

EXPORTING OUT OF AGRICULTURE: THE IMPACT OF WTO ACCESSION ON STRUCTURAL TRANSFORMATION IN CHINA

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Abstract—This paper analyzes the effect of China's accession to the World Trade Organization in 2001 on structural transformation at the local level, exploiting cross-sectional variation in tariff uncertainty faced by county economies pre-2001. Using a new panel of 1,800 Chinese counties from 1996 to 2013, we find that counties more exposed to the reduction in tariff uncertainty postaccession are characterized by increased exports and foreign direct investment, shrinking agricultural sectors, expanding secondary sectors, and higher total and per capita GDP. In addition, when labor substitutes from nonagricultural to agricultural production in counties exposed to positive trade shocks, agricultural output declines.

I. Introduction

OVER the past two and a half decades, China has experienced a process of remarkable structural transformation accompanied by rapid economic growth. The share of total employment in the agricultural sector fell from 60% in 1990 to 28% in 2015, and this sectoral shift was matched by unprecedented growth in nonagricultural output, as evident in figures 1a and 1b. At the same time, China also experienced a rapid rise in manufacturing exports, increasing from 2% to 19% of global manufacturing exports. While this transformation can be traced back to the onset of market-oriented reforms in 1979, the pace of the structural shift accelerated following China's accession to the World Trade Organization in 2001.

China's record of growth has generated a robust debate about its causes. While some analysts argue that trade liberalization stimulated economic growth (Sun & Heshmati, 2010; McMillan, Rodrik, & Verduzco-Gallo, 2014), there is relatively little direct evidence of this relationship, and more generally Goldberg and Pavcnik (2016) conclude in a review that there is only limited empirical evidence of the relationship between trade policy and growth. By contrast, a large literature argues that internal policy reforms, particularly the reform of state-owned enterprises and the creation of Special Economic Zones, were crucial in enabling China to increase productivity and realize its comparative advantage in manufacturing (Song, Storesletten, & Zilibotti, 2011; Autor, Dorn, & Hanson, 2016). Evidence suggests that the reduction of domestic tariffs had a large, positive effect on the manufacturing sector (Manova & Zhang, 2017; Brandt et al., 2017), but there

is almost no empirical evidence about the effects of trade liberalization on other economic sectors or on the process of structural transformation writ large.

At the same time, a growing literature has analyzed the determinants of structural change in the developing world, primarily focusing on "push factors," or positive shocks to agricultural productivity.¹ There has been only limited empirical exploration of the role of trade liberalization, arguably among the most important pull factors that can stimulate the substitution of productive factors out of agriculture. Given that productivity is much lower in agricultural compared to nonagricultural production in developing economies, this substitution has important macroeconomic implications (Gollin, Lagakos, & Waugh, 2014; McMillan et al., 2014). Analyzing trade liberalization in China, the focus of this study, represents a valuable opportunity to evaluate the effects of an exogenous pull shock on structural transformation in the context of a fast-evolving economy in which a range of reforms were contributing to a rapid flow of labor out of the agricultural sector.

In this paper, we provide new evidence around the effects of China's WTO accession on structural change and growth at the local level, analyzing a newly assembled panel of approximately 1,800 counties observed between 1996 and 2013. China's WTO membership significantly reduced uncertainty about U.S. trade policy for China, generating a substantial increase in both total Chinese exports to the United States and total exports, as evident in figures 1c and 1d (Handley & Limão, 2017; Pierce & Schott, 2016). At the same time, aggregate shifts in labor allocation patterns emerged: primary employment, previously roughly stagnant at the national level, began to contract at a rate of 3.5% annually after 2002, and the annual growth rate of secondary employment nearly tripled. Given this evidence, we utilize an identification strategy that allows us to examine the effects of cross-sectionally varying shocks generated by the reduction in uncertainty and present evidence that these shocks led to significant growth in exports and foreign direct investment in more exposed regions. This in turn stimulated a reallocation of productive factors from agriculture into manufacturing and services and generated a significant increase in county-level output.

More specifically, China's Most Favored Nation (MFN) status in the United States required annual renewal by Congress prior to 2002, a process entailing considerable

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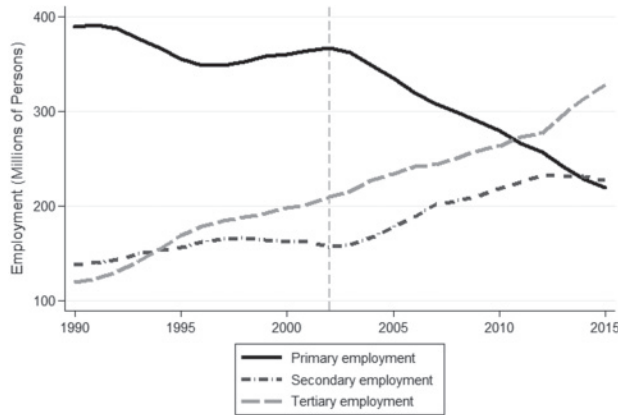
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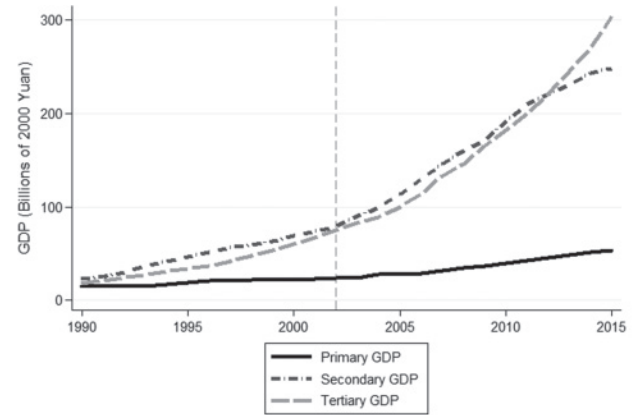
¹For example, Hornbeck and Keskin (2015) find no evidence that positive agricultural growth generated by the construction of an aquifer in the United States generates nonagricultural growth, while Bustos, Caprettini, and Ponticelli (2016) present evidence that technological innovations in the soybean sector in Brazil generate industrial growth only when they are labor saving.

FIGURE 1.—AGGREGATE TRENDS

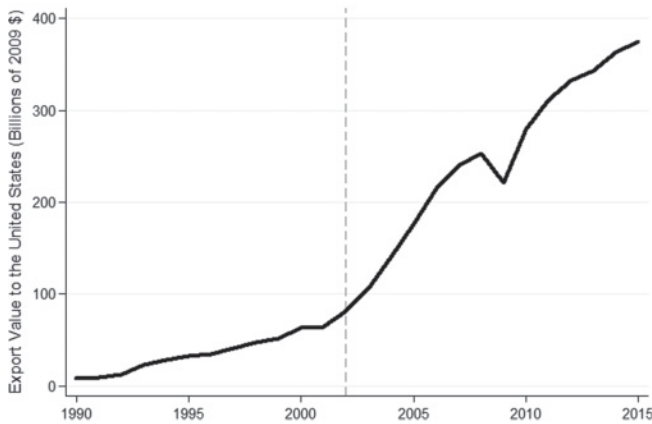
(A) Composition of Employment in China



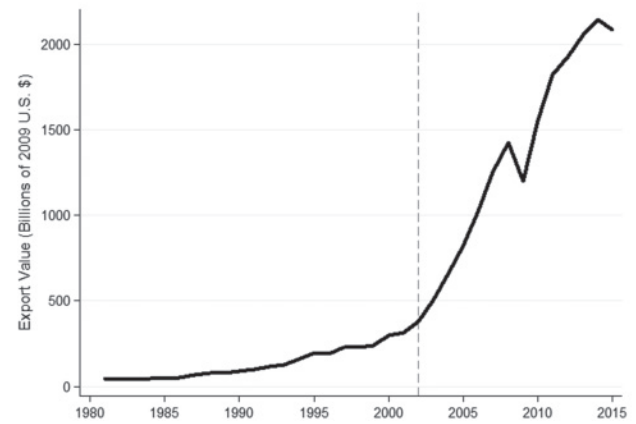
(B) Composition of GDP in China



(C) China's Exports to the United States



(D) China's Total Exports



Panels A and B present aggregate statistics for China as a whole from 1990 to 2015, employing data from the National Bureau of Statistics. The primary sector includes agriculture, forestry and fishing; the secondary sector includes manufacturing and mining, and the tertiary sector includes services. GDP is reported in billions of constant 2000 yuan, and employment is reported in millions of persons. Panels C and D show exports of China to the United States and total exports of China to all countries, respectively, from 1990 to 2015. The data for China's exports to the United States are drawn from the IMF Direction of Trade database, and the data for China's total exports are drawn from the FRED database; both series are deflated to 2009 US dollars using the PCE price index.

risk; if the renewal had failed, Chinese exports would have been subject to the much higher rates reserved for nonmarket economies.² The United States permanently granted Normal Trade Relations (NTR) status—a U.S. term for MFN status—to China in October 2000, tied to its WTO membership and effective as of January 1, 2002 (Handley & Limão, 2017). By contrast, the status of Chinese exports in other markets did not change. Our empirical design utilizes variation across industries in the gap between the NTR tariffs and the non-NTR rates, in conjunction with variation across counties in the composition of employment by industry reported in the 1990 census. The interaction of these two sources of variation generates a county-level variable capturing the exposure of local industries to tariff uncertainty before 2001; the county is an important unit of analysis in the literature on the Chinese

economy, corresponding to a local labor market with defined fiscal and economic policies (Chen & Kung, 2016). If this uncertainty is a significant barrier to exporting, more exposed counties should experience more rapid export expansion and substitution into the secondary sector after 2001.

