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The Surprisingly Swift Decline of US Manufacturing Employment†

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This paper links the sharp drop in US manufacturing employment after 2000 to a change in US trade policy that eliminated potential tariff increases on Chinese imports. Industries more exposed to the change experience greater employment loss, increased imports from China, and higher entry by US importers and foreign-owned Chinese exporters. At the plant level, shifts toward less labor-intensive production and exposure to the policy via input-output linkages also contribute to the decline in employment. Results are robust to other potential explanations of employment loss, and there is no similar reaction in the European Union, where policy did not change. (*JEL* D72, E24, F13, F16, L24, L60, P33)

US manufacturing employment fluctuated around 18 million workers between 1965 and 2000 before plunging 18 percent from March 2001 to March 2007. This paper finds a link between this sharp decline and the United States granting Permanent Normal Trade Relations (PNTR) to China, which was passed by Congress in October 2000 and became effective upon China's accession to the World Trade Organization (WTO) at the end of 2001.[1]

Conferral of PNTR was unique in that it did not change the import tariff rates the United States actually applied to Chinese goods over this period. US imports from China had been subject to the relatively low NTR tariff rates reserved for WTO members since 1980.[2] But for China, these low rates required annual renewals that

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[1] Though this paper focuses on the impact of a particular US trade policy, it relates to a substantial body of research documenting a negative relationship between import competition and US manufacturing employment, including Freeman and Katz (1991); Revenga (1992); Shatz and Sachs (1994); and Bernard, Jensen, and Schott (2006), as well as studies linking Chinese imports to employment outcomes by Autor, Dorn, and Hanson (2013); Utar and Torres Ruiz (2013); Bloom, Draca, and Van Reenen (2016); Ebenstein et al. (2011); Groizard, Ranjan, and Rodriguez-Lopez (2012); and Mion and Zhu (2013).

[2] Normal Trade Relations is a US term for the familiar principle of Most Favored Nation.

were uncertain and politically contentious. Without renewal, US import tariffs on Chinese goods would have jumped to the higher non-NTR tariff rates assigned to nonmarket economies, which were originally established under the Smoot-Hawley Tariff Act of 1930. PNTR removed the uncertainty associated with these annual renewals by permanently setting US duties on Chinese imports at NTR levels.

Eliminating the possibility of sudden tariff spikes on Chinese imports may have affected US employment through several channels. First, it increased the incentive for US firms to incur the sunk costs associated with shifting operations to China or establishing a relationship with an existing Chinese producer.[3] Second, it similarly provided Chinese producers with greater incentives to invest in entering or expanding into the US market, increasing competition for US producers. Finally, for US producers, it boosted the attractiveness of investments in capital- or skill-intensive production technologies or less labor-intensive mixes of products that are more consistent with US comparative advantage. Intuition for these channels of adjustment can be derived from the large literature on investment under uncertainty, where firms are more likely to undertake irreversible investments as the ambiguity surrounding their expected profit decreases.[4]

We quantify the transition from annual to permanent normal trade relations via the "NTR gap," defined as the difference between the non-NTR rates to which tariffs would have risen if annual renewal had failed (which average 37 percent in 1999) and the NTR tariff rates that were locked in by PNTR (which average 4 percent in 1999). Importantly, the NTR gap exhibits substantial variation across industries: in 1999, its mean and standard deviation are 33 and 14 percentage points. Larger responses are expected in industries with higher NTR gaps.

Our generalized difference-in-differences identification strategy exploits this cross-sectional variation in the NTR gap to test whether employment in manufacturing industries with higher NTR gaps (first difference) is lower after the change in policy relative to employment in the pre-PNTR era (second difference). An attractive feature of this approach is its ability to isolate the role of the change in policy. While industries with high and low gaps are not identical, comparing outcomes within industries over time isolates the differential impact of China's change in NTR status.

Regression results reveal a negative relationship between the change in US policy and subsequent employment in manufacturing that is both statistically and economically significant. The baseline specification implies that moving an industry from an

[3] A *New York Times* article reporting on the passage of PNTR noted the link to uncertainty: "US companies expect to benefit from billions of dollars in new business and an end to years of uncertainty in which they had put off major decisions about investing in China" (Knowlton 2000). Section IA below and Section A of the online Appendix contain additional anecdotes describing the effect of PNTR-related uncertainty on US and Chinese firms' behavior.

[4] The effect of uncertainty on investment can be positive or negative depending upon a range of firm and market characteristics, including adjustment costs, product market competition, and production technology. The negative association between PNTR and employment found here is consistent with a range of theoretical (e.g., Rob and Vettas 2003) and empirical (e.g,. Guiso and Parigi 1999; Bloom, Bond, and Van Reenen 2007) applications. A theoretical framework closely related to our setting is Pindyck (1993), which shows that uncertainty over input costs increases the value of waiting before undertaking sunk investments. For example, using this framework, Schwartz and Zozaya-Gorostiza (2003) show that input cost uncertainty lowers incentives to invest in new information technology. Handley (2014) and Handley and Limão (2014, 2015) show that reduction in destination-country trade policy uncertainty is associated with increased entry into exporting.

NTR gap at the twenty-fifth percentile of the observed distribution to the seventy-fifth percentile increases the implied relative loss of employment by 0.08 log points.

The relationship between PNTR and US manufacturing employment remains statistically and economically significant after controlling for policy changes in China associated with its accession to the WTO that may be spuriously correlated with the NTR gap, including a reduction in import tariffs, the phasing out of export licensing requirements and production subsidies, and the elimination of barriers to foreign investment. Furthermore, the results are robust to controlling for other US economic developments contemporaneous with PNTR, such as the bursting of the 1990s information technology bubble, the expiration of the global Multi-Fiber Arrangement (MFA) governing Chinese textile and clothing export quotas, and declining union membership in the United States. To further verify that the US reaction can be attributed to the change in US policy, we compare US employment before and after PNTR to that in the European Union, which gave China the equivalent of PNTR much earlier, in 1980. We find no relationship between the US NTR gap and EU manufacturing employment after the US granting of PNTR to China.

We use data from a range of sources to explore the potential mechanisms behind the US response. Using US trade data, we find that PNTR is associated with relative increases in the value of US imports from China as well as the relative number of US importers, Chinese exporters and US-China importer-exporter pairs. These outcomes demonstrate that US imports from China surge in the high-NTR gap products most affected by PNTR, suggesting that the decline in US employment is due in part to substitution of Chinese imports for US output. They also offer a deeper understanding of the impact of reducing uncertainty in international trade. That is, while our finding of a positive association between the NTR gap and Chinese exporters is consistent with models of exporting under trade policy uncertainty,[5] the surge in US importers and US-importer and Chinese-exporter pairs found here highlights a rich set of potential responses among firms in the importing country, e.g., within-firm offshoring. Toward that end, we use Chinese microdata to show that PNTR is associated with a relative increase in Chinese exports to the United States among foreign-owned Chinese firms, and US microdata to demonstrate that PNTR is associated with a relative increase in the number of US and Chinese firms engaged in related party trade. Each of these outcomes is consistent with within-firm relocation of US production to China.

Additional insight into possible mechanisms explaining our main result comes from examining US outcomes at the plant level. Comparison of plant employment and plant death regressions reveals that some plants were able to adapt to the change in US policy rather than die. Further analysis of surviving plants' factor usage shows that PNTR is associated with increased capital intensity, a reaction that is consistent with two mechanisms of trade-induced adaptation: changes in product composition (as in Khandelwal 2010) and adoption of labor-saving technologies (as in Bloom, Draca, and Van Reenen 2016), with the latter suggesting that PNTR may be associated with employment reductions beyond those attributable to replacement of US production by Chinese imports. Finally, we find that employment among continuing

[5] Handley and Limão (2015) note that their framework could be used to examine a link between PNTR and China's export boom, and Handley and Limão (2014) examine such a link using product-level trade data.

plants and plant survival respond negatively to exposure to PNTR in downstream (customer) industries, providing indirect evidence of the sort of trade-induced supply-chain disruptions modeled by Baldwin and Venables (2013).

The paper proceeds as follows: Section I describes our data, Section II describes our empirical strategy and main results, Sections III and IV present additional results, and Section V concludes. An online Appendix provides additional empirical results as well as information about dataset construction and sources.

I. Data

A. *Measuring the Effect of PNTR: The NTR Gap*

Policy Background.—US imports from nonmarket economies such as China are subject to relatively high tariff rates originally set under the Smoot-Hawley Tariff Act of 1930. These rates, known as "non-NTR" or "column 2" tariffs, are often substantially larger than the "NTR" or "column 1" rates the United States offers fellow members of the WTO. However, the US Trade Act of 1974 allows the President of the United States to grant NTR tariff rates to nonmarket economies on an annually renewable basis subject to approval by the US Congress, and US presidents began granting such waivers to China annually in 1980.

While these waivers kept the tariff rates applied to Chinese goods low, the need for annual approval by Congress created uncertainty about whether the low tariffs would continue, particularly after the Tiananmen Square incident in 1989. In fact, the US House of Representatives introduced and voted on legislation to revoke China's temporary NTR status every year from 1990 to 2001. These votes succeeded even in 1990, 1991, and 1992, but China's status was not overturned because the US Senate failed to sustain the House votes. From 1990 to 2001, the average House vote against annual NTR renewal was 38 percent.[6]

Anecdotal evidence indicates that congressional threats to withdraw China's NTR status were taken seriously. Media reports, congressional testimony, and government reports make clear that firms viewed renewal of China's NTR status as uncertain, and that this uncertainty suppressed investment needed to source goods from China. Indeed, in a 1994 report by the US General Accounting Office (US GAO), US firms "cited uncertainty surrounding the annual renewal of China's most-favored-nation trade status as the single most important issue affecting US trade relations with China" (US GAO 1994, p. 3) and indicated that "uncertainty over whether the US government will withdraw or place further conditions on the renewal of China's most-favored-nation trade status affects the ability of US companies to do business in China" (US GAO 1994, p. 5). These findings echoed a letter to President Clinton from the CEOs of 340 firms, including General Motors, IBM, Boeing, McDonnell Douglas, and Caterpillar, in which they stated that "[t]he persistent threat of MFN withdrawal does little more than create an unstable and excessively risky environment for US companies considering trade and investment in China, and leaves China's booming economy to our competitors" (Rowley 1993). Moreover, the

[6] Table A.1 of the online Appendix summarizes the House votes by year.

anecdotes underscore the idea that uncertainty can have a chilling effect on investment even if the probability of rescinding NTR is low. Testifying before the House Ways and Means Committee, a representative from Mattel asserted that "[w]hile the risk that the United States would withdraw NTR status from China may be small, if it did occur the consequences would be catastrophic for US toy companies given the 70 percent non-MFN US rate of duty applicable to toys" (St. Maxens 2000, p. 185).[7] After passage of PNTR, the Congressional Commission created to track its effects reported that: "In the months since the enactment of PNTR legislation with China there has been an escalation of production shifts out of the US and into China … [B]etween October 1, 2000 and April 30, 2001 more than eighty corporations announced their intentions to shift production to China, with the number of announced production shifts increasing each month from two per month in October to November to nineteen per month by April" (Bronfenbrenner et al. 2001, p. i).

