth from China. Later in the estimation, we use the gravity model to measure trade exposure (as in Autor, Dorn, and Hanson, 2012), which permits weaker identifying assumptions.

2.2 Measuring Industry Trade Exposure

Appendix Table 1 describes changes in import penetration, using (3), summarized at the two-digit level, for SIC manufacturing industries over the period 1991 to 2007. Data for U.S. imports are from UN Comtrade, concorded from HS product codes to four-digit SIC industries (see the Data Appendix). Data for U.S. four-digit industry shipments are from the NBER Productivity Database (Bartelsman, Becker, and Gray, 2000). There is immense variation in import growth across industries. Leather products (shoes), toys, furniture, electronics, and apparel each have increases in import penetration of more than 20 percentage points. Tobacco, petroleum, food products, chemicals, and transportation equipment each have increases in import penetration of less than 2 percentage points. The more exposed industries have in common production stages that are intensive in the use of less skilled labor; the less exposed industries have in common intensive use of natural resources (land, oil reserves) or physical capital. These patterns are consistent with China's strong

[17] These countries are Australia, Denmark, Finland, Germany, Japan, New Zealand, Spain, and Switzerland, which represent all high income countries for which we can obtain disaggregated bilateral trade data at the Harmonized System level back to 1991.

comparative advantage in labor-intensive sectors (Amiti and Freund, 2010) and within these sectors in labor-intensive production activities (Feenstra and Hanson, 2005).

While Appendix Table 1 shows that there is substantial variation in import growth across broad manufacturing sectors, there is also variation in changes in trade exposure within these sectors. Figure 3 plots the share of production workers in industry employment in 1991 against the change in industry import penetration from China from 1991 to 2007. Each four-digit industry is a point on the graph. We use common symbols for industries that fall within each of ten broad sectors, where each sector consists of industries that have relatively similar production-worker employment shares. The sectors are food processing and tobacco; furniture and wood products; chemicals and petroleum; metals and metal products; transportation equipment; apparel, leather (footwear), and textiles; paper and printing; plastic, rubber, glass, and nonmetallic minerals; machinery and electronics; and miscellaneous industries (including toys, sports equipment, and jewelry). The location of the green diamonds high on the vertical axis indicates that apparel, leather, and textile industries are heavily dependent on production workers, reflecting their intensive use of less-skilled labor. Yet, within the sector there is wide variation in the change in import penetration. The most exposed industries see changes of over 90 percentage points, whereas the least exposed see changes of less than 10 percentage points. Clearly, exposure to import competition from China is not simply a function of an industry's skill intensity. Additional factors surely matter, including transportation costs, the ease of offshoring production, and the importance of proximity to upstream suppliers or downstream buyers. In the empirical analysis, we will include controls for the ten broad sectors, meaning that we identify the impact of trade exposure on long-run outcomes based on variation in import growth among industries with similar skill intensities.

An important simplification of the model behind (2) is the absence of intermediate inputs. In actuality, China's export production relies heavily on imported intermediates. During the sample period, approximately half of China's manufacturing exports were produced by export processing plants, which import parts and components from abroad and assemble these inputs into final export goods (Feenstra and Hanson, 2005). The importance of processing plants in China's exports may create the impression that the country's position in global production is limited to the low-value added task of product assembly. Because assembly occurs at the end of the production chain, the gross value of China's exports may seem to greatly overstate the actual value added in China.[18]

[18]The *Wall Street Journal*, for instance, reports that of the $179 in production costs for a new iPhone, the final assembly performed by Chinese workers accounts for only $7 (Andrew Batson, "Not Really 'Made in China'," *Wall Street Journal*, December 15, 2010). What such an accounting misses is that China also helps produce the Japanese touchscreen, the Korean microprocessor, and the Taiwanese DRAM used in the iPhone, meaning that its contribution to value added is well above the 4% of production costs absorbed by final assembly.

However, recent evidence suggests that the domestic content of China's exports is substantial and rising. Koopman, Wang, and Wei (2012) find that the share of domestic value added in China's exports rose from 50% in 1997 to over 60% in 2007. Even within the highly specialized export processing sector, domestic value added rose from 32% of gross exports in 2000 to 46% in 2006 (Kee and Tang, 2012). Our instrumental variable strategy does not require that China is the sole producer of the goods it ships abroad but rather that the growth of its manufacturing exports is driven largely by factors internal to China (as opposed to shocks originating in the United States).

To account for how complexities in global production may affect the transmission of trade shocks in China to U.S. industries, we use six alternative measures of changes in import competition, alongside our principal measure in (3). These measures, which are discussed in more detail in section 6.2, include (i) the change in import penetration from China calculated using the gravity model of trade, (ii) changes in import penetration due to trade with all low-wage countries and not just China, (iii) changes in import penetration due to China in all domestic and foreign markets that U.S. industries serve (and not just the U.S. market), (iv) changes in net imports (imports – exports) from China, (v) changes in the net labor content of U.S. trade with China, and (vi) changes in import penetration due to China net of changes in imported intermediate inputs from China.

To summarize our approach, we examine changes in outcomes for workers over the 1992 to 2007 period that are associated with exposure to the growth in imports from China. We measure a worker's exposure according to his industry of employment in the pre-shock period. By taking workers and their initial industry of employment as the unit of analysis, we isolate the long-run changes in outcomes that are associated with greater exposure to trade at the time China's export growth accelerates. Under what conditions would we fail to find evidence of worker-level adjustment? If labor markets are frictionless, such that workers can easily change industries and obtain similar compensation levels in alternative lines of work (i.e., they do not face inter-firm or inter-industry wage differences), we will see no impacts from exposure to China trade—though in this case, we should be able to detect inter-firm and inter-industry mobility induced by trade exposure. If growing imports from China cause wages to change for entire skill groups, our approach would also fail to identify adjustments in earnings or employment, since in this case the wage effects would not be firm or industry-specific. We *will* find trade impacts on worker outcomes if trade shocks induce exposed firms to cut wages and employment *and* either (i) it is costly for workers to change their employers or to change their industries (due, say, to the presence of firm or industry-specific human capital; e.g., Neal, 1995), or (ii) costly job search or other barriers complicate obtaining another job once a worker has lost his initial employment (Rogerson and Shimer, 2011; Helpman, Itskhoki, and

Redding, 2010); or (iii) workers in affected industries tend to be those who are more likely to exit the labor force in response to an adverse wage shock (Blau, 1994; Peracchi and Welch, 1994).

3 Data sources and measurement

Our main source of data on U.S. workers is a one percent extract from the Master Earnings File (MEF) of the U.S. Social Security Administration. The MEF data provide annual earnings and an employer identification number (EIN) for each job that a worker held in the years 1978 through 2007.[19] The MEF also contains basic demographic information that stems from a worker's application for a Social Security card. Our analysis uses data on birth year, sex, race, and immigrant status (U.S. or foreign born). For 97% of employees in 1991, we are able to match the EIN of the employer to firm data that provides information on industry, firm size (measured by employment or payroll), and geographic location of the firm. The industry classification is based on firms' registration with the Internal Revenue Service (IRS). The Data Appendix provides more details.

We focus on workers who were born between 1943 and 1970 and study their outcomes over the period 1992 to 2007, during which these individuals were between 22 and 64 years old. In the estimation, we use two samples drawn from this group. The full sample is all working-age individuals who had positive earnings (and a valid industry code) for at least one year in each of the three-year periods, 1987 to 1989 and 1990 to 1992,[20] which comprises 880,465 workers. Our primary sample consists of the subset of workers who have high labor-force attachment, which we define as those individuals who earned at least $7,950 per year in each of the four years 1988 to 1991. The value of $7,950 (in 2007 dollars) corresponds to the earnings of a worker who was employed for 1,600 annual hours at the Federal minimum wage as of 1989. The restricted sample includes 511,792 workers.

For each worker in each year, we observe annual labor earnings, annual benefit receipts from the Social Security Administration, and the program from which these benefits derived. Because the sample is limited to individuals of working age, the vast majority of non-elderly workers who report Social Security benefits receive them in the form of Social Security Disability Insurance, rather than Social Security Retirement Income (whose primary recipients are aged 65 or older) or Supplemental Security Income (whose primary recipients do not participate in the labor force on a frequent basis). The data thus allow us to measure four sets of labor-market outcomes over the sample period: total labor earnings, the number of years with positive labor earnings, earnings per year for years with

[19] For workers who have multiple jobs in a given year, we aggregate earnings across all jobs and retain the EIN of the employer that accounted for the largest share of the worker's earnings.

[20] Observations from the first period are necessary to construct (4) and for the second period to construct (3).

non-zero earnings, and total Social Security benefits. Appendix Table 2 describes variation in these outcomes across workers. For the sample with high labor-force attachment, the average worker had positive labor earnings in 14.2 of the 16 years, cumulatively earned 18.1 times their initial average annual wage (measured as the average of their annual wage between 1988 and 1991), earned an average of 1.22 their initial earnings in years in which earnings were non-zero, and spent 0.32 years (4 months) receiving SSDI income with no labor income. Among individuals initially employed in manufacturing, the average increase in import penetration from China was 7.7 percentage points, with an increase of 26.0 percentage points for workers at the 90th percentile of trade exposure and less than 0.1 percentage points for workers at the 10th percentile.

4 Empirical Results

The data permit us to examine cumulative worker outcomes over the sample period as well as transitions between employers, spells of non-employment, and spells with positive income from Social Security benefits. In this section, we begin the analysis by examining the impact of trade exposure on total earnings and employment and then consider worker adjustment to trade shocks through transitions between jobs and periods of receiving benefits.

We begin by fitting models of the following form:

$$E_{ij\tau} = \beta_0 + \beta_1 \Delta IP_{j\tau} + \beta_2 IP_{j,91} + X'_{ij,0}\beta_3 + Z'_{j,0}\beta_4 + e_{ij\tau}, \quad (5)$$

where $E_{ij\tau}$ is cumulative earnings over 1992 to 2007 (normalized by average annual earnings over 1988-1991) for worker i employed in industry j in 1991; $\Delta IP_{j\tau}$ is the change in import penetration from China over 1991 to 2007 in industry j as defined in (3); $IP_{j,91}$ is import penetration from China in industry j in 1991; the vector X_{ij0} contains controls for the worker's gender, birth year, race, foreign-born status, sector of employment in 1991, average log annual earnings over 1988 to 1991 and its interaction with worker age, indicators for job tenure as of 1991 in the worker's primary firm (0-1, 2-5, 6-10 years), indicators for the size of the primary firm (1-99, 100-999, 1000+ employees), and indicators for count of years between 1978 and 1988 in which the worker had positive earnings (4-5, 6-8, 9-11 years); and the vector $Z_{j,0}$ controls for economic conditions in industry j in 1991. Standard errors are clustered at the level of the 1991 industry.