Our primary results suggest that counties more exposed to tariff uncertainty prior to 2001 experienced significantly faster growth in exports, greater expansion in the secondary sector, greater contraction in the primary sector, and more rapid increases in total and per capita GDP following WTO accession, conditional on county and province-year fixed effects.³ Comparing a county at the median level of uncertainty ex ante to a county characterized by the minimum level of uncertainty, the more exposed county shows evidence of an

²For example, in 2000, the average U.S. MFN tariff was 4%, but China would have faced an average non-MFN tariff of 31% had its MFN status been revoked.

³In this context, the primary sector includes agriculture and agricultural extensions, the secondary sector includes manufacturing and mining, and the tertiary sector includes services. Construction is reported as part of the tertiary sector.

increase in exports of around .20 log points and increases in secondary, total, and per capita county GDP of around .04 log points. This export-driven expansion also has ancillary effects on other sectors: productive factors shift out of agriculture, agricultural production declines, tertiary output expands, and there is some evidence of in-migration. Using firm-level data, we document that more exposed regions also experience an increase in value added per worker in manufacturing and a corresponding rise in wages.

Importantly, the evidence of contraction in agricultural output in counties more exposed to positive export shocks inducing factor substitution into nonagricultural production is inconsistent with the predictions of a classic surplus labor model. Rather, this pattern is consistent with other recent work arguing that stocks of surplus labor in rural areas have largely been depleted as China reaches the Lewis turning point (Zhang, Yang, & Wang, 2011; Kwan, Wu, & Zhuo, 2018). We present additional evidence that the decline in agricultural output is accelerating as labor continues to substitute into new sectors, and that this decline is also larger in areas that have experienced an agglomeration of positive shocks to export-oriented production in multiple counties within a prefecture.

Moreover, the magnitude of the implied effects is substantial; our findings suggest that reduced trade uncertainty accounted for approximately 10% of total output growth during this period and that substitution of productive factors into nonagricultural production generated an increase of at least 10% in aggregate productivity. Clearly, a range of other pull factors during this period—including substantial manufacturing growth driven by a major restructuring of state-owned enterprises—contribute to the observed process of structural transformation, but we argue that enhanced access to advanced markets represents a nontrivial contribution. While an analysis at the level of the local economy is not directly informative about the magnitude of macrolevel shifts, it does enable us to analyze the causal factors shaping these shifts with more precision.

Our paper is the first to estimate the causal effects of enhanced access to U.S. export markets on structural transformation and growth at the local level in China. It is also one of the first to provide evidence on the employment and GDP effects of enhanced access to advanced country markets in a developing country. Accordingly, this project serves to address the evidence gap identified by Goldberg and Pavcnik (2016) about the relationship among trade, growth, and structural transformation in the developing world.

In addition, we contribute to several specific bodies of literature. First, a number of studies have sought to identify the impact of trade liberalization on the Chinese manufacturing sector, focusing on industries or firms as the unit of analysis, and primarily analyzing variation in tariff levels. Although our findings complement these studies, our paper differs significantly in its focus on structural transformation and county-level growth. In the literature, Brandt and Morrow (2017) and Manova and Zhang (2017) show that reduced tariffs have also

resulted in increased access to imported inputs. Brandt et al. (2017) demonstrate that both input and output tariff cuts have implications for productivity and mark-ups, but those effects are heterogeneous for incumbent firms vis-a-vis new entrants and also for state-owned vis-a-vis private firms. Bai, Krishna, and Ma (2017) and Khandelwal, Schott, and Wei (2013) analyze the impact of the removal of export restrictions and MFA quotas on export growth and manufacturing productivity at the firm level, respectively. Recent work has also found that the diminished trade policy uncertainty following China's WTO accession has boosted patent applications (Liu & Ma, 2020) and stimulated entry into export-oriented production (Feng, Li, & Swenson, 2017).

Second, our study contributes to the literature on trade liberalization in developing countries by presenting evidence on the employment and GDP effects of the elimination of trade policy uncertainty in China. A number of papers have analyzed the effects of domestic tariff cuts on regional labor market outcomes in Brazil (Chiquiar, 2008; Kovak, 2013; Dix-Carneiro & Kovak, 2017), but existing studies evaluating the effects of expanded access to developed country markets largely focus on Vietnam. Exploiting shocks generated by a bilateral trade agreement, McCaig (2011) finds that the U.S. tariff cuts reduced poverty in Vietnam, and McCaig and Pavcnik (2018, 2016), analyze reallocation of labor between household businesses and the formal sector. Another paper analyzes the effect of China's WTO accession on internal migration, but it uses only prefecture-level data (Facchini, Mayda, & Zhou, 2019).

Third, our results are consistent with a theoretical literature that predicts a reallocation of workers from less income-elastic sectors such as agricultural production into more income-elastic sectors, including manufacturing in response to increased access to export markets. Open-economy models with nonhomothetic preferences predict that lower trade costs result in productivity gains and higher income growth, shifting expenditure toward income-elastic sectors (Matsuyama, 2009, 2019; Herrendorf, Rogerson, & Valentinyi, 2014). More generally, open economy models of structural change predict that declining trade costs can induce labor reallocations across sectors (Uy, Yi, & Zhang, 2013; Cravino & Sotelo, 2017), but previous empirical work has generally found limited evidence of intersectoral labor reallocation in response to trade shocks, particularly in the short run.⁴ Our empirical specification allows us to capture the factor reallocation effects generated by declining implied trade costs at the level of local labor markets over a relatively long period of time.

Finally, an extensive literature analyzes the effects of Chinese imports on manufacturing in developed economies (Autor et al., 2013, 2016). The identification strategy employed in this paper is closely related to Pierce and Schott (2016) and Handley and Limão (2017), examining the effects of trade

⁴Recent work in this literature includes Attanasio, Goldberg, and Pavcnik (2004), Wacziarg and Wallack (2004), and Topalova (2010).

policy uncertainty on manufacturing employment and consumer prices in the United States.

The remainder of the paper proceeds as follows. Section II provides more background on China's accession to the WTO and a simple conceptual framework. Section III describes the data. Section IV presents the identification strategy and the empirical results. Section V presents robustness checks, and section VI concludes.

II. Background and Conceptual Framework

A. China's WTO Accession

China's accession to the WTO in 2001 entailed both new trade access benefits for the Chinese economy and a commitment to additional, liberalizing domestic reforms. However, both the benefits and the reforms were largely phased in gradually and did not result in any discontinuous jumps in 2001. It is useful to highlight the most important policy changes that China implemented as part of this process, including reduced import tariffs, the relaxation of export licensing rules, and fewer barriers to foreign investment. Additional details are provided in section A1.1 in the appendix.

First, Chinese import tariffs had already been sharply cut prior to 2001 (from a weighted average of over 45% in 1992 to approximately 13%). WTO accession entailed further cuts, but these shifts were small in magnitude (Bhattasali, Li, & Martin, 2004). Figure 2a shows the evolution of the average weighted domestic tariff rate over time, calculated using industry-level tariffs and the share of each industry in total Chinese imports as reported in 1996 (the first sample year). Second, restrictions on direct exporting were previously substantial, and firms that were not granted licenses to export directly were required to export via partners. By 2004, all firms were allowed to export freely (Bai et al., 2017). Third, prior to WTO accession, China had generally implemented relatively attractive policies to draw in foreign investment, subject to performance requirements for foreign firms; these requirements were eliminated following 2002 (Long, 2005).

What about changes in the tariffs imposed by trading partners? Figure 2b shows fluctuations in tariffs over time for China's most important trading partners: the NTR tariffs imposed by the United States and the average tariff rates imposed on Chinese exports by the European Union, Japan, Korea, and Taiwan. We again construct these rates as weighted averages of industry-level tariffs, utilizing the shares of total exports constituted by each industry's output in 1996 as weights. There is no evidence of any dramatic shifts in tariff rates at the point of China's WTO accession. Despite their gradual nature, however, all of the preceding shifts in trade policy are relevant in understanding structural change during this period, and we include these variables in our empirical specifications.

Importantly, there was a discontinuous jump in one important dimension of China's market access in 2001: the tariff

uncertainty faced in the U.S. market. Prior to WTO accession, the United States granted China NTR tariff rates on a discretionary basis subject to annual congressional renewal. Failure of that renewal would have triggered the imposition of much higher tariffs, originally set by the Smoot-Hawley Act, and designated for nonmarket economies. Hence, although the tariff applied to Chinese imports remained low because China's NTR status was never withdrawn, the required annual approval generated considerable uncertainty. Using media and government reports, Pierce and Schott (2016) document that firms perceived the annual renewal of MFN status as far from guaranteed, particularly in periods of political tension in the early 1990s.

In October 2000, Congress passed a bill that granted permanent NTR status to China, effective as of January 1, 2002. This was subsequently followed by a substantial spike in China's exports to the United States, as evident in figure 1c. Growth in China's total exports showed a parallel trend (figure 1d), consistent with the hypothesis that the increase in exports to other markets was minimal; we further substantiate this point in subsequent robustness checks.

