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 post-accession 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 non-agricultural to agricultural production in counties exposed to positive trade shocks, agricultural output declines. *JEL Classification:* F14, F16, O14, O19.

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1 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 non-agricultural 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 and Heshmati 2010; McMillan et al. 2014), there is relatively little direct evidence of this relationship, and more generally Goldberg and Pavcnik (2016) conclude in a recent 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 et al. 2011; Autor et al. 2016). Existing evidence suggests that the reduction of domestic tariffs had a large positive effect on the manufacturing sector (Manova and 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

[1]For example, Hornbeck and Keskin (2015) find no evidence that positive agricultural growth generated by the construction of an aquifer in the U.S. generates non-agricultural growth, while Bustos et al. (2015) present evidence that technological innovations in the

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 non-agricultural production in developing economies, this substitution has important macroeconomic implications (Gollin et al. 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 vis-a-vis China, generating a substantial increase in both total Chinese exports to the U.S. and total exports, as evident in Figures 1c and 1d (Handley and Limão 2017; Pierce and 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 percent annually post-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 U.S. required annual renewal by Congress prior to 2002, a process entailing considerable risk; if the renewal had failed, Chinese exports would have been subject to the much higher rates reserved for non-

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soybean sector in Brazil generate industrial growth only when they are labor-saving.

market economies.[2] The U.S. 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 and 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 pre-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 and 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 post–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 increase in exports of around .15 log points, and increases in secondary, total and per capita county GDP of around .05 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,

[2]For 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.

[3]In 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.

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 non-agricultural 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 et al. 2011; Kwan et al. 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 non-agricultural 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 enhanced markets represents a non-trivial contribution. While an analysis at the level of the local economy is not directly informative about the magnitude of macro-level 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 between 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 existing 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 et al. (2017) and Khandelwal et al. (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 and Ma 2016) and stimulated entry into export-oriented production (Feng et al. 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 and Kovak 2015), 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) and McCaig and Pavcnik (2016) analyze reallocation of labor between household businesses and the formal sector. Another recent paper analyzes the effect of China's WTO accession on internal migration, but it utilizes only prefecture-level data (Facchini et al. 2016).

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; Herrendorf et al. 2014; Matsuyama 2018). More generally, open economy models of structural change predict that declining trade costs can induce labor reallocations across sectors (Uy et al. 2013; Cravino and 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 policy uncertainty on manufacturing employment and consumer prices in the United States.

The remainder of the paper proceeds as follows. Section 2 provides more background on China's accession to the WTO and a simple conceptual framework. Section 3 describes the data. Section 4 presents the identification strategy and the empirical results. Section 5 presents robustness checks, and Section 6 concludes.

2 Background and conceptual framework

2.1 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

[4]Recent work in this literature includes Attanasio et al. (2004), Wacziarg and Wallack (2004), and Topalova (2010).

any discontinuous jumps in 2001. It is useful to highlight the most important policy changes implemented by China 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 et al. 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 U.S. 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 these variables will be included 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 non-market 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 U.S., 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 will also further substantiate this point in subsequent robustness checks.

Again, a number of policy shifts during this period shaped economic outcomes. However, we will preferentially focus on reduced trade uncertainty given that the previous literature has highlighted this shift had a major impact on the U.S. market, and given the discontinuous nature of the reduction in uncertainty. We will 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 post period, 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 U.S. and other trading partners vary continuously over time. Further details are provided in section 3.2.

2.2 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 et al. 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 and 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. 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 non-agricultural 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 non-agricultural 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) into 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 and 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 non-trivial 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 non-tradables, as well as any producers of tradables that sell partly to the local market. If there is some input in non-tradable (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 et al. 2014; Matsuyama 2018). 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 and 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

[5]The existing 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).

reallocation of productive factors and the expansion of local demand.

3 Data

3.1 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 is 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 1805 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 is 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 available. Here, we will briefly discuss each case; a detailed discussion can be found 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, 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 those 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 1000 and 1700. 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 will subsequently demonstrate that

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

the primary results are all robust to controlling for patterns of selection into the sample. In addition, we will 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.

3.2 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 post-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]

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

[8]We should note that this methodology of calculating county-level NTR gaps, while con-

$$NTR\,Gap_c = \sum_i empshare_{ic}^{1990} \times NTR\,Gap_i \tag{1}$$

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 post-reform 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 will 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 non-tradable 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

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sistent with the previous literature, does not take into account input-output linkages: i.e., 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.

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 will 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 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.

3.3 Other policy changes

In the main empirical analysis, we also consider a number of other policy changes in China and the U.S. 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 post–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 require 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]

[9]Since the industry categories for the export licensing and contract intensity variables are

We also control for policy changes in the U.S., 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.

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 is 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 4.3, 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.

4 Empirical results

4.1 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

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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.

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:

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

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 zero and a standard deviation of one, and a post–WTO dummy, equal to one for 2002 and subsequent years.

The specification also includes a number of additional controls denoted $\boldsymbol{X}'_{cfpt}$. 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 and Schott (2016); we will demonstrate in Section 5 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 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

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

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

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 will 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 one standard deviation; 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 .18 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 .23 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 the decrease 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 .014 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 .12 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 zero 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 5.3, these effects are of non-trivial magnitude relative to overall growth in this period.

Missing data Again, the number of observations fluctuates in the main specifications because many provincial 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 1000 and 1700. We will 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 re-estimate 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 12 year post period for which data is 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 and 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 re-calculate 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 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 zero weight to the tertiary (non-tradable) 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 non-tradable sector a weight of zero.[13] Using this alternate strategy to re-calculate the NTR gaps and re-estimate 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.)

4.2 Pre-trends

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

[12]The 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.

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

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.

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

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 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 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 U.S. over the same period.

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

[15]While 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 non-convertible currency. Accordingly, this shock should not be a source of bias in this analysis.

The regression analogues to these results are presented in Columns (1) and (2) of Table A13. We can also test whether the estimated coefficients β are equal when compared across the pre-treatment 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 one percent 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 re-estimated 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 pre-existing 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 re-estimating 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]

[16]We also re-generate plots parallel to Figure 3a and 3b using the methodology proposed by Roth (2018) and find generally consistent results: in particular, the coefficients on the

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 can be found in Section A1.3 in the Appendix.

4.3 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 data source described in detail in Brandt et al. (2012). The data are collected in annual surveys conducted by the National Bureau of Statistics, and they include all state-owned industrial firms (in mining, manufacturing, and public utilities) and all non-state 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

pre-period shocks remain consistently insignificant.

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 follows.

$$\ln(Y_{fpt}) = \beta_1 Post_t \times NTR\,Gap_{fp} + \beta_2 NTR\,Gap_{fp} + \boldsymbol{X}'_{fpt}\theta + \gamma_{pt} + \nu_f t + \epsilon_{cfpt} \tag{4}$$

The results are reported in Table 4; again, the coefficients correspond to prefecture-level aggregates. The first three columns show that a one standard deviation 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 that there has been productivity gains from the reduction in tariff uncertainty associated with the WTO accession.

Additional province-level data Given that export data is 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 re-estimate 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 one standard deviation increase in tariff uncertainty ex-ante is associated with increases of around .2 log points in exports and .5 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.

4.4 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, as previously noted, 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 non-tradable (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 non-homothetic 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.

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.

5 Additional robustness checks

5.1 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 2-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 U.S., 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 $\boldsymbol{X}_{pdt}$, and product-year fixed effects.

$$\ln(Exp_{pdt}) = \beta_1 NTR_{pt} \times US_d \times Post_t + \beta_2 NTR_{pt} \times Other_d \times Post_t + \boldsymbol{X}_{pdt} + \omega_{dt} + \epsilon_{dpt} \quad (5)$$

We hypothesize that β_1 will be positive, and β_2 will not be significantly different from zero: products characterized by a larger NTR gap exhibit an increase in exports to the U.S. post-WTO, but there should be no significant increase in exports to other destinations. The

[17] The 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 to be tentative.

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.

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 re-estimated 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

[18]The 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.

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

$Other_{cfpt}$.[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.

5.2 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 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 will 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 sector 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.

[20]Specifically, we generate a set of dummy variables for each two-percent range in the distribution of the high tariff rate (50 dummy variables in all) and include these variables, as well as their interaction with the post dummy.

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 one percent 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 re-estimate 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

[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.

the observed substitution away from agriculture.[23]

5.3 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 over this period. First, we can quantify the contribution of labor reallocation across sectors (from agricultural production to non-agricultural production) to aggregate productivity, following McCaig and Pavcnik (2018). A growing literature has documented that value added per worker is significantly higher in non-agricultural 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; this data suggests a productivity gap of around six between the secondary and primary sector, or four 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 can be found 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 zero results in an increase in GDP of .1 log point. Accordingly, export-driven growth enhanced by WTO

[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 post period.

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.

6 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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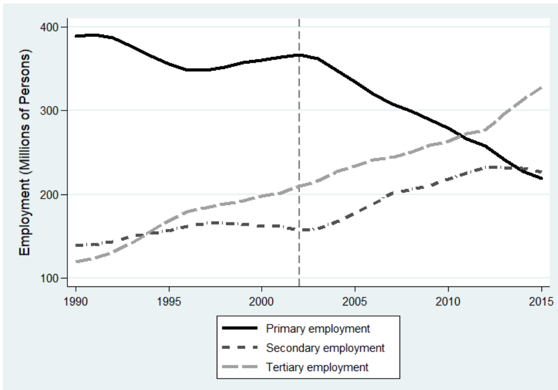
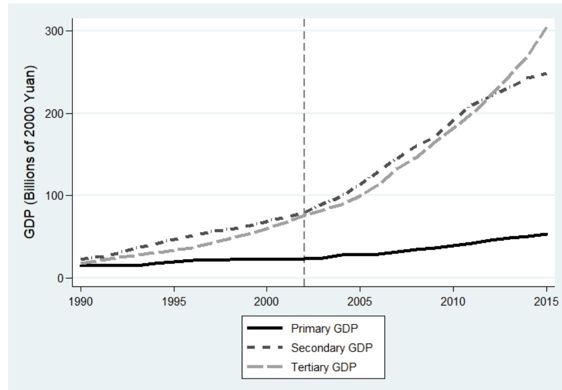
7 Figures and Tables