Uncertainty associated with annual renewals of China's NTR status is also apparent in a simplified version of the well-known Baker, Bloom, and Davis (2015) policy uncertainty index, which we calculate to relate specifically to China's NTR renewals. In constructing this index, a research assistant searched the database Proquest for articles that contain the words "China," "uncertain" or "uncertainty," and "most favored nation" or "normal trade relations," for the years 1989 to 2013. The search was limited to articles in the *Wall Street Journal*, the *New York Times*, and the *Washington Post*, and irrelevant articles were manually screened from the search results.[8] Following Baker, Bloom, and Davis (2015), article counts are summed by year and then divided by the total number of articles produced by the three newspapers. The resulting index is displayed in Figure 1. As shown in the figure, the policy uncertainty index spikes in periods of tension in US-China relations, with the highest levels observed in the early 1990s after Tiananmen Square and in 2000 during the debate over PNTR.[9] After passage of PNTR in 2000, the index goes essentially to zero indicating that uncertainty regarding China's NTR status was effectively resolved.

The US Congress passed a bill granting PNTR status to China in October 2000 following the November 1999 agreement between the United States and China governing China's eventual entry into WTO. PNTR became effective upon China's accession to the WTO in December 2001, and was implemented on January 1, 2002.[10] The baseline analysis in Section II treats years from 2001 forward as being "post-PNTR." Alternate specifications in Section B relax this assumption by allowing the relationship between the NTR gap and employment to differ in each year.

The change in China's PNTR status had two effects. First, it ended the uncertainty associated with annual renewals of China's NTR status, thereby eliminating any option value of waiting for US or Chinese firms seeking to incur sunk costs

[7] Additional anecdotes are provided in Section A of the online Appendix.

[8] A list of the articles included in the index as well as those that were screened out manually is available from the authors upon request.

[9] Additional peaks occur around the time of China's transfer of missile technology to Pakistan (1993) and the Taiwan Straits Missile Crisis (1996).

[10] While each of these milestones likely contributed to the overall reduction in policy uncertainty, both the anecdotal evidence and the policy uncertainty index described above indicate that passage of PNTR in 2000 played a key role in the elimination of uncertainty for US firms.

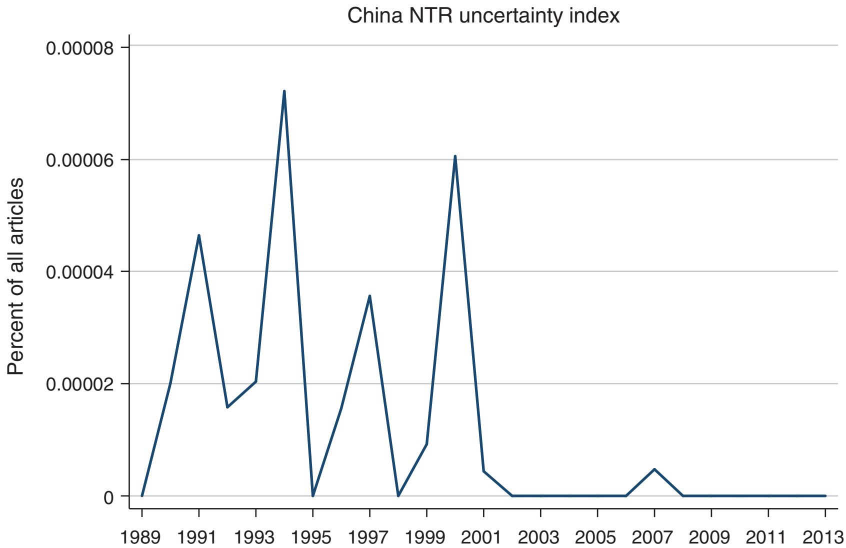

Figure 1. China Most Favored Nation (MFN) Uncertainty Index

Note: Figure displays percent of *New York Times*, *Wall Street Journal*, and *Washington Post* articles discussing the uncertainty of China's NTR status.

associated with greater US-China trade.[11] Second, it led to a substantial reduction in *expected* US import tariffs on Chinese goods. We discuss channels through which the change in policy affected US manufacturing employment in Section IV.

Calculating the NTR Gap.—We quantify the impact of PNTR on industry i as the difference between the non-NTR rate to which tariffs would have risen if annual renewal had failed and the NTR tariff rate that was locked in by PNTR,

$$NTR\,Gap_i = Non\,NTR\,Rate_i - NTR\,Rate_i, \tag{1}$$

and we expect industries with larger NTR gaps to be more affected by the change in US policy. One attractive feature of this measure is its plausible exogeneity to employment after 2000. Seventy-nine percent of the variation in the NTR gap across industries arises from variation in non-NTR rates, set 70 years prior to passage of PNTR. This feature of non-NTR rates effectively rules out reverse causality that would arise if non-NTR rates could be set to protect industries with declining employment. Furthermore, to the extent that NTR tariffs were set to protect industries with declining employment prior to PNTR, these *higher* NTR rates would result in *lower* NTR gaps, biasing our results away from finding an effect of PNTR.

[11] To our knowledge, no other US trade policy generates similar uncertainty with respect to China. For example, while the Omnibus Trade and Competitiveness Act of 1988 requires the US Treasury Secretary to provide semiannual reports indicating whether any major trading partner of the United States is manipulating its currency, such a designation only requires the Secretary to initiate negotiations to have the exchange rate adjusted "promptly" (US Department of the Treasury 2012).

We compute NTR gaps using ad valorem equivalent NTR and non-NTR tariff rates from 1989 to 2001 provided by Feenstra, Romalis, and Schott (2002). Both types of tariffs are set at the eight-digit Harmonized System (HS) level, also referred to as "tariff lines." We compute industry-level NTR gaps using concordances provided by the US Bureau of Economic Analysis (BEA); the gap for industry *i* is the average NTR gap across the eight-digit HS tariff lines belonging to that industry. Further detail on the construction of NTR gaps is provided in Section B.1 of the online Appendix.

We use the NTR gaps for 1999—the year before passage of PNTR in the United States—in our regression analysis, but note that the baseline results are robust to using the NTR gaps from any available year (see Section IIB). Furthermore, the baseline empirical specification explicitly controls for industries' NTR *rates*. In 1999, the average NTR gap across industries is 0.33 with a standard deviation of 0.14, and its distribution is displayed in Figure 2. The corresponding statistics are 0.04 and 0.07 for the NTR rate and 0.37 and 0.16 for the non-NTR rate.

B. *US Manufacturing Employment*

Our principal source of data is the US Census Bureau's Longitudinal Business Database (LBD), assembled and maintained by Jarmin and Miranda (2002). These data track the employment and major industry of virtually every establishment with employment in the nonfarm private US economy annually as of March 12.[12] In these data, "establishments" correspond to facilities in a given geographic location, such as a manufacturing plant or retail outlet, and their major industry is defined at the four-digit Standard Industrial Classification (SIC) or six-digit North American Industry Classification System (NAICS) level. Longitudinal identifiers in the LBD allow establishments to be followed over time.

The long time horizon considered in this paper presents two complications for analyzing the evolution of manufacturing employment. The first complication is that the industry classification scheme used to track establishments' major industries changes from the SIC to the NAICS in 1997 and to subsequent versions of NAICS in 2002 to 2007. Because we need time-consistent industry definitions to track employment over our sample period, we use the algorithm developed in Pierce and Schott (2012a) to create "families" of four-digit SIC and six-digit NAICS codes that are linked through the SIC and NAICS industry classification systems. Further detail on the creation of time-consistent industry codes is provided in Section B.3 of the online Appendix. Unless otherwise noted, all references to "industry" in this paper refer to these families.

The second complication is that some activities (e.g., logging and publishing) are re-classified out of "manufacturing" in the SIC to NAICS transition and, moreover, some plants are sometimes classified within manufacturing and sometimes outside manufacturing. We construct a "constant manufacturing sample" that excludes any families that contain SIC or NAICS industries that are ever classified outside manufacturing. In addition, we exclude any plants that are ever classified

[12] The LBD definition of employment includes both full- and part-time workers; in Section IC we show that our main employment results are robust to examining production hours instead of employment. While the use of staffing services by manufacturing firms was increasing during the 2000s, Dey, Houseman, and Polivka (2012) show that this trend does not account for the steep decline in manufacturing employment after 2000.

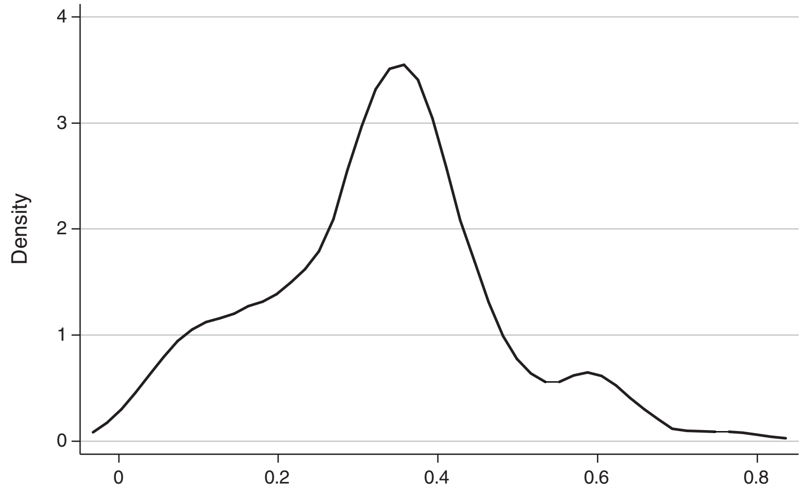

Figure 2. Distribution of NTR Gaps Across Constant Manufacturing Industries, 1999

outside manufacturing. Use of this constant manufacturing sample ensures that our results are not driven by any changes in classification system.[13] We note, however, that qualitatively identical results can be obtained using the simple NAICS manufacturing definition in the publicly available NBER-CES Manufacturing Industry Database from Becker, Gray, and Marvakov (2013), and that neither of these drops has a material impact on the general trend of manufacturing employment over the past several decades.[14]

While the loss of US manufacturing employment after 2000 is dramatic, we note that it is *not* accompanied by a similarly steep decline in value added. Indeed, as illustrated in Figure 3, real value added in US manufacturing, as measured by the BEA, continues to increase after 2000, though at a slower rate (2.8 percent) compared with the average from 1948 to 2000 (3.7 percent).[15]

C. *Data for Alternate Explanations*

We consider a wide array of alternate explanations for the observed decline in US manufacturing employment. To be plausible, these alternate explanations must explain why the decline in employment coincides with the timing of PNTR and why it is concentrated in industries most affected by the policy change. Descriptions and sources of the data used to capture these explanations are presented in Section D of the online Appendix. Here, we provide a brief overview of the three classes of alternate explanations we consider: a decline in the US competitiveness of labor-intensive

[13] The results are also robust to use of a beta version of time-consistent NAICS codes developed for the LBD by Teresa Fort and Shawn Klimek.

[14] Section B.3 of the online Appendix compares annual employment in our "constant" manufacturing sample against the manufacturing employment series available publicly from the US Bureau of Labor Statistics. Both display a stark drop in employment after 2000.

[15] Houseman et al. (2011) argue that gains in manufacturing value-added in the later years of Figure 3 may be overstated as purchases of low-cost foreign materials are not fully captured in input price indexes.