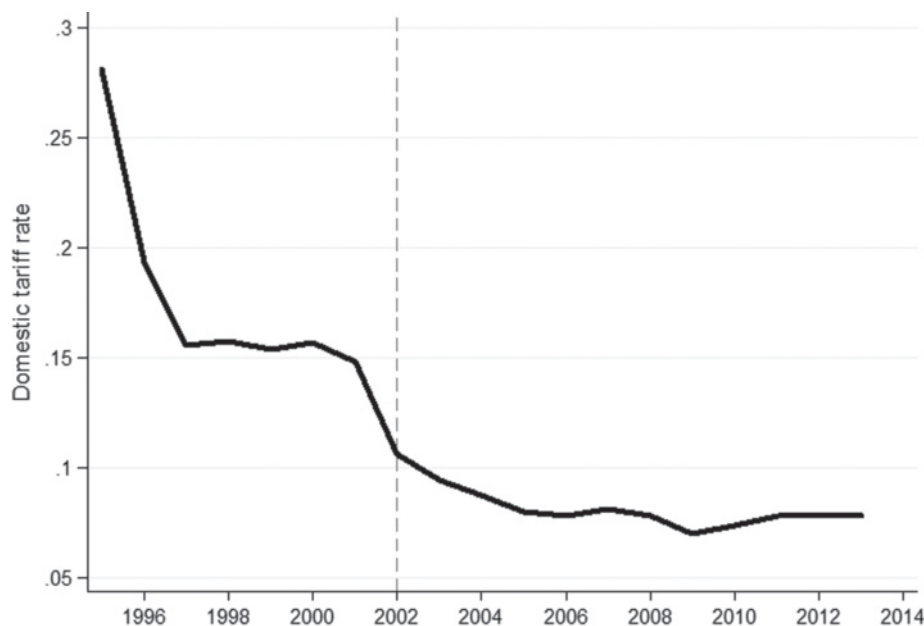
Again, a number of policy shifts during this period shaped economic outcomes. However, we preferentially focus on reduced trade uncertainty given that the previous literature has highlighted that this shift had a major impact on the U.S. market and given the discontinuous nature of the reduction in uncertainty. We also present evidence that while the other reforms implemented during this period had a meaningful impact on local economic outcomes in China, the effect of reduced tariff uncertainty generally proves to be largest in magnitude. Our analysis allows us to separately identify the impact of tariff uncertainty vis-a-vis levels by exploiting the fact that tariff uncertainty varies only comparing the pre- and postperiod, and is proxied by the difference between low tariff rates and the counterfactual high rates specified by the U.S. tariff schedule. By contrast, realized tariff levels imposed by both the United States and other trading partners vary continuously over time. Further details are provided in section IIIB.

B. Conceptual Framework

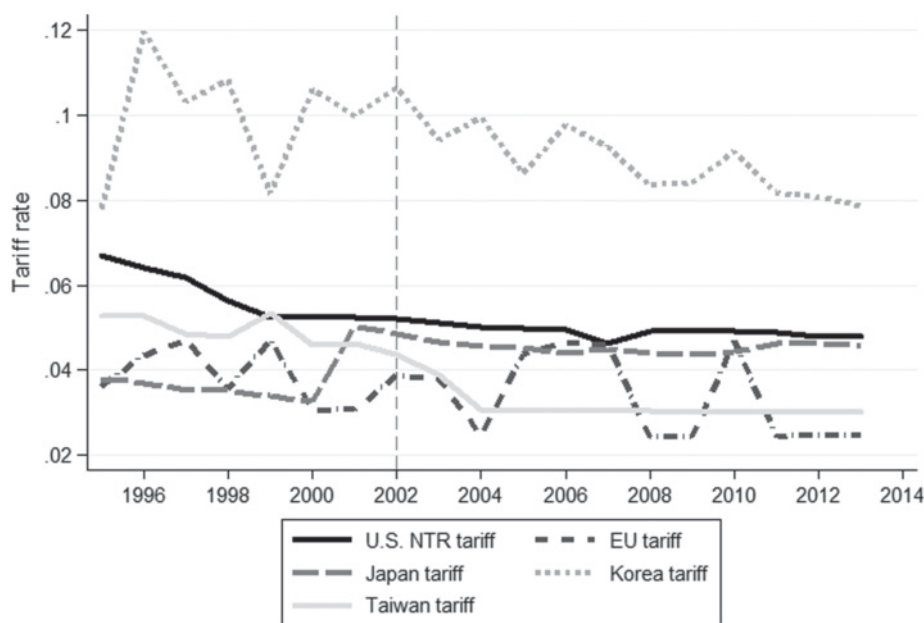
The reduction of tariff uncertainty can affect structural change through several channels. First, it creates incentives for Chinese firms to increase their exports to the U.S. market. A large literature has established that price uncertainty (in this case, generated by tariff uncertainty in the destination market) generates an option value of waiting, decreasing investment (Bloom, Bond, & Van Reenen, 2007). When tariff uncertainty is reduced, firms facing positive demand in the destination market, primarily manufacturing firms, have a greater incentive to make irreversible investments required to enter foreign markets (Handley & Limão, 2015, 2017). Given that industries differ in their exposure to tariff uncertainty, those with greater exposure ex ante will face a greater decline in the option value of waiting post-WTO accession.

FIGURE 2.—VARIATION IN TARIFF POLICY OVER TIME

(A) China's Import Tariffs Over Time



(B) Major Trading Partners' Tariffs Over Time



Panel A shows China's average domestic import tariff, calculated as the weighted average of industry-level tariffs and utilizing as weights the share of total Chinese imports constituted by each industry's imports in 1996. Panel B shows the mean tariff imposed on Chinese exports by major trading partners. For each trading partner, we again calculate the weighted average of industry-level tariffs, utilizing as weights the share of total Chinese exports constituted by each industry's exports in 1996. Tariff data are obtained from the WITS-TRAINS database.

Exports from these tradable industries and counties with a greater concentration in these exposed industries will differentially increase.

Moreover, in the Chinese case, the effects of reduced uncertainty are plausibly concentrated in nonagricultural production. This primarily reflects the fact that international demand

for Chinese agricultural products is minimal, and thus trade policy uncertainty is unlikely to be a meaningful constraint in this sector. In addition, the reduction in tariff uncertainty was much larger for nonagricultural production, suggesting that this shock is likely to disproportionately increase secondary exports.

Second, a reduction in tariff uncertainty induces U.S. firms to increase foreign direct investment (FDI) in China, as again the option value of delaying investment declines. In addition, export-oriented industries in China are generally characterized by high FDI, as foreign investors producing for export have benefited from a variety of preferential policies, including the exemption of imported components from import duties and the establishment of preferential zones that offer reduced taxes on profits and other benefits (Cheng & Kwan, 2000). Accordingly, a growing export sector can be expected to attract increased FDI, and these effects would be particularly large in industries and counties more exposed to tariff uncertainty *ex ante* and those industries facing nontrivial foreign demand, primarily in manufacturing. This investment channel is therefore likely to enhance the structural change induced by the expansion of exports.

Third, the reduction in tariff uncertainty will induce a reallocation of productive factors across sectors. Increased demand for exports and increased FDI in the secondary sector will increase the returns to capital and labor, and this local reallocation effect implies an in-flow of productive factors (Acemoglu et al., 2016). On the other hand, an increase in exports and FDI at the county level generates positive local demand effects, benefiting producers of nontradables, as well as any producers of tradables that sell partly to the local market. If there is some input in nontradable (tertiary) production that is not mobile across sectors, the local demand effect will dominate the local reallocation effect (Kovak, 2013),⁵ suggesting that reduced trade uncertainty will stimulate growth in both the secondary and tertiary sectors.

Finally, given nonhomothetic preferences, a positive local income effect will shift consumption away from agricultural goods, reinforcing the reallocation of productive factors toward the secondary sector (Uy et al., 2013; Gollin, Lagakos, & Waugh, 2014; Matsuyama, 2019). Shifting consumption patterns in conjunction with the local reallocation effect implies that the net effect on agriculture is plausibly negative. If there is considerable surplus labor employed in low-productivity activities in agriculture, then labor reallocation may not lead to an immediate decline in agricultural output, as predicted by classic surplus labor models (Lewis, 1954; Fei & Ranis, 1964). In the presence of a sustained labor drain, however, agricultural output will decline over time in counties that are relatively more exposed to the trade shock. By examining economic outcomes at the level of the local labor market, we are able to capture both the direct effect of reduced uncertainty on the expansion of sectors that benefit from increased exports and increased FDI, as well as the indirect effects generated by the reallocation of productive factors and the expansion of local demand.

⁵The literature analyzing the response of U.S. local labor markets to Chinese trade shocks also finds that the local demand effect dominates local reallocation effects (Autor et al., 2013; Acemoglu et al., 2016).

III. Data

A. County-Level Data

The main outcomes of interest are county-level economic indicators reported by provincial economic yearbooks. Each year, every province in China publishes a statistical yearbook, primarily reporting economic indicators for the full province or for larger aggregate units such as prefectures. However, provincial yearbooks also include some economic indicators reported at the county level. These data were compiled and digitized for every year available between 1996 and 2014. (Each yearbook reports data from the previous year; thus, 2013 is the final year observed in the data.) To the best of our knowledge, this study is the first to construct a comprehensive county-level panel of economic outcomes for this time period.

Only one limitation is imposed on the sample. We exclude provincial-level autonomous regions—Tibet, Xinjiang, Ningxia, Inner Mongolia, and Guangxi—as well as the island of Hainan, for which data are generally unavailable. Otherwise, all counties that can be matched between the 1990 county census and the provincial yearbooks are included. Aggregated to the county level, the 1990 census reports data on 1994 units that are (approximately) at the county level in the provinces of interest; of these units, 91%, or 1,805 counties, can be matched to the yearbooks.

