TRADE INDUCED TECHNOLOGICAL CHANGE: DID CHINESE COMPETITION INCREASE INNOVATION IN EUROPE?

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Trade Induced Technological Change: Did Chinese Competition Increase Innovation in Europe?[†]

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Abstract

Bloom, Draca, and Van Reenen (2016) find that Chinese competition induced a rise in patenting, IT adoption, and TFP by 30% of the total increase in Europe in the early 2000s. We find that the average patents per firm fell by 94% for the most China-competing firms in their sample, but also by 94% for non-competing firms (starting from an initially higher level), and that various intuitive controls, such as controls for sectoral trends, renders the impact on patents-per-firm insignificant. We also find that while TFP appears to be positively correlated with the rise in Chinese competition, IV estimates are inconclusive, and other measures of productivity, such as value-added per worker and profits, are not correlated. Various instrumental and proxy variable approaches also do not support a positive impact of the rise of China on European patents.

JEL Classification: F14, F13, L25, L60

Keywords: Patents, China, Europe, Textiles, Trade Shocks, Manufacturing

†. Special thanks are in order to Nicholas Bloom, Mirko Draca, and John Van Reenen for their path-breaking study, for providing their data on their webpages, and for responding quickly to questions about their data. We also thank participants at the CES Ifo Institute Mountain Retreat in Austria in 2018 for their comments, and to Marta Troya Martinez for her helpful comments.

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1 Introduction

In recent years, growth in many developed economies has slowed, leading to a major debate among economists over the causes of this "Secular Stagnation". Some economists, notably Ben Bernanke, have pointed to international factors, including the savings glut and the rise of China, as being proximate factors in the initial growth slowdown which began around the year 2000 for the US.[1] A similar timing of the slowdown can also be observed in Europe, where recent growth ranges significantly below its log-run trend.[2] Both the EU and the US experienced large, comparable rates of expansion in their imports from China.[3]

Surprisingly, in a recent paper, Bloom et al. (2016, hereafter BDV) suggest that Chinese import competition in Europe stimulated growth in patenting, IT, and TFP at the firm and industry level. Their study attributes up to 30% of growth in these performance measures from the mid-1990s to the mid-2000s to China's economic expansion. This is a remarkable finding, as it appears to contradict the conjectures mentioned above, and implies that the economic slowdown in Europe would have been even more severe had China not expanded into these markets. It also contradicts the empirical findings of a similar study in the US, where patenting activity was found to decrease as a consequence of increased Chinese competition (Autor et al., forthcoming, hereafter ADH). Despite both studies being frequently cited, to the best of our knowledge, the discrepancy between these results have not yet been submitted to further scrutiny.

Intuitively, opposite signs in the estimated effects of competition intensity on patenting could suggest the existence of strong non-linearties, but could also indicate inconsistencies in the empirical approach between the two studies. The latter would have the uncomfortable implication that results are sensitive to different specifications, and one needs to decide which one is to be preferred. Non-linearities, however, are also possible as illustrated in a formal model by Aghion et al. (2005), where moderate levels of competition encourage innovation while high levels of competition (after passing a certain threshold) discourage innovation. Yet, levels of Chinese market penetration do

1. Bernanke first raised this idea in a speech as Fed Chair in 2005, and then followed up with a series of blog posts in a debate with Larry Summers.

2. Figure A1 shows growth in real GDP per capita for five large European countries, relative to their 1973-2000 trend growth rates. They currently stand roughly 20% below this trend. Although the precise timing of the slowdown is not certain, the 2000s were a period of slow growth for France, Germany, and Italy, and were merely average for the UK and Spain, despite the international housing bubble.

3. Figure A2 shows Chinese imports as a fraction GDP in the US and Europe. While the US appear to face higher average penetration during the 1990 and early 2000s, expansion rates are similar in that period.

not appear to be so different between Europe and the US. They ranged, respectively, from 0.5 to 0.8 percent in 1996 and from 1.75 to 2.0 percent in 2007 (which is the main period studied in these papers). The US faced slightly higher Chinese competition, on average, but this difference became smaller over time: it increased by a factor of 3.5 in the EU, while the corresponding number in the US was only 2.5. This suggests that firms in Europe should at least be equally discouraged from patenting as firms in the US.[4]

Instead of speculating about potential differences between the two economies, we focus on testing whether the findings of BDV on the impact of Chinese expansion in Europe are robust. We use the same data set as BDV and only modify their specifications slightly by including, for instance, pre-treatment trends, the lagged level of patenting activity, or using a different measure of Chinese competition (*i.e.*, domestic market penetration rather than the Chinese share of imports). We follow a consistent procedure to, first, test the robustness of the positive correlation between Chinese exposure and growth in patents and productivity (*i.e.*, TFP). Second, we use the Autor et al. (2013) approach to instrument for the increase in Chinese import competition. Third, as BDV do, we use the relaxation of textile quotas after 2001 as an IV (and as a proxy) for firms in textile sectors which subsequently saw greater increases in Chinese competition.

Our essential findings are displayed in Figure 1, where we present a standard difference-in-difference event study diagram. We compare the evolution of patents in textile sectors in which the quotas on Chinese imports were most binding before removal, and compare to sectors in which the quotas did not bind. The first thing that stands out is that, in the BDV data, the overall level of patents per firm was falling sharply in both groups for the full period. There is a 95.8% decline in patenting for the China-competing group, vs. a 96.2% decline for the non-competing ("No quota") group. By 2005, average patents per firm is close to zero in both groups (.04 in the China-competing sectors vs. .11 in the others). However, in the "No quota" group, the initial level of patents – close to three per firm per year – was much larger than in the quota group. Since patents are falling rapidly in both groups but bounded by zero[5], the fall in patents in the non-quota group is more precipitous, but one can easily see that much of this decline happens before quotas are removed. We find that controlling for simple time trends in a panel

4. It could also be that different labor market institutions in the EU and the US result in different levels and increases of effective competition from China (Hennings, 2018). Again, however, the EU would have faced relatively stiffer competition as labor markets are typically less regulated in the US.

5. BDV actually use the log of patents plus one, which is also bounded by zero and exacerbates the problem. If both China-competing and other sectors both decline by 96%, but the level of patents in "other" sectors begins at a higher value, then adding one and taking the logs will make the "other" sectors appear to contract at a much faster pace (72% vs. 48%).

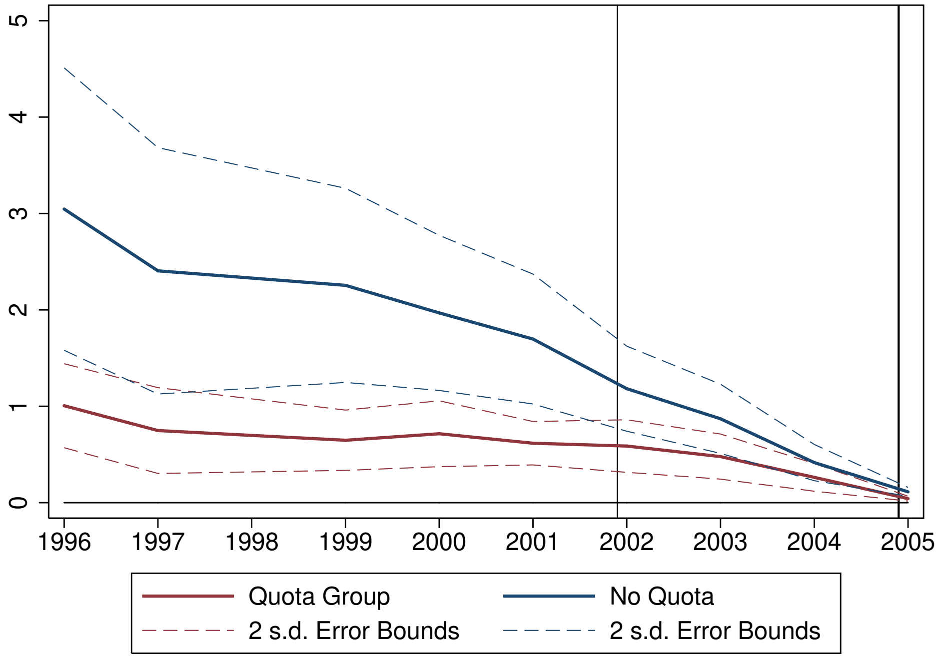


Figure 1: Avg. Patents by Firm, Textile Sector: Sectors with Quota vs. Others

Notes: The red solid line shows the average patents over time in China-competing Textile sectors (firms in sectors which faced textile quotas before they were relaxed and removed), with two standard deviation error bounds (the red dashed lines; computed by regressing patents per firm on a constant for each year). The blue lines show the evolution of average patents for Textile firms in the "No quota" group. The first black vertical line denotes China's accession to the WTO, and the second one shows when the final quotas were removed.

regression setting with continuous measures of exposure to textiles removes the correlation found by Bloom et al. (2016), as does controlling for the lagged level of patents, or switching to Chinese import penetration (in a specification with sectoral FEs), arguably more theoretically appropriate. The overall declining share of patents in the BDV data also raises questions about data selection issues, as patents granted in the BDV data in the later years were a smaller share of the total patents actually granted in reality. We also find that while the correlation between BDV's TFP measure and exposure to China is robust, the relationship is not necessarily robust to every specification (such as using an Autor-Dorn-Hanson inspired IV). Also, we find that increasing Chinese competition is negatively correlated with sales-per-worker, and is uncorrelated with value-added per worker or profits.