Cumulative earnings embody the sum of labor-market shocks over the sample period. In (5), we model the cumulative shock due to trade exposure as a function of import penetration in 1991 plus the growth in import penetration from 1991 to 2007, which is equivalent to the initial condition plus the average annual change. Implicitly, our analysis compares workers with similar demographic characteristics, initial earnings, initial experience on the job, and initial employer size, some of whom work in industries that see subsequent increases in import competition from China and some of whom do not. Because we compare workers with similar pre-shock observable characteristics, we do not capture changes in wages that are common to workers in a given skill or experience group. Our interest is in seeing whether otherwise similar workers have distinct long-run outcomes based on differential initial exposure to import competition from China, as would be consistent with costly worker adjustment to trade shocks.

An obvious challenge for the analysis is that industries that are subject to greater import competition may be exposed to other economic shocks that might be confounded with China trade. To address this concern, we include extensive controls for industry exposure to other types of shocks and also employ falsification tests. Our main models control for the ten manufacturing sectors described in section 2, as well as for a large set of industry characteristics as measured in 1991: the share of production workers in employment (from Bartelsman, Becker, and Gray, 2000), the ratio of capital to value added, the industry average log wage, import penetration by countries other than China, and the share of imported intermediate inputs in material purchases (from Feenstra and Hanson, 1999). The intensity with which an industry uses production labor or capital may indicate the exposure of the industry to technical change. In recent decades, technological progress within manufacturing has been most rapid in skill intensive sectors (Doms, Dunne, and Troske, 1997; Autor, Katz, and Krueger, 1998). Initial non-China import penetration and use of imported intermediates captures overall industry exposure to trade in final goods and to offshoring. Surely, U.S. industry import penetration ratios would have grown even if had China remained closed to the rest of the world and not contributed to such a substantial increase in global manufacturing capacity.

Over the time period that we examine, U.S. manufacturing experienced a secular decline, with the most pronounced contractions occurring in labor-intensive industries. Could increased imports from China be a symptom of this decline rather than a cause? To verify that our results capture the period-specific effects of exposure to China trade, and not some long-run common causal factor behind both the fall in manufacturing employment and the rise in Chinese imports, we perform two robustness tests. We augment equation (5) to include the change in each industry's employment share and the change in its log average wage during the prior 16 years. These variables capture pre-existing trends in industry growth or contraction that may predate the rise of exposure to China trade. We subsequently conduct falsification tests by regressing *past* earnings and employment outcomes for workers on *future* changes in their industry's trade exposure to China.

4.1 Baseline Regressions

Table 1 presents estimates of the relationship between Chinese import exposure and cumulative earnings from 1992 to 2007, normalized by average annual earnings over 1988 to 1991, such that total labor earnings are denominated as a multiple of initial annual income. We begin by using the restricted sample of individuals with high labor-force attachment, who report positive labor earnings above minimum annual income levels in the four consecutive years, 1988 to 1991. The first two columns of Table 1 present simple bivariate regressions of cumulative earnings on the change in Chinese import penetration. The regression in column 1 is based on OLS, whereas the regression in column 2 is based on two-stage least squares, using the variable described in (4) as an instrument for the change in import penetration given in (3). In both cases, there is a negative and statistically significant correlation between the change in import penetration and cumulative earnings over 1992 and 2007. Greater exposure to imports from China based on a worker's initial industry of employment is associated with lower total earnings over the subsequent 16-year period.

To interpret the coefficient estimates, we compare a manufacturing worker at the 90th percentile of the change in trade exposure with a manufacturing worker at the 10th percentile.[21] The implied differential reduction in earnings over the 16-year outcome period for the worker at the 90th percentile is 92% ($-3.5\times(26.00 - 0.06)$) of initial annual earnings in column 1, and 197% ($-7.6\times(26.00 - 0.06)$) of initial annual earnings in column 2.[22] The 2SLS estimate is roughly twice the magnitude of the OLS estimate, which is consistent with there being a positive correlation between U.S. industry import demand shocks and U.S. industry labor demand, which would contribute to an OLS estimate in column 1 that is biased toward zero. The 2SLS regressions are intended to purge such correlation from data.

In column 3 we add controls for a full set of birth year dummies, as well as dummies for female, non-white and foreign-born. These controls reduce the magnitude of the coefficient on import exposure by about one-fifth.[23] Column 4 controls for individuals' work history by adding variables for initial annual log wage averaged over 1988-1991, an interaction of initial wage with age, and dummies for firm tenure (0-1, 2-5, 6-10 years), experience (4-5, 6-8, 9-11 years), and firm size (1-99, 100-999, 1000-9999 employees). Unreported coefficient estimates indicate that workers with higher initial earnings, higher tenure, or larger initial employers have higher cumulative earnings. The additional controls have little impact on the coefficient of primary interest.

[21] Non-manufacturing workers are uninteresting as a comparison group as by definition they have zero trade exposure.

[22] The implied differential reduction in earnings for the worker at the 75th percentile is 24% ($-3.5\times(7.30 - 0.62)$) of initial annual earnings in column 1 and 51% ($-7.6\times(7.30 - 0.62)$) of initial annual earnings in column 2.

[23] Cumulative earnings over the period are lower for women, non-whites, and the foreign born.

To account for cross-industry heterogeneity, the remaining four columns the table successively add an extensive set of industry-level controls, including: initial levels of penetration by imports from China and other countries, as well as the share of imported intermediate inputs in material purchases (column 5); 10 broad manufacturing sector dummies (column 6); the employment share of production workers, log average wage, and the ratio of capital to value-added in 1991, as well as the 1990 levels of computer investment and the investment share of high-tech equipment (column 7); and the change in industry employment share and log average wage level during the preceding 16 years (column 8). The inclusion of 10 dummy variables for manufacturing sub-sectors is particularly noteworthy because it implies that the subsequent regression models compare outcomes for manufacturing workers who are initially employed in different industries of the same sub-sector, rather than comparing workers across very different fields of economic activity. A notable pattern across these columns is that each subsequent set of controls increases the magnitude of the point estimate for import penetration, which obtains a coefficient of -8.32 in the final column. This pattern suggests that conditional on demographic measures, workers with somewhat higher potential earnings are initially employed in industries that subsequently experience sharp rises in trade exposure; thus, accounting for these sources of industry heterogeneity leads to a somewhat larger estimate of the earnings losses that workers experience due to trade exposure.

In Table 2, we consider two additional outcome measures and perform falsification tests. The first column of the upper panel replicates the final (and most exhaustive) specification for cumulative earnings from Table 1 in column 8, which will serve as our baseline specification going forward. The second column considers an additional outcome measure: the number of years between 1992 and 2007 in which the worker has non-zero labor earnings. This measure is rather coarse: an individual who works a single day in a year will have non-zero earnings, so even prolonged periods of non-employment will go undetected unless they span a full calendar year. The point estimate of -0.71 in column (2) is negative, suggesting that increases in industry trade exposure reduce subsequent years of employment among industry workers. But this coefficient is not statistically significant, and implies only a modest effect of trade exposure on years with positive earnings.[24]

The third column of Table 2 considers the impact of trade exposure on earnings per year of employment (expressed in multiples of the initial annual wage) for years in which labor earnings are non-zero. The point estimate of -0.48 (t=2.9), suggests that trade exposure substantially depresses future earnings. Recall that the 90/10 trade exposure differential is 25.9 percentage points, implying that earnings are differentially reduced by 12.4% *per year* (25.9×-0.48) for a worker initially

[24] The differential drop in employment years for a manufacturing worker at the 90th percentile of exposure relative to a worker at the 10th percentile is 18.4% of a year (25.9×-0.71), or 2.2 months, during the 16-year outcome period.

employed in an industry at the 90th of exposure relative to a worker at the 10th percentile of exposure.[25] Thus, the reduction in cumulative earnings evident in column 1 appears to be largely the result of changes in within-year earnings, rather than of extensive periods of non-employment. These within year earnings changes are a combination of reduced earnings per hour and reduced hours worked, which we cannot disentangle, meaning that our results do not negate an impact of import competition on the *within-year* extensive margin of employment.

The lower panel of Table 2 examines whether the growth in import competition from China in the 1990s and 2000s "predicts" earnings and employment outcomes for an earlier cohort of workers. This provides a falsification test of our results. We draw on an extended version of the Social Security data to construct cumulative earnings from 1976 to 1991 for workers who were 22 and 64 years of age during this outcome period.[26] We then examine whether cumulative earnings, years of non-employment, and average earnings per year employed for these workers from 1976 to 1991 are correlated with the change in Chinese import penetration from 1991 to 2007 that occurred in the industry that employed a worker in 1975. The estimates in panel B provide scant evidence that workers who in 1975 were employed in industries that subsequently saw large increases in China trade exposure (during the 1990s and 2000s) suffered reduced earnings or employment during the 1970s and 1980s. Column 1 estimates a negative relationship between cumulative earnings and future industry-level China trade exposure. But the point estimate is less than one-fifth the magnitude of the analogous contemporaneous estimate in panel A, and it is not remotely close to significance. Column 2 finds a weakly *positive* relationship between years of non-zero labor income and subsequent industry trade exposure, opposite to panel A. Finally, column 3 finds a negative but insignificant relationship between annual wages in years with non-zero earnings and subsequent trade exposure. The point estimate in this case is but one-quarter the magnitude of the estimated contemporaneous effect above. Future trade exposure at best weakly predicts past earnings and employment outcomes for workers, suggesting that our results are not attributable to a common causal factor that is behind both the long-run decline of manufacturing and the rise of import competition from China. These results are consistent with our previous finding that the estimated

[25]In comparing columns 2 and 3 to the estimate in column 1, note that 16 times the reduction in earnings per year (column 3) plus the reduction in years with earnings (column 2) is $16 \times -0.48 - 0.71 = -8.38$, which is close to the estimated effect for cumulative earnings (column 1). These numbers will generally not match the column (1) estimate exactly, however, because there are important differences between manufacturing workers' average years of employment (14.3 years) over these 16 years and their and cumulative earnings (18.1 times initial wages), reflecting the fact that workers' real earnings typically rise until late career. Consequently, an employment reduction by one year will typically reduce earnings by more than the equivalent of one initial annual wage.

[26]The sample for the analysis of the 1976-1991 period uses the same sampling criteria as our main sample, and is hence restricted to workers who earned at least the equivalent of $7,950 at 2007 values in each of the four years preceding the outcome period.

effect of trade exposure on cumulative earnings after 1991 is robust to controlling for lagged trends in industry employment shares and industry average wages (column 8 in Table 1).

4.2 Impact of Trade Shocks on Patterns of Employment and Benefit Receipts

How do workers and employers respond to an increase in import competition? Firms may adjust labor quantities, by temporarily or permanently reducing employment. Workers who separate from their employers must then decide whether to search for a position in a similar line of work, which may reward the skills they have accumulated on the job, or to search more broadly, in fields of work where their earnings potential may be less. The SSA data permit us to evaluate the margins along which workers adjust to changes in import penetration.

Panel A and B of Table 3 shows cumulative earnings and years of work at the worker's initial employer (column 2), at other employers within the worker's initial two-digit industry (column 3), at employers within manufacturing but outside the worker's initial industry (column 4), outside of manufacturing entirely (column 5), and for new employers whose industry is unrecorded in the data (column 6), which account for less than five percent of observations in the sample. For panels A and B (containing results for cumulative earnings and cumulative years of employment), summing the coefficients in columns 2 through 6 produces the value in column 1.