The county-level panel includes information on exports, GDP and employment by sector, and detailed information about investment in agriculture. GDP and employment are reported for the primary, secondary, and tertiary sectors. Again, the primary sector includes agriculture, fishing, and forestry; the secondary sector includes manufacturing and mining; and the tertiary sector includes services. (Agricultural employment is also reported as a supplement to primary employment, as it is available for a larger sample.)

Exports and GDP are reported in millions of yuan, and per capita GDP is reported in yuan. The nominal figures for GDP and exports reported in the provincial yearbooks are deflated using World Bank deflators. Additional variables capturing investment in agriculture include cultivated area (reported in thousands of hectares), agricultural machinery used (reported in 10,000 kilowatts), grain and partial cash crop output (reported in thousands of tons), and grain yield (reported in tons per hectare).⁶ Summary statistics are reported in table A1 in the appendix; for each outcome variable, the mean in logs is reported, followed by the mean, minimum and maximum in levels.

Missing data. Data are missing from the county-level panel for two reasons: counties cannot be matched between the census and the provincial yearbooks, and counties are matched to the yearbooks but specific indicators are not

⁶The production of cash crops is calculated as the sum of the production of meat and edible oils, the most commonly reported cash crops.

available. Here, we briefly discuss each case; a detailed discussion is in section A1.2 in the appendix.

First, some counties that are observed in the census do not appear in provincial yearbooks. These are disproportionately counties that are part of larger, prefecture-level cities, and accordingly, any bias due to missing counties will orient the sample toward rural areas that are not already fully industrialized. The differences between counties observed and not observed in provincial yearbook data are summarized in table A2 in the appendix, in which we estimate a series of specifications regressing county covariates as observed in the 1990 census on a dummy for missing counties, conditional on province fixed effects. The results suggest that counties missing from the sample are characterized by larger populations and a greater concentration of labor outside of agriculture.

Second, for the counties that are observed in yearbooks, different provinces in different years opt to report different county-level indicators. As a result, the number of observations varies significantly for different variables, as evident from the summary statistics. For each variable presented in table A1, we also note the number of counties reporting any data for that variable. This figure ranges between 1,000 and 1,700. We present further evidence in table A3 that the number of observations for the key variables of interest is in general lower for more urban and industrialized counties. We subsequently demonstrate that the primary results are all robust to controlling for patterns of selection into the sample. In addition, we present evidence around the evolution of exports and secondary employment, key outcomes of interest that are infrequently reported in the county-level data, drawing on additional data sources at the prefecture and province level.

B. County-Level NTR Gap Measure

Our empirical analysis seeks to identify the effect of the substantial reduction in tariff uncertainty in the U.S. market that China experienced after 2002. To estimate the impact of China's permanent NTR status, we define the NTR gap at the industry level for each of the 39 subsectors of tradable production represented in the census data as the linear difference between the higher tariff rate that would have applied in the case of revocation of China's NTR status and the lower NTR rate, $NTR\ Gap_i = Non\ NTR\ Rate_i - NTR\ Rate_i$.

The industry-level NTR gap data were constructed by Pierce and Schott (2016) using ad valorem equivalent NTR and non-NTR rates. The NTR gap for industry i is the average NTR gap across the four-digit ISIC Revision 3 tariff lines belonging to that industry. Throughout the empirical analysis, we use the NTR gaps for 1999.⁷ We manually match the ISIC industry categories to the industry categories reported

in the Chinese employment data, and tables A4 and A5 in the appendix provide the details associated with this matching.

We then construct a county-level NTR gap measure equal to the weighted average of industry gaps, where the baseline composition of employment by industry prior to WTO accession is used to construct the weights. More specifically, we utilize the employment data reported in the 1990 census to calculate the share of tradable employment by industry in each county, interacting the NTR gap faced by industry i with each industry's county-specific employment share:⁸

$$NTR\ Gap_c = \sum_i empshare_{ic}^{1990} \times NTR\ Gap_i. \quad (1)$$

Given that each county's sectoral composition prior to WTO accession is used to construct the employment shares, the NTR gap does not reflect endogenous changes in employment composition that are driven by reduced trade policy uncertainty. Counties characterized by a larger NTR gap experience a greater reduction in trade policy uncertainty post-2001 and thus ceteris paribus should show greater expansion in export-oriented industries. Permanent NTR rates were effective for China as of January 1, 2002, and thus our analysis characterizes all years from 2002 onward as the postreform period.

In addition, we preferentially employ the employment shares observed in the 1990 census rather than the 2000 census to minimize potential endogeneity in employment composition. We hypothesize that by 2000, counties with more informed leaders or enterprises with more foresight may have already shifted toward subsectors that were less exposed to trade policy uncertainty. This would generate some correlation between county-level unobserved characteristics and the size of the county NTR gap. We subsequently demonstrate that the results are robust to the use of 2000 employment weights and are also consistent when the employment shares are recalculated with respect to total employment, including nontradable employment.

Table A6 in the appendix summarizes the NTR gap observed for each industry. The highest NTR gaps are observed for textiles, garments, other manufacturing, medical and pharmaceutical products, and furniture manufacturing; the lowest NTR gaps are observed for mining products and agricultural output. At the county level, the average NTR gap is .123 with a standard deviation of .043. Approximately 5% of counties face NTR gaps of more than 20%. Figure A2 shows a histogram of the NTR gap at the county level. While there is some evidence of outliers, we demonstrate that the primary results are robust to winsorizing the NTR gap. Figure A3 in the appendix shows a map of cross-country variation in

⁷We follow Pierce and Schott (2016) in utilizing the 1999 NTR gaps. These gaps are almost identical to those in 2000 or 2001; accordingly, the results are robust to the use of data from other years.

⁸We should note that this methodology of calculating county-level NTR gaps, while consistent with the previous literature, does not take into account input-output linkages; that is, a sector that faces a low NTR gap may primarily produce intermediate goods for another high gap sector. In that case, the NTR gap may be a poor proxy for the true level of tariff uncertainty in the sector. While fully addressing this challenge is beyond our scope here, we highlight it as an important area for future research.

the NTR gap, utilizing the residuals after the NTR gap is regressed on province fixed effects. Overall, there is substantial variation in exposure to reduction in tariff uncertainty across Chinese counties.

C. Other Policy Changes

In the main empirical analysis, we also consider a number of other policy changes in China and the United States to isolate the impact of China's accession to the WTO. In particular, we examine whether other policy shocks could be the cause of the structural change that China has experienced over the past decade. Other policy shocks may constitute plausible alternative explanations if their timing coincides with China's WTO accession and if these shocks would disproportionately affect counties that are more exposed to reduced tariff uncertainty after 2001. As previously noted, major domestic reforms in this period included lower import tariffs, the elimination of import licensing requirements, and reduced restrictions on FDI.

In our regressions, we use data on China's import tariffs from the WITS-TRAINS database, data on export licensing requirements from Bai et al. (2017), and data on the nature of contracting from Nunn (2007) to control for these policy changes. The data on the nature of contracting provide a measure of the proportion of intermediate inputs employed by a firm that requires relationship-specific investments by the supplier; contract-intensive industries are likely to be characterized by higher levels of FDI *ceteris paribus* and may enjoy greater potential gains from the reduction in barriers to foreign investment. For each of these variables, we construct a county-level weighted average from the industry-level source data using employment weights from the 1990 census.⁹

We also control for policy changes in the United States, including the time-varying NTR rate itself, for which we construct an industry-weighted county average. An additional important policy shift during this period was the elimination of textile and clothing import quotas in 2002 and 2005 as part of the global MFA. We employ data on MFA quotas from Khandelwal et al. (2013) and follow their methodology to construct a measure of the degree to which industries' quotas were binding under the MFA by calculating the import-weighted average fill rate. The fill rates represent the ratio of actual imports to allowable imports under the quota; thus, a higher value indicates greater exposure to MFA quota reductions. Using these industry-level data, we construct a county-level MFA variable, where greater values represent greater exposure to quota reductions and, thus, greater benefits from the policy shift.

⁹Since the industry categories for the export licensing and contract intensity variables are available for SIC categories, these categories are manually matched to the census employment categories. The industry classification for the import tariff data is available in ISIC Revision 3, the same source utilized to construct the NTR gap variable. Tables A4 and A5 in the appendix provide the details associated with the matching.

Finally, we control for variation in the baseline level of employment in state-owned enterprises (SOEs), given that this period coincides with the period of rapid SOE reform. Given that there are no data on SOE employment reported at the county level, we estimate at the prefecture level the share of employment in above-scale firms that is in state-owned enterprises in 1998, using the survey described in more detail in section IVC, and employ this as a proxy for baseline SOE employment. The specification then includes interactions between year dummy variables and dummies for each quartile of baseline SOE employment.

IV. Empirical Results

A. Baseline Specification

We use a difference-in-difference specification to analyze the effect of reduced trade policy uncertainty on county-level economic outcomes. More specifically, we examine whether the trajectory of economic outcomes in counties characterized by relatively large gaps between NTR tariff rates and non-NTR rates is different following China's accession to the WTO in 2001. The sample includes annual county-level data from 1996 to 2013; all dependent variables are calculated as the log of the variable of interest.

We employ ordinary least squares (OLS) to estimate the following specification:

$$\ln(Y_{cftp}) = \beta_1 Post_t \times NTR\ Gap_{cftp} + X'_{cftp} \theta + \gamma_{pt} + Urb_{cftp} \times \gamma_{pt} + \delta_c + \epsilon_{cftp}. \quad (2)$$

The dependent variable observed in county c in prefecture f in province p in year t is regressed on the interaction of the county NTR gap, standardized to have a mean of 0 and a standard deviation of 1, and a post-WTO dummy, equal to 1 for 2002 and subsequent years.