Our findings contribute to the recent literature on the impact of increasing low-wage competition on innovation. Autor et al. (forthcoming) and Hombert and Matray (2018) find a negative impact of increased Chinese competition on patenting in the US and

Kueng et al. (2016) find a negative effect of Chinese competition on process innovations in Canada. Our findings for European countries are similar with Xu and Gong (2017), who find no impact of China on R&D in the US.[6] We also contribute to the literature on the impact of the rise of China on Europe more broadly (Dauth et al. (2014), Mestieri et al. (2017), Mau (2017)), the first of which concludes that the impact of the rise of China on Germany has been less severe than in the US. A third contribution of our paper is that it highlights the importance of replication in applied empirical research, as we show that rather straightforward controls can overturn a well-cited, seminal paper.

In the following sections, we first consider patents, looking at the reduced form-correlation between Chinese competition and patent growth, the Autor/Dorn/Hanson IV and then use the relaxation of textile quotas as an IV and proxy, as BDV do. After that we consider TFP, value-added per worker, and profits, but we reserve IT for the online appendix, as the data begins in 2000 and thus one cannot control for meaningful pre-trends which our various identification strategies require (including the BDV and ADH strategies).

2 Empirical Strategy and Data

2.1 Baseline Empirical Strategy

The first strategy BDV employ is to simply regress five-year changes in the Chinese share of imports on five-year differences in patents, IT, and technology, where the Chinese share of imports is measured at the four-digit SIC level, and patents are recorded at the level of the firm in a highly unbalanced panel.

BDV estimate the following panel regression:

$$\Delta lnY_{ijkt} = \alpha \Delta IMP_{jkt}^{CH} + \Delta f_{kt} + \epsilon_{ijkt}, \tag{2.1}$$

where Δ denotes five-year changes, Y_{ijkt} is an outcome variable (five year log changes in the number of patents plus one, computers per worker, or TFP) from plant i (22,957 in total, although unbalanced) in four-digit industry j (=366), from country k (=12), at time t (varies based on the dependent variable, but t=2001,...,2005 for patents and

6. In a related finding, Pierce and Schott (2018) find that Chinese accession to the WTO reduced investment. One potential reason why the rise of China may have been more severe than in the US is offered by Boehm et al. (2015), who find that US multinationals had an outsized influence in the offshoring of US manufacturing jobs. Multinationals in a country like Germany, where labor unions have seats on the board, may behave differently.

TFP). The key variable of interest is ΔIMP^{CH}_{jkt}, the change in China's share of imports, computed at the four-digit SIC level by country. The regression includes country*year interactive fixed effects (f_{kt}) to control for country-specific year shocks. Additionally, the authors cluster at the four-digit level, while showing robustness to three-digit industry trends.

We add in the following robustness checks. First, given the strong correlation with initial patent level and subsequent decline (as can be seen in Figures 1 and A5), we add a control for the lagged level of patents. This is important, as Figure 1 seems to imply that patents in all sectors are merely collapsing toward zero. Given this extreme form of mean reversion, and given the functional form BDV use for patents (log of patents plus one), we believe controlling for the lagged level of patents is a necessary control. Secondly, economic theory and intuition suggest that chinese penetration should matter more than the share of imports from China. If, for example, a sector trades very little (say .1% of production), and half of its imports come from China, then it should not be affected by a 100% increase in the share of Chinese imports (from .1 to .2% of production) as much as a sector where imports are equal to domestic production, and imports from China increase by 10% of domestic production, but by just 20% of total imports. Thus, the first robustness check we try is to use the BDV specification, only controlling for Chinese penetration instead of the share of Chinese imports, and including three-digit SIC FEs as dummies. (Indeed, BDV also scale Chinese imports by domestic production as a robustness check, but do not include industry FEs in that specification.) Third, while BDV control for three-digit trends, we allow these three-digit industry trends to vary by country. A motivation is, once again, that our treatment-control diagram in Figure 1, not plotted in BDV, suggests that trends which existed prior to treatment are driving their results.

2.2 The Autor, Dorn, Hanson IV

Next, we use an Autor, Dorn, Hanson (2013) (hereafter ADH) type of IV, instrumenting for five-year changes in Chinese import penetration using average five-year changes in Chinese import penetration for other European countries in our sample.[7]

Alternatively, we use the ADH specification more exactly, using the change in imports

7. I.e., we follow both BDV and ADH in defining Chinese import penetration for country k (and industry j at time t) as: $ChineseImportPenetration_{jkt} = IMP^{China}_{jkt}/(Sales_{jkt} + IMP_{jkt} - EXP_{jkt})$ The instrument for country k is then the average import penetration for the other countries ($\neq k$) in the sample.

in the other countries in our sample divided by initial domestic consumption.

$$I.e., \Delta ChinaPen^{IV}_{jkt,t-5} = \sum_{c=1,\ldots,11,c\neq k}^{C} \frac{\Delta ChineseImports_{jct,t-5}}{D_{jk,t-5}} \tag{2.2}$$

Where initial domestic consumption (at date t-5) for country k is given by: $D_{jk,t-5} = Prod_{jk,t-5} + IMP_{jk,t-5} - EXP_{jk,t-5}$ – production plus total imports minus total exports.

2.3 Alternative Strategy: Using Textile Quotas as an IV/Proxy

Recognizing that the relaxation of textile quotas had a large impact on the textile sector, BDV also employ an IV around this variable, instrumenting for future increases in Chinese imports based on how tightly the quotas bound pre-removal. The first stage can thus be written:

$$\Delta IMP^{CH} = \phi \Delta QUOTA_{jk,2000} + \Delta f^{Q}_{kt} + \Delta \epsilon^{Q}_{ijkt}, \tag{2.3}$$

where IMP^{CH} are five-year changes in imports from China, $\Delta QUOTA_{jk,2000}$ are the quota fill rate in the year 2000 (the value-weighted proportion of HS6 products in the four-digit industry that were covered by a quota restriction on China in 2000 that were planned to be removed by 2005, via BDV), and Δf^{Q}_{kt} are country-year FEs.[8]

The reduced form is thus:

$$\Delta PATENTS_{ijkt} = \pi QUOTA_{jk,2000} + \Delta \zeta^{Q}_{kt} + \Delta e^{Q}_{ijkt}. \tag{2.4}$$

where we expect that more tightly-binding quotas will induce innovation and result in faster patent growth. However, in this specification (BDV Table 2), the authors use data in 5-year changes just for two years, 2004 and 2005, and thus this is not a proper difference-in-difference, as one cannot control for trends. Additionally, BDV use the quotas not just as an IV, but as a proxy variable (in their Table 3). They thus interact the variable quota with a dummy for post-2000 ($QUOTA_{jk,2000} * I(year > 2000)$), and interacted with a variable for the number of years after 2000 ($QUOTA_{jk,2000} *$ # years after 2000). In this specification, BDV use a longer panel and include firm-specific fixed effects. One can note that the timing of these variables is a bit strange given that China entered the WTO in December of 2001, with the next large phase-out of textile quotas

8. BDV actually include a negative sign in front of the ϕ, and claim that they expect a positive sign for ϕ. However, this is not what they find (see BDV Table 2, Col. 2). *I.e.*, they find that more stringent quotas are associated with higher future imports.

starting in 2002 (we show robustness to our results when using 2002 instead). While it might have been anticipated, it's also true that changes in trade policy tend to operate with a lag.

2.4 Data

We use the same data sources as BDV. They should be commended for providing their data free of charge on their website, which allow us to replicate most of their results exactly. The only exception is that we also asked the authors if they would provide the data (and code) used to compute their TFP variable, but as of the time of writing, we do not yet have access (understandable, in our view, as it has been some time since they created this data). Their TFP measure was created using a version of the Olley and Pakes (1996) method with data for just four of the countries France, Italy, Spain, and Sweden. The firm-level variables for 12 European countries mostly come from Bureau Van Dijk's Amadeus, and are then matched to UN Comtrade trade data at the 4-digit level using Pierce and Schott (2012)'s trade data concordance.[9] Other sector-level variables come from Eurostat's Prodcom database. In Figure A3, we provide some data on the number of firms over time in our highly unbalanced sample, and on the shrinking number of total recorded patents in our data. Figure A4 plots the share of Chinese imports over time for the non-textile sectors and for the textile sectors, and then disaggregates the latter category based on sectors with at least some binding quotas. Growth in the Chinese share of imports picks up overall after 1999, and, in the textile sector, in the quota sector after 2002.