FIGURE 1: AGGREGATE TRENDS

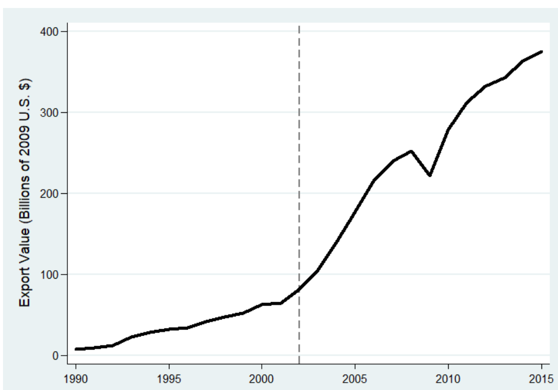
(A) Composition of Employment in China



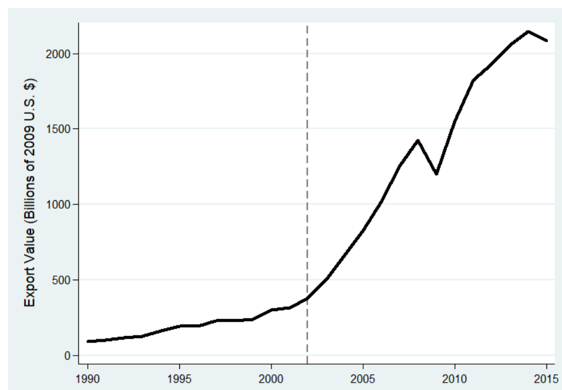
(B) Composition of GDP in China



(C) China's Exports to the United States



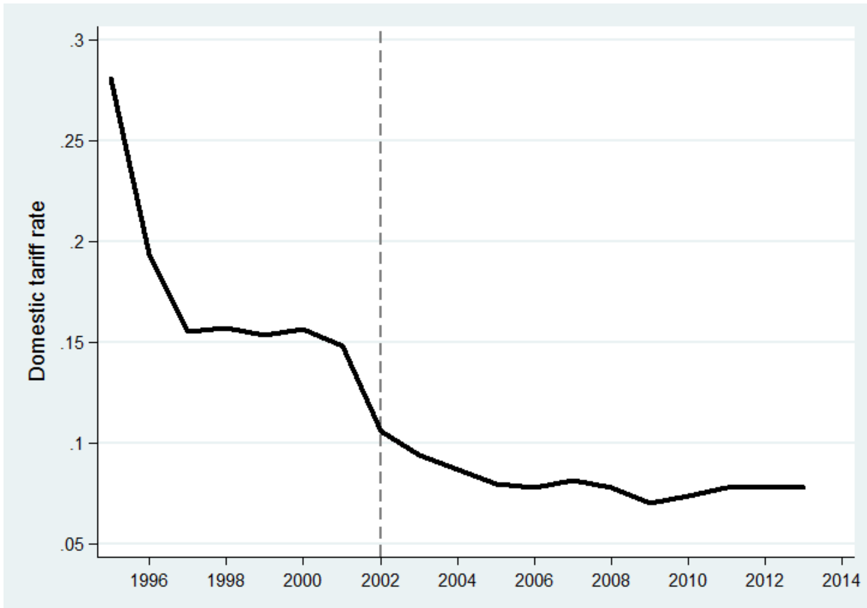
(D) China's Total Exports



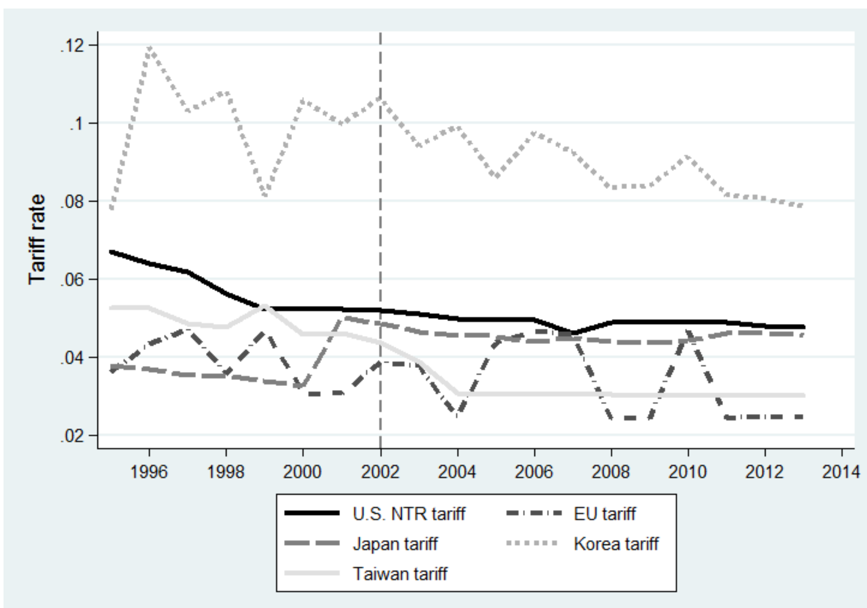
Notes: Subfigures 1a and 1b presents aggregate statistics for China as a whole from 1990 to 2015, employing data from the National Bureau of Statistics. The primary sector includes agriculture, forestry and fishing, the secondary sector includes manufacturing and mining, and the tertiary sector includes services. GDP is reported in billions of constant 2000 yuan, and employment is reported in millions of persons. Subfigures 1c and 1d 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 is drawn from the IMF Direction of Trade database, and the data for China's total exports is drawn from the FRED database; both series are deflated to 2009 US dollars using the PCE price index.

Figure 2: Variation in Tariff Policy Over Time

(a) China's Import Tariffs Over Time



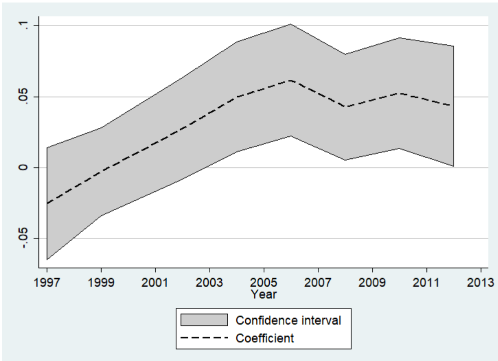
(b) Major Trading Partners' Tariffs Over Time



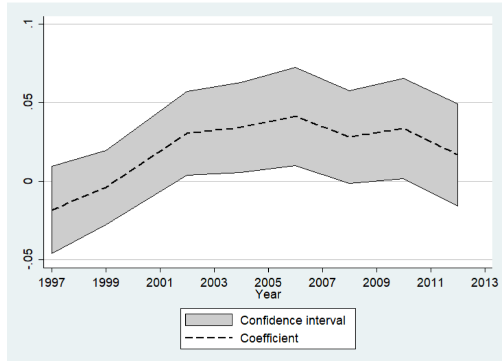
Notes: The first subfigure shows China's average domestic import tariff, calculated as the weighted average of industry-level tariffs and utilizing as weights the share of total Chinese imports constituted by each industry's imports in 1996. The second subfigure shows the mean tariff imposed on Chinese 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 is obtained from the WITS-TRAINS database.

Figure 3: Estimated Dif-in-dif Coefficients and 90% Confidence Intervals

(a) GDP



(b) GDP - simple specification



Notes: 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 zero and standard deviation one. The specifications estimated to construct Figure 3a 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 Figure 3b 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.

Table 1: Primary Results

	(1)	(2)	(3)	(4)	(5)	(6)
	Panel A: Exports and GDP					
	Exports	Primary	Secondary	Tertiary	GDP	Per capita
Post x NTR gap	.197	.005	.033	.025	.040	.030
	(.081)**	(.018)	(.015)**	(.014)*	(.012)***	(.016)*
Obs.	5158	14722	15688	15375	29782	26339
Num. counties	1017	1496	1496	1496	1688	1609
	Panel B: Employment					
	Primary	Agri.	Secondary	Tertiary	Total emp.	Total pop.
Post x NTR gap	-.072	-.069	.257	.096	.0004	.013
	(.050)	(.027)**	(.102)**	(.116)	(.012)	(.006)**
Obs.	3214	21532	4523	4659	19972	28867
Num. counties	354	1619	1235	1235	1440	1642
	Panel C: Agricultural investment					
	Sown area	Agri. machine	Grain	Cash	Grain yield	
Post x NTR gap	-.037	-.085	-.126	-.053	-.042	
	(.020)*	(.024)***	(.038)***	(.025)**	(.022)*	
Obs.	8322	28149	28161	26818	7168	
Num. counties	989	1637	1627	1574	885	

Notes: 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. Asterisks indicate significance at the ten, five, and one percent level.

Table 2: Main specifications controlling for selection into the sample

	Exports (1)	Primary (2)	Secondary (3)	Tertiary (4)	GDP (5)	Per capita (6)
Panel A: Sample reporting export data						
Post x NTR gap	.185	-.033	.032	.052	.067	.059
	(.083)**	(.014)**	(.023)	(.017)***	(.017)***	(.016)***
Obs.	5158	2981	3005	3005	5152	5004
Panel B: Sample excluding prefectures with sparse observations						
Post x NTR gap	.196	.004	.032	.020	.038	.005
	(.081)**	(.018)	(.014)**	(.013)	(.013)***	(.016)
Obs.	5117	13479	14388	14112	22989	21187
Panel C: Including observation number quartile - year fixed effects						
Post x NTR gap	.188	.001	.030	.022	.030	.036
	(.083)**	(.016)	(.015)**	(.014)	(.012)**	(.016)**
Obs.	5158	14722	15688	15375	29782	26333

Notes: 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 interactions between this dummy variable and year fixed effects. Asterisks indicate significance at the ten, five, and one percent level.

Table 3: Robustness Checks

	Exports (1)	Primary (2)	Secondary (3)	Tertiary (4)	GDP (5)	Per capita (6)
Panel A: NTR gaps estimated using 2000 employment weights						
Post x NTR gap	.111	-.019	.041	.039	.040	.036
	(.051)**	(.012)	(.013)***	(.011)***	(.010)***	(.011)***
Obs.	5158	14690	15646	15340	29740	26318
Panel B: NTR gaps estimated assigning non-tradables zero weights						
Post x NTR gap	.088	-.056	.003	-.009	.024	.020
	(.049)*	(.019)***	(.014)	(.010)	(.009)**	(.009)**
Obs.	5158	14722	15688	15375	29782	26347
Panel C: Main specification controlling for employment pre-trends						
Post x NTR gap	.196	-.011	.042	.021	.033	.020
	(.082)**	(.018)	(.016)***	(.013)	(.013)**	(.018)
Obs.	5158	14706	15672	15359	29766	26333

Notes: 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 non-tradable sector a zero weight. In Panel C, the long-difference in primary and non-primary employment between 1990 and 2000 interacted with a post dummy is included. Asterisks indicate significance at the ten, five, and one percent level.

Table 4: Factor utilization and other firm outcomes

	(1)	(2)	(3)	(4)	(5)
	Employment	Capital	Foreign capital	Value added per worker	Wages per worker
Post x NTR gap	.062	.119	.166	.028	.089
	(.035)*	(.044)***	(.048)***	(.016)*	(.050)*
Obs.	2492	2515	2496	2492	2240

Notes: 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. Asterisks indicate significance at the ten, five, and one percent level.