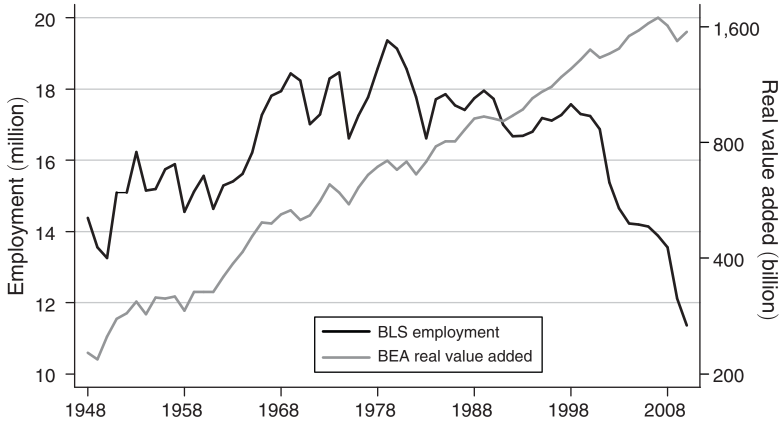

Figure 3. US Manufacturing Employment versus Value Added

Note: Figure compares annual manufacturing employment as of March according to the US Bureau of Labor Statistics (1948–2010, series CEU3000000001) to real value added as measured by the Bureau of Economic Analysis (1948–2010).

goods, policy changes in China, and other notable macroeconomic events in the United States.

US manufacturing employment may have fallen after 2000 due to a decline in the competitiveness of US labor-intensive industries for some reason other than the change in US trade policy, such as a general movement toward offshoring encouraged by the 2001 recession or a positive productivity shock in labor-abundant China.[16] We control for these explanations by including measures of industry capital and skill intensity in our specification and by allowing the impact of these industry factor intensities to vary before and after PNTR.

As part of its accession to the WTO, China agreed to institute a number of policy changes which could have influenced US manufacturing employment, including liberalization of its import tariff rates, export licensing rules, production subsidies and barriers to foreign investment. We control for these policy changes using data on Chinese import tariffs from Brandt et al. (2012), data on export licensing requirements from Krishna, Bai, and Ma (2015), and data on production subsidies from China's National Bureau of Statistics. Because China's reduction of barriers to foreign investment may have affected industries differently based on the nature of contracting in their industry, we also include Nunn's (2007) measure of the proportion of intermediate inputs that require relationship-specific investments.

Finally, the granting of PNTR to China overlaps with several notable events in the United States. The first was the abolishment of import quotas on some textile and clothing imports in 2002 and 2005 under the global MFA. The second was the bursting of the US tech "bubble" and the subsequent recovery. A third is a steady decline in unionization in the manufacturing sector. We control for the potential impact of

[16] We show in Section E of the online Appendix that China's TFP growth is uncorrelated with the NTR gap. Furthermore, we demonstrate in Section III that the EU does not experience a similar decline in manufacturing employment in high NTR gap industries after 2000.

these events using data on US textile and clothing quotas from Khandelwal, Schott, and Wei (2013), definitions of advanced technology products posted on the US Census Bureau's website, and industry-level unionization rates from Hirsch and MacPherson (2003).

Table A.2 of the online Appendix summarizes the relationships between the NTR gap and the industry-level control variables we employ in the baseline specification, described in greater detail below. The strongest relationship among these variables is a negative relationship with capital intensity ($R^2 = 0.23$).

II. PNTR and US Manufacturing Employment

A. *Baseline Specification*

We examine the link between PNTR and US manufacturing employment using a generalized OLS difference-in-differences (DID) specification that examines whether employment losses in industries with higher NTR gaps (first difference) are larger after the imposition of PNTR (second difference). Industry fixed effects capture the impact of any time-invariant industry characteristics, and year fixed effects account for aggregate shocks that affect all industries equally. The sample includes annual industry-level data from 1990 to 2007.

We estimate the following equation:

$$(2) \qquad \ln(Emp_{it}) = \theta PostPNTR_t \times NTR\,Gap_i + PostPNTR_t \times \mathbf{X}_i'\boldsymbol{\gamma} + \mathbf{X}_{it}'\boldsymbol{\lambda} + \boldsymbol{\delta}_t + \boldsymbol{\delta}_i + \alpha + \varepsilon_{it},$$

where the dependent variable is the log level of employment in industry i in year t. The first term on the right-hand side is the DID term of interest, an interaction of the NTR gap and an indicator for the post-PNTR period, i.e., years from 2001 forward. The second term on the right-hand side is an interaction of the post-PNTR dummy variable and time-invariant industry characteristics, such as initial year (1990) industry capital and skill intensity or the degree to which industries encompass high-technology products. This term allows for the possibility that the relationship between employment and these characteristics changes in the post-PNTR period. The third term on the right-hand side of equation (2) captures the impact of time-varying industry characteristics, such as exposure to MFA quota reductions, union membership and the NTR tariff rate.[17] $\boldsymbol{\delta}_i$, $\boldsymbol{\delta}_t$, and α represent industry and year fixed effects and the constant. Regressions are weighted by industry employment in 1990.

Results are reported in Table 1 with robust standard errors clustered by industry. The first column includes only the DID term and the necessary fixed effects, while the second column adds industry initial factor intensities. The third column includes

[17] NTR tariff rates from Feenstra, Romalis, and Schott (2002) are unavailable after 2001 and so are assumed constant after that year. As discussed in Section IIB, we obtain nearly identical results using analogously computed "revealed" tariff rates from public US trade data for all years but use the Feenstra, Romalis, and Schott (2002) measures because they are available for a larger set of industries.

all covariates capturing the effect of the alternate explanations discussed in Section IIC and represents the "baseline" specification to which we refer throughout the remainder of the paper.

As indicated in the first row of Table 1, estimates of θ are negative and statistically significant in all specifications, indicating that the imposition of PNTR coincides with lower manufacturing employment. Moving across the columns from left to right shows that the estimate for θ decreases in absolute value as additional covariates are added, but remains statistically significant at conventional levels.

The estimated effects are also economically significant. The difference-in-differences coefficient in the baseline specification in column 3 indicates that moving an industry from an NTR gap at the twenty-fifth (0.23) to the seventy-fifth percentile (0.40) of the observed distribution increases the implied relative loss of employment by -0.08 ($= -0.47 \times (0.40 - 0.23)$) log points. We also perform a two-step calculation of the implied impact of PNTR that takes into account the employment weights of industries across the distribution of NTR gaps. First, for each industry i, we multiply θ by the industry's NTR gap. This yields an implied effect of PNTR (versus the pre-period) on employment for each industry *relative to* a hypothetical industry with a zero NTR gap. Second, we average the implied relative effects for all manufacturing industries, using initial industry employment as weights. As reported in the final row of the third column of the table, the baseline specification implies a *relative* decline in manufacturing employment of -0.15 log points.[18]

The remaining rows of the third column of Table 1 display a positive and statistically significant relationship between employment and industries' initial skill intensity (defined as the ratio of non-production workers to total employment), and negative and statistically significant relationships between employment and industries' exposure to tariff reductions in China and MFA quota reductions.[19] The positive coefficient for skill intensity indicates that skill-intensive industries more in line with US comparative advantage do relatively well in terms of employment after 2000. The negative point estimate on exposure to Chinese import tariffs reveals that US employment rises in relative terms in industries where Chinese import tariffs decline. The negative coefficient for $MFA\ Exposure_{it}$ indicates that textile and clothing industries more exposed to the elimination of quotas experience greater relative employment loss.[20]

[18] Though our difference-in-differences identification strategy precludes estimation of the overall share of employment lost to the change in US policy, we note that several prominent studies of the impact of trade liberalization on manufacturing employment have found large effects. Autor, Dorn, and Hanson (2013), using an alternate means of identification, find that depending on assumptions used to isolate the Chinese supply shock, Chinese import penetration explains 26 to 55 percent of the overall decline in US manufacturing employment from 2000 to 2007, or -5 to -11 percentage points of the overall -20 percent decline. In a different setting, Trefler (2004) finds that the Canada-US Free Trade Agreement reduced Canadian manufacturing employment by 12 percent among industries in the top tercile of import tariff declines, i.e., those with an average reduction of -10 percent. Moreover, the growth in Chinese exports to the United States during our sample period dwarfs that of US exports to Canada during the period studied by Trefler (2004). According to the US International Trade Commission website, Chinese exports to the United States grew by $223 billion from 2000 to 2007 (from $100 billion to $323 billion), while US exports to Canada grew by $44 billion between 1989 and 1996 (from $75 billion to $119 billion), in nominal terms.

[19] As discussed further in Section D.3 of the online Appendix, the negative and statistically significant relationship between PNTR and manufacturing employment is also robust to simply dropping industries that contain products subject to the MFA.

[20] Following Brambilla, Khandelwal, and Schott (2010), we measure the extent to which industries' quotas were binding under the MFA as the import-weighted average fill rate of the textile and clothing products that were under quota, where fill rates are defined as the actual imports divided by allowable imports under the quota. Industries

TABLE 1—BASELINE RESULTS (*LBD*)

	$\ln(\text{Emp}_{it})$	$\ln(\text{Emp}_{it})$	$\ln(\text{Emp}_{it})$
Post × NTR Gap_i	−0.714	−0.601	−0.469
	(0.193)	(0.191)	(0.147)
Post × $\ln(\text{K/Emp}_{i,1990})$		0.037	−0.016
		(0.031)	(0.025)
Post × $\ln(\text{NP/Emp}_{i,1990})$		0.081	0.132
		(0.054)	(0.053)
Post × Contract Intensity_i			−0.181
			(0.112)
Post × ΔChina Import Tariffs_i			−0.244
			(0.140)
Post × ΔChina Subsidies_i			0.063
			(0.088)
Post × ΔChina Licensing_i			−0.238
			(0.164)
Post × 1{Advanced Technology_i}			−0.036
			(0.045)
MFA Exposure_{it}			−0.342
			(0.060)
NTR_{it}			−0.455
			(0.670)
US Union Membership_{it}			−0.123
			(0.203)
Observations	5,700	5,700	5,700
R^2	0.98	0.98	0.99
Fixed effects	*i*,*t*	*i*,*t*	*i*,*t*
Employment weighted	Yes	Yes	Yes
Implied impact of PNTR	−0.229	−0.193	−0.151

Notes: Table reports results of OLS generalized difference-in-differences regressions. The dependent variable is the log of industry-year employment and the independent variable representing the effect of PNTR is the interaction of the NTR gap and a post-PNTR indicator. Additional controls include time-varying variables—MFA exposure, NTR tariff rates, union membership rates—as well as interactions of the post-PNTR indicator with time-invariant controls including the log of 1990 capital and skill intensity, contract intensity (Nunn 2007), changes in Chinese import tariffs, changes in Chinese production subsidies, changes in Chinese export licensing requirements, and an indicator for whether the industry produces advanced technology products. Data span 1990 to 2007. Robust standard errors adjusted for clustering at the industry (i) level are displayed below each coefficient. Estimates for the year (t) and industry fixed effects as well as the constant are suppressed. Observations are weighted by 1990 industry employment. Final row reports the predicted relative change in the dependent variable implied by the difference-in-differences coefficient. Number of observations has been rounded to nearest thousand due to Census Bureau disclosure avoidance procedures.

B. *Robustness and Extensions*

This section assesses the timing and linearity assumptions inherent in the baseline specification, the exogeneity of the NTR gap, and the sensitivity of our results to alternate controls for business-cycle fluctuations and an alternate measure of tariffs.

containing textile and clothing products with higher fill rates faced more binding quotas and are therefore more likely to experience employment reductions when quotas are eliminated. Fill rates are set to zero for unbound products. See Section D.3 of the online Appendix for additional information regarding construction of the MFA variable.