In column 2A, the large negative and significant coefficient on import penetration indicates that workers more exposed to trade with China have substantially reduced earnings at their initial employer. Manufacturing workers with greater exposure to import penetration thus appear to be more likely to separate from their employers. In column 3A, the dependent variable is total earnings in multiples of the initial average wage at employers in the worker's 1991 two-digit industry that are distinct from the initial firm. The negative and marginally significant coefficient on import penetration indicates that workers more exposed to imports experience reductions in subsequent earnings both at the initial firm and also within other firms in the original industry of employment.

Panel B considers the analogous impacts of trade exposure on cumulative years with positive employment. Between 1992 and 2007, the average worker in the high-labor-force-attachment sample spent 7.7 years working in his 1991 two-digit industry, with approximately one-fifth of this time at firms other than the 1991 employer. Comparing workers at the 90th versus the 10th percentile of trade exposure, the more-exposed worker spent 1.7 fewer years ($-6.4 \times (26.0-0.06)$) working for his initial firm and 2.2 fewer years in total ($(-6.4-2.0)\times(26.0-0.06)$) working in his initial two-digit industry. Thus, the trade-induced reduction of a worker's years of employment in the initial industry is ten times larger than the overall decline employment as measured in column 1.

Since the net effect of trade exposure on earnings in column 1A is less negative than the reduction in own-firm and own-industry earnings (columns 1B and 1C), we infer that trade-impacted workers are able to partly offset their earnings losses in the initial firm and industry by moving across industries. Where do these offsets accrue? In column 4A, we use as a dependent variable total earnings in the same sector as the 1991 employer but in a different firm and two-digit industry. For manufacturing workers, this variable measures total earnings from employers in two-digit manufacturing industries other than their initial industry and employer. The coefficient on import penetration is positive and precisely estimated, indicating that more trade-exposed workers are relatively more likely to obtain earnings from a different industry within manufacturing. But these offsetting earnings gains are only 40 percent as large as the losses incurred with the original employer and sector $(5.57/(9.97 + 3.09) = 0.43)$. Thus, an increase in trade exposure in the worker's initial firm reduces the worker's total manufacturing earnings, even net of sectoral mobility. Columns 5A and 6A complete the earnings picture by considering earnings accrued outside of the worker's initial sector and with firms whose industry could not be identified.[27] For manufacturing workers, the impact of trade exposure on earnings outside of manufacturing are on net negative but small relative to the own-sector effects. Thus, the primary impact of trade exposure on earnings of manufacturing workers is reduced earnings in manufacturing.

These results do however suggest that more trade exposed workers are subject to increased churning across employers and industries. To gauge these effects, we consider in columns 4B through 6B whether more trade-exposed workers are more likely to work outside of their original two-digit manufacturing industry or outside of manufacturing altogether. Column 4B shows that workers more exposed to import growth from China have a substantial increase in years of employment in manufacturing outside of the original firm and two-digit industry. Summing across columns 2 through 4, we find that workers more exposed to import growth from China are more likely to leave manufacturing. Comparing those at the 90th and 10th percentiles of trade exposure, more exposed workers spend 0.98 fewer years working in manufacturing over the next sixteen years $((-6.37 - 2.00 + 4.60) \times 25.9 = 0.98)$. This is a substantial reduction from the base level of 9.3 years among workers initially employed in manufacturing. The estimates of columns 5A and 6A imply that this reduction in manufacturing employment is only partially compensated for by additional employment in firms outside the manufacturing sector or in firms that lack an industry code in the

[27] A large majority of firms with missing industry code were incorporated in the years 2000 to 2007, when a new data collection process no longer facilitated information on industry. Even if one assumes that all new firms that employ former manufacturing employees operate in the manufacturing sector, there is still a sizable negative effect of trade exposure on manufacturing earnings and employment, which may be seen by summing the coefficients across columns 1, 2, 3 and 5 of Panel A or B.

data. In the presence of firm or industry-specific human capital, such reallocations of employment across firms, industries and sectors may imply a loss in earnings.

The results in panel B also allow us to determine the fraction of the decline in cumulative earnings that is associated with reduced earnings per year of employment, versus reduced years employed. In column 2, the ratio of the coefficients in panel B to panel A is 0.63. About two-thirds of reduced earnings at the initial employer resulting from exposure to import growth is due to fewer years worked at the employer and about one-third is due to lower earnings per year worked. For manufacturing earnings as a whole, approximately 50 percent of the total earnings effect is due to reduced years of employment with the other half due to reduced earnings per year. Panel C of the table suggests that workers with more trade exposure also experience lower earnings per year of employment once they left their initial firm and moved to other employers within or outside the manufacturing sector.[28]

The churning of trade-affected workers among industries is important in light of how the U.S. government helps workers who face import competition. The primary government labor program related to imports is Trade Adjustment Assistance, which allows eligible workers who lose their jobs due to increased imports to extend unemployment benefits for an additional 18 months, as long as they spend this time in a certified training program.[29] In the literature, there is skepticism about the economic rationale for worker training programs (Heckman, LaLonde, and Smith, 1999), though there has been little formal evaluation of TAA (see Decker and Corson, 1995; Baicker and Rehavi, 2004). In the case of adjustment to trade shocks, it appears that workers more exposed to import competition are more likely to end up changing their industry of employment, suggesting that they in fact may have demand for retraining.

One adjustment program that is observable in our data is Social Security Disability Insurance (SSDI), in which the federal government makes cash payments to workers who have developed a physical or mental disability that prevents them from being gainfully employed. In panel A of Table 4, column 1 has as the dependent variable total years that a worker receives labor income only, column 2 has total years with positive labor income and positive SSDI benefits, column 3 has total years with zero labor income and positive SSDI benefits, and column 4 has total years with zero labor income and zero SSDI benefits. Echoing the results in Table 2, column 1A shows a negative but not significant correlation between trade exposure and years with labor earnings as the sole source of income in the data. In column 2A, trade exposure is positively but not significantly

[28]These results must be interpreted with some caution, however, since the earnings-per-year effects mix together variation stemming from hours and wages.

[29]Relocation allowances and other benefits are also available. See http://www.doleta.gov/tradeact/.

correlated with total years receiving both SSDI benefits and labor income. In column 3A, however, trade exposure predicts a significant increase in years receiving SSDI benefits with no labor income. For the 90th and 10th percentile comparison, the more trade-exposed worker spends 1.4 additional months receiving SSDI benefits with no labor earnings. To place this magnitude in context, the average manufacturing worker in our sample spends approximately four months (0.32 years) over the sample period with zero labor income and positive SSDI benefits. Comparing the impact of trade exposure on years with labor earnings but no SSDI (column 1) and years with SSDI but no labor earnings (column 3), we find that slightly more than half (53%) of the reduction in years with positive earnings is accounted for by years of non-participation accompanied by SSDI receipt. Of the remainder, approximately one-third is accounted for by periods of SSDI receipt with positive labor earnings and two-thirds by periods of zero income from either source.[30]

In unreported results, we repeat the analysis using receipt of any type of Social Security benefit, which adds to SSDI Social Security Retirement Income and Supplemental Security Income. The results are nearly identical to those in panel A of Table 4, indicating that most of the responsiveness of Social Security benefits to import penetration is coming through SSDI. This feature of the results is unsurprising, given that our main sample consists of working-age individuals with high-attachment to the labor force who are unlikely to qualify for other types of Social Security payments.

Panel B of Table 4 studies more closely the impact of trade exposure on the incidence and quantity of SSDI benefits. Column 1B shows a positive and significant impact of trade exposure on the cumulative receipt of SSDI income measured in units of the initial average wage. Applying the 90/10 exposure metric, the point estimate of 0.36 implies that a worker at the 90th percentile of exposure receives an additional 9% of his initial annual earnings in SSDI benefits relative to a worker at the 10th percentile of exposure. Recall for comparison from Table 1 that the differential loss in total *labor* earnings at the 90th relative to 10th percentile of import exposure is a substantial 197% of initial income. Thus, SSDI benefits only replace on average a small fraction (less than 5 percent) of the income lost to trade exposure. Yet, seemingly paradoxically, SSDI payments average a substantial 47 percent of initial average labor earnings for years in which workers in our sample receive SSDI.

Column 2B clarifies why SSDI benefits offset such a small fraction of earnings losses despite their relatively high replacement rate. While trade exposure significantly increases the likelihood that a worker receives SSDI benefits at some point in the next sixteen years, the impact is not large.

[30]Workers may exit the labor force and obtain SSDI in the same calendar year without having both sources of income concurrently. In addition, SSDI recipients are permitted to work up to a Substantial Gainful Activity threshold (currently $1,010 per month for non-blind adults) without jeopardizing their SSDI benefits.

Comparing the 90th and 10th percentile manufacturing worker, the increment to the probability of SSDI receipt is 2.1 percentage points, which is approximately a 25% increase over the base rate among manufacturing workers in our sample. Thus, most of the reduction in earnings from trade exposure accrues due to lower annual earnings in years in which exposed workers remain in the labor force. Disability plays an important role on the extreme intensive margin–that is, among workers who exit the labor force altogether–but the majority of trade-exposed workers remain attached to the labor market, albeit at reduced earnings and employment levels.

Our finding that increased uptake of SSDI benefits is associated with negative labor demand shocks is consistent with other literature (Black, Daniel and Sanders, 2002; Autor and Duggan, 2003). The broader policy significance of uptake of SSDI comes from the fact that most workers who begin receiving benefits from the program continue to receive them until retirement or death (Autor and Duggan, 2006). Workers who exit the labor force and take up SSDI as a consequence of increased import competition therefore may receive these benefits for an extended period of time.

5 Heterogeneity in Adjustment to Trade Exposure

So far, our regression models do not specifically allow for heterogeneity in the marginal impacts of trade exposure across individuals in the sample. Given China's strong comparative advantage in low-skill intensive production tasks, it is unlikely that the impacts are uniform across demographic groups. To explore sources of heterogeneity in adjustment to trade shocks, we re-estimate the main regressions for years of employment, cumulative earnings, and years of SSDI receipt separately for individuals according to their observable characteristics.