The specification also includes a number of additional controls denoted X'_{cftp} . This includes the interaction of the post-dummy and a time-invariant dummy capturing whether the county is characterized by industries with high contract intensity and SOE quantile-year interactions.¹⁰ We also control for time-varying shocks: the industry-weighted MFA quota fill rate for county-produced goods, the industry-weighted domestic import tariff rate, the industry-weighted percentage of local firms licensed to export, and the industry-weighted NTR tariff rates. (All variables capturing other changes in trade policy during this period are also included in the specifications estimated in Pierce & Schott, 2016; we demonstrate in section V that the results are consistent when estimated without these additional controls.) The specification also includes province-year fixed effects, province-year fixed effects interacted with an urban dummy to allow for differential trends

¹⁰Specifically, the high contract intensity dummy is equal to 1 if the weighted average of industry contract intensity is above the mean.

TABLE 1.—PRIMARY RESULTS

	(1)	(2)	(3)	(4)	(5)	(6)
A: Exports and GDP						
	Exports	Primary	Secondary	Tertiary	GDP	Per capita
Post × NTR gap	.197 (.081)**	.005 (.018)	.033 (.015)**	.025 (.014)*	.040 (.012)***	.030 (.016)*
Observations	5,158	14,722	15,688	15,375	29,782	26,339
Number of counties	1,017	1,496	1,496	1,496	1,688	1,609
B: Employment						
	Primary	Agri.	Secondary	Tertiary	Total emp.	Total pop.
Post × NTR gap	−.072 (.050)	−.069 (.027)**	.257 (.102)**	.096 (.116)	.0004 (.012)	.013 (.006)**
Observations	3,214	21,532	4,523	4,659	19,972	28,867
Number of counties	354	1,619	1,235	1,235	1,440	1,642
C: Agricultural Investment						
	Sown area	Agri. machine	Grain	Cash	Grain yield	
Post × NTR gap	−.037 (.020)*	−.085 (.024)***	−.126 (.038)***	−.053 (.025)**	−.042 (.022)*	
Observations	8,322	28,149	28,161	26,818	7,168	
Number of counties	989	1,637	1,627	1,574	885	

The primary independent variable is the interaction of a post-2001 dummy and the standardized county NTR gap. The specification also includes a number of control variables: an interaction of the post dummy and a dummy for high contract intensity, SOE quantile-year interactions, the industry-weighted MFA quota fill rate, the industry-weighted national tariff rate, the industry-weighted percentage of firms licensed to export, and the industry-weighted time-varying NTR rate. Province-year and county fixed effects are included, and the province-year fixed effects are interacted with an urban dummy. Standard errors are clustered by county, and the regressions are weighted with respect to baseline employment. Significant at *** 1%, ** 5%, and * 10%.

in urban areas, and county fixed effects.¹¹ Standard errors are clustered at the county level, and all specifications are weighted with respect to total county-level employment in 1990.

The results of estimating equation (2) are reported in table 1; for concision, only the coefficient β_1 is reported. (The full set of coefficients is reported in tables A7 through A9 in the appendix, and discussed in section A1.3 in the appendix.) To analyze the magnitude of the effects, we compare a county at the median level of uncertainty ex ante to a county characterized by the minimum level of uncertainty observed, a difference equal to 1 SD; accordingly, the coefficients reported in the panel can be interpreted directly as the effect in log points. In panel A, we observe that this increase would lead to an increase in exports of approximately .20 log points in the post-2001 period. There is also evidence of an increase in secondary, tertiary, total, and per capita GDP of around .04 log points. No significant effects are observed for primary output. While the estimated effect for total GDP is larger than the effect for its subcomponents, the sample is also much larger for this variable. Accordingly, the observed pattern suggests that counties that do not report secondary and tertiary GDP in general show a larger response to the shock of interest.

Panel B reports the employment results; again, employment data are available for a more limited sample, and the results are thus more noisily estimated. There is weak evidence of a decline in primary employment, but the decline

in agricultural employment (reported for a larger sample) is significant and indicates an decrease of .07 log points. We observe an increase in secondary employment of .26 log points, but no shift in tertiary or total employment. The absence of any significant effect for total employment may be somewhat surprising, but the sample for total employment is again much larger; accordingly, this result suggests a drop in primary employment, and the increase in secondary employment may be of roughly equal magnitude in the full sample of counties. In addition, we observe a relative increase in population of .013 log points in counties ex ante more exposed to tariff uncertainty, suggestive of some, albeit limited, in-migration. Finally, panel C reports the results for agricultural variables, suggesting that sown area, agricultural machinery, grain and cash crop production, and grain yield show declines of between .04 and .13 log points.

Taken together, these results suggest a clear pattern. Counties with high concentrations of industries exposed to large gaps between NTR and non-NTR tariffs show evidence of significantly more expansion in the secondary sector following China's WTO accession, and this growth generates a reallocation of productive factors out of agriculture and an increase in local GDP. If we assume that uncertainty is reduced to 0 for a county at the median level of uncertainty ex ante, the implied effect is an increase of .12 log points in county-level GDP and .1 log points in per capita GDP. As will be explored further in section VC, these effects are of nontrivial magnitude relative to overall growth in this period.

Missing data. Again, the number of observations fluctuates in the main specifications because many provincial

¹¹ This dummy variable is equal to 1 if the county name includes the “shi” (i.e., city) suffix in 1990. Approximately 19% of the counties are designated as urban.

TABLE 2.—MAIN SPECIFICATIONS CONTROLLING FOR SELECTION INTO THE SAMPLE

	Exports (1)	Primary (2)	Secondary (3)	Tertiary (4)	GDP (5)	Per Capita (6)
A: Sample reporting export data						
Post $\times$ NTR gap	.185 (.083)**	-.033 (.014)**	.032 (.023)	.052 (.017)***	.067 (.017)***	.059 (.016)***
Observations	5,158	2,981	3,005	3,005	5,152	5,004
B: Sample excluding prefectures with sparse observations						
Post $\times$ NTR gap	.196 (.081)**	.004 (.018)	.032 (.014)**	.020 (.013)	.038 (.013)***	.005 (.016)
Observations	5,117	13,479	14,388	14,112	22,989	21,187
C: Including observation number quartile - year fixed effects						
Post $\times$ NTR gap	.188 (.083)**	.001 (.016)	.030 (.015)**	.022 (.014)	.030 (.012)**	.036 (.016)**
Observations	5,158	14,722	15,688	15,375	29,782	26,333

The base specification and the dependent variables are identical to those described in table 1. In panel A, the sample is restricted to county-year observations reporting export data. In panel B, the sample for each variable is restricted to the subset of counties that report at least eight observations for this variable. In panel C, we characterize each county by the number of observations reported for each variable and generate a dummy variable for whether the number of observations is above the median; the specification then interact between this dummy variable and year fixed effects. Significant at ***1%, **5%, and *10%.

yearbooks do not report specific indicators of interest (particularly sectoral employment and exports). We report in each panel the number of unique counties observed in the sample for each variable; this number ranges between 1,000 and 1,700. We subsequently present results derived from additional data sources—a survey of large firms and data reported at the provincial level—that will enable us to corroborate the observed patterns for secondary employment and exports.

We can also use a number of additional specifications to explore whether selection into the sample is a source of bias in the primary results, focusing on the results for exports and output; these results are reported in table 2. In panel A, we restrict the sample to county-years that report export data. In panel B, we include for each variable only the subset of counties that reports at least eight observations for that variable, to avoid bias due to the entry and exit of counties from the sample. In panel C, we characterize each county and each variable as to whether the number of observations is above or below the median number of observations for that variable, and interact the dummy variables for a high number of observations with year fixed effects. In all three cases, the results are generally robust, though the coefficients on secondary and tertiary output are in some cases noisily estimated. The consistency across a range of specifications suggests that selection into the sample is not a significant source of bias.

Structural transformation and the surplus labor hypothesis. Appendix table A10 reports additional specifications for key agricultural variables. In panel A, we reestimate the primary specification, including an additional interaction between the NTR gap and a dummy variable for the post-2008 period. (This demarcation evenly divides the twelve year post period for which data are observed, 2002–2013.) The decline in agricultural employment, sown area, and cash crop production accelerates later in the period, and there is also a significant decline in primary output.

In panel B, we estimate the mean NTR shock at the prefecture level and include this shock, in addition to the interaction between the county- and prefecture-level shock. The objective is to identify whether an agglomeration of positive shocks to the exporting sector generates an intensified pattern of substitution out of agriculture. Here, we can observe that the coefficients on the prefecture-level shocks are consistently negative, and the coefficients on the interaction term are significant and negative for sown area, grain output, and primary GDP. This constitutes suggestive evidence that given an agglomeration of local shocks, the decline in output is larger in magnitude.

The observed decline in output given a reallocation of factors out of agriculture is inconsistent with classic surplus labor models (Lewis, 1954; Fei & Ranis, 1964). Rather, these results suggest that surplus labor stocks have been declining over time, and declining more rapidly in regions where there have been consistent positive shocks to the secondary exporting sector. If the pull factor generated by reduced trade costs is persistent over time or over space, this reallocation ultimately stimulates contraction in primary output. These results are also consistent with other recent evidence arguing that stocks of surplus labor in China have largely been depleted (Zhang et al., 2011; Kwan et al., 2018).