Table 5: Placebo Tests

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Chinese exports to all destinations						
Post x NTR gap x U.S.	.338	.338	.337	.337		
	(.029)***	(.007)***	(.029)***	(.007)***		
Post x NTR gap x Other four	-.113	-.113	-.118	-.118		
	(.478)	(.081)	(.478)	(.082)		
Obs.	330669	330669	330669	330669		
Panel B: Placebo NTR Gap						
	Exports	Primary	Secondary	Tertiary	GDP	Per capita
Other partner gap	-.535	.106	.085	.017	.038	.015
	(.573)	(.060)*	(.056)	(.049)	(.027)	(.028)
Obs.	5158	14722	15688	15375	29782	26347

Notes: 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 2-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 specification is 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. Asterisks indicate significance at the ten, five, and one percent level.

A1 Appendix - for online publication

A1.1 Additional background

This section provides additional details about China's WTO accession, supplementing Section 2. It may be useful to describe the continuous variation over time in tariffs imposed on Chinese exports by trading partners. On average during this period, the U.S. is the destination for approximately 20% of Chinese exports, followed by the European Union at 17%, Japan at 12%, Korea at 5% and Taiwan at 2%. It is evident in Figure 2b that the estimated tariffs imposed by Korea are highest, but show no significant trend. Tariffs imposed by the U.S. and Taiwan decline gradually, and the tariffs imposed by Japan and the EU are roughly constant. In all cases, there is no evidence of any dramatic shifts in tariff rates at the point of China's WTO accession.

Figure A1 in the Appendix provides an alternate representation of the evolution of both domestic tariffs and trading partner tariffs over time, utilizing county-level employment weights provided by the 1990 census to calculate a county-level weighted average tariff and then reporting the mean weighted county-level tariff by year over time. (These average county-level tariffs will subsequently be employed as control variables in the regressions of interest.) The graphs are largely similar, except that the tariffs imposed by Korea on Chinese imports appear much higher, reflecting Korea's extremely high tariffs on agricultural exports from China.

With respect to the reduced uncertainty in the U.S. market post-WTO, in October 2000, Congress passed a bill that granted permanent NTR status to China, effective as of January 1, 2002. The EU had granted China permanent NTR status much earlier (effective in 1980); thus, China did not face any tariff uncertainty in this market either before or after its WTO accession (Pierce and Schott 2016). The permanency of China's NTR status in other markets is ambiguous, but the descriptive evidence generally suggests there were no dramatic changes in the status of China's exports to other markets during this period, and analysts have noted that WTO members other than the U.S. had already provided China with permanent MFN status prior to its accession to the WTO (Rumbaugh and Blancher 2004). Moreover, growth in China's total exports showed a trend almost exactly parallel to the observed growth in exports to the U.S., as evident in Figure 1d, consistent with the hypothesis that the increase in exports to other markets was minimal.

A1.2 Missing data

Data can be 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 available. First, some counties that are observed in the census do not appear in provincial yearbooks at all; these are disproportionately counties that are part of the urbanized areas of larger, prefecture-level cities, as some provinces omit data for these areas. To provide more systematic evidence about the characteristics of these missing counties, we estimate the following specification at the county level in which county covariates as observed in the 1990 census are regressed on a dummy variable equal to one if the county is missing, as well as province fixed effects. Standard errors are clustered at the province level. (Note the total sample for these regressions includes the 1994 units observed in the 1990 census in the provinces of interest; one county has some missing data for covariates of interest, and thus does not appear in all regressions. In the 1990 census, unlike subsequent censuses, data for prefecture-level cities are reported only at the prefecture level, not for the constituent county-level units. Accordingly, each prefecture-level city enters only once as an aggregate unit.)

$$Y_{ifp}^{1990} = \beta Missing_{ifp} + \omega_p + \epsilon_{ifp} \tag{6}$$

The results are reported in Table A2, employing six covariates: total population, the percentage of households including children, the percentage of households including elderly, the percentage of individuals who received a post-primary education, the percentage of individuals with an agricultural registration, and the percentage of individuals working in the non-primary (secondary and tertiary) sectors. We can observe that counties missing from the sample are characterized by larger populations, higher levels of education, and a greater concentration of labor outside of agriculture, consistent with the hypothesis that these are more urbanized counties.

Second, for those counties observed in provincial yearbooks, different provinces in different years opt to report different indicators at the county level in their yearbooks. As a result, the number of observations varies significantly for different variables, as evident from the summary statistics. Thus (for example) Guangdong consistently reports employment data by sector for all counties for all years; Shanxi does not report employment data by sector for any county in any year. It is never the case that in the same yearbook (corresponding to a single province-year), a particular indicator is reported for some counties and not for others. The indicators that are reported most infrequently include employment at the sector level and exports, while indicators reported near-universally include gross domestic product, total employment, population, and agricultural inputs and production.[24]

Again, to provide more systematic evidence, we estimate the following specification, in which the dependent variable is the number of observations for a particular variable observed for a particular county, and the independent variables include the same county-level covariates as observed in the 1990 census.

$$Obs_{ifp} = \xi X_{ifp}^{1990} + \omega_p + \epsilon_{ifp} \tag{7}$$

For counties that are missing, the number of observations is set at zero. The results are reported in Table A3, and we again observe that the number of observations is in general lower for more populous counties, and higher for those that are more agricultural and have a lower proportion of employment outside the primary sector. This is consistent with more

[24]In particular, a strong positive correlation exists between the probability of reporting any data on export sales value and county-level GDP, and six relatively poor provinces (Shanxi, Sichuan, Guizhou, Shaanxi, Gansu, and Qinghai) report almost no data on exports.

urban and industrialized counties being generally underrepresented in the sample.

In the bottom of the table, we also report the average number of observations per county for each variable, conditional on reporting any data. The main years represented in the sample are the 18 years from 1996 to 2013 inclusive, though a very small number of counties report data for 1994 and 1995. The average number of observations per county is considerably lower for all outcomes other than GDP, for which the average is 17 years per county. However, conditional on reporting any data, counties generally report at least eight years of data for the key variables of interest, excluding only exports.

A1.3 More details on primary results

The coefficients for the full set of control variables for the main results are reported in Tables A7 through A9. In general, there is evidence of more rapid substitution away from agriculture in counties that benefit more from MFA quota reductions, and slower growth in secondary production in counties more exposed to a decline in domestic tariff rates and an increase in competition from imports. The coefficients on the post-contract interaction and the time-varying NTR rate are generally insignificant, and varying in sign. These patterns are consistent with the hypothesis that, while other trade reforms in this period were relevant for the evolution of county-level outcomes, no other policy shift had a positive effect on county-level expansion of exports and secondary production as large as that produced by reduced uncertainty in the U.S. market. In some specifications, the coefficients on the domestic tariff rate are large in magnitude; however, as previously noted the majority of the reduction in domestic tariffs was observed prior to WTO accession, and the sign of the coefficient suggests a negative shock from domestic tariff reduction, rather than a positive shock.[25]

[25] A seeming anomaly can be observed here in that the proportion of firms licensed to export is negatively correlated with GDP. In the cross-section, we observe the expected positive correlation between the proportion of firms exporting and county-level GDP prior to 2004 (when export licensing requirements were eliminated). However, when county fixed effects are included, counties that show larger increases over time in export licensing are, mechanically, those with initially lower levels of export licensing, given that the maximum value for this variable is one. These counties with low initial export license levels are also characterized by slower GDP growth. In addition, the positive coefficient on the NTR rate

In addition, this analysis can be extended to present some evidence regarding heterogeneous effects, identifying counties concentrated in industries that should show a more robust response to the reduction of tariff uncertainty. In particular, we focus on counties that are more capital-intensive, counties concentrated in industries that export a higher proportion of their output to the U.S., and counties that are more proximate to ports.[26] Since capital investments are generally irreversible, counties with an initially higher concentration of capital-intensive industries are likely to respond more robustly to the reduction in tariff uncertainty. Similarly, the effect of reduced tariff uncertainty is likely to be larger for counties that specialize in industries exporting a higher proportion of their output to the U.S. ex ante, as well as for counties that are more proximate to ports and thus face a lower transaction cost of exporting.

While the county-level panel does not include any detailed information about capital investment that would allow for a direct test of this hypothesis, we can examine heterogeneous effects with respect to capital intensity of the industries observed in the county at baseline. Using a capital intensity variable constructed from a survey of large firms (described in more detail in Section 4.3), we calculate average capital intensity for non-state owned firms at the industry level in 1998, the first year of the panel, and construct a county-level proxy for capital intensity in the (non-SOE) secondary sector using the 1990 employment weights.[27] We then re-estimate equation (3) for counties below and above the baseline median level of capital intensity; to increase power, we use the simple specification without controls.

Similarly, the export data available at the county level do not report the destination of

in the specification for exports is of the opposite sign from what is expected; this primarily reflects the small sample of counties reporting export data.

[26]There are thirteen Chinese ports that are among the largest 50 ports in the world by shipping volume; the five largest of these are Shanghai, Shenzhen, Ningbo-Zhoushan, Hong Kong, and Guangzhou. Data on their geographic coordinates is drawn from the China Geo-Explorer offered by the University of Michigan China data Center.

[27]Information about capital intensity in the primary sector is not available, and thus it is excluded from this analysis.

these exports. However, we can use the available UNCOMTRADE data on Chinese exports at the product-destination level to calculate the proportion of exports destined for the U.S. by industry in 1996, the first sample year. We then generate a county-specific weighted average, under the assumption that the proportion of exports directed to the U.S. is balanced across counties. Insofar as this assumption is not fully accurate, this estimate is an imprecise proxy for county exports to the U.S.

We then again re-estimate equation (3) for counties below and above the baseline median level of U.S. export share. Finally, we calculate for each county the average distance between the centroid of the county and the five largest Chinese container ports. We then characterize a county as either non-proximate to a port (above the median of the cross-county distribution of average port distance) or proximate (below the median), and re-estimate equation (3) for both subsamples.

The graphical results are presented in Figure A5. For counties below the median level of capital intensity at baseline, there is little evidence of any significant effects of the elimination of tariff uncertainty; by contrast, the effects are large and significant post–2001 for counties above the median level of capital intensity. A similar pattern is observed for counties below and above the median U.S. export share, and counties that are non-proximate and proximate to major ports.

The regression analogues to these results are reported in Columns (3) through (8) of Table A13. In Columns (3), (5), and (7) we observe no significant coefficients for low-capital intensity, low-U.S. share and non-port proximate counties. Columns (4), (6) and (8) report the results for high-capital intensity, high-U.S. share and port-proximate counties, and show coefficients that are insignificant in the pre-period, followed by positive and significant coefficients post–2001. If we again test the equality of coefficients pre- and post-WTO, the hypothesis that the pre and post coefficients are equal can uniformly be rejected for these specifications. This suggests that as expected, the effects are concentrated in counties for which uncertainty was more likely to be a binding constraint on capital investment, counties in which uncertainty was highly salient due to the presence of exporters focusing on the U.S. market, and counties in which the transaction costs of exporting were lower.