5.1 Variation in Adjustment among Strongly versus Weakly Attached Workers

The analysis to date has focused exclusively on workers with high labor force attachment, those who earned at least the real 1989 full-time annual federal minimum wage in each of the four years between 1988 and 1991. In Table 5, we estimate separate models for samples of less strongly attached workers (panels B and C), those who between 1988 and 1991 had part-time and discontinuous employment .In panel D, we pool the sub-samples of less attached workers with the primary sample of high attachment workers. For reference, panel A presents a comparison set of results using exclusively the primary sample of high-attachment workers. .[31] [*Updated results TBA.*]

[31] The full sample includes all working-age individuals who had positive earnings (and a valid industry code) for at least one year in each of the three-year periods, 1987 to 1989 and 1990 to 1992. The weakly attached sample excludes individuals who earned at least three-fourths of the real 1989 full-time annual federal minimum wage in each of the

5.2 Variation in Adjustment by Initial Earnings Level, Sex, and Age

Table 6 considers impacts of trade exposure on employment and earnings separately by initial wage level and sex. The first panel presents estimates for workers whose initial average wage level in 1988 through 1991 was, alternatively, below the median of their birth cohort (panel A1) and above the cohort median (panel A2). The second panel presents analogous estimates for males and females separately (panels B1 and B2), and the third and fourth panels (C and D) further subdivide each sex into high and low-wage workers.[32]

Strikingly, the adverse impacts of trade exposure on subsequent earnings and employment are almost entirely concentrated on low-wage workers. The estimate in column 1 for the impact of trade exposure on cumulative earnings of below-median workers yields a large and highly significant negative coefficient that, scaled by the 90/10 metric, implies that a low-wage worker in manufacturing at the 90th percentile of exposure loses approximately 5.2 (-20.0×(26.00 - 0.06)) additional years of cumulative earnings over the subsequent sixteen years relative to a worker at the 10th percentile of exposure. This effect is more than twice as large as the impact for the full sample (Table 2, column 1A), and almost eight times larger than the comparable impact for high-wage workers (Table 6, column 1 of panel A2).

The next three columns of estimates help to illuminate why the impact is so much greater for low-wage workers. While both high and low-wage workers experience substantial earnings losses at the initial employer, high-wage workers on average make up approximately two-thirds of these losses with additional employment at other firms in the same sector and employers outside of the sector. Low-wage workers, by contrast, experience no offsetting increase in earnings within the same sector and accrue further negative earnings effects outside of the original sector. The second set of rows in panel A reveal that the differential impact of import exposure on high versus low-wage workers does not stem primarily from larger declines in years of employment among the latter group but rather from lower earnings per year.[33] It is, in turn, likely that some of the reduced earnings among low-wage workers is due to their reduced work hours within each year rather than reduced hourly pay. Unfortunately, our data do not allow us to explore this margin further.

The second panel of Table 6 presents analogous estimates where the sample is split on sex rather than initial earnings. We find robust and large earnings effects of trade exposure for both sexes.

four years between 1988 and 1991.

[32]The same median wage level is used for all three splits.

[33]Indeed, the estimated effects of trade exposure on years with positive earnings are not significant for either subgroup—though this appears primarily to reflect loss of precision due the sample split since both point estimates are economically significant.

For males, the point estimate of -6.65 implies a differential loss of 1.72 years of initial earnings for a worker at the 90th versus 10th percentile of exposure. For females, this differential impact is twice as large, amounting to 3.46 years of lost earnings. The next two panels of clarify why the impact is so much larger for females than males. The differentiating factor is the initial level of earnings. Males and females with below-median initial earnings experience comparably large adverse impacts on subsequent earnings. Conversely, males and females with above-median earnings experience no significant net effect of trade exposure on subsequent employment outcomes. Thus, females as a group are typically more adversely affected than males because they comprise a disproportionate share of low-wage workers within a cohort. Indeed, 73% of the female workers in our sample are initially earn below their cohort's annual median earnings versus only 29% of males.

For both sexes, the key factor that appears to mediate the impact of trade exposure on earnings is workers' ability to obtain re-employment apart from the initial employer. Specifically, among high and low-wage workers of both sexes, trade exposure results in comparably large and statistically significant reductions in earnings with the initial employer. Not only do low-wage males and females appear unable on average to recover the lost earnings with the initial employer in subsequent jobs inside or outside the original sector, their subsequent employment experiences exacerbate the initial loss. Thus, comparing columns 1 and 2 of panels C1 and C2 (for low-wage males and females, respectively), it is apparent that the total effect of trade exposure on subsequent earnings (column 1) is twice as large as the earnings loss with the initial firm (column 2); lower earnings in subsequent years of employment at other employers explains the remainder. By contrast, the same comparison applied to high-wage males and females (panels C2 and D2) reveals that the total effect on earnings is less than one-third as large as the direct effect on initial-employer earnings; high-wage workers appear to regain lost ground through a combination of additional earnings inside and outside the original sector of employment.

The results for cumulative years of employment reveal that high-wage workers are also considerably more mobile across firms and sectors. Among both males and females, the reduction of employment years at the initial firm is twice as large for high-wage workers compared to their low-wage peers, and while firm mobility among low-wage workers is largely constrained to moves between incumbent manufacturing firms, high-wage workers appear to experience substantial, though imprecisely estimated, increases of employment outside the manufacturing sector or in newly established firms. High-wage workers' greater mobility between firms and sectors may help them to avoid some of the earnings losses that would have resulted if they had stayed in their initial, trade-exposed manufacturing firms.

Alongside initial wage level and sex, a third important source of potential heterogeneity in worker adjustment to trade exposure is the age at which workers are required to make adjustments. One might hypothesize, for example, that older workers would be most adversely impacted by trade exposure since their ability to adapt to new employers, industries and skill sets may be somewhat limited. Alternatively, greater seniority with the current employer might tend to shield older workers from displacement whereas younger workers could be at risk of greater disruption to their career trajectories. Table 7 explores are-related heterogeneity in impacts of trade exposure by subdividing our sample into three cohorts based on their age in 1992: young workers, ages 22 through 30 (panel A); early prime-age workers, ages 31 through 40 (panel B), and late prime-age workers, ages 41 through 49 (panel C).[34] Comparing across the three panels, it is immediately clear that while all three age groups experience economically and statistically significant earnings effects from trade exposure, the impact is declining with age. We estimate that the 90/10 differential earnings impact is 275% of initial annual salary for young workers, 164%of initial annual salary for early prime-age workers, and 132% of initial annual salary for late prime-age workers.

What explains these age patterns? Two obvious explanations for the differential effects among young workers can be ruled out: concentration of young workers in the sample of low-wage workers that we studied in Table 6, and longer career horizons. On the first point, because our definition of high versus low-wage workers (used in Table 6) is based on an age-cohort specific median split, exactly half of all workers in each age cohort are designated as high wage by construction. Thus, young workers are not overrepresented in the low-wage sample in Table 6. On the second point (career horizon), our sample is constructed so that workers do not "age out" of the sample during the outcome window. Thus, even the oldest workers in panel C of Table 7 are below the typical retirement age of 65 in 2007.

There do, however, appear to be substantive differences in the nature of trade adjustment between younger versus older workers—though we caution that precision is limited by the three-way sample split, so our inferences must be viewed as tentative. While the first two columns show that the reduction in employment years is slightly larger for older workers, both overall and at the initial firm, the third row of each panel reveals that younger workers experience more pronounced reductions in earnings per year of employment across all employers. The 90/10 differential earnings losses for younger workers amounts to an average 30 percent reduction in annual earnings relative to base year wages for each subsequent year with positive earnings. For early and late prime-age workers, the differential reduction is no more than one-fourth as large. While we cannot disentangle how much of

[34] Recall that our sample is drawn so that workers' age does not exceed 64 in the final outcome year of 2007.

the differential earnings reduction among the young is due to losses of hours versus hourly wages, we suspect that both forces combine to lower earnings per year. Early job loss likely inhibits the steep earnings trajectory that young workers typically experience (Oreopoulos, von Wachter and Heisz, 2012), likely leading to lower wages and less stable employment at mid-career.

5.3 Variation in Adjustment by Firm Size and Firm Average Wages

There is a large literature in international trade on how firm heterogeneity affects adjustment to trade shocks. In the influential Melitz (2003) model, larger, more productive firms are more likely to export and less likely to exit production in response to a reduction in import barriers. These predictions are supported by a substantial body of evidence that documents a positive correlation between exporting and measures of firm size, TFP, skill intensity, and capital intensity (Bernard, Jensen, Redding, and Schott, 2007). Recent literature draws an explicit link between firm productivity and earnings, with larger firms paying higher wages (e.g., Helpman, Itskhoki, and Redding, 2010; Amiti and Davis, 2012; Helpman, Itskhoki, Muendler, and Redding, 2012). We next consider whether the characteristics of firms matter for worker adjustment to changes in import penetration.

Table 8 examines the impact of exposure to China trade on cumulative earnings, cumulative years of employment, and annual earnings per year worked for individuals based on the characteristics of their employer in 1991. We present results either for the overall impact on workers (columns 1-3) or for the impact that workers perceive at the initial firm (columns 4-6), separating initial firms according to whether their 1991 mean wage is above or below the industry average (panel A) or by total employment in 1991 (panel B).

Beginning with column 1, workers initially employed in low-wage firms (panel A1) suffer large trade-induced losses in cumulative earnings compared to workers from high-wage firms (panel A2). For the 90/10 split of workers by trade exposure, the impact on cumulative earnings for more exposed workers is 2.6 times larger in low-wage firms (-3.0 years of initial annual earnings = -11.6×25.9) than in high-wage firms (-1.1 years of initial annual earnings = -4.4×25.9). These differences do not arise because of larger trade-induced reductions in years with positive earnings for workers from low-wage firms, however. In column 2, the impact of trade on cumulative years with positive income is actually larger for workers from high-wage firms (panel A2) than for workers from low-wage firms (panel A1), though neither effect is precisely estimated. The explanation for the larger effect of trade on cumulative earnings for low-wage-firm workers must therefore rest on how trade affects their annual earnings, evidence for which we see in column 3. The impact of a given trade shock on earnings per year worked is three times larger for workers from low-wage firms (-0.69, panel A1) than for workers from high-wage firms (-0.23, panel A2), with the former effect significant and the latter effect insignificant.

Why might workers from low-wage firms be differentially hurt by trade shocks? One indication is that these workers appear to be slower to separate from their initial employers in response to an increase in industry import penetration. Comparing panels A1 and A2 shows that for a given change in Chinese imports, workers from low-wage firms have smaller reductions in cumulative earnings (column 4) and in cumulative employment (column 5) at their initial places of work. Workers from low-wage firms thus appear to be less mobile in response to industry-level increases in import competition, which may contribute to their relatively poor earnings trajectory.

In panel B of Table 8, we turn to firm size differences as a mediating factor in worker adjustment to trade exposure. In response to a given trade shock, workers initially employed in large firms see larger reductions in cumulative earnings over the 16-year sample period (column 1). Using the 90/10 metric for trade exposure, the impact on more exposed workers from large firms (-4.8 years of initial annual earnings = -18.5×25.9, panel B3) is 3.4 times that for more exposed workers from middle-size firms (-1.4 years of initial annual earnings = -5.5×25.9, panel B2). Similar to panel A, these differential trade impacts are only weakly related to changes in cumulative years worked. Taking the ratio of column 2 to column 1, the reduction in cumulative years with positive earnings can account for only 11% (2.0/18.5, panel B3) of the change in cumulative earnings for workers from large firms and for only 12% (0.7/5.5, panel B2) of the change in cumulative earnings for workers from middle-size firms. Rather, in response to a given trade shock, workers initially employed in large firms experience larger reductions in earnings per year worked, as seen in column 3. For the 90/10 split, the impact on earnings per year worked for more exposed workers from large firms (-26% of initial annual earnings = -1.0×25.9, panel B3) that is 3.3 times larger that for more exposed workers from middle-size firms (-8% of initial annual earnings = -0.3×25.9, panel B2).