3 Results: Chinese Competition and Patents

Our results showing the impact of Chinese competition on patents are presented in Table 1. The first column of panel A is an exact replication of BDV Table 2, Panel A, Column 1. In column (2), when we include a lag for the level of patents, the sign on Chinese competition flips. In column (3), when we use five-year changes in Chinese import penetration instead of changes in the share of Chinese imports, and control for three-digit sectoral fixed effects (as do BDV), we do not find a correlation between Chinese competition and patent growth. (In their paper, BDV normalize by domestic production and control for three-digit SIC FEs separately.) In column (4), we include

9. Their data is available here: http://www.stanford.edu/ nbloom/TITC.zip. The countries in the sample are Austria, Denmark, Finland, France, Germany, Ireland, Italy, Norway, Spain, Sweden, Switzerland, and the UK. Our code is available at http://dougcampbell.weebly.com/.

three-digit SIC*country interactive FEs, and once again find an insignificant impact of changes in the Chinese import share. In column (5), we adopt an ADH-like method, instrumenting for changes in Chinese import penetration based on changes in other European countries. This is only a borderline significant predictor of patent growth, but this correlation disappears when we include the lagged level of patents as a control. (In the Online Appendix, we show that the first stage is strong in Table A9, and we show that this conclusion holds up when we include various FEs and versions of the ADH IV in Table A7.)

In Panel B, we replicate and test robustness for BDV Table 2, which uses data only for the textiles sector, and also only uses data ending in two years – 2004 and 2005. Column (1) of Panel B is an exact replication of BDV Table 2, column (1). Note that while BDV label these "within firm results", it does not include within firm, or indeed any sectoral fixed effects. Column (2) adds in a control for the lagged level of patents, which renders the correlation between Chinese import growth and patent increases insignificant. In column (3), we use a longer panel, including an extra three years of data, and include three-digit SIC FEs, which also has the same effect. In Column (4), we replicate the IV regression from BDV Table 2, column (3), where we use the extent to which the quotas bound pre-removal as an IV for subsequent increases in Chinese competition. However, in column (5), when we include the lagged value of the level of patents, the effect is no longer significant. In the last column, we include three-digit SIC FEs, and again extend the sample, and interact the quotas with a post-WTO dummy for China (beginning in 2002), and once again find no significant correlation between the sectors where the textile quotas bound, and subsequent patent growth after the quotas were progressively removed starting in 2002.

One of the main arguments so far is that the BDV finding that Chinese competition led to an increase in patents is not robust to controls for trends (as well as to controls for the inital level of patents). In their Table 3, however, BDV introduce a longer panel data set and in some specifications include firm-level FEs, a much stronger set of fixed effects than the sector-level FEs we have employed. In Panel C, column (1), we thus replicate BDV Table 3, column (2), with firm-specific FEs, where the key variable of interest is now the degree of "toughness" of the quota before China's WTO accession, interacted with a post-2000 dummy.

Table 1: The Impact of Chinese Competition on Patent Growth

	(1)	(2)	(3)	(4)	(5)	(6)
A. BDV Table 1 Robustness						
5-year Δ Chinese Imports	0.32***	-0.029		0.12		
	(0.10)	(0.066)		(0.10)		
L5.ln(Patents+1)		-0.57***				-0.57***
		(0.018)				(0.020)
5-year Δ Chinese Import Pen.			0.025		1.01*	0.51
			(0.098)		(0.54)	(0.37)
Notes	Rep.	+Lag	Rob.	+FEs	ADH IV	ADH IV
Fixed Effects	None	None	SIC3	Cty*SIC3	None	None
Observations	30251	30251	26788	30251	24697	24697
B. BDV Table 2 Rob.: Textiles Only						
5-year Change in Chinese Imports	1.16***	0.055	0.019	1.90*	-0.038	5.36
	(0.38)	(0.14)	(0.24)	(1.02)	(0.36)	(3.74)
L5.ln(Patents+1)		-0.67***			-0.67***	
		(0.035)			(0.035)	
Notes	Rep.	+Lag	+FEs	IV Rep.	IV+Lag	IV+FEs
Fixed Effects	None	None	SIC3	None	None	SIC3
Time Period	1999-2005	1999-2005	1996-2005	1999-2005	1999-2005	1992-2005
Observations	3436	3436	7131	3436	3436	14697
C. BDV Table 3 Rob., Textiles Only						
Quota Removal: I(year>2000)	0.22**	0.096				
	(0.11)	(0.066)				
L5.ln(Patents+1)		-1.12***		-0.38***	-0.38***	
		(0.019)		(0.032)	(0.033)	
Quota Removal*# Years after 2000			0.075**	0.010		
			(0.033)	(0.012)		
5-year Δ Chinese Imports					0.46	-0.18
					(0.58)	(0.37)
Fixed Effects	Firm	Firm	Firm	None	None	Firm
Notes	Rep.,Col.2	Rob.,Col.2	Rep.,Col.4	Rob.,Col.4	IV	Rob., Col.4
Observations	14768	14768	14768	14768	14699	14699

*$p < 0.1$, ** $p < 0.05$, *** $p < 0.01$, with errors clustered at the country*4-digit SIC level in panel A and at the 4-digit SIC level in B and C. The dep. var. for all 18 regressions in this table is the five-year change in log patents (plus one). All regressions include country*year interactive FEs. Additional fixed effects and whether the regression is an IV or not is listed in the notes at the bottom of each panel. Columns (1) of panel A are exact replications of BDV Table 1, Panel A, col. (1). Panel B and C use data for the Textile sectors only, and are robustness checks for BDV Tables 2 and 3, respectively.

When we add in a control for patents lagged five years in column (2), panel C, however, the results are no longer significant. Column (3) is a replication of BDV's Table 3, column (4), which provides an alternative measure of Chinese exposure, counting the years since 2000 and interacting this with the quota measure pre-2000. Thus, this measure is the same as the previous one for 2001, and then doubles in 2002, and triples in 2003, and so on. In column (4), when we include a control for the lagged level of patents, and omit the first FEs, the coefficient on this variable is no longer significant. In column (5), instead of using this as a proxy variable, we use it instead as an IV for growth in Chinese imports. We do not find a significant relationship. Finally, in column (6), we dispense with the proxies and IVs, and simply use actual changes in Chinese imports as the independent variable, and find a negative, insignificant coefficient on five-year differences in Chinese imports. Thus, to the extent that quotas removal did lead to an increase in patents, it did not occur in sectors which actually realized increases in Chinese imports.

3.1 Additional Robustness

Another control we tried, but saved for the online appendix (Table A5) is to sum the number of patents up by sector and country, and run the same regression by country-sector, while controlling for sector-level trends. These regressions, too, are generally not significant, regardless of whether we control for Chinese imports directly, or use the relaxation of quotas as a proxy or IV for the growth in Chinese imports. The pre- and post-treatment trends of patents summed up to the sector level (see Figure A7) are also not suggestive of a positive impact of Chinese competition on patenting.

There are many different potential combinations of controls and FEs to choose from. How special are the, admittedly somewhat arbitrary, choices for FEs and controls chosen by BDV, and also in the controls in Table 1, Panel A? BDV include several other controls in their Table 2, including one where they normalize inputs by domestic production, and include a control for offshoring (a control they did not find significant). Given that there are five different potential choices of FEs (no sectoral FEs, three-digit SIC, four-digit SIC, three-digit SIC*country, or four-digit SIC*Country interactive controls), three variations on the variable of interest (share of Chinese imports, share of Chinese imports, normalized, and Chinese import penetration), and one can run these options with or without a control for outsourcing (which we do, following BDV) and for the lagged level of patents, there are 60 potential variations overall. What we do next is run each of these regressions and then plot the t-scores in descending order in Figure 2, and highlight the choices made by BDV, and the versions highlighted in Table 1, panel A.[10] What can be seen is that the coefficients reported by BDV were relative outliers, and that most of the specifications here are not statistically significant, and two are

10. We report the full results for various combinations in Appendix Table A8.

significant with the opposite sign.