A1.4 Prefecture-level cities in the 1990 and 2000 censuses

As previously noted, the 1990 census has one unusual characteristic that differentiates it from subsequent census rounds (2000 and 2010) and from the provincial yearbooks: data for prefecture-level cities are reported only at the prefecture level, not for the constituent county-level units. In some cases, provincial yearbooks report data for these county-level units of prefecture cities. Accordingly, a single census observation can in these cases be linked to multiple county-level observations in subsequent waves of yearbook data.

In addition, given that the 1990 and 2000 census waves report data differently for prefecture-level cities, it is useful to briefly elaborate on the construction of the NTR gap using the 2000 employment data. A prefecture is a level of geographic aggregation intermediate between a province and a county, comprising six counties on average; in addition, larger cities (e.g., provincial capitals) generally have the status of a prefecture. In that case, the prefecture-level city is nonetheless comprised of county-level units. For illustration, we will denote a prefecture-level city as City A, comprised of county-level units B, C and D.

In the 1990 census, employment data for prefecture-level cities is reported for the entire area, prefecture-level city A. (Rural prefectures have data reported for the constituent counties in the 1990 census.) By contrast, in the outcome data (provincial statistical yearbooks) as well as in the 2000 census, data is uniformly reported at the level of the county unit; thus prefecture city A would appear as county-level units B, C and D. In our sample, we link these units by matching the appropriate prefecture and county codes. The NTR gap constructed using 1990 employment data for prefecture city A is assigned to constituent units B, C, and D, and since the corresponding county codes are identical, the clustering takes into account this common shock.

To construct the NTR gap using 2000 employment data in parallel, we again use aggregates of employment data at the level of the prefecture-level city for those cities that are observed only as aggregates in the 1990 employment data. The estimated coefficients are also consistent if we estimate the 2000 weights for each constituent county B, C, and D, and employ these shocks in the analysis.

A1.5 Addressing measurement error

To address the potential challenge introduced by measurement error or selective misreporting in county yearbook data, we can employ two strategies. We first re-estimate the results employing as the dependent variable the average night lights index within county borders as a proxy for the intensity of local economic activity.[28] We observe a correlation of .65 between the night lights index and county GDP, and when the primary specification is re-estimated using the night lights index as a dependent variable, the estimated coefficient suggests that a county at the median level of tariff uncertainty shows evidence of a 17% relative increase in night brightness post-2001 compared to a county at the minimum level of tariff uncertainty, significant at the one percent level. The robustness of our results suggests that bias due to misreporting is of limited importance.

We also conduct an additional test to evaluate whether there may be selective misreporting in statistical yearbooks that could be correlated with the shock of interest. We focus on county-level GDP, and construct a balanced panel of the counties for which GDP data is reported every year between 1998 and 2010.[29] We then calculate a province-year level sum of

[28]To generate county-level averages of night lights data, high-resolution light density data was downloaded from `http://ngdc.noaa.gov/eog/dmsp/downloadV4composites.html`. ArcMAP was used to process the files. They were converted from raster to GRID files, and averaged across the two sets of data available for each year. Gas flares were removed by using the China gas flares shapefile. The average night light intensity observed within each county boundary was then calculated using the zonal statistics function and the shape file corresponding to the 2010 county boundaries. The night lights variable ranges from 0 to 63 across counties for each year, based on the highest and lowest brightness captured on the satellite images.

[29]These years are employed as the start point and end point of the period because availability of data contracts sharply before 1998 and after 2010. 20 provinces are represented in the balanced panel for 13 years each, yielding a sample of 260 observations; the provinces that are dropped do not have any counties reporting GDP data for this full period.

GDP, adjust this sum to reflect the percentage of total employment within a given province represented in the balanced panel of counties, and calculate a variable denoted "GDP gap" equal to the percentage gap between this figure and total reported GDP at the provincial level according to the National Bureau of Statistics. The GDP gap is thus designed to capture any systematic misreporting in county statistics.

To evaluate whether the GDP gap is correlated with the shock of interest, we regress the gap at the province-year level on the NTR gap and the post-NTR interaction, with and without province and year fixed effects and additional controls. The results are reported in Table A19 in the Appendix, and show uniformly insignificant results. This suggests that there is no evidence of systematic variation in the quality of GDP reporting that is correlated with cross-provincial variation in the NTR gap.

A1.6 Calculations for aggregate effects

Effects on aggregate productivity First, in order to estimate the effect on aggregate productivity generated by the reduction in uncertainty post-WTO accession, we utilize data from the National Bureau of Statistics on value-added per sector (primary, secondary and tertiary) and employment per sector. This data is available from 1999 forward (value-added per sector was not reported prior to 1999), and we calculate the average for 1999–2001, corresponding to the pre-WTO period.

Second, we adjust these estimates of value-added per worker to take into account variation across sectors in the level of human capital. The county-level census reports only average levels of educational attainment per county, not per sector. Accordingly, we draw on a different source of data: the CHIP (Chinese Household Income Project) surveys for both rural and urban individuals in 1995 and 2002. (This corresponds to the two rounds of data collection that are immediately prior to the WTO; we exclude the data from 1988, given that educational levels changed dramatically over the subsequent decade.) We observe that among individuals of working age (between 18 and 65), average educational attainment is 5.76 years in the primary sector, 9.69 years in the secondary sector, and 10.72 years in the tertiary sector. We then follow Gollin et al. (2014) and McCaig and Pavcnik (2018) in calculating the average level of human capital in the sector as $\exp(r * Y_s)$, where r is the estimated rate of return on schooling, pegged at 10 percent, and Y_s is average years of schooling in the sector. We then adjust estimated value-added by the level of human capital in each sector. Using these adjusted measures yields a value-added gap between the secondary and primary sector of 3.95 (i.e., value-added per worker in the secondary sector is nearly four times higher than value-added per worker in the primary sector).[30]

Third, we calculate sectoral labor shares using aggregate employment data provided by the National Bureau of Statistics prior to and including 2001, again corresponding to the pre-WTO period. The labor shares are 50% in the primary sector, 23% in the secondary sector, and 27% in the tertiary sector.

Fourth, we calculate the magnitude of the shift of labor from the primary to the secondary sector that the mean county will experience. The results reported in Table 1 suggest a decline of .069 log points in agricultural employment and .072 log points in primary employment; the latter is noisily estimated, and estimated for a smaller sample of county-year observations. Hence, we use the coefficient estimate for agricultural employment and calculate the percentage change in agricultural employment implied for a county with the mean level of agricultural employment in the pre-WTO period (160.664, in thousands of workers). The mean effect implies a 30% decline in agricultural employment.[31] In line with the evi-

[30]More specifically, we calculate the average level of human capital in the primary and secondary sectors as $\exp(0.1 * 5.78) = 1.78$ and $\exp(0.1 * 9.69) = 2.64$, and then adjust the value added in each sector by dividing each figure to the sector-specific average level of human capital ($4.21/1.78 = 2.36$ for the primary sector, $24.63/2.64 = 9.34$ for the secondary sector). The ratio of these adjusted measures of value added by human capital yields 3.95 (the ratio of 9.34/2.36). Unfortunately, while the CHIP data provides some details about hours worked in non-agricultural employment, agricultural households do not report estimated hours worked. Accordingly, we are not able to implement a similar correction for differences in hours worked across sectors.

[31]The specific calculation involves taking the log of mean agricultural employment and subtracting the decline implied by our coefficient estimate ($ln(160.664) - 0.069 * ln(160.664)$), converting this to the level figure, and then calculating its percentage change ((113.164 −

dence presented in Table 1, we assume these workers transition to the secondary sector. In addition to calculating the mean effect implied by the coefficient estimate, we calculate a lower bound effect using the 95% confidence interval.[32]

The calculation conducted to generate the estimated productivity effect can be described as follows. Note that $\frac{VA}{L}$ denotes value-added per worker in the specified sector, and Sh denotes the employment share in the specified sector. The estimated effect using the coefficient point estimate can be calculated as follows.

$$.3 * \left(\frac{VA}{L}_{sec} - \frac{VA}{L}_{prim}\right) / \left(\frac{VA}{L}_{prim} * Sh_{prim} + \frac{VA}{L}_{sec} * Sh_{sec} + \frac{VA}{L}_{tert} * Sh_{tert}\right) \tag{8}$$

This calculation yields an increase in productivity of 38%. If the same calculation is done using the lower bound of the coefficient estimate, this results in an increase in productivity of 10%.[33]

Local GDP growth In order to conduct a simple back-of-the-envelope calculation estimating the contribution of the export shock captured by the NTR gap to total growth over this period, we must first make some assumptions about the magnitude of the decrease in uncertainty experienced by the average county between the pre and the post period. First, we assume that uncertainty captured by the NTR gap is reduced to zero in the post-WTO period, a decrease of 2.9 standard deviations. Second, we calculate the implied increase in GDP (.12 log points) and secondary GDP (.10 log points) predicted for the mean county in the post-WTO period, and compare these implied increases to the mean overall growth in each measure observed in the sampled counties in this period. We calculate the mean growth rates across all counties that report the indicators of interest; the mean county shows growth

160.664)/160.664).

[32]The lower bound of the coefficient estimate is 0.016 $(0.069 - (1.96 * 0.027))$.

[33]The calculations involve the following: $0.30 * (9.34 - 2.36)/(0.5 * 2.36 + 0.23 * 9.34 + 0.27 * 7.87)$ for the mean effect, and $0.08 * (9.34 - 2.36)/(0.5 * 2.36 + 0.23 * 9.34 + 0.27 * 7.87)$ for the lower bound.

in total GDP of 1.21 log points, and in secondary GDP of 1.12 log points. We then estimate that growth driven by the WTO accession shock accounts for approximately $\frac{.12}{1.21} = 9.9\%$ of all total GDP growth, and $\frac{.10}{1.12} = 8.9\%$ of secondary growth.