The responsiveness to trade shocks of workers initially employed in large firms does not appear to be due to these individuals being immobile between employers. In response to a given increase in import competition, workers from large firms have large reductions in cumulative years worked at their initial employer compared to workers from smaller employers. For the 90/10 split, more exposed workers in large firms have 4.0 fewer years (-15.5×25.9, column 5, panel B3) of positive earnings from their initial employer but only 0.5 fewer years (-2.0×25.9, column 2, panel B3) of positive earnings overall, indicating substantial mobility. For workers in middle size firms, these values are 0.8 fewer years (-15.5×25.9, column 5, panel B3) with positive earnings from the initial employer and 0.2 fewer years (-2.0×25.9, column 2, panel B3) with positive earnings overall. Thus, the vulnerability of workers from large firms to trade shocks must lie elsewhere.

We are not the first to show that larger firms are more affected by labor-market shocks. Following mass layoffs, Jacobsen, LaLonde, and Sullivan (1993) and von Wachter and Bender (2006) find that earnings losses are greatest for workers separated from the largest employers. Bernard, Jensen, and Schott (2006) find that the impact of import penetration on plant-level employment growth in the United States is more negative in plants with higher levels of TFP, which is strongly positively correlated with plant size. Biscourp, and Kramarz (2007), using French data, find that in large firms (but not small firms) import growth at the firm level is positively correlated with job destruction. Holmes and Stevens (2010) obtain similar results in U.S. data, based on the calibration of a model that allows for two types of firms within an industry, those that produce standard goods and are subject to heterogeneous productivity (as in Melitz, 2003) and specialty firms that produce customized goods for particular clients. In equilibrium, standard firms are relatively large and it is they who contract most sharply in response to a surge in imports from China.

6 Alternative Specifications

In this section, we describe alternative measures of industry exposure to import growth from China or other low-wage countries. Using these measures, we re-estimate the regressions for cumulative earnings from column 8 of Tables 1. Table 9 contains the results. The alternative measures of trade exposure are the following:

(i) *Gravity-based measure of trade exposure.* Our strategy for identifying the impact of trade exposure as measured in (3) is based on the assumption that growth in imports from China in high income countries is due to supply shocks in China, or global changes in trade policy toward China, rather than to import demand shocks in these countries. As an alternative approach, we use import growth from China as predicted by the gravity model of trade. Using data on bilateral imports by high income countries at the industry level, we estimate a gravity model in which the dependent variable is log imports from China minus log imports from the United States and the regressors are dummy variables for the importing country, dummy variables for the industry, and controls for trade costs. Changes in the residuals from this regression represent the change in China's comparative advantage and trade costs in an industry relative to the United States. As described in the appendix to Autor, Dorn, and Hanson (2012), we use these residuals to construct an alternative measure of import growth. This approach, shown in panel I of Table 9, allows us to estimate the impacts of trade exposure under weaker identifying assumptions.

(ii) *Other low-income countries.* Changes in import penetration from China may overstate the change in trade exposure for U.S. workers if China competes with other low-wage countries in the U.S. market. We add to imports from China imports from all other low-income countries. Grouping countries accounts for possible displacement effects, in which growth in U.S. imports from China is offset by reduced imports from other countries that compete with China in the U.S. market. Given that China accounts for over 90 percent of growth in U.S. imports from low-wage countries, this modification is unlikely to have large effects on the trade exposure measure. Results using this measure of trade exposure are shown in panel II of Table 9.

(iii) *Other destination markets.* In (2), growth in China's exports affects U.S. industry output not just through intensifying competition in the U.S. market but also in foreign markets in which U.S. firms compete with China. Following this logic, we expand the definition of import penetration in (3) to include all destination markets to which U.S. industries export goods. Results using this measure of trade exposure are shown in panel III of Table 9.

(iv) *Net imports.* China's growth means increased demand for U.S. exports, as well as an increased supply of goods to the U.S. market. To account for U.S. exports to China, we also measure trade exposure using *net* imports rather than gross imports, which allows U.S. exports to China to offset the loss in production from greater import penetration. Because U.S. manufacturing imports from China are six times larger than U.S. manufacturing exports to China, this change is also unlikely to have only a large effect on the trade exposure measure. Results using this measure of trade exposure are shown in panel IV of Table 9.

(v) *Factor content of trade.* If the labor content of production varies across goods that China ships to the U.S. market, measuring trade in dollar terms may not accurately capture the impact of import growth on U.S. workers (Deardorff and Staiger, 1988; Borjas, Freeman, and Katz, 1997; Burstein and Vogel, 2011). To account for differences in labor intensity across sectors, we measure net imports in worker equivalent units, using direct and indirect labor usage in the production of industry outputs, based on the 1992 U.S. input-output table. Results using this measure of trade exposure are shown in panel V of Table 9.

(vi) *Intermediate inputs.* Growth in exports by China represents not just greater competition for U.S. producers but also greater supply of inputs they use in production, which may have positive effects on industry productivity (Goldberg, Khandelwal, Pavcnik, and Topalova, 2010). To account for input supply effects, we adjust total industry imports for imports of intermediate inputs. Results using this measure of trade exposure are shown in panel VI of Table 9.

Table 9 documents that each of these alternative measures of trade exposure has a negative impact on cumulative earnings of workers over the 16-year sample period, consistent with the main results in Table 1. The estimated effects are statistically significant in all setups except for panel I where the coefficient estimate has a p-value of 0.13. Results for cumulative years with positive earnings and for earnings per year also reflect the pattern of our main specification in Table 2, which documented particularly strong negative effects of exposure to Chinese imports on earnings per year, and more modest effects on employment years.

7 Conclusion

China's spectacular export growth in recent decades provides a rare opportunity to examine how economies adjust to trade shocks. Changes in trade flows typically have myriad causes and are jointly determined with other outcomes of interest. In the case of China, its highly backward state at the time the country began to open to foreign trade and investment meant that its subsequent export growth would be driven by the convergence of its economy toward the global technology frontier, rather than by idiosyncratic shocks in its trading partners. We exploit this feature of recent Chinese history to examine how U.S. workers adjust to a surge in imports in their initial industries of employment. Data from the Social Security Administration give us a unique longitudinal perspective over an extended period of time to observe how U.S. workers respond to greater import competition. We define a worker's exposure to China trade based on the industry of employment in 1991, prior to the acceleration of China's global export growth.

Workers who were initially employed in an industry more exposed to import growth from China experienced over the 1992 to 2007 period lower cumulative earnings, weakly lower cumulative employment, lower earnings per year worked, and greater reliance on Social Security Disability Insurance. Exposure to trade induces workers to move between employers and between industries. Workers initially employed in industries with larger increases in import competition were more likely to leave their initial employer, more likely to leave their initial two-digit industry, and more likely to leave manufacturing overall.

There is considerable heterogeneity across workers in adjustment to import competition. Reductions in cumulative earnings are concentrated among low-wage workers, younger workers, and workers with weak attachment to the labor force, a pattern that may result because industries subject to greater import competition are more intensive in the use of their skills. Women are differentially exposed to import growth from China due to their relative concentration in low-wage jobs within manufacturing. However, the impact of trade shocks on low-wage women is comparable to that on low-wage men. Our results are robust to including a large set of industry controls, to using alternative measures of trade exposure, and to falsification tests that verify that future increases in trade exposure do not predict past changes in worker outcomes by industry.

We focus on import growth from China while recognizing that China actively participates in global production networks. Goods exported by China use inputs produced in other developing economies and in high-income countries. Still, China's enormous size and its rapid rate of technology convergence means that its own growth has been a major impulse for the expansion of global production networks in recent decades. Our findings do not preclude a role for other countries in the recent growth in U.S. imports of labor-intensive manufactures.

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Data appendix

Social Security Data

Our main source of data is a one percent extract from the Master Earnings File (MEF) of the U.S. Social Security Administration. The MEF data provides annual earnings and an employer identification number (EIN) for each job that a worker held in the years 1978 through 2007. For workers who have multiple jobs in a given year, we aggregate earnings across all jobs and retain the EIN of the employer that accounted for the largest share of the worker's earnings. Earnings data is inflated to 2007 using the Personal Consumption Expenditure Index, and annual earnings are winsorized at the 99th percentile of each year's wage distribution in order to mitigate the impact of outliers on the empirical analysis. The MEF also contains basic demographic information that stems from a worker's application for a Social Security card. Our analysis uses data on birth year, sex, race, and immigrant status (U.S. or foreign born). We code race as non-white if the race indicator is missing in the data, which is the case for about 3.5% of all observations.

For about 97% of all employees in 1991, we are able to match the EIN of the employer to firm data that provides information on industry, firm size (measured by employment and payroll), and geographic location of the firm. The industry classification is based on firms' registration with the Internal Revenue Service (IRS). Coders at the Social Security Administration transform the write-in information from the IRS form to a four-digit SIC code, or to a three-digit or two-digit SIC code if the description of firm activity is not sufficiently detailed to permit a preciser classification. The IRS switched from a paper-based application for obtaining an EIN to an online application procedure in the year 2000. For new firms that have been incorporated as of this year, we are no longer able to observe industry or other firm-level characteristics.

Our main sample comprises workers who were born between 1943 and 1970. We use this sample to study outcomes during the period 1992 to 2007 when these workers were between 22 and 64 years old. The sample is restricted to workers who were earning at least $7,950 per year in each of the four years 1988 to 1991, prior to the outcome period. The value of $7,950 (in 2007 dollars) corresponds to the earnings of a worker who was employed during 1,600 annual hours at the Federal minimum wage of 1989. The sample size of this main sample is 511,792. We also show additional results for a more sample that includes workers with a weaker labor force attachment. This alternative sample comprises the 880,465 workers who had positive earnings (and a valid industry code) during at least one year in each of the three-year periods 1987 to 1989 and 1990 to 1992.

Matching trade data to industries

Data on international trade for 1991 to 2007 are from the UN Comrade Database (*http:// comtrade.un.org/db/default.aspx*), which gives bilateral imports for six-digit HS products. To concord these data to four-digit SIC industries, we proceed as follows. First, we take the crosswalk in Pierce and Schott (2009), which assigns 10-digit HS products to four-digit SIC industries (at which level each HS product maps into a single SIC industry) and aggregate up to the level of six-digit HS products and four-digit SIC industries (at which level some HS products map into multiple SIC industries). To perform the aggregation, we use data on US import values at the 10-digit HS level, averaged over 1995 to 2005. The crosswalk assigns HS codes to all but a small number of SIC industries. We therefore slightly aggregate the four-digit SIC industries so that each of the resulting 397 manufacturing industries matches to at least one trade code, and none is immune to trade competition by construction. We also aggregate the trade data to three-digit and two-digit SIC industries in order to construct measures of import exposure for firms whose industry is not identified at the four-digit level in the Social Security Administration data. Details on our industry classification are available on request. Second, we combine the HS-SIC crosswalk with six-digit HS Comrade data on imports for the United States (for which Comrade has six-digit HS trade data from 1991 to 2007) and for all other high-income countries that have data covering the sample period (Australia, Denmark, Finland, Germany, Japan, New Zealand, Spain, and Switzerland) and then aggregate up to SIC industries. All import amounts are inflated to 2007 US$ using the Personal Consumption Expenditure deflator.