Timing.—For the decline in employment to be attributable to PNTR, our policy measure, the NTR gap, should be correlated with employment after PNTR, but not before. To determine whether there is a relationship between the NTR gap and employment in the years before 2001, we replace the *PostPNTR* indicator used in equation (2) with interactions of the NTR Gap and the full set of year dummies,

$$(3)\quad \ln(Emp_{it}) = \sum_{y=1991}^{2007} \big(\theta_y 1\{y=t\} \times NTR\,Gap_i\big) + \sum_{y=1991}^{2007} \big(1\{y=t\} \times \mathbf{X}_i'\boldsymbol{\beta}_y\big)$$
$$+ \mathbf{X}_{it}'\boldsymbol{\lambda} + \boldsymbol{\delta}_t + \boldsymbol{\delta}_i + \alpha + \varepsilon_{it}.$$

As above, we estimate equation (3) both with and without the industry controls.

Results for the difference-in-differences coefficients, θ_y, are displayed visually along with their 90 percent confidence intervals in Figure 4, as well as numerically in Table A.4 of the online Appendix. Coefficient estimates for the remaining covariates are omitted to conserve space. As indicated in both the figure and the table, point estimates are statistically insignificant at conventional levels until after 2001, at which time they become statistically significant and increasingly negative.[21] This pattern is consistent with the parallel trends assumption inherent in our difference-in-differences analysis, lending further support for the baseline empirical strategy.

Exogeneity.—Though nearly all of the variation in the NTR gap arises from non-NTR rates set in 1930, and increases in NTR rates to protect declining industries would result in *smaller* NTR gaps, we examine two alternate specifications designed to evaluate the exogeneity of the NTR gaps. First, we estimate a two-stage least squares specification in which we instrument the baseline DID term, $PostPNTR_t \times NTR\,Gap_i$, with an interaction of the post-PNTR indicator and the Smoot-Hawley-based non-NTR tariff rates, $PostPNTR_t \times NNTR_i$. As indicated in the first column of Table 2, the DID term remains negative and statistically significant, with a magnitude somewhat larger in absolute value than that in our baseline result. Second, we re-estimate our baseline specification (equation (2)) using the NTR gap observed in 1990, ten years prior to PNTR. As shown in column 2 of Table 2, the DID coefficient estimate remains negative and statistically significant, with a magnitude somewhat larger than that of our baseline result.

Nonlinearity.—We estimate two nonlinear specifications to determine whether the NTR gap has less of an effect on firms' employment decisions beyond some threshold level or, alternatively, whether the effect of the NTR gap grows disproportionately as it increases with higher values of the NTR gap. The first augments equation (2) with the interaction of the square of the NTR gap with the $1\{PostPNTR_t\}$ dummy. The second constrains the relationship between employment and the NTR

[21] Results are similar for an event study version of this specification that compares outcomes across years for industries in the top versus bottom quintiles of the NTR gap distribution.

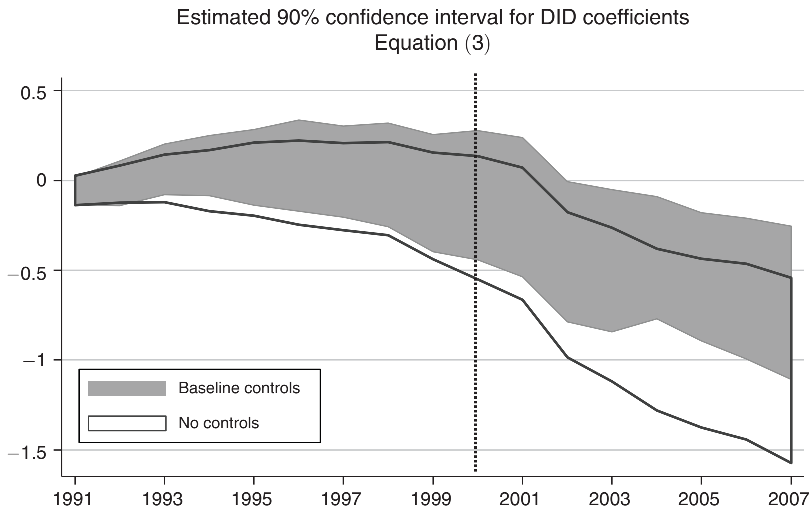

Figure 4. Estimated Timing of the PNTR Effect (*LBD*)

Notes: Figure displays the 90 percent confidence level interval (CI) for the estimated difference-in-differences (DID) coefficients for interactions of year dummies with the NTR gap from equation (3). Shaded CI represents the specification which includes all baseline covariates. Unshaded CI represents the specification which includes only the DID coefficients and the fixed effects. Baseline covariates include time-varying variables—MFA exposure, NTR tariff rates, union membership rates—as well as interactions of year dummies with time invariant controls including the log of 1990 capital and skill intensity, contract intensity (Nunn 2007), changes in Chinese import tariffs, changes in Chinese production subsidies, changes in Chinese export licensing requirements, and an indicator for whether the industry produces advanced technology products. Observations are weighted by 1990 industry employment. Confidence interval is based on robust standard errors adjusted for clustering at the industry level.

gap to be a two-segment spline.[22] Results are reported in columns 3 and 4 of Table 2. p-values testing the joint significance of the difference-in-differences coefficients in the quadratic specification and implied economic significance, computed using the two-step procedure as noted above, are reported in the final two rows of the table. In addition, Figure A.2 in the online Appendix plots the relationship between the DID terms and log employment implied by each specification over the range of NTR gaps observed in the data.

As indicated in both the table and the figure, the results provide some support for the idea that employment loss accelerates with the NTR gap. On the other hand, column 3 of Table 2 reveals that while the coefficients for the NTR gap terms in the quadratic specification are jointly statistically significant at conventional levels, the square term is not itself statistically significant. In terms of economic significance, the nonlinear specifications yield economic impacts comparable to that implied by the baseline linear specification. The quadratic specification yields a relative decline in manufacturing employment of -0.12 log points and the spline specification yields

[22] The spline is estimated using a constrained OLS regression that restricts the post-PNTR relationship between employment and the NTR gap to be two successive line segments starting at the origin and joined at a "knot." We grid over NTR gap knots in increments of 0.05 and report the specification that minimizes the Akaike Information Criterion (AIC), reported in the penultimate row of Table 2. Minimization of Schwarz's Bayesian Information Criterion yields identical results.

Table 2—Robustness Exercises (*LBD*)

	$\ln(\text{Emp}_{it})$	$\ln(\text{Emp}_{it})$	$\ln(\text{Emp}_{it})$	$\ln(\text{Emp}_{it})$	$\ln(\text{Emp}_{it})$	$\ln(\text{Emp}_{it})$	$\ln(\text{Emp}_{it})$
Post × NTR Gapi	−0.617		−0.244		−0.475	−0.461	−0.484
	(0.152)		(0.429)		(0.147)	(0.146)	(0.164)
Post × 1990 NTR Gap_i		−0.410					
		(0.166)					
Post × NTR Gap_{i2}			−0.346				
			(0.636)				
Post × NTR Gap_i (Slope 1)				−0.460			
				(0.513)			
Post × NTR Gap_i (Intercept 2)				0.551			
				(0.630)			
Post × NTR Gap_i (Slope 2)				−1.683			
				(1.054)			
Post × $\ln(\text{K/Emp}_{i,1990})$	−0.026	−0.020	−0.015	0.414	−0.044	−0.016	−0.009
	(0.023)	(0.026)	(0.025)	(0.204)	(0.018)	(0.025)	(0.027)
Post × $\ln(\text{NP/Emp}_{i,1990})$	0.129	0.132	0.130	−0.511	0.186	0.130	0.132
	(0.049)	(0.050)	(0.053)	(0.283)	(0.047)	(0.052)	(0.056)
Post × Contract Intensity_i	−0.191	−0.154	−0.184	1.306	−0.178	−0.178	−0.058
	(0.103)	(0.108)	(0.114)	(0.738)	(0.112)	(0.113)	(0.120)
Post × ΔChina Import Tariffs_i	−0.230	−0.282	−0.269	−0.557	−0.248	−0.248	−0.157
	(0.136)	(0.142)	(0.144)	(0.489)	(0.140)	(0.140)	(0.177)
Post × ΔChina Subsidies_i	0.068	0.051	0.073	−1.650	0.064	0.066	−0.042
	(0.085)	(0.086)	(0.092)	(0.691)	(0.088)	(0.088)	(0.117)
Post × ΔChina Licensing_i	−0.220	−0.217	−0.237	−1.319	−0.240	−0.236	−0.433
	(0.155)	(0.161)	(0.166)	(0.658)	(0.164)	(0.165)	(0.224)
Post × 1{Advanced Technology_i}	−0.033	−0.050	−0.036	0.018	−0.038	−0.036	−0.052
	(0.044)	(0.045)	(0.045)	(0.146)	(0.045)	(0.045)	(0.053)
MFA Exposure_{it}	−0.337	−0.347	−0.342	−0.541	−0.342	−0.345	−0.344
	(0.057)	(0.058)	(0.061)	(0.198)	(0.063)	(0.059)	(0.062)
NTR_{it}	−0.578	−0.501	−0.430	24.346	−0.724	−0.448	
	(0.656)	(0.852)	(0.672)	(13.226)	(0.672)	(0.670)	
US Union Membership_{it}	−0.124	−0.123	−0.110	15.049	−0.086	−0.124	−0.165
	(0.195)	(0.203)	(0.199)	(7.792)	(0.200)	(0.203)	(0.209)
$\ln(\text{RGDP}_t) \times \ln(\text{K/Emp}_{i,1990})$					0.104		
					(0.097)		
$\ln(\text{RGDP}_t) \times \ln(\text{NP/Emp}_{i,1990})$					−0.193		
					(0.181)		
Trefler Business Cycle_{it}						0.242	
						(0.106)	
Revealed NTR_{it}							0.495
							(0.291)
Observations	5,700	5,700	5,700	5,700	5,700	5,700	5,700
R^2	0.99	0.99	0.99		0.99	0.99	0.99
Estimation	2SLS	OLS	OLS	OLS	OLS	OLS	OLS
Instrument	NNTR rate	—	—	—	—	—	—
Fixed effects	*i,t*	*i,t*	*i,t*	*i,t*	*i,t*	*i,t*	*i,t*
Employment weighted	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Joint significance *p*-value				0.008	0.011		
Constrained estimation?	No	No	No	Yes	No	No	No
Knot				0.45			
AIC				13,810			
Implied impact of PNTR	−0.198	−0.132	−0.120	−0.158	−0.153	−0.148	−0.155

Notes: Table reports results of OLS generalized difference-in-differences regressions of log industry employment on noted permutations of an interaction of the NTR gap with an indicator for the post-PNTR period. Additional controls include time-varying variables—MFA exposure, NTR tariff rates, union membership rates—as well as interactions of the post-PNTR indicator with time-invariant controls including the log of 1990 capital and skill intensity, contract intensity (Nunn 2007), changes in Chinese import tariffs, changes in Chinese production subsidies, changes in Chinese export licensing requirements, and an indicator for whether the industry produces advanced technology products. Data span 1990 to 2007. Robust standard errors adjusted for clustering at the industry (i) level are displayed below each coefficient. Estimates for the year (t) and industry fixed effects as well as the constant are suppressed. Observations are weighted by 1990 industry employment. "Joint significance" reports the p-value of a test of joint significance of the linear and polynomial NTR gap terms in column 3 and the intercept and slope terms in column 4. Penultimate row reports the Akaike information criterion (AIC) for the two-segment spline estimated in the fourth column. Final row reports the predicted relative change in the dependent variable implied by the difference-in-differences coefficient. Number of observations has been rounded to nearest thousand due to Census Bureau disclosure avoidance procedures.

a relative decline of −0.16 log points, compared to −0.15 log points in the baseline linear specification.