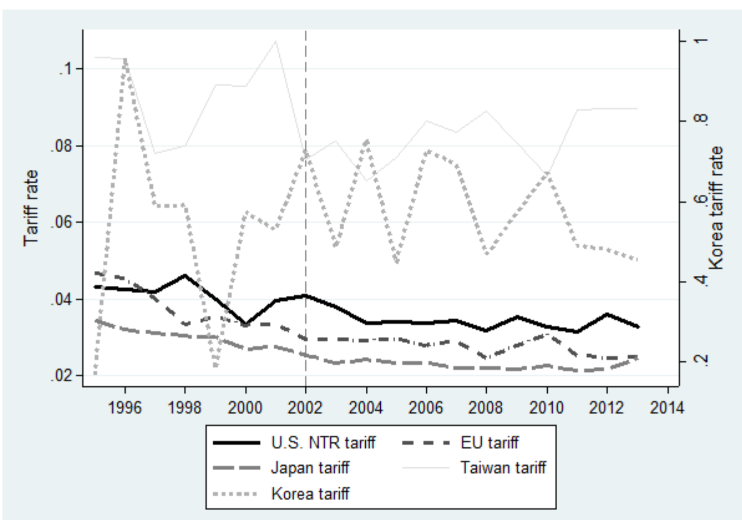
It should be noted that these estimates reflect a number of underlying assumptions and should be considered merely illustrative. However, they do suggest that the effects of export expansion driven by the reduction in uncertainty are non-trivial in magnitude.

A1.7 Appendix Figures and Tables

Figure A1: Variation in Tariff Policy Across Counties and Over Time

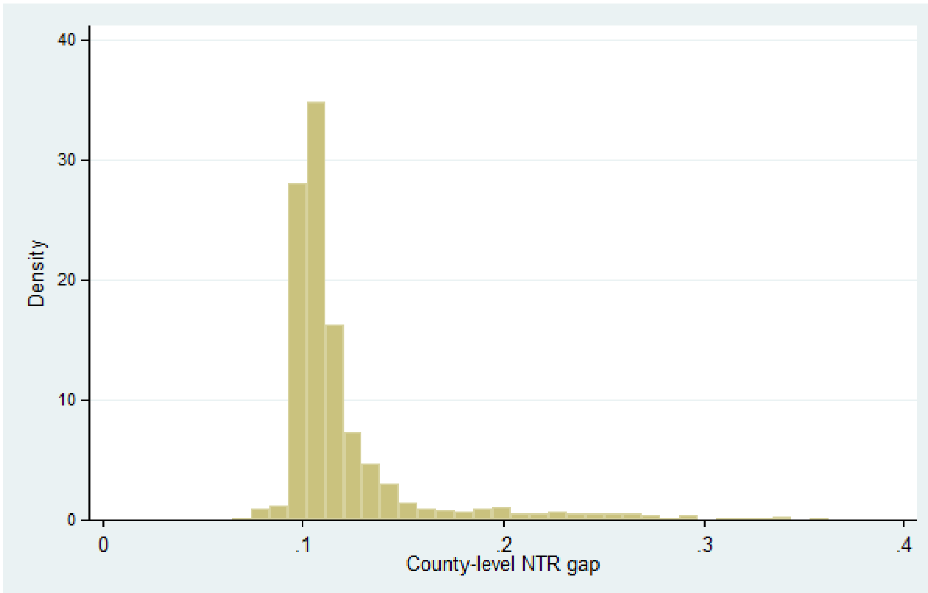
(a) China's Import Tariffs Over Time

(b) Major Trading Partners' Tariffs Over Time



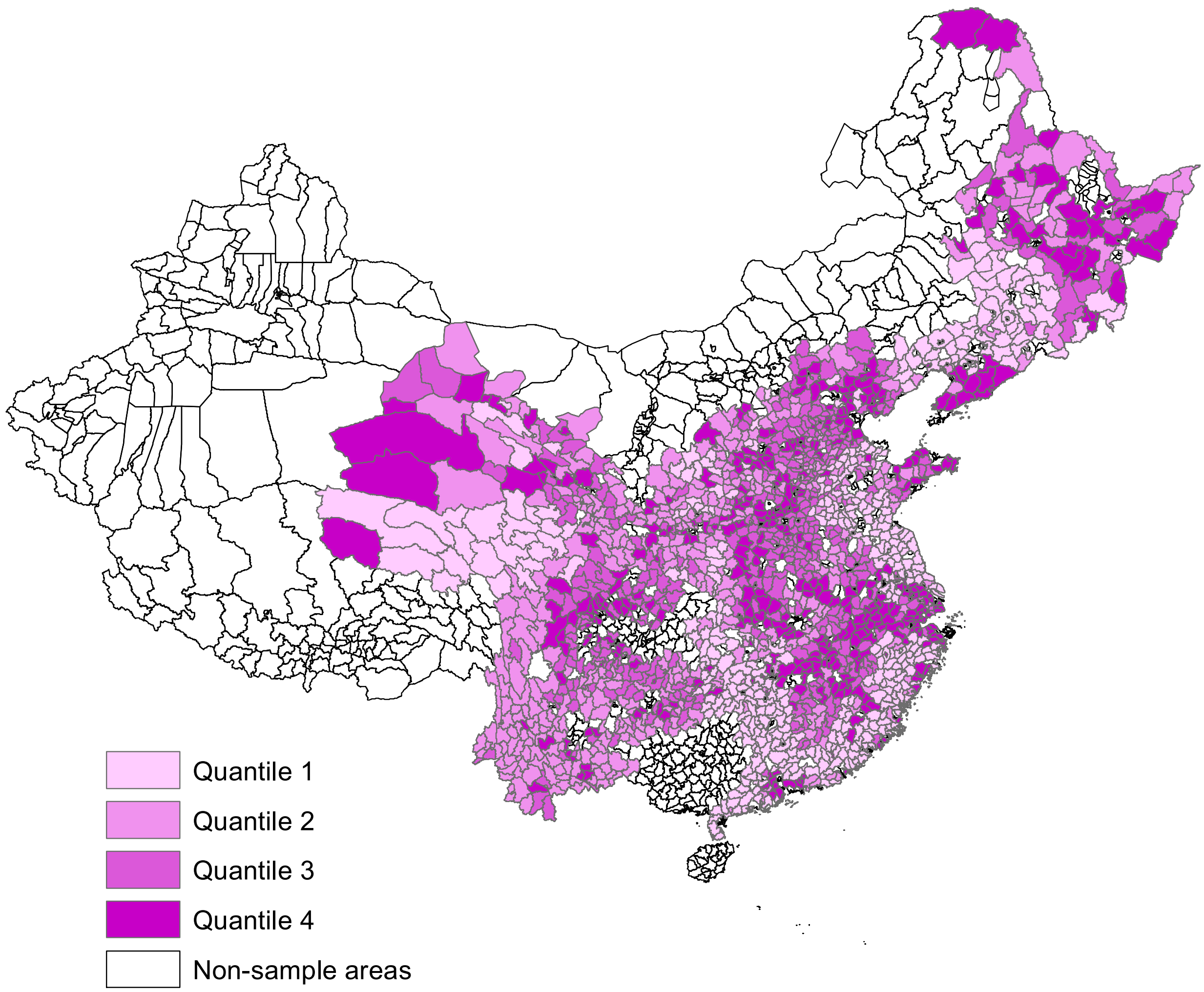
Notes: The first subfigure shows the average domestic import tariff and the second subfigure shows the mean tariffs imposed on Chinese exports by major trading partners. For each variable, we calculate the average county-level weighted average tariff, using tariffs by industry and employing as weights the county-level employment share of each industry as reported in the 1990 census. We then report the mean weighted tariff over all counties in each year. Tariff data is obtained from the WITS-TRAINS database.

Figure A2: NTR Gap at the County Level



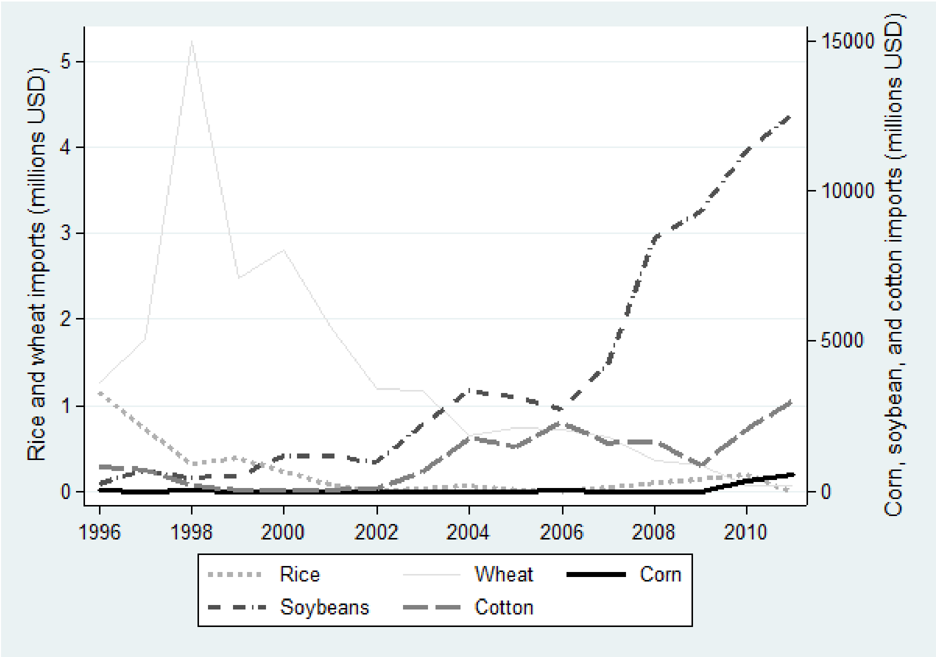
Notes: The figure is a histogram of the gap between normal trade relations (NTR) tariffs and non-NTR tariffs, calculated at the county level utilizing industry employment shares as reported in the 1990 census as weights.

Figure A3: NTR Gap by County



Notes: This figure shows the NTR gap at the county level, utilizing the residuals from the gap regressed on provincial fixed effects. Areas not shaded are out of sample. This includes the autonomous regions (Inner Mongolia, Guangxi, Ningxia, Tibet, and Xinjiang) and counties that cannot be matched between the county-level census data and the provincial yearbooks.

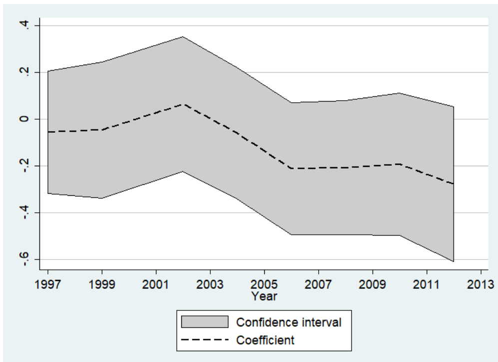
Figure A4: China's Agricultural Imports from the U.S.



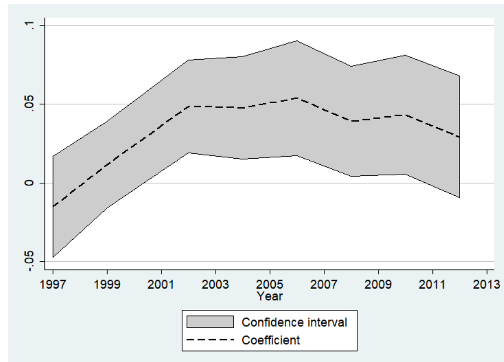
Notes: This figure shows the evolution of Chinese imports of agricultural products from the U.S. during the period of interest in the primary analysis.