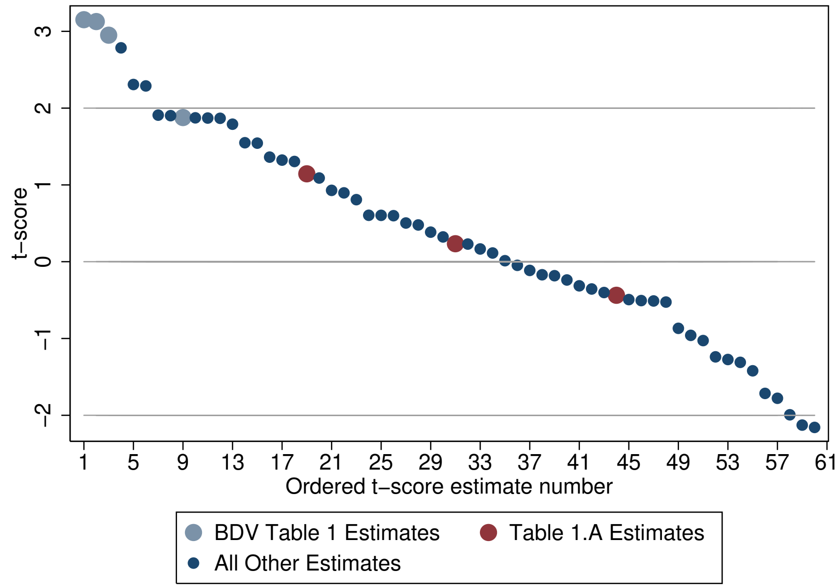


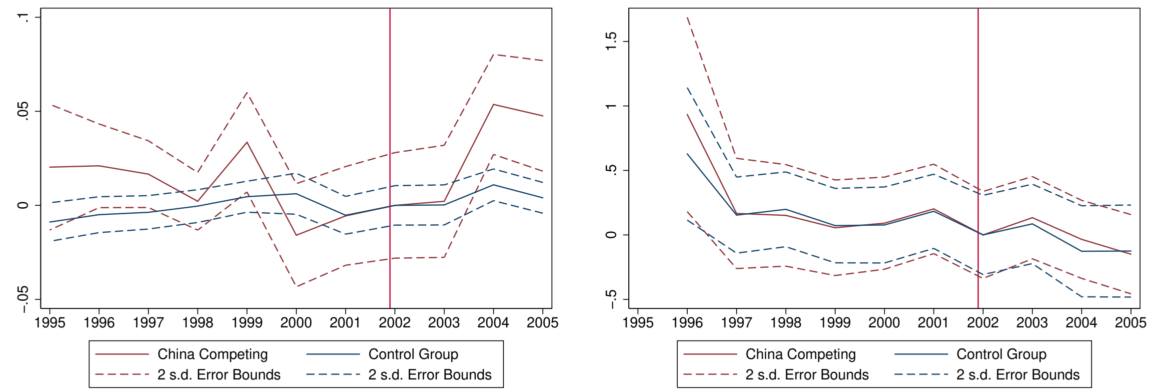
Figure 2: The T-Curve: Estimates of the Impact of Chinese Competion on Patents

Notes: This graph orders the various estimates of Chinese competion on patent growth by (1) varying the FEs (No FEs, 3-digit SIC, 4-digit SIC, 3-digit SIC*country interactive FEs, and 4-digit SIC*country interactive FEs), (2) altering the measure of Chinese competition, and (3) including a separate control for outsourcing (which BDV do as well).

For which combination of controls are the results significant and positive, vs. significant and negative (meaning a negative impact of Chinese import competition on patent growth)? We present a heat map of the t-scores for various FEs and choices of controls in Table A1. When controlling for lagged patents and outsourcing, and using Chinese penetration, one is more likely to get negative and significant coefficients. Including more FEs does not always dampen significance – in several cases results only become significant when one includes interactive country*industry FEs.

4 Results: Chinese Competition and TFP

Lastly, we look at the impact of the rise of China on European productivity. We begin by plotting the evolution of the level of log TFP for the China-competing sectors vs. other sectors, in Figure 3(a). Here, the pre-treatment trends look stable, and TFP clearly rises in the China-competing sectors vs. the others. In panel (b), however, when we look at value-added per worker, it is difficult to see much difference between the China-competing and non-competing sectors after China's WTO accession.



(a) TFP

(b) Value-Added per Worker

Figure 3: Chinese Competition and Productivity, Value-Added per Worker

Notes: These graphs compare the evolution of TFP (left) and Value-Added per worker (right) over time for the China-competing sectors vs. other sectors. Here, the definition of Chinese-Competing is those sectors with an average increase in Chinese import penetration in the top 15% of firms (.05 on the left, and .035 on the right, with the difference owing to different samples. The results are relatively robust to minor changes in the cutoffs). The red vertical lines denote China's accession to the WTO.

Next, we provide regression results for the impact of Chinese competition on TFP, value-added and sales per worker, and profits using regression equation 2.1. First, we benchmark the results in the first row of BDV, Table 1, column (3), and find that an increase in the Chinese share of imports is associated with faster TFP growth at the firm level. In the second column, we use chinese import penetration instead, and include four-digit SIC FEs. This time, the results are robust.

As any TFP measure will depend on various assumptions, and this one was calculated using data for just four of the 12 countries in the sample (France, Italy, Spain, and Sweden), next we try other measures of productivity. The first is a simple measure of labor productivity – value-added per worker, a measure we have for eight countries.[11] In the third column, we find that changes in chinese import penetration do not predict changes in value-added per worker, regardless of whether we include country*four-digit SIC interactive FEs (col. 4), or not (col 3). In the next column, we examine profits, following Autor et al. (forthcoming). We do not find any correlation between five-year changes in Chinese penetration and profits. In the last column, we use sales per worker as the dependent variable, and find a relatively robust negative impact of five-year changes in Chinese import penetration, even when controlling for country*four-digit SIC interactive FEs.

11. These include Austria, Switerland, Germany, Spain, Finland, France, Italy, and Sweden.

Table 2: The Impact of Chinese Competition on Productivity and Profits

	(1) TFP	(2) TFP	(3) VA/L	(4) VA/L	(5) Profits	(6) S/L
A. Raw Correlation						
5-year Δ Chinese Imports	0.26***					
	(0.072)					
5-year Δ Chinese Import Pen.		0.081**	0.43	0.43	-0.37	-2.29***
		(0.039)	(0.50)	(0.50)	(0.61)	(0.55)
Sectoral FEs	None	SIC4	None	Cty*SIC4	Cty*SIC4	Cty*SIC4
Observations	292167	292167	12715	12715	15852	28797
B. IV Regressions						
5-year Δ Chinese Import Pen.	2.85*	0.12	9.89	0.44	-0.17	-0.95
	(1.53)	(0.099)	(8.30)	(18.0)	(1.33)	(1.32)
Sectors	Textiles	All	Textiles	All	All	All
Regression	BDV IV	ADH IV	BDV IV	ADH IV	ADH IV	ADH IV
Sectoral FEs	SIC3	SIC4	SIC4	SIC4	SIC4	SIC4
Observations	55788	284935	3197	12977	15805	29646

*$p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Errors clustered at the country*4-digit SIC level in Panel A and the 4-digit SIC level in panel B (following BDV). All regressions include country*year interactive FEs. The dependent variable in the first two columns (in both panels) is a TFP measure created by BDV (all dependent variables here measured in five-year log changes). In columns (2) and (3), the dependent variable is value-added per worker, profits in column (5), and sales-per-worker in column (6). In Panel B, the same set of dependent variables are used, but deploys IV regressions (first stage shown in the appendix). Columns (1) and (3) use the BDV IV regression using the Quota IV from Table 1.B, using Textile data only, while the other columns use the Autor/Dorn/Hanson IV.

These are puzzling results, seemingly at odds with each other, as TFP and Sales-per-worker are significant with different signs, while value-added and profits are not significant at all. Yet, these are also just correlations, and might not imply causality even if they are suggestive. Thus, we now deploy our IV strategies in Table 2 panel B, focusing on the BDV IV for the textile sector, and the ADH IV for all sectors. In the first column, we use the BDV IV, namely quotas interacted with a post-2000 dummy, and find that this instrument does predict TFP growth, although in this particular instance, it is only significant at a 90% level of confidence. Next, we use the ADH IV, and find that it does not predict gains in TFP, although the first stage is significant (see Table A10). Next, we use value-added per worker as the dependent variable, and find that neither identification strategy, either the BDV version in column (3) or the ADH version in column (4), predict value-added per worker growth. In columns (5) and (6), we find that the ADH IV does not predict changes in profits or sales-per-worker.

Of course, there are various other robustness checks one could run, which we implement in the online appendix (see Tables A10 to A13). The raw correlation between Chinese competition and TFP growth appears robust, as is one of the IV methods, and the pre- and post-treatment trends in Figure 3(a) do look convincing, so we conclude that the balance of the evidence points toward Chinese competition having an impact on the measure of TFP we have. However, given that we did not have access to the data and code used to create the TFP variable, a puzzle remains of why we get such different results for value-added, profits, and sales-per-worker, so we can only conclude that this is a topic for further study.