Business Cycles.—We estimate two alternate specifications that control explicitly for the potential influence of business cycle fluctuations on employment.[23] The first adds interactions of capital and skill intensity with real GDP, indexed to a base year of 1990, to our baseline specification (equation (2)). The second follows Trefler (2004) by including industry-year-specific predictions of the change in employment associated with growth in US real GDP and the US real effective exchange rate, as well as one- and two-period lags of growth in these two variables. As shown in columns 5 and 6 of Table 2, inclusion of these additional business-cycle controls has little effect on our DID coefficient estimate either in terms of statistical or economic significance.

Revealed Tariffs.—We re-estimate equation (2) using a measure of revealed tariffs in place of the applied NTR rates used in the baseline specification. We calculate ad valorem equivalent revealed NTR tariff rates by summing the duties collected for each eight-digit HS product by year and dividing this sum by the corresponding dutiable value. These revealed tariff measures capture changes in tariff rates due to NAFTA and other preferential trade agreements. As shown in column 7 of Table 2, using these revealed tariff data does not lead to any material change in the statistical or economic significance of our results.[24]

III. The United States versus the European Union

Comparison of outcomes in the United States versus the European Union provides an alternate test of the idea that PNTR drives the employment decline in the United States. In contrast to the United States, the European Union granted permanent most-favored-nation status to China in 1980 (Casarini 2006). As a result, there was little change in either the actual or expected EU tariffs on Chinese goods when the US granted PNTR to China in 2000, and imports from China were not subject to the annual potential tariff increases present in the United States.[25] Comparing the United States and the European Union therefore helps determine whether US NTR gaps are spuriously correlated with other factors that may have affected employment in both the United States and European Union, such as technological change, policy changes in China related to its entry to the WTO, or positive Chinese productivity shocks.

[23] To the extent that aggregate shocks affect all industries equally, their effect on employment is captured by the year fixed effects included in equation (2). Furthermore, including interactions of initial capital and skill intensity with the full set of year dummies when estimating equation (3) allows for annual aggregate shocks to have differential effects on industries based on variation in those industry characteristics.

[24] As noted above, the revealed tariff data are available for fewer industries than are covered in the Feenstra, Romalis and Schott (2002) data. As a result, the number of observations for this regression is reduced.

[25] China was a Generalized System of Preferences (GSP) beneficiary in the European Union before and after its accession to the WTO. According to European Commission (2003), Chinese import tariffs under the EU GSP program did not change when it joined the WTO. The European Union renews GSP every decade and conducts annual revisions to their rates. These changes are generally made on a product-by-product rather than country-by-country basis, suggesting that they are not biased toward China. Nevertheless, we note that the majority of the EU's GSP rate changes in recent years involve products in which Chinese exporters are active.

Our comparison makes use of data from the United Nations Industrial Development Organization's (2013) INDSTAT 4 dataset, which tracks employment by country and four-digit International Standard Industrial Classification (ISIC) industries from 1997 to 2005.[26] We estimate a triple difference-in-differences specification that examines employment for industries with varying NTR gaps (first difference) after the imposition of PNTR (second difference) and across the United States and the EU (third difference):[27]

$$\ln(Emp_{ict}) = \theta PostPNTR_t \times NTR\,Gap_i \times US_c + \boldsymbol{\delta}_{ct} + \boldsymbol{\delta}_{ci} + \boldsymbol{\delta}_{it} + \alpha + \varepsilon_{ict}. \tag{4}$$

The dependent variable is log employment for four-digit ISIC industry i in $c \in \{US, EU\}$ in year t. θ is the coefficient for the triple-difference term of interest where US_c is an indicator variable that takes the value one for the United States. $\boldsymbol{\delta}_{ct}$, $\boldsymbol{\delta}_{ci}$, and $\boldsymbol{\delta}_{it}$ represent country $\times$ year, country $\times$ industry, and industry $\times$ year fixed effects. α is the regression constant.

Results are reported in the first column of Table 3, with robust standard errors clustered by country $\times$ industry. As shown in the first row of the table, θ is negative and statistically significant, indicating that PNTR is associated with a relative decline in manufacturing employment in the United States versus the European Union. Separate difference-in-difference specifications for the European Union and the United States (columns 2 and 3) provide complementary evidence: PNTR is associated with statistically significant employment declines in the United States but not the European Union.[28]

The results in Table 3 are evidence against the idea that post-PNTR employment loss in the United States is due to an unobserved shock affecting manufacturing employment globally, or a shock in China that affects its exports to the United States and European Union equally. They also confirm the relationship between employment and the NTR gap for the United States using an entirely different dataset and industrial classification system for employment.

IV. Potential Mechanisms

PNTR may have caused a decline in US manufacturing employment via several mechanisms, including: (i) encouraging US firms to start sourcing inputs or final

[26] The four-digit ISIC industries across which employment is reported are more aggregated than either the SIC or NAICS industries across which US employment data is reported in the LBD. We aggregate NTR gaps to the six-digit HS level and then map them to the four-digit ISIC level using publicly available concordances from the World Bank. See Section F of the online Appendix for additional information regarding the UNIDO data.

[27] Data for the European Union member countries are aggregated to the EU level, so that the regression includes observations for two "countries," the United States and the European Union. See Section F of the online Appendix for additional information regarding these data.

[28] The results for the United States using UNIDO data in column 3 of Table 3 are comparable to those using US Census data in column 1 of Table 1. In both cases, the point estimates for the difference-in-differences term are negative and statistically significant, and they are of similar magnitude despite the use of different datasets. The substantially smaller number of observations in column 3 of Table 3 versus column 1 of Table 1 is due to the shorter time interval available in the UNIDO data (1997 to 2005 versus 1990 to 2007) as well as the fact that industry definitions in the UNIDO data are broader than those used by the US Census.

Table 3—Employment in the United States versus European Union (*UNIDO*)

	$\ln(\text{Emp}_{it})$	$\ln(\text{Emp}_{it})$	$\ln(\text{Emp}_{it})$
Post × NTR $\text{Gap}_{i,1999}$ × $1\{c = \text{US}\}$	−0.641		
	(−0.247)		
Post × NTR $\text{Gap}_{i,1999}$		0.016	−0.649
		(−0.112)	(−0.270)
Observations	1,664	999	832
R^2	0.997	0.994	0.982
Fixed effects	*ct*, *ci*, *it*	*i*,*t*	*i*,*t*
Employment weighted	Yes	Yes	Yes

Notes: First column displays results of an OLS generalized triple differences regression of the log of employment on a triple interaction of an indicator for the post-PNTR period, the NTR gap and an indicator for if the country is the United States. The countries included are the United States and European Union. The second and third columns display results of industry-level generalized difference-in-differences regressions for the European Union and United States, respectively. Data span 1998 to 2005. Estimates for country × year (*ct*), country × industry (*ci*), and industry × year (*it*) fixed effects (for column 1), and industry and year fixed effects (for columns 2 and 3), as well as the regression constant are not reported. Robust standard errors adjusted for clustering at the country *x* industry-level (for column 1) and industry-level (for columns 2 and 3) are displayed below each coefficient. Observations are weighted by 1998 employment.

goods from Chinese rather than domestic suppliers; (ii) persuading Chinese firms to expand into the US market; (iii) motivating US manufacturers either to invest in labor-saving production techniques or to produce more skill- and capital-intensive products that are more in line with US comparative advantage; and (iv) inducing US firms to shift all or part of their operations offshore, perhaps in conjunction with other firms in their supply chains. In this section we provide evidence consistent with all of these mechanisms.

A. *US Imports*

Given that PNTR entailed a change in US trade policy vis-à-vis China, we examine whether it was associated with changes in US imports from China versus other countries. As noted in the introduction, relative growth in Chinese imports could be due to US firms sourcing goods from China, the expansion of Chinese exporters or offshoring by US manufacturers.

We use customs data from the US Census Bureau's Longitudinal Foreign Trade Transaction Database (LFTTD). As described in greater detail in Bernard, Jensen, and Schott (2009), the LFTTD tracks all US international trade transactions beginning in 1992. For each import transaction we observe the product traded, the US dollar value and quantity shipped, the shipment date and the origin country. The data also contain codes identifying both the US importer and the foreign supplier of the imported product.

We employ a generalized triple differences specification that compares products with varying NTR gaps (first difference) before and after PNTR (second difference) and across source countries (third difference) for the years 1992 to 2007:

$$O_{hct} = \theta 1\{c = China\}_c \times PostPNTR_t \times NTR\,Gap_h + \lambda Tariff_{hct} + \boldsymbol{\delta}_{ct} + \boldsymbol{\delta}_{ch} + \boldsymbol{\delta}_{ht} + \alpha + \varepsilon_{hct}. \tag{5}$$

The left-hand-side variable represents the log level of one of several dimensions of US import activity aggregated to the eight-digit HS product by source country by year level.[29] These dimensions are import value, the number of US firms importing product h from country c in year t, the number of country c firms exporting product h to the United States in year t, and the number of importer-exporter pairs engaged in US imports of product h from country c in year t. The first term on the right-hand side is the primary term of interest: a triple interaction of an indicator for China, an indicator for the post-PNTR period, and the NTR gap for product h. Its coefficient, θ, captures the impact of the change in US policy. $Tariff_{hct}$ represents the US revealed import tariff for product h from country c in year t, computed as the ratio of duties collected to dutiable value using publicly available US trade data. $\boldsymbol{\delta}_{ct}$, $\boldsymbol{\delta}_{ch}$, and $\boldsymbol{\delta}_{ht}$ represent country $\times$ year, country $\times$ product and product $\times$ year fixed effects. α is the regression constant.[30]

Results are reported in Table 4, with robust standard errors clustered at the country $\times$ product level. Estimates of θ are positive and statistically significant for all four dimensions of US importing. As indicated in the bottom row of the table, these estimates imply that PNTR raises the relative import value of the affected products by 0.17 log points vis-à-vis imports of those products from other sources after the change in US policy. The analogous responses for the number of US importers, the number of Chinese exporters, and the number of importer-exporter pairs are 0.15, 0.17, and 0.17 log points.

These results demonstrate that US import value from China surges in the high-NTR-gap products most affected by PNTR, suggesting that the decline in US employment is due in part to substitution of Chinese imports for US output, either due to growth of Chinese exporters or offshoring/outsourcing by US manufacturers.[31] Moreover, the relative increases in both the number of US importers and the number of Chinese exporters are consistent with US and Chinese firms being more willing to undertake irrecoverable investment in establishing bilateral trade relationships after PNTR, in line with the broad literature on investment under uncertainty. Relative to the existing literature on trade policy uncertainty (Handley 2014, Handley and Limão 2014, 2015), which focuses on exporting, the results with respect to US importers highlight the potential importance of reactions to uncertainty by firms in the importing country.[32] We pursue these reactions further in the next section.

B. *Offshoring of Production by US Firms*

One way in which PNTR could lead to employment declines in the US is via offshoring, in which US firms locate production in China that would otherwise

[29] As with SIC and NAICS industries, the eight-digit HS product codes are linked to time-invariant families using the concordance from Pierce and Schott (2012a).

[30] Although this specification omits observations where the left-hand-side variable is equal to zero, we note that similar results are obtained in a previous version of this paper (Pierce and Schott 2012b) when examining changes in those variables normalized as suggested by Davis, Haltiwanger, and Schuh (1996).

[31] Our findings relate to Harrison and McMillan (2011), who show that offshore employment in low-wage countries is a substitute for domestic employment among US manufacturers.

[32] Handley and Limão (2014) discusses welfare implications of eliminating trade policy uncertainty for the importing country, via the price index, but does not consider adjustments by firms in the importing country, such as offshoring.