Figure A5: Estimated Dif-in-dif Coefficients: Heterogeneous effects

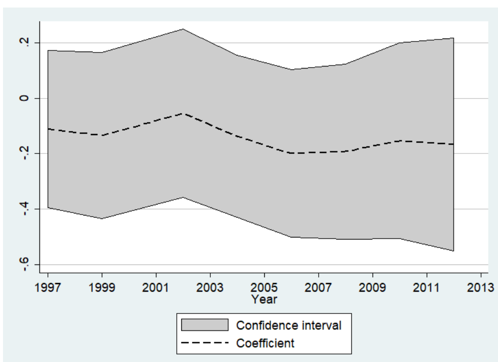
(a) Low capital intensity



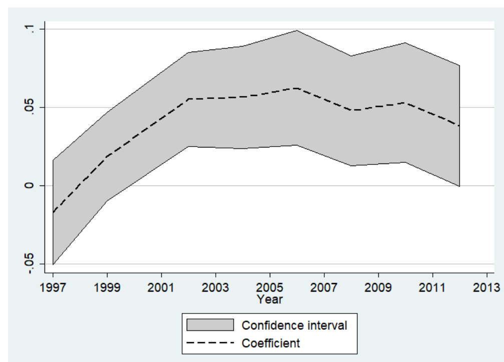
(b) High capital intensity



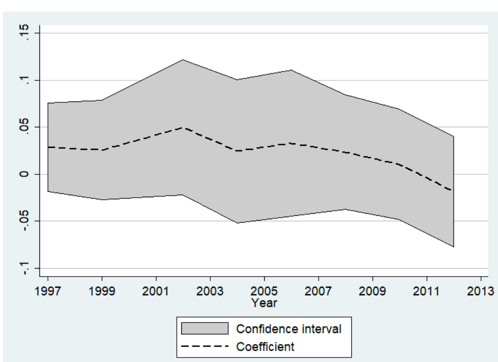
(c) Low U.S. share of exports



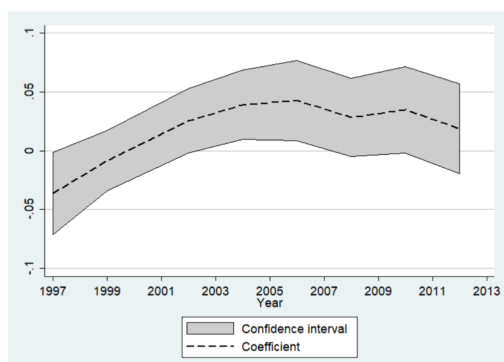
(d) High U.S. share of exports



(e) Low port proximity



(f) High port proximity



Notes: These graphs report the coefficients on the interaction of dummy variables for each two-year interval and the county-level NTR gap, standardized to have mean zero and standard deviation one. The specifications estimated include province-year and county fixed effects, and province-year fixed effects interacted with an urban dummy; standard errors are estimated employing clustering at the county level, and the regressions are weighted with respect to baseline county-level employment.

In Figures A5a and A5b, the sample is restricted to counties below (above) median baseline capital intensity. In Figures A5c and A5d, the sample is restricted to counties below (above) median baseline share of exports to the U.S. In Figures A5e and A5f, the sample is restricted to counties below (above) median proximity to the five largest ports.

Table A1: Summary Statistics

Variable	Mean (log)	Mean (level)	Min. (level)	Max. (level)	Obs.	Num. counties
Primary emp.	4.89	181.33	.6	779	3214	354
Ag emp.	4.32	159.94	0	3681	21539	1619
Secondary emp.	3.80	101	.04	1708.53	4523	1235
Tertiary emp.	3.99	86.72	.5	1169.02	4659	1235
Total pop.	5.94	519.67	.8	6850.02	28867	1642
Total emp.	5.26	256.92	3.4	1550.4	19972	1440
Exports	4.93	1184.65	0	190204.6	5337	1017
GDP	7.95	9813.69	.1	611638.25	29782	1688
GDP per capita	8.79	9942.79	0	254907.92	26903	1609
Primary	6.4	1119.97	3.39	18743.66	15673	1496
Secondary	6.88	6937.37	.06	6295413.3	15688	1496
Tertiary	6.74	5979.91	.69	4403172.2	15616	1496
Sown area	3.63	64.76	0	1620.79	8328	989
Agri. machine	2.9	37.76	0	1669.41	28246	1637
Grain output	4.99	247.81	0	5600.1	28277	1627
Cash output	2.91	46.74	0	2377.79	26823	1574
Grain	3.51	56924.16	0	2305598	7169	885

Notes: This table reports the mean in logs, mean in levels, minimum, maximum, number of observations and number of counties reporting any observations for key variables. Total population and employment is reported in thousands of persons. Exports and GDP are reported in millions of yuan and GDP per capita in yuan, deflated to 2000 constant prices. Sown area is reported in thousands of hectares; agricultural machinery power used is reported in 10,000 kilowatts. Grain production and cash crop production are reported in thousands of tons, and grain yield is reported in tons per hectare.

Table A2: Counties missing from the provincial yearbooks

	Pop.	Hh incl. children	Hh incl. elderly	Post primary educ.	Prop. agri.	Prop. non-prim. empl.
	(1)	(2)	(3)	(4)	(5)	(6)
Missing dummy	226877.700 (63938.950)***	-.0006 (.007)	.010 (.005)*	.119 (.016)***	-.217 (.052)***	.229 (.057)***
Mean dep. var.	520671.43	.24	.2	.34	.83	.28
Obs.	1994	1993	1993	1994	1993	1994

Notes: The dependent variables are variables reported in the 1990 census: county population, the percentage of households including children age 0-7, the percentage of households including elderly members, the proportion of adults with post-primary education, the proportion of the population designated as agricultural, and the proportion of the population working in the secondary and tertiary sectors. The independent variable is equal to one if the county is missing from the provincial yearbooks; all specifications include province fixed effects and standard errors clustered at the province level. Asterisks indicate significance at the ten, five, and one percent level.

Table A3: Number of observations and initial county characteristics

	Number of observations					
	GDP	Primary	Secondary	Tertiary	Exports	Emp.
	(1)	(2)	(3)	(4)	(5)	(6)
Pop	-.002	-.0006	-.0006	-.0006	.00002	-.0002
	(.0003)***	(.0002)***	(.0002)***	(.0002)***	(.0002)	(.0001)**
Prop children	-3.570	-1.281	-1.284	-1.362	-9.913	4.894
	(5.364)	(3.255)	(3.255)	(3.241)	(2.963)***	(1.943)**
Prop elderly	14.761	4.095	4.117	4.108	8.359	-1.995
	(8.161)*	(4.951)	(4.953)	(4.931)	(4.507)*	(2.956)
Post-primary	-5.702	-3.027	-3.039	-2.999	7.643	-2.742
	(2.019)***	(1.225)**	(1.225)**	(1.220)**	(1.115)***	(.731)***
Prop agri	13.520	3.722	3.711	3.685	9.323	1.704
	(2.076)***	(1.260)***	(1.260)***	(1.254)***	(1.147)***	(.752)**
Prop non-prim	-4.501	-3.654	-3.652	-3.663	.493	.757
	(1.836)**	(1.114)***	(1.114)***	(1.110)***	(1.014)	(.665)
Mean (Obs. > 0)	16.92	9.77	9.77	9.73	5.24	8.74
Obs.	1993	1993	1993	1993	1993	1993

Notes: The dependent variable is the number of observations observed at the county level for the specified variable. The independent variables are a series of county characteristics observed at baseline: the fraction of the population engaged in primary employment, the total population, and the fraction of the population with post-primary education (all observed in the 1990 census); GDP in the first year in which the county is observed in a provincial yearbook; and a dummy for an urban county. All specifications include prefecture fixed effects. Asterisks indicate significance at the ten, five, and one percent level.

Table A4: Concordance between Chinese Census Industry Categories, ISIC and SIC

Chinese Census Industry:		*ISIC Revision 3:*		*SIC:*	
Codes	Labels	2-Digit	3-Digit	2-Digit	3-Digit
90136	Farming		11	1	
90137	Forestry	2		8	
90138	Animal Husbandry		12	2	
90139	Fishery	5		9	
90140, 90141	Agricultural Services		11	7	
90142	Coal Mining and Dressing	10		12	
90143	Extraction of Petroleum and Natural Gas	11		13	
90144	Mining and Dressing of Ferrous Metals	12			101
90145	Mining and Dressing of Nonferrous Metals	13			102, 103, 104, 105, 106, 107, 108, 109
90146	Mining and Dressing of Nonmetal Minerals		141		141
90147, 90148	Mining and Dressing of Other Minerals		142		142, 143, 144, 145, 146, 147, 148, 149
90149	Logging and Transport of Wood and Bamboo	2			241
90151	Food Processing		151, 152, 153, 154		201, 202, 203, 204, 205, 206, 207, 209
90152	Beverages		155		208
90153	Tobacco	16		21	
90155	Textiles	17		22	
90156	Garments and Other Fiber Products	18		23	
90157	Leather, Furs, Down and Related Products	19		31	
90158	Timber Processing, Bamboo, Cane, Palm Fiber and Straw Products	20		24	
90159	Furniture Manufacturing		361	25	

Notes: This table reports the industry categories and their labels in the 1990 Chinese Census that can be matched to ISIC Revision 3 codes and SIC codes. Three-digit codes represent more disaggregated industry categories compared to two-digit codes. All industry categories reported in the Chinese Census are matched to two- or three-digit codes in ISIC or SIC codes. The category of cultural, educational, and sporting goods (90162, 90163) does not match to the ISIC or SIC codes, and is therefore excluded.

Table A5: Concordance between Chinese Census Industry Categories, ISIC and SIC (cont.)