5 Conclusion

BDV find that Chinese competition may have accounted for some 30% of the growth in patenting, IT, and TFP in Europe in the early 2000s. This is significant in part because the period since 2000 has been one of rising Chinese imports in Europe, and also a period of slow growth in TFP and GDP. Thus, BDV's findings exacerbate the puzzle over slower European growth during this time. Yet, we show that the dramatic decline in patents (in the BDV data) was similar for both China-competing and non-competing sectors. We find that the apparent positive impact of Chinese competion on European patenting disappears once one controls for richer sectoral trends, the lagged level of patents, or switches to Chinese import penetration instead of the Chinese share of imports. Other specifications which use textile quotas as an instrument, or as a proxy variable also appear not to be very robust. Chinese competition does appear to have had a positive impact on BDV's TFP measure. However, we also find that Chinese competition does not predict growth in value-added per worker, or of profits, suggesting that further research is needed. Thus, we believe we have partially solved the puzzle of why the rise of China ostensibly had a negative impact on patents in the US (or, others have found no impact on R&D for the US), but a positive impact in Europe – the latter results appear to be spurious.

We believe that pointing out false-positives is important giving the "replication crisis" – the growing realization that since researchers are under pressure to find statistical signficance, and in general do not face threats from replication since it is so rare, many published studies in the social sciences are not robust.[12] A key problem with the initial

12. See, for example, this article in the Atlantic "Psychology's Replication Crisis Is Running Out of Excuses": https://www.theatlantic.com/science/archive/2018/11/psychologys-replication-crisis-real/576223/. This crisis may not have come to Economics yet merely because replication – which includes robustness – is rare. Evidence for the rarity is that, in an analysis of publications in the Review of Economic Studies over the last few years, we could not find any comment papers. In this paper one

study is that it did not plot any relevant data, including pre-treatment trends. Future work should put more emphasis on visualizing the key results and data.

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A Appendix

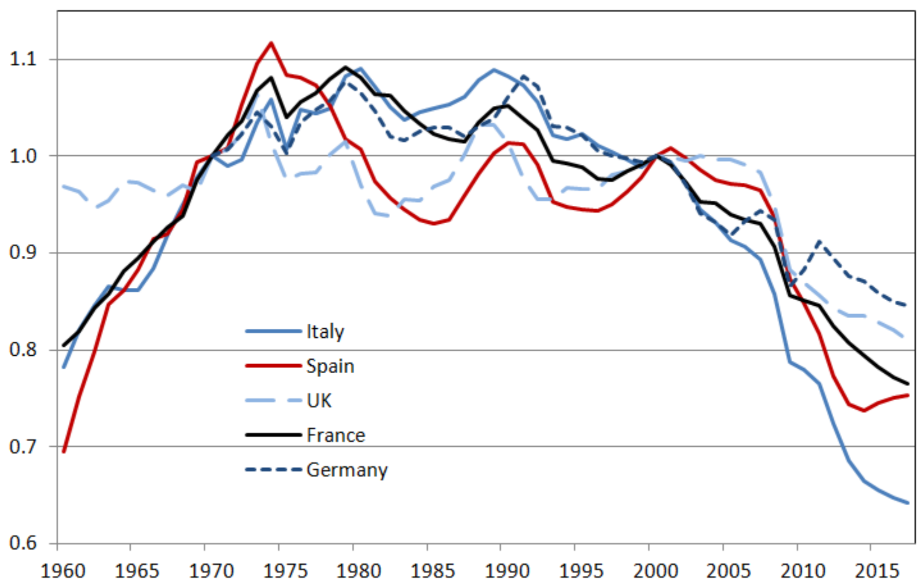


Figure A1: Real GDP Relative to Long-Run Trend

Notes: This graph plots real GDP relative to the long-run (from 1973 to 2000) trend for the five largest economies in the sample. It shows that the 2000s was already a poor decade for growth for Italy, France, and Germany, and was merely average in Spain and the UK despite the existence of the international housing bubble.

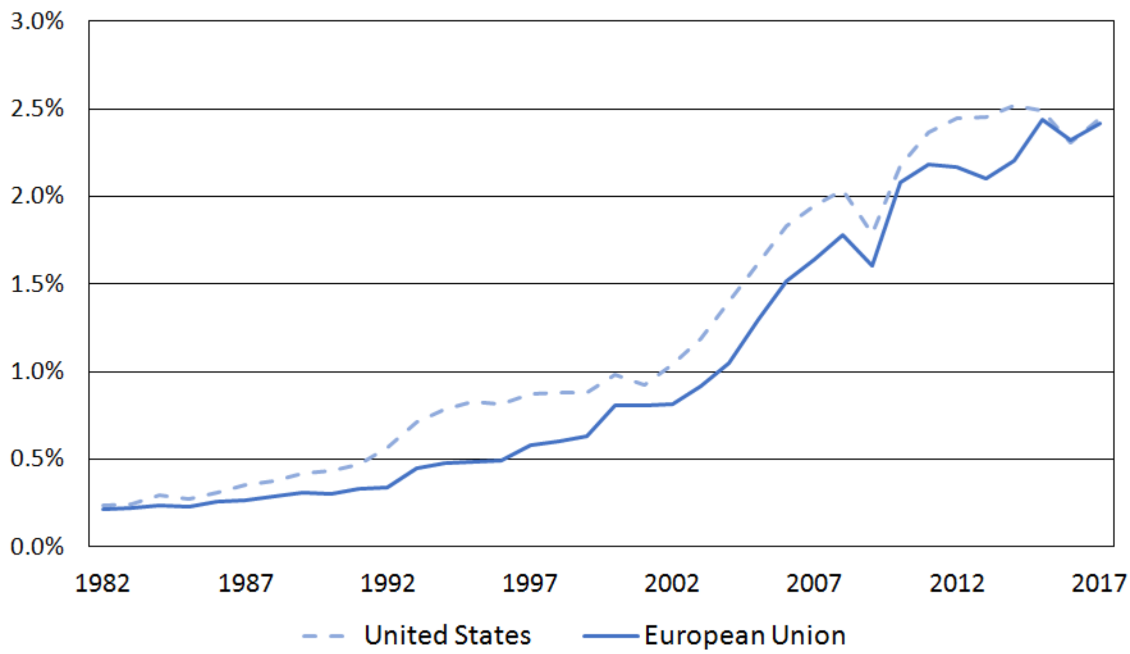
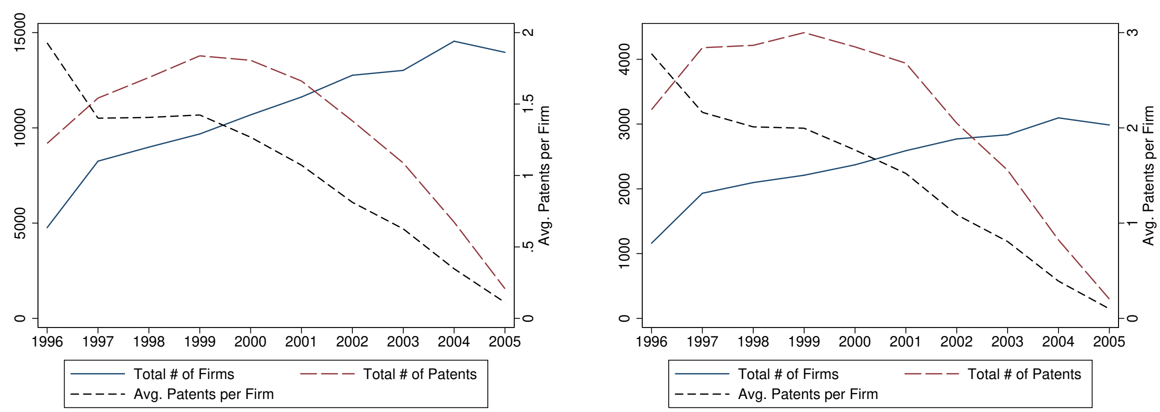


Figure A2: Chinese Imports as a Share of GDP

Notes: This is a graph of total imports from China as a share of GDP in the US vs. Europe. Through 2007, Chinese import intensity was higher in the US, but since then, the gap has closed.