Table 4—PNTR and US Imports (*LFTTD*)

	$\ln(\text{Value}_{hct})$	$\ln(\text{Importers}_{hct})$	$\ln(\text{Exporters}_{hct})$	$\ln(\text{Pairs}_{hct})$
$1\{c = \text{China}\} \times \text{Post} \times \text{NTR Gap}h$	0.476	0.461	0.515	0.517
	(0.102)	(0.051)	(0.058)	(0.061)
$\ln(\text{Tariff}_{hct})$	0.039	0.024	0.026	0.028
	(0.010)	(0.003)	(0.003)	(0.004)
MFA phase 1_{hct}	0.100	0.039	0.067	0.072
	(0.058)	(0.021)	(0.024)	(0.026)
MFA phase 2_{hct}	−0.101	−0.021	−0.016	−0.030
	(0.036)	(0.013)	(0.015)	(0.016)
MFA phase 3_{hct}	−0.066	0.070	0.053	0.041
	(0.039)	(0.014)	(0.016)	(0.017)
MFA phase 4_{hct}	−0.452	0.034	−0.069	−0.085
	(0.026)	(0.009)	(0.011)	(0.011)
Observations	1,396,000	1,396,000	1,396,000	1,396,000
R^2	0.84	0.91	0.91	0.91
Fixed effects	*hc*,*ct*,*ht*	*hc*,*ct*,*ht*	*hc*,*ct*,*ht*	*hc*,*ct*,*ht*
Implied impact of PNTR	0.17	0.17	0.19	0.19

Notes: Table displays results of product (h)-country (c)-year (t) level OLS generalized triple difference-in-differences regression of noted dependent variable on interaction of China country indicator, post-PNTR indicator, and NTR gap, along with country × year (ct), country × product (hc) and product × year (ht) fixed effects, the revealed tariff rate and indicators for the four phases of the MFA. Data span 1992 to 2007. Robust standard errors adjusted for clustering at the product × country level are displayed below each coefficient. Estimates for the fixed effects and constant are suppressed. Final row reports the predicted relative change in the dependent variable implied by the triple differences coefficient. Number of observations has been rounded to nearest thousand due to Census Bureau disclosure avoidance procedures.

occur in the United States. We find evidence consistent with offshoring by US firms using both Chinese data tracking the exports of Chinese firms and additional US trade data that classifies US imports according to whether they take place between arm's-length or related parties.

Evidence from Chinese Exports.—We first examine whether PNTR is associated with changes in the pattern of Chinese exports using firm-level customs data from China's National Bureau of Statistics (NBS) provided by Khandelwal, Schott, and Wei (2013).[33] One advantage of these Chinese export data vis-à-vis the US import data is the ability to classify Chinese exporters as domestic versus foreign-owned. As a result, they can shed light on whether China's surge in high-NTR-gap exports to the United States may be due to offshoring by foreign firms versus market expansion by Chinese firms. Translated anecdotes from Chinese language news accounts provided in Section A.2 of the online Appendix offer support for both of these channels. For example, *Shanghai Securities News* (1999) noted that if China's accession to the WTO led to PNTR being granted: "…[T]his will help to build confidence among investors at home and abroad, especially among United States investors, because currently, China faces the issue every year of maintaining Most Favored Nation trading status."

[33] The Chinese data track China's exports by firm, product, destination, country, and year from 2000 to 2005. For each firm-product-destination-year observation, we observe the nominal value of exports shipped as well as codes for the ultimate ownership of the firm and the type of export shipment.

Following Khandelwal, Schott, and Wei (2013), we use the ownership codes to classify firms into three groups: state-owned enterprises (SOEs), privately owned domestic firms (domestic), and privately owned foreign firms (foreign).[34] In addition, we decompose overall exports into "general" versus "processing and assembling" (P&A), where the latter refers to goods produced with intermediate inputs imported tariff-free on the condition that they not be sold domestically.[35]

We examine the effect of PNTR on Chinese exports using the same triple differences specification used for the US import data above (equation (5)), but with two differences. First, we replace the indicator for China as a source of imports with an indicator for the United States as a destination for exports. Second, we aggregate the Chinese data to the six-digit HS level in order to assign NTR gaps, as US and Chinese product codes are not consistent at more disaggregated levels. Coefficient estimates and robust standard errors clustered by country $\times$ product are reported in Table 5.

The first column of panel A presents results for all firms and all trade types, and the positive and statistically significant coefficient indicates that PNTR is associated with an increase in Chinese exports to the United States, relative to other countries. This result complements and confirms the trade effects reported in Section IVA using an independent dataset. That is, where the US data indicate that US imports from China relative to other sources increase with the change in US policy, the Chinese data show that Chinese exports to the United States increase relative to other destinations with the change in US policy.

Examining results by firm type, we find the strongest relationship between PNTR and exports among foreign-owned firms (column 4). Indeed, for these firms, higher NTR gaps are associated with increases in relative exports to the United States for both general exports (panel B) and P&A exports (panel C). While the country of foreign ownership is not reported in the NBS data, to the extent that some portion of these exporters are affiliates of US firms, the results are consistent with offshoring by US producers following PNTR.[36] Coefficient estimates for SOEs and privately owned domestic firms, while also positive for both types of exports, are generally statistically insignificant at conventional levels.

Evidence from US Related Party Importers.—We further investigate the potential role of offshoring within firms using data on US imports between related parties. A shift of domestic production by US manufacturers to new or newly acquired affiliates in China in response to PNTR could result in an increase in related-party

[34] SOEs include collectives, and foreign firms include joint ventures.

[35] General and P&A exports account for more than 95 percent of exports in each year of the sample. Other export categories are omitted. Across the years for which the data are available, general exports represent approximately 43 percent of total exports.

[36] Noisy data on US firms' overseas employment posted on the BEA's website provide some support for this interpretation, though it should be treated with caution. Available for seven highly aggregate manufacturing sectors, these data track US multinationals' employment in their overseas affiliates by country and year on a consistent basis starting in 1999, though 18 percent of cells are imputed or suppressed to protect confidential information. Nevertheless, using a triple differences specification similar to equation (5), we find that PNTR is associated with a relative increase in overseas manufacturing employment after PNTR, though the coefficient estimate is not statistically significant at conventional levels (p-value 0.27). The seven sectors are: food; chemicals; primary and fabricated metals; machinery; computers and electronic products; electrical equipment, appliances and components; and transportation equipment.

TABLE 5—PNTR AND CHINESE EXPORTS (*Chinese Data*)

	All firms $\ln(V_{hct})$	SOE $\ln(V_{hct})$	Domestic $\ln(V_{hct})$	Foreign $\ln(V_{hct})$
Panel A. All trade				
$1\{c = \text{US}\} \times \text{Post} \times \text{NTR Gap}_h$	0.214	0.187	0.815	1.018
	(0.126)	(0.138)	(0.473)	(0.207)
Observations	1,159,132	972,780	473,590	510,839
R^2	0.84	0.75	0.71	0.76
Fixed effects	*hc*,*ht*,*ct*	*hc*,*ht*,*ct*	*hc*,*ht*,*ct*	*hc*,*ht*,*ct*
Panel B. General trade				
$1\{c = \text{US}\} \times \text{Post} \times \text{NTR Gap}_h$	0.357	0.333	0.728	0.919
	(0.129)	(0.150)	(0.475)	(0.226)
Observations	1,112,173	945,902	467,854	419,451
R^2	0.82	0.81	0.81	0.79
Fixed effects	*hc*,*ht*,*ct*	*hc*,*ht*,*ct*	*hc*,*ht*,*ct*	*hc*,*ht*,*ct*
Panel C. Processing and assembly trade				
$1\{c = \text{US}\} \times \text{Post} \times \text{NTR Gap}_h$	0.287	0.185	1.802	0.707
	(0.176)	(0.211)	(2.086)	(0.209)
Observations	344,604	182,274	39,444	275,940
R^2	0.86	0.85	0.85	0.85
Fixed effects	*hc*,*ht*,*ct*	*hc*,*ht*,*ct*	*hc*,*ht*,*ct*	*hc*,*ht*,*ct*

Notes: Table displays results of product (h)-country (c)-year (t) level OLS generalized triple difference-in-differences regression of log Chinese export value on interaction of US country indicator, post-PNTR indicator, and NTR gap, along with country × year (ct), country × product (hc), and product × year (ht) fixed effects, and the NTR tariff rate. Data span 2000 to 2005. Robust standard errors adjusted for clustering at the product × country level are displayed below each coefficient. Estimates for the fixed effects and constant are suppressed.

imports of products with higher NTR gaps from China, vis-à-vis other countries. We examine this mechanism using the "related-party" flag present in the US import data, which indicates whether the US importer and the foreign exporter are "related" by ownership of at least 6 percent.[37]

Using the same specification (equation (5)) employed in Section IVA, we find in Table 6 that higher NTR gaps are associated with statistically significant increases in the number of US importers sourcing imports from related-parties in China, the number of Chinese exporters exporting to a related-party in the United States, and the number of related-party importer-exporter pairs. The relationship with respect to value, while positive, is not statistically significant at conventional levels, though we note that this lack of significance appears to be driven by a lag between the formation of the related-party importer-exporter pairs and the imports that flow between them.[38] Overall, these results indicate a relative increase in the number of Chinese

[37] Growth of related-party trade is just one potential manifestation of offshoring. For example, it does not include the growth in trade associated with firms that produced and sold to arm's-length customers in the United States prior to PNTR but that subsequently moved production to China while continuing to sell to their previous customers.

[38] For example, consideration of an alternate specification focusing on long differences—i.e., comparison of related party import growth in the six years prior to PNTR to that in the six years after PNTR—reveals a positive and statistically significant relationship between the NTR gap and Chinese export growth to the United States, post-PNTR. This specification is similar to that estimated in an earlier version of this paper, Pierce and Schott (2012b): $\Delta\ln(O_{hct:t+6}) = \theta 1\{c = China\}_c \times PostPNTR_t \times NTR\,Gap_h + \lambda Tariff_{hct} + \delta_{ct} + \delta_{ch} + \delta_{ht} + \alpha + \varepsilon_{hct}$, where $t \in \{1995, 2001\}$.

Table 6—PNTR and Related-Party US Imports (*LFTTD*)

	$\ln(\text{RP Value}_{hct})$	$\ln(\text{RP Importers}_{hct})$	$\ln(\text{RP Exporters}_{hct})$	$\ln(\text{RP Pairs}_{hct})$
$1\{c = \text{China}\} \times \text{Post} \times \text{NTR Graph}$	0.205	0.328	0.379	0.380
	(0.180)	(0.063)	(0.074)	(0.074)
$\ln(\text{Tariff}_{hct})$	−0.045	0.001	0.002	0.002
	(0.016)	(0.004)	(0.005)	(0.005)
MFA Phase 1_{hct}	−0.151	0.005	0.022	0.016
	(0.103)	(0.030)	(0.035)	(0.036)
MFA Phase 2_{hct}	−0.246	−0.049	−0.030	−0.046
	(0.067)	(0.019)	(0.022)	(0.022)
MFA Phase 3_{hct}	−0.109	0.004	0.033	0.021
	(0.073)	(0.020)	(0.025)	(0.025)
MFA Phase 4_{hct}	−0.617	0.029	−0.150	−0.154
	(0.049)	(0.014)	(0.017)	(0.017)
Observations	712,000	712,000	712,000	712,000
R^2	0.82	0.88	0.87	0.87
Fixed effects	*hc*,*ct*,*ht*	*hc*,*ct*,*ht*	*hc*,*ct*,*ht*	*hc*,*ct*,*ht*
Implied impact of PNTR	0.06	0.10	0.12	0.12

Notes: Table displays results of product (h)-country (c)-year (t) level OLS generalized triple difference-in-differences regression of related-party trade variable on interaction of China country indicator, post-PNTR indicator, and NTR gap, along with country × year (ct), country × product (hc) and product × year (ht) fixed effects, the revealed tariff rate and indicators for the four phases of the MFA. Data span 1992 to 2007. Robust standard errors adjusted for clustering at the product × country level are displayed below each coefficient. Estimates for the fixed effects and constant are suppressed. Final row reports the predicted relative change in the dependent variable implied by the triple differences coefficient. Number of observations has been rounded to nearest thousand due to Census Bureau disclosure avoidance procedures.

affiliates from which US firms source goods in response to PNTR, consistent with an expansion of offshoring activity.