Alternate estimates of the NTR gap. In table 3, we recalculate the NTR gap using a number of alternate strategies to evaluate the robustness of these results, focusing on exports and GDP. In panel A, we construct the NTR gap utilizing the employment data reported in the 2000 census to construct employment weights rather than utilizing the 1990 weights. The results are generally comparable, although the estimated coefficients for secondary, GDP, and per capita GDP are slightly larger. The use of 2000 employment weights introduces two potential sources of bias: areas already industrialized by 2000 will generally have larger NTR gaps, while industrialized areas that are more strategic in investing in industries

TABLE 3.—ROBUSTNESS CHECKS

	Exports (1)	Primary (2)	Secondary (3)	Tertiary (4)	GDP (5)	Per capita (6)
A: NTR gaps estimated using 2000 employment weights						
Post × NTR gap	.111 (.051)**	−.019 (.012)	.041 (.013)***	.039 (.011)***	.040 (.010)***	.036 (.011)***
Observations	5,158	14,690	15,646	15,340	29,740	26,318
B: NTR gaps estimated assigning nontradables zero weights						
Post × NTR gap	.088 (.049)*	−.056 (.019)***	.003 (.014)	−.009 (.010)	.024 (.009)**	.020 (.009)**
Observations	5,158	14,722	15,688	15,375	29,782	26,347
C: Main specification controlling for employment pre-trends						
Post × NTR gap	.196 (.082)**	−.011 (.018)	.042 (.016)***	.021 (.013)	.033 (.013)**	.020 (.018)
Observations	5,158	14,706	15,672	15,359	29,766	26,333

The base specification and the dependent variables are identical to those described in table 1. In panel A, the NTR gap is estimated using 2000 census employment weights. In panel B, the NTR gap is estimated using 1990 census employment weights and assigning the nontradable sector a 0 weight. In panel C, the long-difference in primary and nonprimary employment between 1990 and 2000 interacted with a post dummy is included. Significant at ***1%, **5%, and *10%.

characterized by less tariff uncertainty may have lower NTR gaps. The latter phenomenon will lead to upward bias in the estimates of the effect of uncertainty reduction, and this upward bias does seem to be evident in these specifications.¹²

In panel B, we construct the NTR gap by weighting each subsector with respect to total employment, assigning a 0 weight to the tertiary (nontradable) sector. In our main specification, we estimate the NTR gap without considering the relative size of the services sector, weighting employment with respect to tradable employment; this methodology is recommended by Kovak (2013), though earlier papers in the trade literature assign the nontradable sector a weight of 0.¹³ Using this alternate strategy to recalculate the NTR gaps and reestimate equation (2) yields consistent results for exports, total GDP, and GDP per capita, though the estimated coefficients for secondary and tertiary output are not significant. (For these robustness checks, parallel results for employment and agriculture are reported in tables A11 and A12 in the appendix and show generally consistent results.)

B. Pretrends

Given that we attribute the observed patterns to the reduction in tariff uncertainty following China's accession to the WTO in 2001, a more demanding test of the assumptions of the difference-in-difference specification can be conducted by evaluating the correlation between the variables of interest and the NTR gap prior to 2001. To implement this test, we estimate a more complex specification, interacting the NTR gap with a series of dummy variables for two-year intervals. (A

single variable captures the three-year interval 1999–2001.) Dummy variables for the years prior to 1997 are omitted, rendering 1996 and the small sample of pre-1996 observations the reference period. The specification of interest can thus be written as follows in equation (3), including the same control variables employed in the main specification.¹⁴ Again, standard errors are clustered at the county level, and the regressions are weighted with respect to initial county-level employment:

$$\ln(Y_{cft}) = \sum_{y=1997}^{2013} \beta_y 1\{y = t, t + 1\} NTR Gap_{cft} + X'_{cft} \theta + \gamma_{pt} \times (1 + Urb_{cft}) + \delta_c + \epsilon_{cft}. \quad (3)$$

The coefficients are presented graphically for county-level GDP in figure 3; we focus on GDP given that it is the variable reported for the largest sample. Figure 3a shows the main specification, and figure 3b shows the simpler specification estimated without control variables. We observe that the coefficients for the NTR gap prior to 2002 are uniformly insignificant and generally small in magnitude.¹⁵ However, following China's accession to the WTO, the magnitudes of the coefficients for the NTR gap are increasing over the subsequent decade, and generally they are statistically significant. This evidence is consistent with the hypothesis that the NTR gap is uncorrelated with any variation in county outcomes pre-2001 but highly predictive of the economic trajectories observed in the same counties post-2001. The pattern of an effect that is consistently positive after 2001, but growing

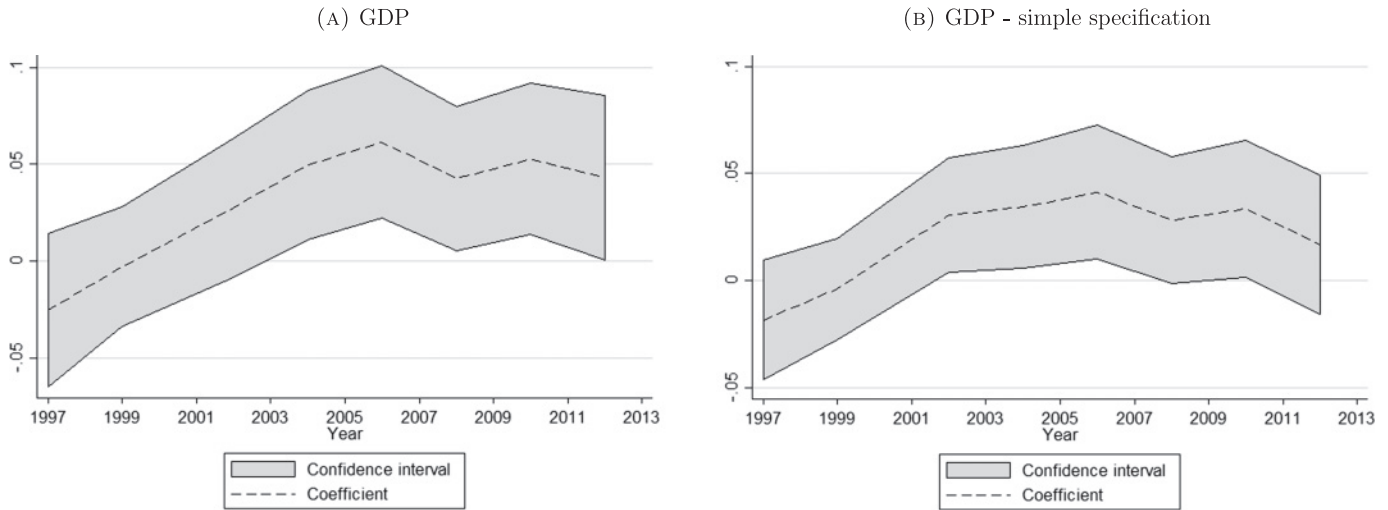
¹²The number of observations contracts slightly, as some county codes cannot be matched to the 2000 census; more details about the construction of the NTR gap variable using 2000 employment data are provided in appendix A1.4.

¹³More specifically, the alternate NTR gap is calculated as $NTR Gap_c = \sum_i empshare_{ic}^{1990, total} \times NTR Gap_i$, where $empshare_{ic}^{1990, total}$ is the employment share for each tradable subsector relative to total county employment.

¹⁴In this specification, to increase precision, we convert the MFA variable into ten dummy variables for each decade.

¹⁵While the early years of the period analyzed here coincided with the onset of the Asian financial crisis in 1997, China was not directly affected by the associated financial contagion due to its maintenance of capital restrictions and a nonconvertible currency. Accordingly, this shock should not be a source of bias in this analysis.

FIGURE 3.—ESTIMATED DIF-IN-DIF COEFFICIENTS AND 90% CONFIDENCE INTERVALS



These graphs report the coefficients on the interaction of dummy variables for each two-year interval and the county-level gap between NTR tariffs and the non-NTR rates, standardized to have mean 0 and standard deviation 1. The specifications estimated to construct panel A also include a number of control variables: an interaction of the post dummy and a dummy for high contract intensity, SOE quantile-year interactions, the industry-weighted MFA quota fill rate, the industry-weighted national tariff rate, the industry-weighted percentage of firms licensed to export, and the industry-weighted time-varying NTR rate. Province-year and county fixed effects are included, and the province-year fixed effects are interacted with an urban dummy. The specifications estimated to construct panel B include only the fixed effects of interest. Standard errors are estimated employing clustering at the county level, and the regressions are weighted with respect to baseline county-level employment.

slowly in magnitude, is also consistent with the parallel evidence presented by Pierce and Schott (2016) showing a gradual decline in manufacturing employment in the United States over the same period.

The regression analogues to these results are presented in columns 1 and 2 in table A13. We can also test whether the estimated coefficients β are equal when compared across the pretreatment period (the dummy variables for 1997–1998 and 1999–2001) and the post-2001 period. All of the pairwise tests except two allow us to reject the hypothesis that the pre- and post-coefficients are significantly different at the 1% level.

As an additional test of bias introduced by pre-trends, we construct the long difference in county-level primary and non-primary employment as observed between the 1990 and 2000 census (i.e., in the pre-WTO period). We focus on employment given that it is the only indicator reported consistently for all counties in both years. The primary specification is then reestimated, including as an additional control variable the two constructed long-difference variables interacted with the post dummy, in effect controlling directly for any differential post-accession trend in counties characterized by different pre-trends; a similar methodology is employed in Autor et al. (2013). The results of estimating this specification are reported in panel C of table 3 for exports and GDP, as well as in panels C of tables A11 and A12 in the appendix for employment and agricultural variables. The estimated coefficients are entirely consistent, suggesting that the scope for potential bias due to differential pre-trends is minimal.