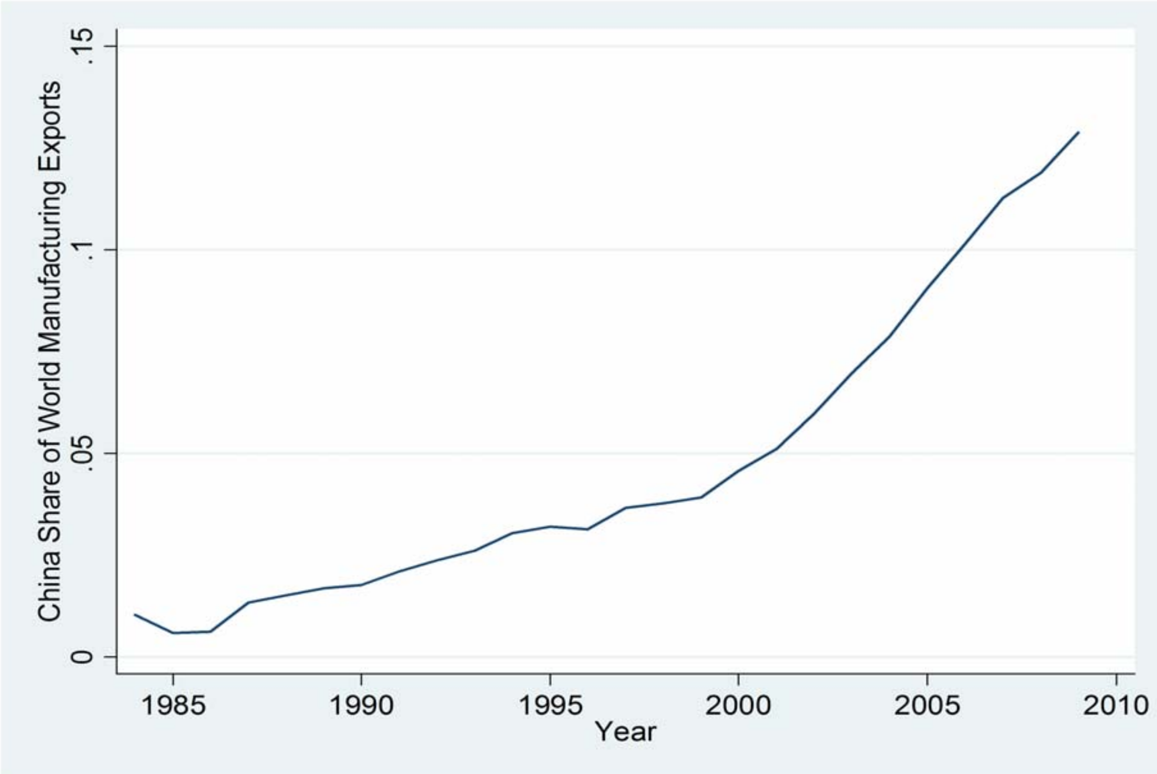


Figure 1.
China Share of World Manufacturing Exports, 1984-2009.

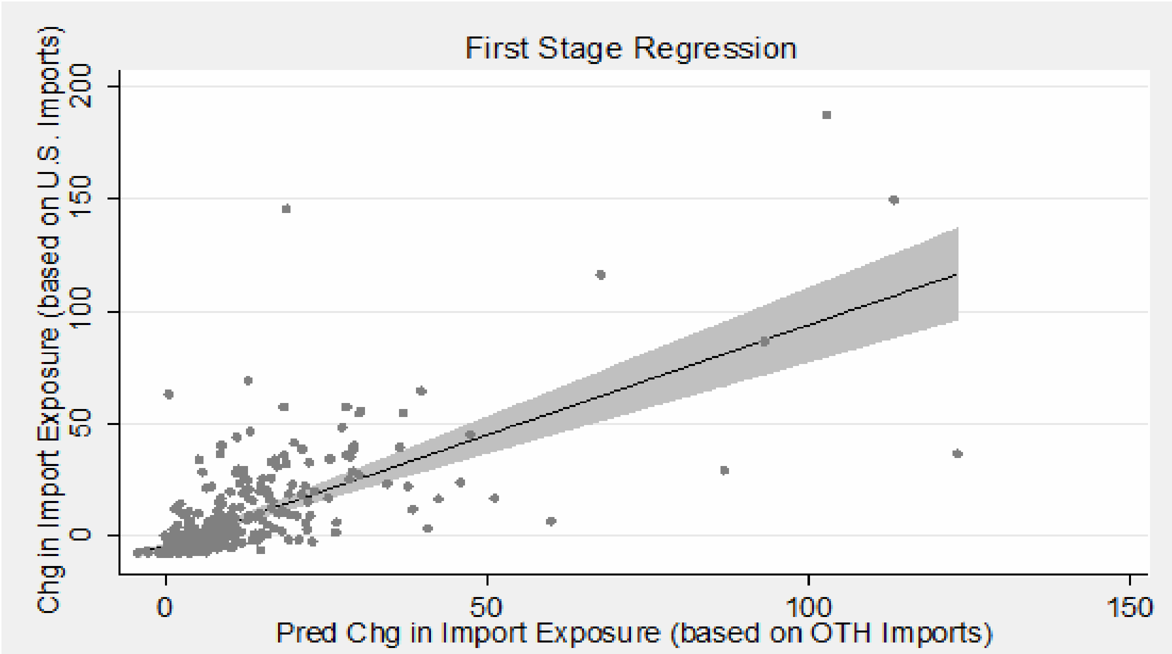
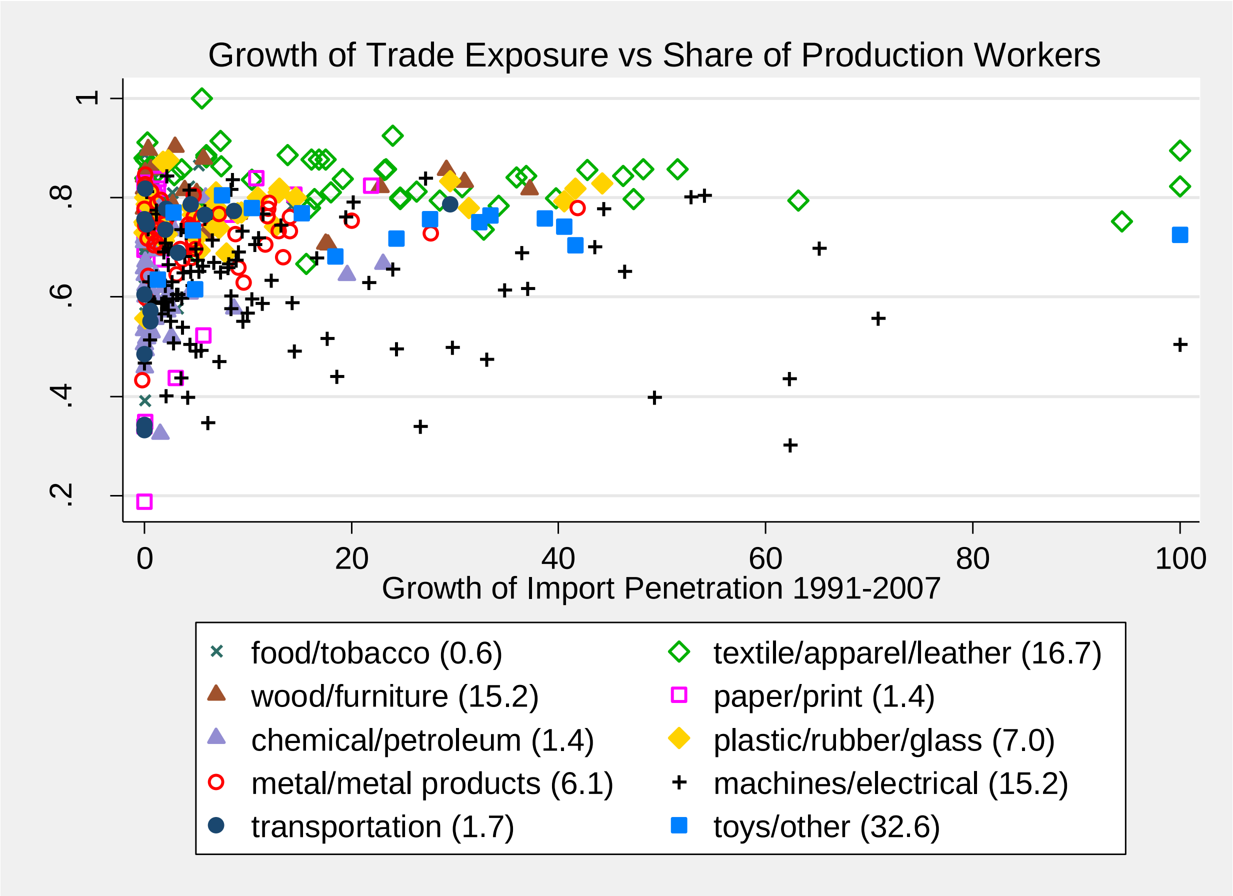


Figure 2.
2SLS First Stage Regression.

Notes: The graph corresponds to the first stage regression for the model in column 2 of Table 1 (coefficient 0.713, s.e. 0.083), and partials out a dummy variable for workers employed in manufacturing industries. The shaded area indicated a 95% confidence interval around the fitted regression line. The scatterplot is displayed only for workers who did not change their industry of employment between 1988 and 1991.



Notes: Numbers in parentheses in the legend indicate average growth of import penetration within industry group, weighted by 1991 employment. Values for growth of import penetration are winsorized at 100.

Figure 3

B. Pre-Period 1976-1991

(Δ Imports from China to US)/US Consumption$_{91}$	-1.571	0.099	-0.120
	(1.328)	(0.456)	(0.078)

Notes: N=511,792/509,961 in columns 1-2/3 of Panel I, N=324,058/322,556 in columns 1-2/3 of Panel II. Regressions in Panel I include the full control vector from column 8 of Table 1. Regressions in Panel II include the same controls except tenure, experience and firm size, and industry-level controls are measured for 1975 except for intermediate imports, computer investment and high tech equipement which are measured in 1972. Robust standard errors in parentheses are clustered on start-of-period 3-digit industry. ~ $p \leq 0.10$, * $p \leq 0.05$, ** $p \leq 0.01$.