C. *Inducing Changes in US Factor Intensity*

PNTR may have affected US manufacturing employment not only through the substitution of imports from China for US production, but also by inducing firms facing increased import competition to decrease employment through adjustment of their production processes or product mix. To examine this possibility, we analyze the relationship between PNTR and factor usage—i.e., skill and capital intensity—using quinquennial data collected in the US Census of Manufactures (CM). We perform this analysis at both the industry *and* plant level to determine the extent to which changes in factor intensity are driven by entry and exit versus changes within continuing plants.[39]

For years ending in "2" and "7," the CM contains plant characteristics including total employment, a breakdown of total employment into production and non-production workers, production worker hours, and capital.[40] As in Section II, we define skill intensity as the ratio of non-production workers to total employment

[39] Holmes and Stevens (2014) show that increased import competition from China can have heterogeneous effects among plants within an industry, with the biggest negative effect observed at large plants producing standardized goods. Small plants producing specialty goods are less affected.

[40] Real book value of capital is deflated using industry-level investment price indexes from Becker, Gray, and Marvakov (2013).

and capital intensity as the ratio of capital to total employment. Our analysis makes use of the same generalized difference-in-differences specification defined in equation (2), with one important difference: because the CM tracks establishments' attributes only every five years, the pre-PNTR period is defined as 1992 and 1997 and the post-PNTR period is defined as 2002 and 2007.

We first present industry-level results in Table 7 that capture adjustments due to entry and exit of plants with different factor intensities, as well as changes within continuing plants. As indicated in columns 1 and 2 of the table, PNTR is associated with statistically and economically significant increases in both industry skill intensity and industry capital intensity. The gain in skill intensity arises from heterogeneous responses for the two types of workers tracked in our data. While we find negative and statistically significant relationships between employment and the NTR gap for both non-production (column 3) and production workers (column 4), the implied impact of PNTR for production workers is more than one and a half times that for non-production workers. This result is consistent with research (e.g., Ebenstein et al. 2014) finding that the effect of import competition on wages is concentrated among production workers engaged in routine blue-collar production occupations.[41] As indicated in column 6, the gains in capital intensity arise from statistically significant declines in total employment (column 5) compared to a statistically insignificant response for capital (column 6).[42]

Next, we examine the extent to which the increases in industry-level capital and skill intensity associated with PNTR are driven by changes within continuing plants. Estimates from a series of plant-level regressions are reported in Table 8, with robust standard errors clustered by plants' major industry. These regressions differ from the industry-level regressions in two ways. First, they make use of plant-level NTR gaps, defined as the weighted-average NTR gap across all of the industries in which the plant is active in 1997. Second, they contain plant fixed effects as well as plant-level control variables such as age and total factor productivity in addition to the industry-level control variables used in the baseline specification.[43]

Results in the first two columns of Table 8 indicate that while PNTR is not associated with changes in skill intensity for continuing plants, it is associated with capital deepening. Indeed, as noted in the final row of column 2, the implied economic impact of PNTR on plant capital intensity is a relative increase of 0.09 log points. This relative capital deepening *within* plants is consistent with two mechanisms of employment loss: trade-induced technological change, as in Bloom, Draca, and Van Reenen (2016), and trade-induced product upgrading, as in Bernard, Jensen, and Schott (2006), Khandelwal (2010), and Schott (2003, 2008), with the former

[41] Results in column 7 show that the PNTR-related decline in production hours is similar in magnitude to that for total employment, ruling out the possibility that the decline in employment resulted from a contraction on the extensive margin (the number of employees) that was offset by an expansion on the intensive margin (the number of hours per worker).

[42] Results for total employment in column 5 are similar in terms of both statistical and economic significance to those reported in the baseline specification in Section II, despite use of a different dataset.

[43] We follow Foster, Haltiwanger, and Syverson (2008) in measuring TFP as the log of deflated revenue minus the log of inputs, weighted by the average cost share for each input across industries (see Section B.4 of the online Appendix for more detail). We note that productivity measures constructed from revenue information may be biased due to unobserved establishment-level variation in prices, which can be affected by changes in trade policy (Pierce 2011 and De Loecker et al. 2016).

Table 7—Other Industry Outcomes (*CM*)

	$\ln(\mathrm{NP/Emp}_{it})$	$\ln(\mathrm{K/Emp}_{it})$	$\ln(\mathrm{NProd}_{it})$	$\ln(\mathrm{Prod}_{it})$	$\ln(\mathrm{Emp}_{it})$	$\ln(\mathrm{K}_{it})$	$\ln(\mathrm{Hours}_{it})$
Post × NTR Gap_i	0.159	0.556	−0.324	−0.531	−0.481	−0.097	−0.567
	(0.062)	(0.157)	(0.186)	(0.222)	(0.218)	(0.230)	(0.228)
Post × $\ln(\mathrm{K/Emp}_{i,1990})$	−0.049		−0.031	0.019	0.006	−0.082	0.010
	(0.018)		(0.031)	(0.042)	(0.039)	(0.041)	(0.041)
Post × $\ln(\mathrm{NP/Emp}_{i,1990})$		−0.021	0.075	0.217	0.181	0.200	0.223
		(0.054)	(0.077)	(0.079)	(0.079)	(0.083)	(0.081)
Post × Contract $\mathrm{Intensity}_i$	0.134	0.172	−0.017	−0.299	−0.201	−0.193	−0.322
	(0.045)	(0.130)	(0.159)	(0.178)	(0.169)	(0.158)	(0.179)
Post × ΔChina Import $\mathrm{Tariffs}_i$	0.127	−0.213	−0.142	−0.467	−0.332	−0.507	−0.495
	(0.066)	(0.159)	(0.206)	(0.217)	(0.213)	(0.212)	(0.228)
Post × ΔChina $\mathrm{Subsidies}_i$	0.061	0.298	0.140	0.015	0.070	0.401	−0.017
	(0.054)	(0.085)	(0.106)	(0.133)	(0.121)	(0.129)	(0.143)
Post × ΔChina $\mathrm{Licensing}_i$	−0.051	0.065	−0.314	−0.222	−0.265	−0.095	−0.156
	(0.071)	(0.138)	(0.232)	(0.250)	(0.235)	(0.229)	(0.262)
Post × $1\{\text{Advanced Technology}_i\}$	−0.044	−0.015	−0.010	−0.040	−0.018	−0.021	−0.043
	(0.019)	(0.055)	(0.068)	(0.075)	(0.070)	(0.070)	(0.074)
MFA $\mathrm{Exposure}_{it}$	0.072	0.048	−0.274	−0.352	−0.335	−0.306	−0.344
	(0.060)	(0.117)	(0.080)	(0.132)	(0.117)	(0.103)	(0.132)
NTR_{it}	−0.108	0.182	−1.246	−0.696	−1.094	−0.709	−0.781
	(0.494)	(0.959)	(1.114)	(1.406)	(1.280)	(1.147)	(1.417)
US Union $\mathrm{Membership}_{it}$	0.298	0.241	0.170	−0.292	−0.158	−0.113	−0.273
	(0.148)	(0.263)	(0.376)	(0.347)	(0.359)	(0.354)	(0.362)
Observations	1,280	1,280	1,280	1,280	1,280	1,280	1,280
R^2	0.97	0.97	0.98	0.98	0.98	0.98	0.98
Fixed effects	*i,t*	*i,t*	*i,t*	*i,t*	*i,t*	*i,t*	*i,t*
Employment weighted	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Implied impact of PNTR	0.051	0.178	−0.104	−0.170	−0.154	−0.031	−0.182

Notes: Table reports results of industry-year level OLS generalized difference-in-differences regression of noted industry outcome on the interaction of the NTR gap and a post-PNTR indicator. Additional controls include time-varying variables—MFA exposure, NTR tariff rates, union membership rates—as well as interactions of the post-PNTR indicator with time-invariant controls including the log of 1990 capital and skill intensity, contract intensity (Nunn 2007), changes in Chinese import tariffs, changes in Chinese production subsidies, changes in Chinese export licensing requirements, and an indicator for whether the industry produces advanced technology products. NProd, Prod, Hours, and K represent nonproduction workers, production workers, production hours, and the real book value of capital. Data are from the CM and for census years 1992, 1997, 2002, and 2007. Robust standard errors adjusted for clustering at the industry level are displayed below each coefficient. Estimates for the year (t) and industry (i) fixed effects as well as the constant are suppressed. Observations are weighted by 1992 industry employment. Final row reports the predicted relative change in the dependent variable implied by the difference-in-differences coefficient.

suggesting that PNTR may be associated with employment reductions beyond those attributable to replacement of US production by Chinese imports.[44]

D. *Input-Output Linkages*

PNTR may also affect employment at US manufacturing plants indirectly via their supply chains, i.e., the upstream firms from which they purchase their inputs or the downstream firms to which they sell their outputs. Indeed, recent theoretical

[44] We provide anecdotal evidence supporting these mechanisms in Section A.3 of the online Appendix. For example: "To beat the Chinese and other foreign competitors threatening [their] business, [the owners] invested several million dollars to double the production capacity of their plastic-part plant, PM Mold, with the latest in robotics and automation equipment. Now, [it] can make twice as many parts—and better ones at that—without adding to [its] work force (Neikirk 2002)."