Chinese Census Industry:		*ISIC Revision 3:*		*SIC:*	
Codes	Labels	2-Digit	3-Digit	2-Digit	3-Digit
90160	Paper-making and Paper Products	21		26	
90161	Printing and Record Medium Reproduction	22		27	
90165, 90166	Petroleum Processing and Coking	23		29	
90167	Raw Chemical Materials and Chemical Products		241, 242		281, 283, 284, 285, 286, 287, 288, 289
90168	Medical and Pharmaceutical Products	33			384
90169	Chemical Fiber		243		282
90170	Rubber Products		251		301, 302, 303, 304, 305, 306
90171	Plastic Products		252		308
90172	Nonmetal Mineral Products	26		32	
90173	Smelting and Pressing of Ferrous Metals		271		331, 332
90174	Smelting and Pressing of Nonferrous Metals		272		333, 334, 335, 336, 337, 338, 339
90175	Metal Products	28			341, 342, 343, 344, 345, 346, 347, 349
90176	Ordinary Machinery		291, 293		351, 352, 353, 354
90177	Transport Equipment	34, 35		37	
90178	Electric Equipment and Machinery	31			361, 362, 363, 364, 365
90179	Electronic and Telecommunications Equipment	32			366, 367, 368, 369
90180	Instruments, Meters, Cultural, and Office Machinery	30		38	
90181	Other Manufacturing		369	39	

Notes: This table reports the industry categories and their labels in the 1990 Chinese Census that can be matched to ISIC Revision 3 codes and SIC codes. Three-digit codes represent more disaggregated industry categories compared to two-digit codes. All industry categories reported in the Chinese Census are matched to two- or three-digit codes in ISIC or SIC codes. The category of cultural, educational, and sporting goods (90162, 90163) does not match to the ISIC or SIC codes, and is therefore excluded.

Table A6: NTR gap by industry

Subsectors	*NTR gap*
Coal Mining and Dressing	.000
Mining and Dressing of Ferrous Metals	.000
Fishery	.012
Extraction of petroleum and Natural Gas	.059
Mining and Dressing of Nonferrous Metals	.061
Animal Husbandry	.076
Petroleum Processing and Coking	.088
Farming	.096
Agricultural Services	.096
Forestry	.123
Logging and Transport of Wood and Bamboo	.123
Mining and Dressing of Other Minerals	.128
Food Processing	.134
Mining and Dressing of Nonmetal Minerals	.175
Smelting and Pressing of Ferrous Metals	.199
Beverages	.201
Timber Processing, Bamboo, Cane, Palm Fiber and Straw Products	.206
Rubber Products	.217
Transport Equipment	.222
Smelting and Pressing of Nonferrous Metals	.231
Printing and Record Medium Reproduction	.242
Raw Chemical Materials and Chemical Products	.269
Leather, Furs, Down and Related Products	.283
Papermaking and Paper Products	.284
Cultural, Educational and Sports Goods	.305
Nonmetal Mineral Products	.309
Tobacco	.317
Instruments, Meters, Cultural and Office Machinery	.321
Electric Equipment and Machinery	.334
Electronic and Telecommunications Equipment	.338
Ordinary Machinery	.363
Metal Products	.384
Chemical Fiber	.383
Plastic Products	.420
Furniture Manufacturing	.424
Medical and Pharmaceutical Products	.425
Other Manufacturing	.426
Garments and Other Fiber Products	.457
Textiles	.523

Notes: This table reports the NTR gap by industry for each tradable subsector reported in the 1990 Chinese county census.

Table A7: Exports and GDP, Full Results

	Exports (1)	Primary (2)	Secondary (3)	Tertiary (4)	GDP (5)	Per capita (6)
Post x NTR gap	.197	.005	.033	.025	.040	.030
	(.081)**	(.018)	(.015)**	(.014)*	(.012)***	(.016)*
Post x Contract	.030	.023	-.093	-.111	-.010	.030
	(.105)	(.037)	(.033)***	(.028)***	(.022)	(.023)
MFA	-.043	-.080	.001	-.014	.008	-.003
	(.030)	(.025)***	(.008)	(.007)*	(.007)	(.007)
Tariff	.425	-.042	.001	.094	.104	.106
	(.565)	(.099)	(.092)	(.091)	(.056)*	(.066)
License	-.086	.056	-.117	.027	-.084	-.059
	(.245)	(.043)	(.053)**	(.039)	(.031)***	(.030)**
NTR rate	.378	.011	-.057	-.0002	-.001	.004
	(.114)***	(.030)	(.022)***	(.018)	(.016)	(.019)
Obs.	5158	14722	15688	15375	29782	26339

Notes: 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. Asterisks indicate significance at the ten, five, and one percent level.

Table A8: Employment, Full Results

	Primary (1)	Agri. (2)	Secondary (3)	Tertiary (4)	Total emp. (5)	Total pop. (6)
Post x NTR gap	-.072	-.069	.257	.096	.0004	.013
	(.050)	(.027)**	(.102)**	(.116)	(.012)	(.006)**
Post x Contract	.060	-.098	-.119	-.073	-.034	-.044
	(.063)	(.039)**	(.102)	(.099)	(.013)**	(.011)***
MFA	-.043	.044	.020	.004	.022	.014
	(.016)***	(.025)*	(.029)	(.027)	(.006)***	(.009)
Tariff	-.080	.034	.005	.261	-.003	.021
	(.174)	(.059)	(.267)	(.194)	(.034)	(.021)
License	.022	-.052	.144	.147	-.048	-.037
	(.058)	(.040)	(.109)	(.114)	(.013)***	(.013)***
NTR rate	.022	-.040	-.052	.055	.002	-.028
	(.032)	(.032)	(.070)	(.047)	(.010)	(.016)*
Obs.	4577	21532	5660	5802	19972	28867

Notes: 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. Asterisks indicate significance at the ten, five, and one percent level.

Table A9: Agricultural Investment, Full Results

	Sown area (1)	Agri. machine (2)	Grain (3)	Cash (4)	Grain yield (5)
Post x NTR gap	-.037	-.085	-.126	-.053	-.042
	(.020)*	(.024)***	(.038)***	(.025)**	(.022)*
Post x Contract	-.025	-.005	.055	.027	.022
	(.034)	(.027)	(.032)*	(.034)	(.040)
MFA	.005	-.068	-.066	-.011	-.014
	(.017)	(.014)***	(.021)***	(.013)	(.016)
Tariff	-.083	-.158	-.198	.020	.159
	(.090)	(.078)**	(.102)*	(.086)	(.139)
License	.056	.028	.043	-.042	-.085
	(.034)*	(.038)	(.036)	(.039)	(.046)*
NTR rate	-.045	.003	-.028	-.044	-.061
	(.037)	(.021)	(.038)	(.024)*	(.082)
Obs.	8322	28149	28161	26818	7168

Notes: 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. Asterisks indicate significance at the ten, five, and one percent level.

Table A10: Additional Results on Agricultural Employment and Output

	Agri. emp. (1)	Sown area (2)	Grain (3)	Cash (4)	Primary GDP (5)
Panel A: Persistent effects over time					
Post x NTR gap	-.063	-.036	-.121	-.028	.008
	(.026)**	(.022)*	(.040)***	(.023)	(.018)
Post-2008 x NTR gap	-.068	-.035	-.029	-.068	-.042
	(.015)***	(.014)**	(.040)	(.018)***	(.016)**
Obs.	21532	8322	28161	26818	14722
Panel B: Local agglomeration effects					
Post x NTR gap	-.028	.009	-.059	-.047	.012
	(.025)	(.012)	(.022)***	(.016)***	(.022)
Post x NTR gap (prefecture)	-.062	-.059	-.0002	.005	.007
	(.018)***	(.030)**	(.018)	(.018)	(.018)
County x pref. int.	.008	-.035	-.041	-.002	-.011
	(.006)	(.019)*	(.018)**	(.011)	(.005)**
Obs.	21663	8481	28406	26887	15098

Notes: In Panel A, the primary independent variable is the interaction of a dummy variable equal to one for the post–2001 period and the county-level gap between NTR tariffs and the non-NTR rates, standardized to have mean zero and standard deviation one; the second independent variable is an interaction of a dummy variable for the post–2008 period and the same county-level gap. In Panel B, the independent variables include the county-level shock, the average shock within the prefecture, and the interaction of the two. The specifications also include the same control variables and standard errors as the primary specifications reported in Tables A7 through A9. Asterisks indicate significance at the ten, five, and one percent level.

Table A11: Robustness Checks - Employment

	Primary (1)	Agri. (2)	Secondary (3)	Tertiary (4)	Total emp. (5)	Total pop. (6)
Panel A: NTR gaps estimated using 2000 employment weights						
Post x NTR gap	-.045	-.078	.159	-.065	.022	-.0004
	(.051)	(.028)***	(.064)**	(.057)	(.007)***	(.005)
Obs.	3199	21520	4489	4625	19972	28820
Panel B: NTR gaps estimated assigning non-tradables zero weights						
Post x NTR gap	-.020	-.030	.122	.040	.008	.003
	(.046)	(.014)**	(.054)**	(.044)	(.007)	(.005)
Obs.	3214	21532	4523	4659	19972	28867
Panel C: Main specification controlling for pre-trends in employment						
Post x NTR gap	-.046	-.094	.328	.221	.004	.017
	(.073)	(.030)***	(.133)**	(.123)*	(.012)	(.008)**
Obs.	3194	21532	4507	4643	19972	28855

Notes: The base specification and the dependent variables are identical to those described in Tables A7 through A9. 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 non-tradable sector a zero weight. In Panel C, the long-difference in primary and non-primary employment between 1990 and 2000 interacted with a post dummy is included. Asterisks indicate significance at the ten, five, and one percent level.

Table A12: Robustness Checks - Agriculture

	Sown area	Agri. machine	Grain	Cash	Grain yield
	(1)	(2)	(3)	(4)	(5)
Panel A: NTR gaps estimated using 2000 employment weights					
Post x NTR gap	-.034	-.089	-.131	-.053	-.046
	(.019)*	(.021)***	(.028)***	(.016)***	(.021)**
Obs.	8291	28123	28122	26818	7140
Panel B: NTR gaps estimated assigning non-tradables zero weights					
Post x NTR gap	.015	-.115	-.116	-.033	.007
	(.016)	(.012)***	(.031)***	(.015)**	(.017)
Obs.	8322	28149	28161	26818	7168
Panel C: Main specification controlling for pre-trends in employment					
Post x NTR gap	-.011	-.078	-.125	-.053	-.040
	(.024)	(.026)***	(.051)**	(.026)**	(.028)
Obs.	8322	28149	28141	26818	7144

Notes: The base specification and the dependent variables are identical to those described in Tables A7 through A9. 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 non-tradable sector a zero weight. In Panel C, the long-difference in primary and non-primary employment between 1990 and 2000 interacted with a post dummy is included. Asterisks indicate significance at the ten, five, and one percent level.