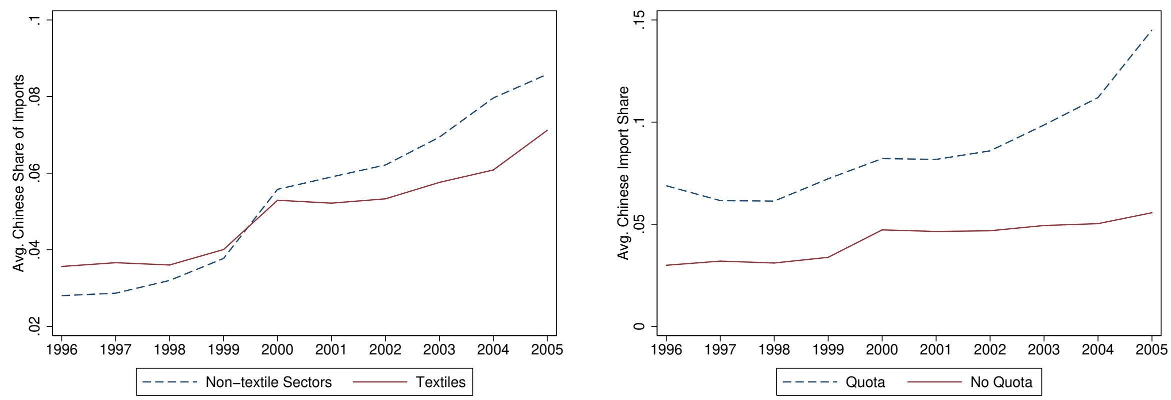


(a) All Sectors

(b) Textiles

Figure A3: Total Firms and Patents, and Avg. Patents

Notes: These graphs display the total number of firms (left axis), the total number of patents (left axis), and the average patents per firm for all sectors in panel (a) and for Textile sectors in panel (b).



(a) All Sectors vs. Textiles

(b) Textile Sector: Quota vs. No Quota

Figure A4: Chinese Imports as a Share of Total Imports

Notes: Panel (a) shows the average Chinese share of imports (averaged across firms in our sample, with data at the four-digit SIC level), for the non-textile sectors (blue dashed line) vs. textile sectors (red). Panel (b) compares firms in sectors with some positive fraction of binding textile quotas vs. those without any quotas.

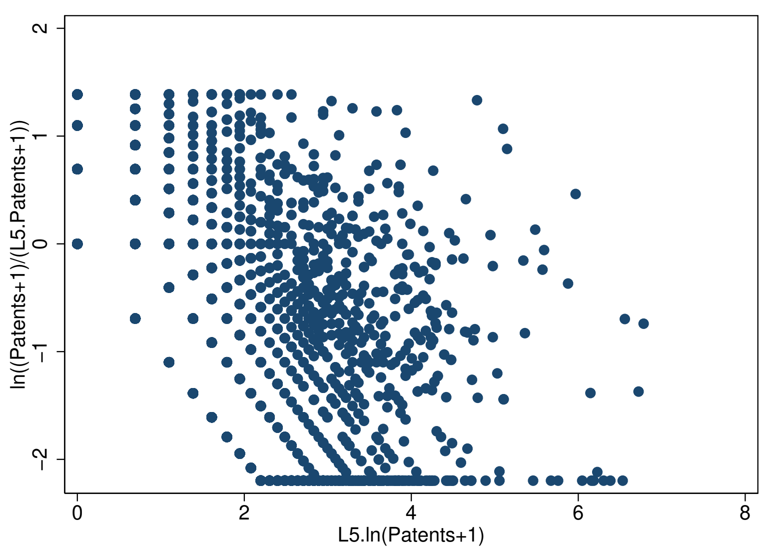


Figure A5: Change in Patents vs. the Lagged Level

Notes: This graph plots the log level of patents (plus one, as you cannot take the log of zero) vs. the log change. An OLS regression yields a coefficient on lagged patents of -.51 with standard errors of (.003), and an R-squared of .41.

Table A1: T-Score Heat Map: Impact of China on Patents

			FEs				
			No FEs	3-digit FEs	4-digit FEs	Country*4-Digit FE	Average
No Lagged Control for Patents	No Control for Outsourcing	Normal Imports	3.15	1.88	1.31	0.60	1.73
		Imports Normalized	2.95	1.92	1.56	0.51	1.74
		Chinese Penetration	1.80	0.26	-0.33	-0.29	0.36
	Control for Outsourcing	Normal Imports	3.13	1.87	1.08	0.59	1.67
		Imports Normalized	2.79	1.88	1.33	0.47	1.62
		Chinese Penetration	1.56	0.19	-0.49	-0.38	0.22
Lagged Control for Patents	No Control for Outsourcing	Normal Imports	-0.44	-0.24	0.38	0.89	0.15
		Imports Normalized	-0.11	0.33	0.12	1.87	0.55
		Chinese Penetration	-1.23	-1.70	-1.76	-0.84	-1.38
	Control for Outsourcing	Normal Imports	-1.28	-0.52	0.23	0.92	-0.16
		Imports Normalized	-1.02	0.02	-0.04	1.89	0.21
		Chinese Penetration	-2.15	-2.11	-1.97	-0.93	-1.79
		Average:	0.76	0.31	0.12	0.44	0.41

Notes: Each cell is the t-score from a regression of log patents (plus one) using the specifications listed on the left-side, and the FEs denoted in each column title. Thus, the first regression in the north-west corner has a t-score of 3.15, it has no FEs (as per the column title), and the regression includes no control for lagged patents, no control for outsourcing, and is run using the baseline dependent variable using Chinese imports as a share of total imports. We thank Andrea Matranga for suggesting the concept of the T-score heat map. The overall average t-score is .41.

B Online Appendix

B.1 Online Appendix: Chinese Competition and Information Technology

BDV also look at the impact of Chinese competition on information technology, which they proxy by looking at computers per worker. For this outcome variable, however, after taking five-year differences, they are left with just 3 years of data, and thus not really enough to run a proper difference-in-difference regression while controlling for pre-trends (for this reason, BDV's Table 3, which includes firm trends, omits computers-per-worker altogether). Given the short panel, we just consider the impact of Chinese competition on computers-per-worker briefly, using equation 2.1. Here, when we plot the pre-treatment trends, in Figure A6, we do not see a clear need to test for the lagged levels.

In Table A2, we begin by benchmarking the BDV results from Table 1, column (2). This time, switching to Chinese import penetration and including 3-digit FEs does not render the impact of Chinese competition insignificant, although it does when we move to a perfectly balanced panel in the third column. 3-digit SIC*country FEs likewise do not kill the significance, but either 4-digit FEs or 4-digit SIC FEs interacted with country FEs do. It should be mentioned that when we plot the levels of computers-per-worker for the most China-competing sectors vs. other sectors for the data we have available (see Figure A6), it does appear that the gap narrows after 2001, although, as mentioned, it is not possible to control for pre-treatment trends. However, from 2000 to 2002, average Chinese import penetration only rises modestly compared to the 2005 to 2007 period, and yet computer-per-worker in the 2000 to 2002 period rise faster in China-competing sector. This suggests to us that, at a minimum, further research is needed on this question.

Table A2: The Impact of Chinese Competition on Computers-per-Worker

	BVD Reg	+ChinaPen.	Balanced	+FEs	+FEs	+FEs
5-year Change in Chinese Imports	0.36***			0.27***	0.070	0.17
	(0.076)			(0.085)	(0.087)	(0.13)
5-year Change Chinese Import Pen.		0.27***	-0.062			
		(0.10)	(0.26)			
Observations	37500	31225	6253	37500	37500	37500
Sectoral FEs?	None	SIC-3	SIC-3	Cty*SIC-3	SIC-4	Cty*SIC4

*$p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is computers per worker. The first column is a benchmark of BDV, Table 1, column (2). The second column includes 3-digit SIC FEs, and uses Chinese import penetration as the main variable of interest. The third column perfectly balances the sample. The fourth column includes country*SIC 3 digit interactive FEs. The fourth column includes 4-digit SIC FEs. The fifth column includes country*SIC 4 digit interactive FEs.

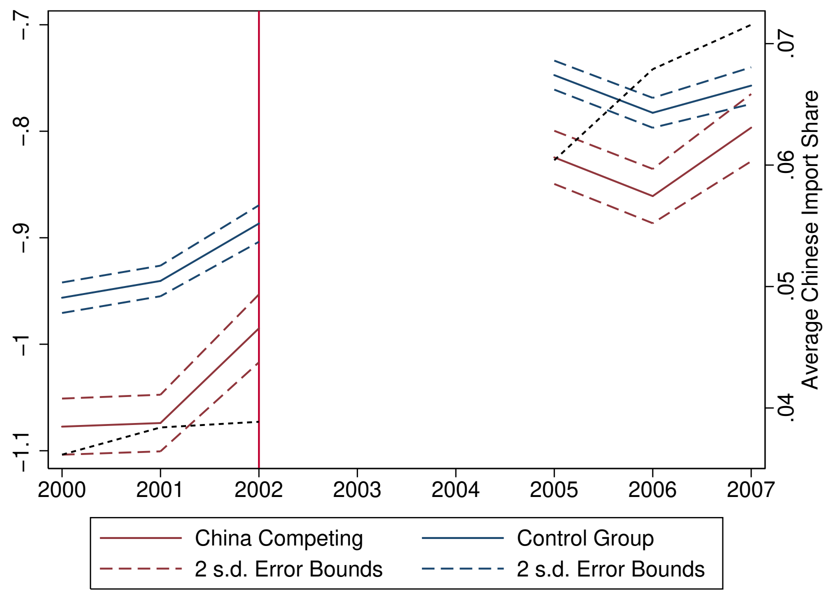


Figure A6: Computers Per Worker: China-Competing Sectors vs. Others

Notes: The Red line are the average computers-per-worker over time in China-competing sectors (those with at least an average of five-year changes in Chinese imports of .05, which puts them in the top 13.5% of sectors in terms of Chinese competition), with 2 standard deviation error bounds with the dashed lines. The blue line is the treatment group. The red vertical line denotes the first full year after China joined the WTO. On the second y-axis is the average level of Chinese imports (as a share of total imports) by year.