We also implement two additional strategies to explore potential bias due to preexisting trends in the main specifications for exports and GDP. We characterize counties by quartile of NTR gap and include differential trends for counties in each

quartile. We also construct the county-level pre-WTO difference in GDP from 1997 to 2001 and include an interaction term between this pre-WTO difference and the post dummy. These results of reestimating the primary specification including these additional control variables are reported in table A14 in the appendix, and again show consistent results, suggesting again that there is little bias due to differential trends *ex ante*.¹⁶

To sum up, these results suggest that the observed divergence in economic trajectories of counties subject to different gaps between NTR and non-NTR tariffs following China's WTO accession is primarily due to increased access to the U.S. market, leading to an increase in exports. These patterns first emerge in the early part of the post-2001 period, but they become steadily more pronounced over the subsequent decade. We can also extend this analysis to present some evidence regarding heterogeneous effects across counties; this discussion is in section A1.3 in the appendix.

C. Firm-Level Outcomes

The county-level data previously used do not include data on some key outcomes of interest—particularly capital investment, foreign investment, and wages. In addition, the data on secondary employment are very limited. As an additional source of evidence, we utilize the large-scale industrial survey collected from 1998 to 2008, a source described in detail in Brandt et al. (2012). The data are collected in annual

¹⁶We also regenerate plots parallel to figures 3a and 3b using the methodology proposed by Roth (2018) and find generally consistent results: in particular, the coefficients on the pre-period shocks remain consistently insignificant.

TABLE 4.—FACTOR UTILIZATION AND OTHER FIRM OUTCOMES

	(1) Employment	(2) Capital	(3) Foreign Capital	(4) Value Added per Worker	(5) Wages per Worker
Post × NTR gap	.062 (.035)*	.119 (.044)***	.166 (.048)***	.028 (.016)*	.089 (.050)*
Observations	2,492	2,515	2,496	2,492	2,240

The primary independent variable is the interaction of a post-2001 dummy and the standardized prefecture NTR gap. The specification includes the same control variables described in the notes to table 1, all calculated as the average at the prefecture-year level, as well as the NTR gap at the prefecture level entering linearly, province-year fixed effects, and prefecture-specific trends. Standard errors are estimated employing clustering at the prefecture level. Significant at ***1%, **5%, and *10%.

surveys conducted by the National Bureau of Statistics, and they include all state-owned industrial firms (in mining, manufacturing, and public utilities) and all nonstate firms with sales above 5 million yuan. For this analysis, we restrict the sample to manufacturing firms.

A variety of firm-level outcomes are observed. Employment and the total wage bill are directly reported, enabling us to estimate the average wage per worker. The perpetual inventory method is used to estimate the capital stock, as the firm's founding year is also reported; the average growth rate observed at the province-sector level over the sample years is used to estimate average annual investment rates. We also use a similar method to calculate foreign-owned capital. For value added, we use the deflators constructed by Brandt et al. (2012) to construct constant-price estimates and calculate value added per worker.

The firms can be geographically linked only to the prefecture, as county indicators are unavailable. Accordingly, we perform this analysis at the prefecture level; the dependent variables are calculated as the sum of the relevant firm-level variables within the prefecture and year to capture the total size of the large-scale manufacturing sector. (For wage and value added per worker, the weighted mean is employed.) All dependent variables are then logged. The NTR gap is constructed as the mean of the NTR gap across all counties in the prefecture, and the same control variables are calculated as prefecture-year means and included in the specification, in addition to province-year fixed effects, prefecture-level trends, and a level control for the prefecture NTR gap. The specification of interest can thus be written as

$$\ln(Y_{fpt}) = \beta_1 Post_t \times NTR\ Gap_{fp} + \beta_2 NTR\ Gap_{fp} + X'_{fpt}\theta + \gamma_{pt} + \nu_{ft} + \epsilon_{cftp}. \quad (4)$$

The results are reported in table 4; again, the coefficients correspond to prefecture-level aggregates. The first three columns show that a 1 SD increase in the prefecture-level NTR gap is associated with increases in employment, capital, and foreign capital of between .06 and .17 log points. This corroborates the evidence of increased employment in the county-level data and suggests there is also an increase in capital investment. In columns 4 and 5, we observe that value and wage per worker both increase, indicating productivity gains from the reduction in tariff uncertainty associated with the WTO accession.

Additional province-level data. Given that export data are reported for a small sample of counties and foreign direct investment is reported only in the firm-level data, we also present additional results using provincial data on exports and foreign direct investment for the full sample of provinces from 1996 to 2013. We then reestimate the primary specification including the same control variables calculated as provincial-level means; the dependent variables include exports, total foreign capital used, foreign loans, and direct foreign investment. All are calculated as the log of real values in millions of yuan.

The results are reported in table A15 in the appendix and suggest a 1 SD increase in tariff uncertainty ex ante is associated with increases of around .2 log points in exports and .6 log points in foreign direct investment. These results corroborate the previous evidence around an increase in exports and foreign direct investment in counties previously more exposed to tariff uncertainty.

D. Mechanisms

Returning to the conceptual framework, it is useful to highlight the mechanisms that generate the observed patterns of accelerated structural transformation post-WTO accession in counties more exposed to ex ante tariff uncertainty. First, we observe both a substantial increase in exports and an increase in foreign direct investment. Both effects are evident in data from a range of complementary sources. Second, there is robust evidence of substitution of productive factors out of agriculture in counties characterized by higher ex ante NTR gaps following WTO accession. Third, we observe increased investment and output in both the secondary and tertiary sectors, although the effects are larger in the secondary sector.

The growth of the secondary sector as the primary sector shrinks is consistent with both the reallocation and the local demand channels. However, the fact that nontradable (tertiary) production is expanding suggests that the local demand effect dominates the reallocation effect. Intuitively, growth in services partly reflects positive spillovers from local growth in export-driven manufacturing. In addition, the substitution of factors out of agriculture is consistent with a reallocation effect driven by both increased secondary exports and rising income, assuming nonhomothetic preferences. Importantly, this reallocation also generates contraction in primary output (at least in the medium term), suggesting that surplus labor stocks in agricultural production are declining or depleted.

TABLE 5.—PLACEBO TESTS

	(1)	(2)	(3)	(4)	(5)	(6)
A: Chinese Exports to All Destinations						
Post $\times$ NTR gap $\times$ U.S.	.338 (.029) ^{***}	.338 (.007) ^{***}	.337 (.029) ^{***}	.337 (.007) ^{***}		
Post $\times$ NTR gap $\times$ Other four	-.113 (.478)	-.113 (.081)	-.118 (.478)	-.118 (.082)		
Observations	330,669	330,669	330,669	330,669		
B: Placebo NTR Gap						
	Exports	Primary	Secondary	Tertiary	GDP	Per Capita
Other partner gap	-.535 (.573)	.106 (.060) [*]	.085 (.056)	.017 (.049)	.038 (.027)	.015 (.028)
Observations	5,158	14,722	15,688	15,375	29,782	26,347

In panel A, the independent variables are the NTR gap interacted with post interacted with a U.S. dummy, and the post-NTR interaction interacted with a dummy for the other four top export destinations. The dependent variable is China's exports to all destinations at the two-digit product level from 1995 to 2013, as reported by UNCOMTRADE. The specification also includes controls for the product-specific tariff and product-year fixed effects; in columns 3 and 4, quadratic tariff controls are added. Standard errors are clustered by partner in columns 1 and 3, and by product in columns 2 and 4. In panel B, the independent variable is the interaction of a post-2001 dummy and the standardized gap between the highest "other trading partner" tariff observed for a given industry and the tariff imposed on Chinese exports. The specifications are otherwise identical to those described in table 1. We also control flexibly for the high "other trading partner" tariff by constructing fifty dummy variables corresponding to different percentiles of the tariff distribution, generating dummy variable fixed effects, and interacting those fixed effects with the post dummy. Significant at ***1%, **5%, and *10%.

In addition, we can document that the reduction in tariff uncertainty seems to generate an increase in returns to factors in the secondary sector in the medium term, as evident in the persistent increase in wages and value added per worker. The persistence of the observed effects is consistent with the hypothesis that there are barriers to mobility of capital and labor that slow the equalization of factor returns across counties.¹⁷ Alternatively, there may be positive agglomeration effects in export production that lead to persistently more rapid growth in counties that benefit from the reduction in tariff uncertainty.