Table 1. Imports from China and Cumulative Earnings, 1992-2007: OLS and 2SLS Estimates.
Dependent Var: 100 x Earnings 1992-2007 (in Multiples of Initial Annual Wage)

	OLS		2SLS													
	(1)		(2)		(3)		(4)		(5)		(6)		(7)		(8)	
(Δ Imports from China to US)/US Consumption$_{91}$	-3.541	**	-7.547	**	-6.135	**	-6.401	**	-7.326	**	-8.054	**	-8.092	**	-8.322	**
	(1.040)		(1.402)		(1.466)		(1.615)		(2.744)		(2.973)		(2.826)		(2.956)	
(Initial Imports from China to US)/US Consumption$_{91}$									3.270		23.384	*	24.563	**	24.852	**
									(10.16)		(9.832)		(8.484)		(8.807)	
(Initial Imports from Non-China to US)/US Consumption$_{91}$									1.750		1.566		2.662	~	2.633	~
									(1.500)		(1.390)		(1.428)		(1.428)	
Demographic controls					yes		yes		yes		yes		yes		yes	
Work history							yes		yes		yes		yes		yes	
Initial trade volumes									yes		yes		yes		yes	
10 mfg industry dummies											yes		yes		yes	
Industry production and technology													yes		yes	
Emp and wage pretrends															yes	

Notes: N=511,792. All regressions include a constant. Demographic controls in column 3 include a full set of birth year dummies plus dummies for female, non-white and foreign-born. Work history controls in column 4 include the worker's initial annual log wage averaged over 1988-1991, an interaction of intial wage with age, and dummies for firm tenure (0-1, 2-5, 6-10 years), experience (4-5, 6-8, 9-11 years), and firm size (1-99, 100-999, 1000-9999 employees). Columns 5-8 add industry-level controls for manufacturing industries: Initial trade volumes in column 5 comprise 1991 levels of import penetration by Chinese imports, import penetration by non-Chinese imports, and fraction of intermediate goods among imports in 1990; column 6 adds 10 dummies for manufacturing sub-industries; column 7 adds 1991 levels for employment share of production workers, log average wage, capital/value added, and 1990 levels for computer investment and share of investment allocated to high-tech equipment; column 8 additionally controls for changes in industry employment share and log average wage level during the preceding 16 years (1976-1991). Robust standard errors in parentheses are clustered on start-of-period 3-digit industry. ~ $p \leq 0.10$, * $p \leq 0.05$, ** $p \leq 0.01$.

Table 3. Imports from China and Earnings and Employment by Firm, Industry and Sector, 1992-2007: 2SLS Estimates.

Dep Vars: 100 x Cumulative Earnings; 100 x Years with Earnings; 100 x Earnings per Year of Employment (in Multiples of Initial Annual Wage)

	All Employers		Same Sector						Other Sect		N/A	
Same 2-digit Industry?			Yes		Yes		No		No		N/A	
Same Firm?			Yes		No		No		No		No	
	(1)		(2)		(3)		(4)		(5)		(6)	
			A. Cumulative Earnings (in Initial Annual Wage*100)									
(Δ Imports from China to US)/US Consumption$_{91}$	-8.322	**	-9.965	**	-3.089	~	5.566	*	-2.282		1.447	~
	(2.956)		(3.579)		(1.697)		(2.211)		(3.057)		(0.761)	
			B. Cumulative Employment (in Years*100)									
(Δ Imports from China to US)/US Consumption$_{91}$	-0.711		-6.370	*	-2.002		4.603	**	1.483		1.576	**
	(0.532)		(2.571)		(1.281)		(1.618)		(2.004)		(0.615)	
			C. Earnings per Year of Emp (in Initial Annual Wage*100)									
(Δ Imports from China to US)/US Consumption$_{91}$	-0.480	**	-0.373	**	-0.664	~	-0.686	*	-0.693	*	-0.725	**
	(0.168)		(0.114)		(0.354)		(0.334)		(0.302)		(0.278)	

Notes: N=511,792 in panels A and B. N=509,961/426,424/157,114/265,691/113,037/121,119 in columns 1-6 of panel C. Column 6 measures employment and earnings in firms with missing industry information. A large majority of these firms are new firms that have been incorporated between the years 2000 and 2007. All regressions include the full vector of control variables from column 8 of Table 1. Robust standard errors in parentheses are clustered on start-of-period 3-digit industry. ~ $p \leq 0.10$, * $p \leq 0.05$, ** $p \leq 0.01$.

Table 4. Imports from China and Social Security Disability Insurance Income, 1992-2007: 2SLS Estimates.
Dep Vars: 100 x Cumulative Years of Indicated Status or Income 1992-2007

A. Cumulative Years with Income from Indicated Source

	(1) Earnings only	(2) Earnings+ SSDI	(3) SSDI Inc only	(4) Neither
(Δ Imports from China to US)/US Consumption$_{91}$	-0.851	0.140	0.448 *	0.263
	(0.536)	(0.122)	(0.219)	(0.456)

B. SSDI Income and Probability of Receipt

	(1) Cum SSDI Inc (/Initial Wage)	(2) 100*Dummy (Yrs SSDI>0)
(Δ Imports from China to US)/US Consumption$_{91}$	0.355 *	0.081 *
	(0.162)	(0.034)

Notes: N=511,792, except N=32,736 in the second column of panel III. The dependent variable in the first column of panel III is a dummy for individuals who received SSDI benefits in at least one year during 1992 to 2007 and the dependent variable in the second column of panel III is the number of calendar years with SSDI benefits conditional on receiving benefits in at least one year. All regressions include a constant and the full vector of control variables from column 8 of Table 1. Robust standard errors in parentheses are clustered on start-of-period 3-digit industry. ~ $p \leq 0.10$, * $p \leq 0.05$, ** $p \leq 0.01$.

Table 5
Not Yet Updated

Table 6. Imports from China and Earnings and Employment by Subgroup of Workers: 2SLS Estimates.
Dep Vars: 100 x Cum Earnings; 100 x Years with Earnings; 100 x Earnings per Year of Emp (in Multiples of Initial Annual Wage)

	Outcomes at				Outcomes at			
	All Firms	Initial Firm	Firm, Same Sector	Other Sector/ NA	All Firms	Initial Firm	Firm, Same Sector	Other Sector/ NA
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	A1. Workers with Initial Wage<Cohort Median				A2. Workers with Initial Wage≥Cohort Median			
Cum Earnings	-19.97 **	-11.68 **	-0.33	-7.97 ~	-2.24	-8.95 *	3.20	3.51
	(5.78)	(3.85)	(3.97)	(4.08)	(1.77)	(4.14)	(2.25)	(4.05)
Cum Yrs Emp	-1.04	-5.08 *	3.65	0.40	-0.47	-6.98 ~	1.78	4.74
	(0.95)	(2.02)	(2.26)	(2.28)	(0.49)	(3.58)	(1.53)	(3.43)
Cum Earn/Yr	-1.23 **	-0.83 **	-2.15 **	-1.22 **	-0.09	-0.15 ~	-0.08	-0.11
	(0.34)	(0.24)	(0.67)	(0.42)	(0.11)	(0.09)	(0.22)	(0.19)
	B1. Males, Initial Wage<Cohort Median				B2. Males, Initial Wage≥Cohort Median			
Cum Earnings	-18.73 **	-8.91 *	-3.16	-6.66	-2.44	-8.43 *	2.19	3.80
	(6.50)	(3.61)	(3.61)	(4.19)	(1.50)	(4.10)	(1.96)	(4.06)
Cum Yrs Emp	-0.19	-3.16 ~	1.97	1.00	-0.34	-6.18 ~	0.99	4.86
	(1.05)	(1.73)	(2.12)	(2.21)	(0.41)	(3.43)	(1.31)	(3.61)
Cum Earn/Yr	-1.18 **	-0.84 **	-2.26 *	-1.25 **	-0.11	-0.17 *	-0.04	-0.12
	(0.39)	(0.29)	(0.92)	(0.49)	(0.09)	(0.09)	(0.22)	(0.16)
	C1. Females, Initial Wage<Cohort Median				C2. Females, Initial Wage≥Cohort Median			
Cum Earnings	-19.48 **	-11.49 **	2.88	-10.87 *	2.14	-9.87 ~	10.51 *	1.50
	(6.52)	(4.41)	(4.70)	(4.99)	(5.07)	(5.36)	(5.30)	(7.01)
Cum Yrs Emp	-1.05	-5.37 *	6.90 *	-2.59	-0.78	-10.74 *	6.48	3.48
	(1.37)	(2.55)	(2.84)	(2.90)	(1.71)	(4.48)	(3.99)	(4.15)
Cum Earn/Yr	-1.21 **	-0.66 *	-2.23 **	-1.20 **	0.21	0.11	-0.22	0.03
	(0.38)	(0.27)	(0.71)	(0.45)	(0.32)	(0.27)	(0.55)	(0.51)

Notes: N=255,887/255,905/114,676/176,387/141,211/79,518 for first two outcomes in panels A1/A2/B1/B2/C1/C2. Sample sizes for earnings/year in columns 1-4 of panel A1: N=254,758/204,561/176,986/102,200; panel A2: N=255,203/221,863/156,514/95,230, panel B1: 114,042/88,620/80,595/52,349; panel B2: 175,899/153,407/105,766/69,443; panel C1: 140,716/115,941/96,391/49,851; panel C2: 79,304/68,456/50,748/25,787. Columns 4 and 8 report outcomes at firms outside the initial sector and at firms with missing industry information (most of which have been incorporated between 2000 and 2007). All regressions include a constant and the full vector of control variables from column 8 of Table 1. Robust standard errors in parentheses are clustered on start-of-period 3-digit industry. ~ $p \leq 0.10$, * $p \leq 0.05$, ** $p \leq 0.01$.

Table 7. Imports from China and Earnings and Employment by Age Group, 1992-2007: 2SLS Estimates.
Dep Vars: 100 x Cum Earnings; 100 x Years with Earnings; 100 x Earnings per Year of Emp (in Multiples of Initial Annual Wage)

	Outcomes at							
	All Firms		Initial Firm		Other Firm Same Sector		Other Sector/NA	
	(1)		(2)		(3)		(4)	
				A. Workers Born in 1962-1970				
Cum Earnings	-17.25	*	-11.99	*	0.48		-5.74	
	(7.05)		(4.82)		(4.67)		(5.24)	
Cum Yrs Emp	1.24		-4.50	*	3.10		2.64	
	(0.80)		(2.21)		(2.26)		(2.60)	
Cum Earn/Yr	-1.17	*	-1.03	**	-1.90	*	-1.14	*
	(0.46)		(0.35)		(0.90)		(0.55)	
				B. Workers Born in 1952-1961				
Cum Earnings	-6.34	**	-6.83	*	-2.68		3.17	
	(2.41)		(3.04)		(2.78)		(3.82)	
Cum Yrs Emp	-0.81		-4.84	*	0.23		3.81	
	(0.66)		(2.18)		(1.63)		(2.73)	
Cum Earn/Yr	-0.34	*	-0.12		-0.67	*	-0.44	*
	(0.15)		(0.11)		(0.31)		(0.22)	
				C. Workers Born in 1943-1951				
Cum Earnings	-5.08	*	-9.14	*	1.49		2.58	
	(2.52)		(3.83)		(1.76)		(2.18)	
Cum Yrs Emp	-1.39		-7.16	*	2.22		3.55	
	(1.08)		(3.22)		(1.36)		(2.30)	
Cum Earn/Yr	-0.23	*	-0.15	~	-0.36	~	-0.10	
	(0.11)		(0.08)		(0.22)		(0.16)	

Notes: N=127,505/196,297/145,170 for first two rows in panels I/II/III. Sample sizes for earnings/year in the third row of panel I: N=127,212/97,819/96,540/59,034; panel II: N=195,634/165,668/126,211/75,789; panel III: 144,449/127,151/82,529/46,214. Column 4 reports outcomes at firms outside the initial sector and at firms with missing industry information (most of which have been incorporated between 2000 and 2007). All regressions include a constant and the full vector of control variables from column 8 of Table 1. Robust standard errors in parentheses are clustered on start-of-period 3-digit industry. ~ p ≤ 0.10, * p ≤ 0.05, ** p ≤ 0.01.