B.2 Online Appendix: Supplemental Graphs and Robustness Tables

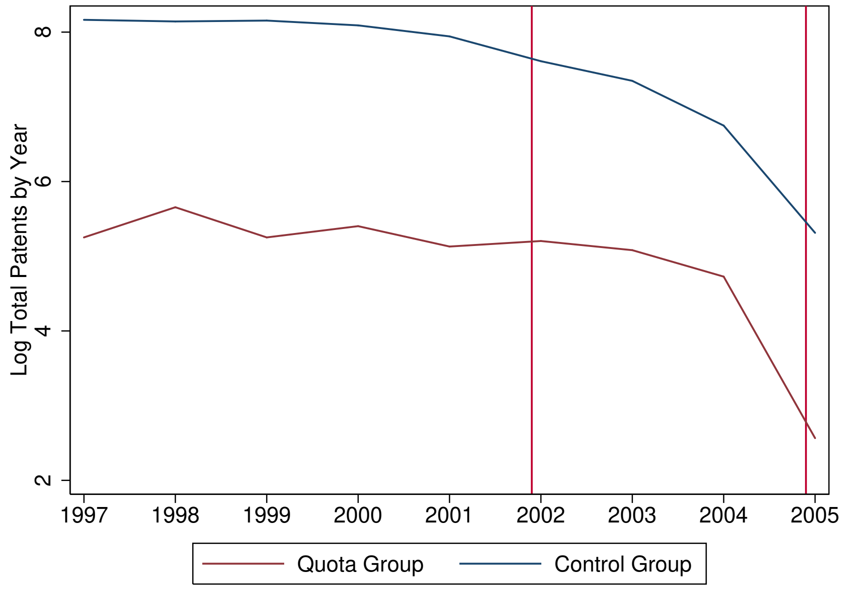


Figure A7: Total Patents, Textile Sector: Quota Group vs. Control

Notes: The red line is the average patents over time in China-competing sectors (the Quota group, defined as log of patents plus one, summed up for all the firms in a sector), and the blue line is the control group (in which quotas weren't binding). The red vertical lines denotes dates when textile quotas were relaxed.

Table A3: Summary Table: # of Firms and Patents over Time

Data Set	Variable	1996	2000	2005
Full Patent Data (Table 1.A)	# of Firms w/ Patent data	4,763	10,683	13,975
	Total Patents	9,185	13,547	1,557
	Patents per Firm	1.9	1.3	0.1
Textile Sample (Table 1.B)	# of Firms w/ Patent data	1,159	2,371	2,985
	Total Patents	3,194	4,188	301
	Patents per Firm	2.8	1.8	0.1
TFP Sample	# of Firms with TFP Data	66,992	20,191	57,067
	# of Firms with Value-Added Data	1,665	4,615	5,287

Table A4: Summary of EU Quota Utilisation Rates for China

	# of Categories where Quota Utilisation Rates are…			Restricted
Year	**Under 50%**	**50-80%**	**Over 80%**	**Categories**
1993	7	9	17	33
1994	9	9	20	38
1995	8	13	18	39
1996	8	9	23	40
1997	7	6	26	39
1998	6	8	25	39
1999	8	3	28	39
2000	3	5	31	39
2001	0	6	28	34
2002	4	3	20	27
2003	3	3	21	27
2004	3	5	19	27
2005	1	0	10	11
2006	0	1	10	11
2007	0	2	9	11

Notes: Data for this table comes from Jackson (2008).

Table A5: Impact of Chinese Competition on Patents (Sector Total Regressions)

	(1)	(2)	(3)	(4)	(5)
Quotas Removal*# Years after 2000	0.093	0.22	0.22		
	(0.15)	(0.68)	(0.69)		
L5.ln(Total Sectoral Patents)			-0.0071	-0.0016	
			(0.0062)	(0.0010)	
5-year Δ Chinese Imports				2.63	-5.71
				(6.88)	(5.88)
FEs	None	Cty*SIC4	Cty*SIC4	Cty*SIC4	Cty*SIC4
Replication of:	Sector	Sector	Sector	Sector	Sector
Unit of Analysis	378	378	378	378	378

*$p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The data is from 1992 to 2005. The dependent variable is the five-year log change of patents summed up at the sector level, and these regressions include the textile sector only. The first column uses the % of binding quotas in 2000 interacted with the # of years since 2000 as a proxy variable. Column (2) adds in country*4-digit SIC FEs. Column (3) adds in a control for the lagged level of patents. Column (4) uses the quotas variable interacted with the years since 2000 as an instrument for changes in the Chinese share of imports, and column (5) simply uses the five-year changes in imports as the key variable of interest.

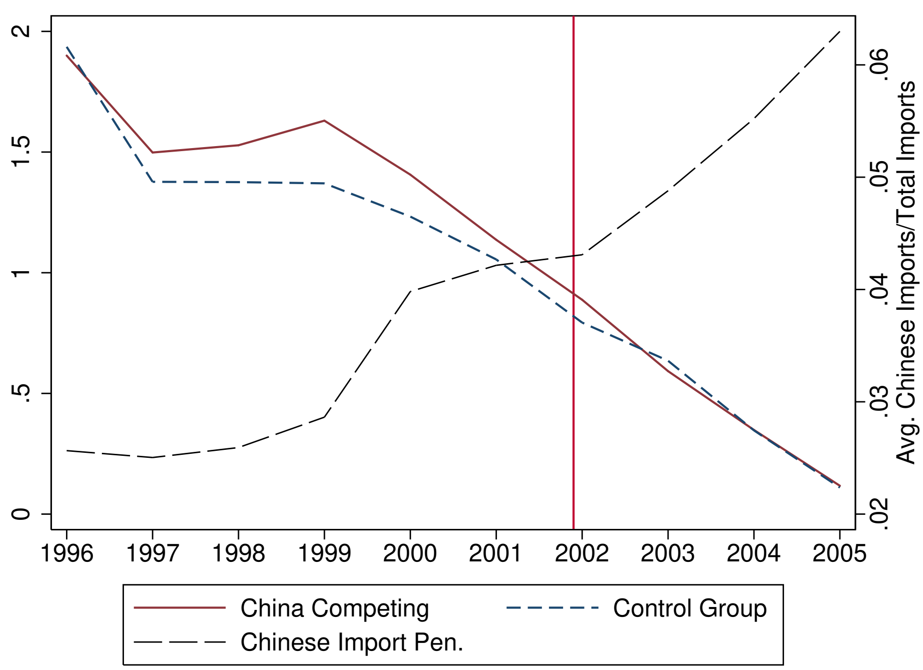


Figure A8: Patent Growth: China-Competing Sectors vs. Others (Full Sample)

Notes: The red line is the average patents over time in China-competing sectors (log of patents plus one), with 2 standard deviation error bounds with the dashed lines. This version includes all sectors which have full data (it is perfectly balanced), whereas Figure 1 includes just the textile sectors, and is not necessarily perfectly balanced. The blue line is the treatment group. The red vertical line denotes China's accession to the WTO. On the second y-axis is the average level of Chinese imports (as a share of total imports) by year.