Table 8—Plant Outcomes (*CM*)

	$\ln(\text{NP/Emp}_{it})$	$\ln(\text{K/Emp}_{it})$	$\ln(\text{NProd}_{it})$	$\ln(\text{Prod}_{it})$	$\ln(\text{Emp}_{it})$	$\ln(\text{K}_{it})$	$\ln(\text{Hours}_{it})$
Post × NTR Gap_p	0.003	0.295	−0.240	−0.280	−0.276	−0.419	−0.312
	(0.082)	(0.139)	(0.123)	(0.142)	(0.112)	(0.268)	(0.139)
Post × $\ln(\text{K/Emp}_{p,1990})$	−0.039		−0.027	−0.008	−0.009	−0.254	−0.017
	(0.006)		(0.013)	(0.014)	(0.012)	(0.023)	(0.013)
Post × $\ln(\text{NP/Emp}_{p,1990})$		0.013	−0.290	0.109	0.016	0.070	0.106
		(0.021)	(0.024)	(0.020)	(0.018)	(0.028)	(0.020)
Age_p	0.022	0.092	0.197	0.213	0.195	0.244	0.216
	(0.017)	(0.026)	(0.031)	(0.030)	(0.025)	(0.027)	(0.027)
TFP_p	−0.042	−0.073	−0.007	0.032	0.031	−0.037	0.046
	(0.012)	(0.021)	(0.012)	(0.022)	(0.017)	(0.025)	(0.023)
Post × Contract Intensity_i	0.034	0.114	0.064	−0.214	−0.094	−0.369	−0.251
	(0.058)	(0.097)	(0.117)	(0.128)	(0.102)	(0.168)	(0.123)
Post × ΔChina Import Tariffs_i	0.236	−0.166	0.222	−0.388	−0.229	−0.294	−0.436
	(0.079)	(0.168)	(0.165)	(0.190)	(0.144)	(0.288)	(0.164)
Post × ΔChina Subsidies_i	0.014	0.239	0.150	0.141	0.103	0.453	0.103
	(0.052)	(0.103)	(0.097)	(0.123)	(0.086)	(0.174)	(0.111)
Post × ΔChina Licensing_i	0.180	0.155	−0.210	−0.550	−0.387	0.064	−0.460
	(0.072)	(0.170)	(0.201)	(0.252)	(0.188)	(0.267)	(0.214)
Post × 1{Advanced Technology_i}	−0.048	−0.015	0.051	−0.130	−0.057	−0.013	−0.107
	(0.020)	(0.054)	(0.043)	(0.063)	(0.048)	(0.079)	(0.063)
MFA Exposure_{it}	0.085	0.081	−0.139	−0.191	−0.185	−0.184	−0.201
	(0.058)	(0.066)	(0.089)	(0.100)	(0.095)	(0.116)	(0.101)
NTR_{it}	−0.849	−0.949	0.015	1.827	0.868	0.904	1.666
	(0.582)	(0.681)	(0.844)	(1.220)	(0.903)	(1.080)	(1.208)
US Union Membership_{it}	0.268	−0.009	0.591	0.179	0.304	−0.262	0.109
	(0.145)	(0.240)	(0.237)	(0.252)	(0.223)	(0.263)	(0.259)
Observations	257,503	257,503	257,503	257,503	257,503	257,503	257,503
R^2	0.78	0.73	0.93	0.93	0.95	0.91	0.92
Fixed effects	*p,t*	*p,t*	*p,t*	*p,t*	*p,t*	*p,t*	*p,t*
Employment weighted	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Implied impact of PNTR	0.001	0.094	−0.077	−0.089	−0.088	−0.134	−0.100

Notes: Table reports results of plant-year level OLS generalized difference-in-differences regression of noted plant outcome on the interaction of the NTR gap and a post-PNTR indicator. Additional controls include time-varying variables—MFA exposure, NTR tariff rates, union membership rates, plant age, plant TFP (index method)—as well as interactions of the post-PNTR indicator with time-invariant controls including the log of capital and skill intensity in the first year the plant is observed, contract intensity (Nunn 2007), changes in Chinese import tariffs, changes in Chinese production subsidies, changes in Chinese export licensing requirements, and an indicator for whether the industry produces advanced technology products. NProd, Prod, Hours, and K represent non-production workers, production workers, production hours and the real book value of capital. Data are from the CM and for census years 1992, 1997, 2002, and 2007. Robust standard errors adjusted for clustering at the level of the plants' major industries are displayed below each coefficient. Estimates for the year (t) and plant (p) fixed effects as well as the constant are suppressed. Observations are weighted by employment in the first year the plant is observed. Final row reports the predicted relative change in the dependent variable implied by the difference-in-differences coefficient.

research by Baldwin and Venables (2013) suggests that reductions in trade frictions for one portion of the supply chain may lead to co-offshoring of its suppliers and customers, leading to large, discontinuous offshoring events.[45] In this sense, input-output linkages may amplify the negative relationship between PNTR and

[45] Ellison, Glaeser, and Kerr (2010), for example, find that proximity to suppliers and customers is an important determinant of the location of manufacturing activity.

manufacturing employment, serving as an important mechanism for the policy's effect. Alternatively, plants benefiting from greater access to lower-priced Chinese inputs might expand operations relative to others whose input suppliers are less exposed to PNTR. More generally, a number of recent papers emphasize the importance of examining input-output linkages when estimating the impact of import competition, e.g., Amiti and Konings (2007); Goldberg et al. (2010); Acemoglu et al. (2016); and Razhev (2015).

We examine the transmission of PNTR through input-output linkages by computing plant-level up- and downstream NTR gaps using information from the BEA input-output tables and including them in a plant-level regression:

$$O_{pt} = \sum_m \theta_d^m PostPNTR_t \times NTR\,Gap_p^m + PostPNTR_t \times \mathbf{X}_i'\boldsymbol{\gamma} + \mathbf{X}_{it}'\boldsymbol{\lambda} + \mathbf{X}_{pt}'\boldsymbol{\mu} + \boldsymbol{\delta}_t + \boldsymbol{\delta}_p + \alpha + \varepsilon_{pt}, \tag{6}$$

where O_{pt} represents either log employment of continuing plant p in year t or an indicator variable that takes a value of one if the plant dies between year t and year $t+1$ and 0 otherwise. $NTR\,Gap_p^m$ represents the NTR gap for $m = \{Own, Upstream, Downstream\}$; for each dependent variable, we report estimates for specifications that both exclude and include the up- and downstream NTR gaps.[46] All specifications use the annual plant-level data available from the LBD.

Results in Table 9 provide evidence that PNTR's effect on employment can be transmitted, and potentially magnified, through supply chains. Columns 1 and 3, which do not control for supply-chain linkages, indicate that higher exposure to PNTR in plants' own industry is associated with lower employment within continuing plants and a higher probability of plant death. By comparison, the results in columns 2 and 4 show that plants whose customers are more exposed to PNTR—as measured by the downstream NTR gap—also contract employment and are more likely to die.[47] This effect via downstream industries is consistent with either a contraction in output when plants' customers face negative demand shocks, or to co-offshoring as plants relocate to China to be closer to their customers. More generally, the results show that PNTR affects US manufacturing employment along both the intensive and extensive margins, by reducing employment within continuing plants and by inducing plant exit.[48]

V. Conclusion

This paper finds a relationship between the sharp decline in US manufacturing employment after 2000 and the United States' conferral of permanent normal trade

[46] Section B.1 of the online Appendix provides a detailed description of calculation of the plant-level upstream and downstream NTR gaps.

[47] In terms of economic significance, the impact of PNTR implied by the results in column 2 is a relative -0.14 log point decline in employment in the post-PNTR period, with the own and downstream NTR gaps contributing roughly equally. Computation of economic significance excludes the impact of the statistically insignificant coefficient for the upstream NTR gap.

[48] The working version of this paper, Pierce and Schott (2012b), shows that anemic job creation accounts for approximately one quarter of the overall estimated impact of PNTR, with the remainder due to exaggerated job destruction. These trends provide a partial explanation for the post-2000 shift in job creation and destruction rates discussed in Faberman (2008).

Table 9—Plant Input-Output Linkages (*LBD*)

	$\ln(\text{Emp}_{it})$	$\ln(\text{Emp}_{it})$	$1\{\text{Death}_{pt+1}\}$	$1\{\text{Death}_{pt+1}\}$
Post × NTR Gap_p	−0.380	−0.208	0.064	0.042
	(0.089)	(0.090)	(0.020)	(0.019)
Post × NTR $\text{Gap}_p^{Upstream}$		−0.280		−0.022
		(0.427)		(0.082)
Post × NTR $\text{Gap}_p^{Downstream}$		−0.691		0.103
		(0.159)		(0.041)
Post × $\ln(\text{K/Emp}_{p,1990})$	−0.082	−0.070	−0.006	−0.009
	(0.016)	(0.015)	(0.003)	(0.003)
Post × $\ln(\text{NP/Emp}_{p,1990})$	0.052	0.034	−0.016	−0.013
	(0.031)	(0.030)	(0.006)	(0.005)
Post × Contract Intensity_i	−0.189	−0.218	0.003	0.010
	(0.081)	(0.081)	(0.013)	(0.014)
Post × ΔChina Import Tariffs_i	−0.396	−0.278	−0.006	−0.027
	(0.104)	(0.109)	(0.020)	(0.018)
Post × ΔChina Subsidies_i	0.022	0.022	0.023	0.023
	(0.073)	(0.069)	(0.012)	(0.011)
Post × ΔChina Licensing_i	−0.121	−0.036	0.007	−0.002
	(0.146)	(0.135)	(0.022)	(0.023)
Post × 1{Advanced Technology_i}	−0.056	−0.055	0.007	0.005
	(0.028)	(0.027)	(0.005)	(0.004)
MFA Exposure_{it}	−0.193	−0.167	0.037	0.035
	(0.064)	(0.053)	(0.014)	(0.013)
NTR_{it}	0.555	0.524	0.031	0.039
	(0.513)	(0.513)	(0.052)	(0.048)
US Union Membership_{it}	0.112	0.164	0.012	0.003
	(0.132)	(0.133)	(0.014)	(0.012)
Observations	1,181,142	1,181,142	2,079,616	2,079,616
R^2	0.95	0.95	0.79	0.79
Fixed effects	*p,t*	*p,t*	*p,t*	*p,t*
Employment weighted	Yes	Yes	Yes	Yes
Implied impact of PNTR	−0.117	−0.143	—	—

Notes: Table reports results of plant-year level OLS generalized difference-in-differences regressions of either log plant-year employment or an indicator for plant death on the interaction of a post-PNTR indicator and the own, upstream and downstream NTR gaps. Additional controls include time-varying variables—MFA exposure, NTR tariff rates, union membership rates, plant age, plant TFP (index method)—as well as interactions of the post-PNTR indicator with time-invariant controls including the log of capital and skill intensity in the first year the plant is observed, contract intensity (Nunn 2007), changes in Chinese import tariffs, changes in Chinese production subsidies, changes in Chinese export licensing requirements and an indicator for whether the industry produces advanced technology products. Data span 1990 to 2007. Robust standard errors adjusted for clustering at the level of the plants' major industries are displayed below each coefficient. Estimates for the year (t) and plant (p) fixed effects as well as the constant are suppressed. Observations are weighted by plant employment in the first year that it is observed in the sample. Final row reports the predicted relative change in the dependent variable implied by the difference-in-differences coefficient. First two columns restricted to the intensive margin of plants active in all years of the sample. Last two columns contain all observations.

relations on China, a policy that is notable for eliminating the possibility of future tariff increases—and the uncertainty with which they were associated—rather than reducing the tariffs actually applied to Chinese goods.

We measure the effect of PNTR as the gap between the high non-NTR rates to which tariffs would have risen if annual renewal of China's NTR status had failed and the lower NTR tariff rates that were locked in by PNTR. Using a generalized difference-in-differences specification, we show that industries with higher NTR gaps experience larger employment declines, along with disproportionate increases in US imports from China, the number of US firms importing from China and the number of Chinese firms exporting to the United States, especially foreign-owned Chinese firms. These results are robust to inclusion of variables proxying for a wide range of alternate explanations for the observed trends in employment and trade. Moreover, we demonstrate that the pattern of employment losses in the United States—which experienced the policy change—is not present in the European Union, which had granted China the equivalent of PNTR status in 1980. Additional analysis of the mechanisms by which the change in policy affected US manufacturers reveals evidence consistent with offshoring by US firms, reallocation within high-gap industries toward less labor-intensive plants, increases in the capital intensity of the most affected plants, and magnification of the effects of PNTR via downstream customers.

Having established a link between the change in trade policy and US employment outcomes, this research raises several important, but challenging questions. To what extent can PNTR explain the diverging trends of value-added and employment in the US manufacturing sector? What impact did PNTR have on US prices and consumption patterns? To what extent did US firms change the composition of their output in response to PNTR, and how large were the associated transition costs? We hope to bring additional data to bear on these questions in future research.

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