Table 8. Imports from China and Earnings and Employment by Wage Level and Size of Initial Firm, 1992-2007: 2SLS Estimates.
Dep Vars: 100 x Cum Earnings; 100 x Years with Earnings; 100 x Earnings per Year of Emp (in Multiples of Initial Annual Wage).

	I. Overall Outcomes			II. Outcomes at Initial Firm		
	Cum Earnings	Yrs w/ Earn>0	Earn/ Year	Cum Earnings	Yrs w/ Earn>0	Earn/ Year
	(1)	(2)	(3)	(4)	(5)	(6)
	A1. Initial Employer: Avg Firm Wage<Industry Avg					
(Δ Imports from China to US)/US Consumption$_{91}$	-11.62 **	-0.40	-0.69 **	-7.88 **	-3.25 *	-0.55 **
	(3.95)	(0.67)	(0.22)	(2.70)	(1.53)	(0.18)
	A2. Initial Employer: Avg Firm Wage≥Industry Avg					
(Δ Imports from China to US)/US Consumption$_{91}$	-4.44 ~	-1.04	-0.23	-10.81 *	-8.84 *	-0.16
	(2.57)	(0.67)	(0.15)	(4.72)	(4.04)	(0.11)
	B1. Initial Employer: Firm Size 1-99 Employees					
(Δ Imports from China to US)/US Consumption$_{91}$	-4.49 ~	1.15	-0.35 *	-3.82 ~	-1.59	-0.15
	(2.45)	(0.74)	(0.15)	(2.08)	(1.36)	(0.12)
	B2. Initial Employer: Firm Size 100-999 Employees					
(Δ Imports from China to US)/US Consumption$_{91}$	-5.46 *	-0.73	-0.30 *	-6.01 **	-3.17 *	-0.35 **
	(2.47)	(0.49)	(0.14)	(2.26)	(1.43)	(0.11)
	B3. Initial Employer: Firm Size 1000+ Employees					
(Δ Imports from China to US)/US Consumption$_{91}$	-18.48 **	-2.01	-1.03 **	-22.33 **	-15.88 *	-0.66 **
	(6.82)	(1.36)	(0.39)	(8.58)	(6.35)	(0.25)

Notes: N=264,800/N=246,992/N=118,699/N=121,593/N=271,500 in panels A1/A2/B1/B2/B3, except N=263,828/246,133/118,075/121,151/270,735 in column 3 and N=212,352/214,072/92,788/97,416/236,220 in column 6. All regressions include a constant and the full vector of control variables from column 8 of Table 1. Robust standard errors in parentheses are clustered on start-of-period 3-digit industry. ~ p ≤ 0.10, * p ≤ 0.05, ** p ≤ 0.01.

Table 9: Alternative Measures of Import Exposure: 2SLS Estimates.
Dep Vars: 100 x Cumulative Earnings; 100 x Years with Earnings; 100 x Earnings per Year of Employment (in Multiples of Initial Annual Wage), 1992-2007

Alternative Measure of Trade Exposure	Cum Earnings (1)	Years w/ Earn>0 (2)	Earn/ Year (3)
	I. Reduced From OLS		
Δ China-US Productivity Differential (Gravity Residual)	-4.591	0.412	-0.323 *
	(2.992)	(1.031)	(0.160)
	II. 2SLS (Instr: Chn-OTH Tr.)		
Δ Import Penetration, using all Low-Income Country Imports	-8.298 **	-0.650	-0.482 **
	(2.923)	(0.520)	(0.167)
	III. 2SLS (Instr: Chn-OTH Tr.)		
Δ Import Penetration, using China Imports to U.S. and other Markets	-6.884 **	-0.662	-0.395 **
	(2.480)	(0.472)	(0.139)

Alternative Measure of Trade Exposure	Cum Earnings (4)	Years w/ Earn>0 (5)	Earn/ Year (6)
	IV. 2SLS (Instr: Chn-OTH Tr.)		
Δ *Net* Import Penetration, using China Imports	-2.484 ~	-0.731 ~	-0.092
	(1.441)	(0.391)	(0.085)
	V. 2SLS (Instr: Chn-OTH Tr.)		
Δ *Net* Imports from China in Worker-Equivalent Units	-4.698 *	-1.115 *	-0.210 ~
	(2.097)	(0.555)	(0.120)
	VI. 2SLS (Instr: Chn-OTH Tr.)		
Δ Import Penetration, using China Imp adjusted for Imported Inputs	-7.517 **	-0.675	-0.428 **
	(2.709)	(0.530)	(0.152)

Notes: N=511,792 in columns 1-2 and 4-5, N=509,961 in columns 3 and 6. The mean (and standard deviation) of trade exposure among manufacturing workers is 1.24 (4.14) in Panel I, 8.56 (14.98) in Panel II, 8.62 (15.25) in Panel III, 6.12 (14.01) in Panel IV, 5.90 (13.93) in Panel V, 5.77 (12.72) in Panel VI. All models in include the full vector of control variables from column 8 of Table 1, except panels III to VI where the 1991 value of penetration by Chinese imports is replaced by the 1991 value of the indicated alternative trade exposure value, and columns IV to VI where the 1991 value of penetration by non-Chinese imports is replaced, respectively, by the 1991 values of net import penetration by non-Chinese imports, net imports from non-China expressed in worker-equivalent units, and penetration by non-Chinese imports adjusted for imported inputs. Robust standard errors in parentheses are clustered on start-of-period industry. ~ $p \leq 0.10$, * $p \leq 0.05$, ** $p \leq 0.01$.

Appendix Table 1. Growth of Import Exposure 1991-2007 and Labor Intensity 1991 by 2-Digit Manufacturing Industry

	2-Digit Manufacturing Industries Ranked by Import Exposure	Chg Import Exposure	Share Prod Workers
1	Leather and leather products	**62.6**	**0.84**
2	Misc. manufacturing ind. (incl. toys)	**32.6**	0.72
3	Furniture and fixtures	**29.6**	**0.79**
4	Electronic and other electric equipm.	**22.2**	0.63
5	Apparel and other textile products	**20.1**	**0.85**
6	Industrial machinery and equipment	**14.9**	0.62
7	Rubber and misc. plastics products	**7.0**	**0.77**
8	Stone, clay and glass products	**6.9**	**0.76**
9	Fabricated metal products	**6.8**	**0.73**
10	Instruments and related products	**4.7**	0.50
11	Primary metal industries	**4.7**	**0.76**
12	Lumber and wood products	**4.7**	**0.83**
13	Paper and allied products	2.4	**0.77**
14	Textile mill products	2.2	**0.86**
15	Transportation equipment	1.7	0.65
16	Chemicals and allied products	1.6	0.57
17	Printing and publishing	1.0	0.53
18	Food and kindred products	0.6	0.72
19	Petroleum and coal products	0.5	0.65
20	Tobacco products	0.0	0.72

Notes: The table indicates the average growth of import exposure during 1991-2007 (in %pts of 1991 consumption), and the share of production workers in 1991 for each 2-digit manufacturing industry. Numbers in bold type exceed the employment-weighted sample medians for all manufacturing industries. All statistics are weighted by 1991 industry employment according to the NBER manufacturing database.

Appendix Table 2. Descriptive Statistics

	Main Sample All Workers	Main Sample: Manuf Workers	Extended Sample: All Workers	Extended Sample: Manuf Workers
	A. Trade Exposure, 1991-2007			
	Individual Exposure of Mfg. Workers (in %pts)			
(Δ Imports from China to US)/US Consumption$_{91}$	1.60	7.72	1.40	6.77
	(7.05)	(13.88)	(6.23)	(12.31)
P90, P10 Interval	[2.65, 0.00]	[26.00, 0.06]	[2.20, 0.00]	[20.12, 0.04]
P75, P25 Interval	[0.00, 0.00]	[7.30, 0.62]	[0.00, 0.00]	[7.24, 0.40]
(1991 Imports from China to US)/US Consumption$_{91}$	0.11	0.54	0.11	0.55
	(0.94)	(2.01)	(0.91)	(1.93)
	B. Main Outcome Variables, 1992-2007			
100*Cumulative Earnings (in mult of Avg Annual Wage 88-91)	1917.9	1806.6	n/a	n/a
	(1176.0)	(1018.9)		
100*Number of Years with Earnings>0	1421.8	1428.1	1326.0	1355.8
	(342.6)	(336.3)	(428.3)	(403.6)
100*Cum Earn/Yrs with Earn>0 (in multiples of Avg Ann Wage 88-91)	130.0	122.3	n/a	n/a
	(69.4)	(59.2)		
100*Number of Years with SSDI Income and No Earnings	25.9	32.1	34.5	39.5
	(141.3)	(157.1)	(170.7)	(181.2)
	C. Worker Characteristics in 1991			
Female	0.431	0.313	0.475	0.359
Non-White	0.207	0.200	0.236	0.235
Foreign-Born	0.077	0.087	0.085	0.097
Employed in Manufacturing	0.207	1.000	0.173	1.000
Tenure 0-1 Years	0.271	0.238	0.418	0.425
Tenure 2-5 Years	0.366	0.356	0.301	0.283
Tenure 6-10 Years	0.166	0.187	0.129	0.134
Tenure 11+ Years	0.197	0.220	0.153	0.158
Firm Size 1-99 Employees	0.232	0.154	0.257	0.199
Firm Size 100-999 Employees	0.238	0.290	0.231	0.285
Firm Size 1000-9999 Employees	0.245	0.290	0.210	0.251
Firm Size 10000+ Employees	0.285	0.266	0.302	0.265
Average Log Wage 1988-1991	10.45	10.54	9.23	9.60
Sample Size	511,792	106,189	880,465	181,900

Notes: The main sample of workers in panel A1 includes all workers who had at least full-time minimum wage earnings during each of the years 1988 to 1991 while panel A2 shows statistics for the subsample of workers who were employed in manufacturing firms in 1991. The extended sample in column B1 includes all workers who had a positive income in at least one year between 1987 and 1989 and one year between 1990 and 1992. Trade exposure for this sample and control variables for manufacturing employment, tenure and firm size are computed are averaged over all years between 1990 and 1992 during which the worker is employed. Average log wage for this sample is computed based on years with positive earnings between 1988 and 1991. Column B2 provides statistics for the subset of workers from the extended sample who were employed in manufacturing during at least one year between 1990 and 1992.