V. Additional Robustness Checks

A. Placebo Analysis

Throughout this analysis, we have assumed that the discontinuous shock experienced by China at WTO accession is a decrease in tariff uncertainty in the U.S. market. Here, we implement two placebo analyses to evaluate this assumption. The first uses data from the UNCOMTRADE database reporting China's exports to all destinations at the two-digit product level from 1995 to 2013. We estimate a simple regression in which the dependent variable is the log of total export value of product p to destination country d in year t . The independent variables include a post dummy interacted with the U.S. NTR gap at the product level and a dummy for the United States, and the post-NTR interaction interacted with a dummy for the other four top export destinations (the EU, Japan, Korea, and Taiwan). The specification also includes controls for the product-specific tariff imposed by each of the five major destinations on each product, summarized X_{pdt} ,

and product-year fixed effects:

$$\ln(\text{Exp}_{pdt}) = \beta_1 \text{NTR}_{pt} \times US_d \times \text{Post}_t + \beta_2 \text{NTR}_{pt} \times \text{Other}_d \times \text{Post}_t + X_{pdt} + \omega_{dt} + \epsilon_{dpt}. \quad (5)$$

We hypothesize that β_1 will be positive, and β_2 will not be significantly different from 0: products characterized by a larger NTR gap exhibit an increase in exports to the United States post-WTO, but there should be no significant increase in exports to other destinations. The results are reported in panel A of table 5; in columns 3 and 4, quadratic controls for tariffs are also included. Columns 1 and 3 include standard errors clustered at the partner level, and columns 2 and 4 include standard errors clustered at the product level. We observe that β_1 is positive and β_2 is insignificant, consistent with the hypothesis that the key immediate shock experienced with WTO accession was a reduction in trade uncertainty in the U.S. market, not a shock in other major export destinations.¹⁸

Second, we construct an artificial "other trading partners gap," comparing the highest tariff rates imposed by other major trading partners (the EU, Japan, Taiwan, and Korea) to the tariff rates imposed by the same trading partners on Chinese goods. For each other trading partner (e.g., the EU), we identify for each industry a "maximum tariff" imposed by the EU on imports of that good.¹⁹ We then calculate a placebo "other trading partner gap" equal to the difference between this high tariff and the tariff imposed on Chinese goods, and calculate the weighted average across the four major non-U.S. trading partners using as weights the share of total Chinese exports shipped to that destination.

¹⁷The gradual leveling in the post-accession trends evident in figure 3 suggests that the effects of the uncertainty reduction may be moderating over time, perhaps as barriers to factor reallocation are reduced, enabling convergence between high- and low-NTR gap counties. This pattern would also be consistent with a reduction in China's comparative advantage in high NTR products. However, this evidence must be considered tentative.

¹⁸The fact that β_2 is roughly one-third of the magnitude of β_1 , albeit insignificant, is consistent with the hypothesis that there is some export diversion.

¹⁹More specifically, we use the mean of the five highest tariffs observed.

The same procedure used to construct the NTR gap is then used to construct a county-level “other trading partners gap.” The intuition is as follows: if Chinese exporters did in fact perceive any tariff uncertainty in other non-U.S. markets, the gap between the realized tariff on Chinese goods and the highest observed tariff is a proxy for the magnitude of this uncertainty, and the constructed “other tariff partner” gap thus captures uncertainty in other markets. If WTO accession reduced this uncertainty, we should expect parallel results when the primary specification is reestimated with the placebo gap.

To test this hypothesis, we estimate the primary specification using the other trading partner county-level gap, including the same control variables and fixed effects included in the main specification. We also control flexibly for the other trading partner high tariff rate $Other_{cft}$.²⁰ The results are reported in panel B of table 5, and the coefficients are small in magnitude, insignificant, and varying in sign. There is no evidence that tariff variation orthogonal to WTO accession predicts cross-county variation in economic outcomes.

B. Alternate Specifications

To further explore the robustness of the primary results, we report a number of alternate specifications in tables A16 and A17 in the appendix. Again, we focus on exports and GDP. As previously noted, in general the NTR gap is relatively low for agricultural products compared to industrial products; this raises the potential challenge that the observed growth in high-NTR gap counties post-2001 may primarily reflect more rapid growth for already more heavily industrialized counties. Another related source of bias may stem from the fact that some of the highest NTR gaps are observed for textiles and garment manufacturing, sectors that also benefited considerably from the relaxation of the MFA quotas. While the main specification includes controls for county-level variation in quotas, bias could be introduced by any shocks to textile production that are not captured by this variable.

We address both points by implementing a similar strategy: including additional control variables for employment shares in different sectors interacted with year fixed effects. First, we calculate the share of employment in the secondary and tertiary sectors as observed in the 1990 census, construct separate quartile dummy variables for each employment share, and include interactions between the quartile dummy variables and year fixed effects in the primary specification. Second, we use the employment shares in the five sectors characterized by the largest NTR gaps (textiles, garments, other manufacturing, medical and pharmaceutical products, and furniture manufacturing), again construct five sets of quartile dummy variables, and interact these variables with year

fixed effects. The results are reported in panels A and B of table A16, and are consistent with the primary specification.

In addition, we estimate the baseline specification including only province-year and county fixed effects; these results are reported in panel C of the same table. In panel D, we include the full set of controls and weight each county observation by its 1990 population.²¹ In panel E, we winsorize the top and bottom 1% of the NTR gap. In each specification, the results are robust.

In panel A of table A17, a full set of interactions between year fixed effects and a dummy variable for each quartile of initial GDP are added. In panel B, we characterize counties based on the proportion of the population in 1990 reported to have post-primary education, generate dummy variables for counties in each quartile of initial education, and include the interactions between these dummy variables and year fixed effects. In panel C, we calculate a Herfindahl index capturing initial concentration in tradable production and include interactions between dummy variables for each quartile of the Herfindahl index and year fixed effects. The results are uniformly consistent.

There is also substantial expansion in China’s agricultural imports during this period, particularly in cotton and soybeans.²² We can utilize data from the 2000 World Census of Agriculture (FAO/IIASA) to analyze the cross-sectional correlation between the NTR gap and the proportion of area sown in soybeans and cotton. In general, this correlation is negative, suggesting that areas experiencing more export-driven growth are less subject to competition from imports. If we reestimate the main specification including an interaction term between high cotton and soybean production (a dummy for the fraction of sown area devoted to cotton and soybeans being above the median) and the NTR gap, the interaction terms are generally insignificant, as reported in panel D of table A17. Accordingly, competition from imports is not a channel that seems to be of first-order importance in generating the observed substitution away from agriculture.²³

C. Aggregate Productivity and Growth

Finally, it may be useful to present some simple back-of-the-envelope calculations that quantify the contribution of the reduction in trade uncertainty generated by WTO accession to shifts in aggregate productivity and growth in China

²¹ A small number of observations are missing population data. The results are also consistent if the regressions are weighted with respect to initial total GDP.

²² Figure A4 in the appendix shows the evolution of China’s agricultural imports.

²³ In appendix table A18, we also evaluate whether shifts in exchange rate policy could be a source of bias in these results; counties with a high ex ante share of U.S. exports could be differentially negatively affected by the gradual appreciation of the yuan during this period. When we estimate a parallel specification interacting a dummy for high U.S. share of exports with annual fluctuations in exchange rates and a post dummy, we find no evidence of this pattern and similarly see no evidence of such a response in a simpler specification that does not take into account differences between the pre- and postperiod.

²⁰ Specifically, we generate a set of dummy variables for each 2% range in the distribution of the high tariff rate (fifty dummy variables in all) and include these variables, as well as their interaction with the post dummy.

over this period. First, we can quantify the contribution of labor reallocation across sectors (from agricultural production to nonagricultural production) to aggregate productivity, following McCaig and Pavcnik (2018). A growing literature has documented that value added per worker is significantly higher in nonagricultural compared to agricultural production in developing countries (Gollin et al., 2014), and we can replicate this stylized fact using national data reported on value-added and employment per sector; these data suggest a productivity gap of around 6 between the secondary and primary sector, or 4 if adjusted for different human capital stocks. Given this gap, the shift of workers from the primary to the secondary sector of the magnitude observed suggests an increase in productivity of at least 10%, and up to 38%; more details about how these calibrations are conducted are in appendix A1.6.

We can also explore the importance of WTO accession in overall growth in county-level GDP during this period. The average county in this sample shows GDP growth of 1.2 log points in the post-WTO period. Our results suggest that for a county characterized by a mean NTR gap, the reduction in tariff uncertainty in the U.S. market to 0 results in an increase in GDP of .1 log point. Accordingly, export-driven growth enhanced by WTO membership accounts for approximately 10% of overall GDP growth. A similar calculation for secondary GDP suggests that growth driven by the WTO accession shock accounts for approximately 9% of overall secondary growth from 2002 to 2010, the final year in which secondary GDP is observed for a substantial sample.

VI. Conclusion

In this paper, we use a new panel of county-level data to present the first evidence of the effect of China's accession to the WTO in 2001—a policy shift that removed uncertainty over the tariff rates that Chinese exporters would face in the U.S. market—on structural transformation and growth. The identification strategy exploits variation across industries in the size of the gap between the MFN tariffs and the higher tariffs that Chinese producers risked exposure to prior to WTO accession, as well as variation across counties in the baseline composition of employment.

Our results suggest that counties that benefited most from the reduced tariff uncertainty show substantial expansion following WTO accession. Employment and GDP in the secondary sector increase, while the agricultural sector contracts. Importantly, we observe not only a decline in employment in the agricultural sector but also a decline in output, a result inconsistent with predictions of the surplus labor hypothesis. We also observe a substantial increase in GDP per capita. Moreover, these patterns are observed only after 2001, suggesting that they do reflect the hypothesized channel of reduced tariff uncertainty and are not evidence of ex ante differences in observable characteristics.

This paper is the first to analyze the impact of the reduction in tariff uncertainty on structural transformation at the

local level in China and joins a limited literature evaluating the role of enhanced trade access in stimulating growth in developing countries. This evidence highlights the importance of securing access to developed country markets for developing countries that pursue export-driven growth strategies. Understanding the implications of U.S. trade for Chinese growth may contribute to a more complete understanding of the global impact of China's rise as a global manufacturing powerhouse over the past two decades.

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