Table A13: Evidence around timing

	GDP							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
NTR gap x 97-98	-.025	-.018	-.056	-.015	-.110	-.017	.004	-.030
	(.024)	(.017)	(.159)	(.020)	(.173)	(.020)	(.019)	(.029)
NTR gap x 99-01	-.003	-.004	-.046	.012	-.135	.019	.023	.003
	(.019)	(.014)	(.178)	(.017)	(.183)	(.017)	(.018)	(.022)
NTR gap x 02-03	.027	.031	.065	.049	-.054	.055	.005	.050
	(.022)	(.016)*	(.176)	(.018)***	(.185)	(.018)***	(.023)	(.023)**
NTR gap x 04-05	.050	.034	-.060	.048	-.137	.056	-.006	.055
	(.024)**	(.017)**	(.171)	(.020)**	(.178)	(.020)***	(.024)	(.024)**
NTR gap x 06-07	.061	.041	-.212	.054	-.200	.062	-.020	.068
	(.024)**	(.019)**	(.173)	(.022)**	(.184)	(.022)***	(.027)	(.025)***
NTR gap x 08-09	.043	.028	-.208	.039	-.192	.048	-.019	.052
	(.023)*	(.018)	(.176)	(.021)*	(.192)	(.021)**	(.026)	(.025)**
NTR gap x 10-11	.053	.034	-.193	.043	-.154	.053	-.026	.063
	(.024)**	(.020)*	(.185)	(.023)*	(.215)	(.023)**	(.024)	(.026)**
NTR gap x 12-13	.043	.017	-.279	.029	-.167	.038	-.047	.052
	(.026)*	(.020)	(.202)	(.024)	(.234)	(.024)	(.025)*	(.028)*
Sample	Full		Low cap. int.	High cap. int.	Low U.S. share	High U.S. share	Low port prox.	High port prox.
Additional controls	Yes	No	No	No	No	No	No	No
Obs.	29782	30390	15892	14498	15902	14488	15200	15002

Notes: The primary independent variable is the interaction of the county-level NTR gap, standardized to have mean zero and standard deviation one, and a series of dummy variables capturing two-year intervals. The dependent variable is the log of county-level GDP. Standard errors are estimated employing clustering at the county level, and the regressions are weighted with respect to baseline employment.

In Column (1), the specification also includes the same control variables reported in the specifications in Tables A7 through A9. The specifications reported in Columns (2) through (6) include only county and province-year fixed effects, and province-year fixed effects interacted with an urban dummy. Column (3) reports the results for counties below the median of baseline capital intensity in non-state owned enterprises; Column (4) reports the results for counties above median baseline capital intensity for non-SOEs. Column (5) reports the results for counties below the median of baseline U.S. share of total exports; Column (6) reports the results for counties above median U.S. export share. Column (7) reports the results for counties characterized by low port proximity, or above the median of average distance to the five largest ports; Column (8) reports the results for counties characterized by high port proximity, or below the median of average distance. Asterisks indicate significance at the ten, five, and one percent level.

Table A14: Additional Tests of Bias Due to Pre-trends

	Exports (1)	Primary (2)	Secondary (3)	Tertiary (4)	GDP (5)	Per capita (6)
Panel A: Differential trends by NTR gap quartile						
Post x NTR gap	.154	.004	.037	.029	.044	.028
	(.083)*	(.018)	(.015)**	(.014)**	(.012)***	(.016)*
Obs.	5158	14722	15688	15375	29782	26333
Panel B: Differencing out pre-trends in GDP						
Post x NTR gap	.178	-.034	.043	.018	.039	.056
	(.084)**	(.016)**	(.021)**	(.021)	(.016)**	(.016)***
Obs.	4978	13120	13607	13410	27257	25118

Notes: The base specification and the dependent variables are identical to those described in Tables A7 through A9. In Panel A, we characterize counties with respect to the quartile of the NTR gap and add additional time trends with respect to each quartile. In Panel B, we manually 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. Asterisks indicate significance at the ten, five and one percent level.

Table A15: Additional Province-level Data

	Exports	Foreign capital used	Foreign loans	Direct FDI
	(1)	(2)	(3)	(4)
Post x NTR gap	.211	.322	.517	.617
	(.111)*	(.085)***	(.266)*	(.117)***
Obs.	384	278	217	382

Notes: The primary independent variable is the interaction of a post-2001 dummy and the standardized province NTR gap. The specification also includes a number of control variables, all calculated as the mean across counties within the province: an interaction of the post-reform indicator variable and a time-invariant dummy capturing whether the county is characterized by high contract intensity industries, the industry-weighted MFA quota fill rate for county-produced goods, the industry-weighted national tariff rate for imports of county-produced goods, the industry-weighted percentage of firms licensed to export, and the industry-weighted time-varying NTR rate. Province and year fixed effects are included. Standard errors are estimated employing clustering at the province level.

The dependent variables include exports, foreign capital used, foreign loans, and direct FDI at the province level, are reported as the log of constant-price million yuan. Asterisks indicate significance at the ten, five, and one percent level.

TABLE A16: ALTERNATE SPECIFICATIONS

	Exports (1)	Primary (2)	Secondary (3)	Tertiary (4)	GDP (5)	Per capita (6)
Panel A: Main specification controlling for non-primary employment						
Post x NTR gap	.209	.006	.026	.023	.032	.010
	(.085)**	(.020)	(.015)*	(.014)	(.012)***	(.015)
Obs.	5158	14722	15688	15375	29782	26347
Panel B: Main specification controlling for high gap employment						
Post x NTR gap	.212	.010	.032	.024	.041	.020
	(.081)***	(.020)	(.015)**	(.014)*	(.012)***	(.015)
Obs.	5158	14722	15688	15375	29782	26347
Panel C: Baseline specification without controls						
Post x NTR gap	.114	-.049	.029	.017	.053	.031
	(.051)**	(.025)**	(.014)**	(.011)	(.012)***	(.015)***
Obs.	5187	15261	16248	15934	30401	26606
Panel D: Population-weighted standard errors						
Post x NTR gap	.181	-.002	.036	.027	.042	.036
	(.082)**	(.018)	(.015)**	(.015)*	(.013)***	(.016)**
Obs.	5155	14716	15682	15369	29767	26332
Panel E: NTR Gap Winsorized at 1/99 percentile						
Post x NTR gap	.179	.021	.028	.022	.038	.036
	(.080)**	(.024)	(.015)*	(.015)	(.013)***	(.015)**
Obs.	5158	14722	15688	15375	29782	26347

Notes: The base specification and dependent variables are identical to those described in Table A7. In Panel A, the specification includes interactions between dummies for quartiles of initial secondary and tertiary employment and year fixed effects. In Panel B, the specification includes interactions between dummies for quartiles of employment in five high NTR gap industries and year fixed effects. In Panel C, the specification includes only county and province year fixed effects. In Panel D, the regressions are weighted with respect to the 1990 county population. In Panel E, the NTR gap is winsorized at the 1st and 99th percentiles. Asterisks indicate significance at the ten, five, and one percent level.

Table A17: Alternate Specifications

	Exports (1)	Primary (2)	Secondary (3)	Tertiary (4)	GDP (5)	Per capita (6)
Panel A: Baseline GDP quartile - year fixed effects						
Post x NTR gap	.180	.004	.034	.023	.043	.039
	(.082)**	(.018)	(.015)**	(.014)	(.012)***	(.017)**
Obs.	5158	14722	15688	15375	29782	26347
Panel B: Baseline education quartile - year fixed effects						
Post x NTR gap	.217	.0009	.031	.029	.045	.035
	(.081)***	(.018)	(.015)**	(.014)**	(.012)***	(.016)**
Obs.	5158	14722	15688	15375	29782	26347
Panel C: Baseline Herfindahl - year fixed effects						
Post x NTR gap	.201	.006	.029	.023	.038	.022
	(.081)**	(.020)	(.015)*	(.014)*	(.012)***	(.016)
Obs.	5158	14722	15688	15375	29782	26347
Panel D: Heterogeneity with respect to import competition						
Post x NTR gap	.163	.016	.029	.010	.033	.042
	(.086)*	(.020)	(.015)*	(.013)	(.013)***	(.017)**
Import comp. int.	.031	.020	-.020	-.038	-.014	.028
	(.089)	(.013)	(.017)	(.012)***	(.015)	(.018)
Obs.	5158	14722	15688	15375	29782	26358

Notes: The base specification and the dependent variables are identical to those described in Tables A7 through A9. In Panel A, a full set of interactions between year fixed effects and dummy variables for each quartile of initial GDP are added. In Panel B, a full set of interactions between year fixed effects and dummy variables for each quartiles of initial post-primary education are added. In Panel C, a full set of interactions between year fixed effects and dummy variables for each quartile of the initial Herfindahl index are added. In Panel D, the post-NTR interaction is interacted with a dummy equal to one for districts who are above the median of soybeans and cotton as a fraction of total sown area, and we also include interactions between quartiles of this fraction and year fixed effects.

Table A18: Exchange rate shocks

	Exports (1)	Primary (2)	Secondary (3)	Tertiary (4)	GDP (5)	Per capita (6)
Panel A: Heterogeneous effects of exchange rate shocks post-accession						
High U.S. exports x Rmb/$	7.230	.504	1.279	.613	.593	.857
	(6.980)	(.369)	(.730)*	(.611)	(.484)	(.560)
High U.S. exports x Rmb/$ x Post	-7.215	-.502	-1.273	-.596	-.602	-.874
	(6.998)	(.369)	(.732)*	(.613)	(.485)	(.561)
Obs.	5158	14722	15688	15375	29782	26365
Panel B: Effects of exchange rate shocks						
High U.S. exports x Rmb/$	-.016	.004	.002	.022	-.009	-.024
	(.100)	(.011)	(.018)	(.013)*	(.008)	(.009)***
Obs.	5158	14722	15688	15375	29782	26365

Notes: The base specification and the dependent variables are identical to those described in Tables A7 through A9. The primary independent variable is the interaction of a dummy variable equal to one for counties above the median of baseline U.S. export share of total exports and the annual average exchange rate in remminbi per dollar. In Panel A, this double interaction is additionally interacted with a dummy variable for the post-2001 period. Asterisks indicate significance at the ten, five, and one percent level.

Table A19: Evaluating Misreporting in County-level GDP

	GDP gap		
	(1)	(2)	(3)
NTR gap	.137 (.525)		
Post x NTR gap		.445 (.300)	-.589 (1.075)
Control variables	None	None	Full
Fixed effects		Province + year	Province + year
Obs.	260	260	260

Notes: The independent variables are the NTR gap at the province-year level standardized to have mean zero and standard deviation one, and the NTR gap interacted with a dummy variable equal to one for the post–2001 period. The dependent variable is the GDP gap at the province-year level, estimated as the percentage gap between the sum of county-level GDP (calculated using a balanced panel of counties, and adjusted for the percentage of counties that are missing from the balanced panel), and province-level GDP as reported by the National Bureau of Statistics. Fixed effects and control variables are as reported in the table. Full controls include the province-level mean of the following control variables: an interaction of the post-reform indicator variable and a time-invariant dummy capturing whether the county is characterized by high contract intensity industries, the industry-weighted MFA quota fill rate for county-produced goods, the industry-weighted national tariff rate for imports of county-produced good, the industry-weighted percentage of firms licensed to export, and the industry-weighted time-varying NTR rate. Standard errors are clustered at the province level. Asterisks indicate significance at the ten, five, and one percent level.