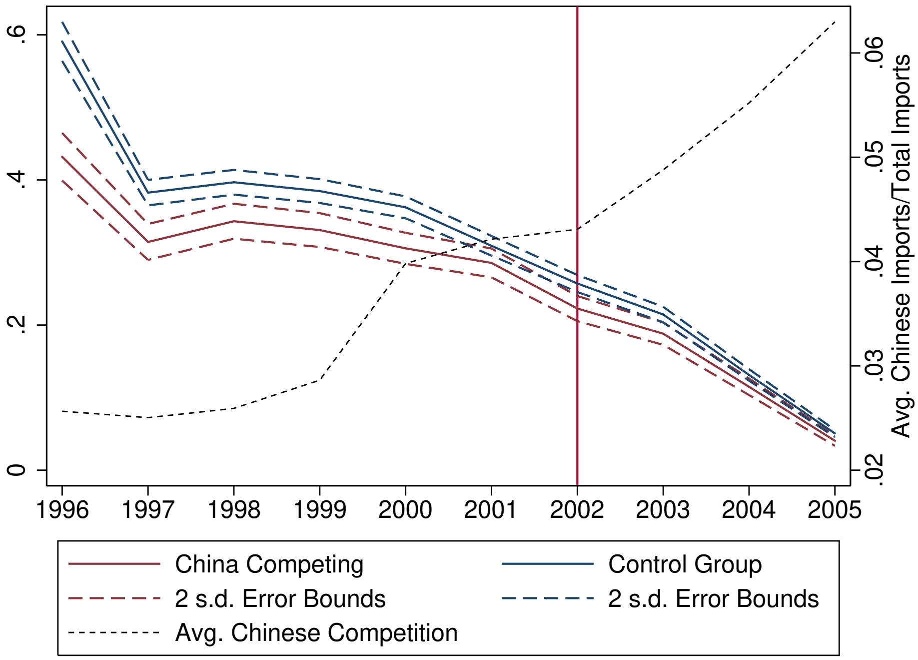


Figure A9: Patent Growth: China-Competing Sectors vs. Others

Notes: The red line is the average patents over time in China-competing sectors (log of patents plus one), with 2 standard deviation error bounds with the dashed lines. The blue line is the treatment group. The red vertical line denotes the first full year after China joined the WTO. On the second y-axis is the average level of Chinese imports (as a share of total imports) by year. This includes the full sample used in Table 1, Panel A.

Table A6: The Impact of Chinese Competition on Patent Growth: Additional FEs

	BDV Replication	Use Chinese Pen.	Add Lag	+FEs	+FEs	+FEs
5-year Δ Chinese Imports	0.32***		-0.029	0.12	0.14	0.075
	(0.10)		(0.066)	(0.10)	(0.11)	(0.12)
5-year Δ Chinese Import Pen.		0.023				
		(0.098)				
L5.ln(Patents+1)			-0.57***			
			(0.018)			
Sectoral FEs	None	SIC3	None	Cty*SIC3	SIC4	Cty*SIC4
Observations	30261	26797	30261	30261	30261	30261

*$p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The first column is a replication of BDV Table 1. The second column switches to Chinese import penetration as the key dependent variable. Column (3) adds in a lag. Column (4) adds in country*SIC 3 digit interactive FEs. Column (5) uses SIC 4-digit controls. And column (6) includes country*SIC 4-digit interactive FEs.

Table A7: Chinese Competition and Patents: Autor/Dorn/Hanson IV Robustness

	(1)	(2)	(3)	(4)	(5)	(6)
5-year Δ Chinese Import Pen. (Other Countries)	0.35*					
	(0.19)					
5-year Δ Chinese Import Pen.		-0.60				
		(0.68)				
5-year Δ Chinese Import Pen.(ADH version)			0.11**		1.10**	0.38
			(0.047)		(0.54)	(0.24)
5-year Δ Chinese Import Pen. (Other Countries, ADH)				0.018***		
				(0.0069)		
L5.ln(Patents+1)						-0.56***
						(0.019)
Regression	proxy	IV	OLS	proxy	IV	IV
Sectoral FEs	None	SIC3	None	None	None	None
Observations	27848	26025	26851	24679	25993	25993

$*p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The first column uses the average five-year change in Chinese import penetration into other European countries in our sample as a proxy variable, and is correlated with increases in patents (our dependent variable). Column (2) uses avg. changes in Chinese import penetration in other countries in the sample as an IV for actual five-year changes in Chinese import penetration. Column (3) measures five-year changes in Chinese import penetration using the ADH method – which only uses the base year value for domestic consumption. Column (4) uses the ADH method using average changes in Chinese imports for other countries in our sample. Columns (5) and (6) use this as an IV for domestic changes in Chinese import penetration, with the last column including a control for the lagged level of patents. If we add FEs to these regressions, the results are qualitatively similar.

Table A8: The Impact of Chinese Competition on Patents: Additional Robustness

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
A. Benchmark vs. Chinese Penetration							
5-year Δ Chinese Imports	0.32***	0.19*		0.31***			
	(0.10)	(0.10)		(0.100)			
5-year Δ Chinese Imports, Normalized			0.14***				
			(0.048)				
5-year Δ in Outsourcing from China				0.17			0.62
				(0.82)			(0.91)
5-year Δ in Chinese Import Penetration					0.18*	0.025	0.15
					(0.10)	(0.098)	(0.099)
Sectoral FEs	None	SIC3	None	None	None	SIC3	None
Observations	30251	30251	30195	30251	26788	26788	26615
B. Robustness to Varying FEs							
5-year Δ Chinese Imports	0.19*	0.15		0.12	0.078		0.079
	(0.10)	(0.11)		(0.11)	(0.12)		(0.13)
5-year Δ Chinese Imports, Normalized			0.077			0.038	
			(0.050)			(0.079)	
5-year Δ in Outsourcing from China				0.57			-0.070
				(1.13)			(1.61)
Sectoral FEs	SIC3	SIC4	SIC4	SIC4	Ctry*SIC4	Ctry*SIC4	Ctry*SIC4
Observations	30251	30251	30195	30251	30251	30195	30251
C. Varying FEs w/ Chinese Penetration							
5-year Δ Chinese Imports, Normalized	0.093*	0.093*					
	(0.050)	(0.050)					
5-year Δ in Outsourcing from China	-0.100	-0.100			0.35		0.037
	(1.01)	(1.01)			(1.24)		(1.71)
5-year Δ in Chinese Import Penetration			0.025	-0.035	-0.051	-0.039	-0.052
			(0.098)	(0.10)	(0.10)	(0.14)	(0.14)
Sectoral FEs	SIC3	SIC3	SIC3	SIC4	SIC4	Ctry*SIC4	Ctry*SIC4
Observations	30195	30195	26788	26788	26615	26788	26615

*$p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Errors clusterd at the country*4-digit SIC level. Every regression also includes country-year interactive FEs. The dependent variable is the log 5-year change in patents (plus one). The first four columns of Panel A are replications of BDV Table 1. The last three columns are robustness checks. Panel B shows robustness using the share of Chinese imports as the key measure of Chinese competition, while Panel C uses Chinese imports normalized by domestic production and Chinese import penetration as the key measures of interest instead.

Table A9: Full IV Results for Table 1 (1st and 2nd Stage)

	(1)	(2)	(3)	(4)	(5)
A. 2SLS Estimates					
5-year Δ in Chinese Import Penetration	1.01*	0.52			
	(0.55)	(0.37)			
L5.ln(Patents+1)		-0.57***		-0.67***	
		(0.020)		(0.035)	
5-year Δ Chinese Imports			1.86*	-0.050	2.72
			(1.00)	(0.35)	(3.06)
Notes	1A Col.(5)	1A Col.(6)	1B Col.(4)	1B Col.(5)	1B Col.(6)
Sectoral FEs	None	None	None	None	SIC4
Underidentification LM Statistic	31.0	30.8	25.9	25.7	6.42
Weak Identification F-Stat	23.8	23.6	53.5	52.5	8.06
Observations	24706	24706	3438	3438	3438
B. First Stage					
ADH IV	0.41***	0.41***			
	(0.084)	(0.084)			
L5.ln(Patents+1)		-0.0022**		-0.0026***	
		(0.0010)		(0.00082)	
Quotas Removal QUOTA			0.11***	0.11***	0.070***
			(0.022)	(0.022)	(0.025)
F-statistic	23.7	23.6	24.0	23.5	7.13

$*p < 0.1$, $** \ p < 0.05$, $*** \ p < 0.01$. This table shows both the 1st and the 2nd stage IV results from Table 1. The dependent variable in Table A, showing the 2nd stage, is the 5-year log change in firm-level patents. Panel B shows the first stage. Column (1) is a replication of Table 1A Column (5), as delineated in the "Notes" row in Panel A, and column (2) is a replication of Table1A, Column (6). The dependent variable in both of these columns in Panel B is 5-year changes in Chinese import penetration. The next three columns are replications of Table 1B, columns 4-6. The dependent variable in Panel B, columns 3-5 is 5-year changes in the Chinese share of imports.

Table A10: Chinese Competition & TFP: Robustness

	(1) TFP	(2) TFP	(3) TFP	(4) ChinaPen	(5) TFP	(6) TFP
A. BDV Table 1 Robustness						
5-year Δ Chinese Imports	0.26***	0.36***				
	(0.072)	(0.071)				
5-year Δ Chinese Import Penetration			0.081**		0.098	0.11
			(0.040)		(0.062)	(0.070)
5-year Δ Chinese Import Pen.(Other)				0.87***		
				(0.051)		
Sectoral FEs	None	Cty*SIC4	Cty*SIC4	SIC3	SIC3	Cty*SIC4
Regression	OLS	OLS	OLS	1st Stage	ADH IV	ADH IV
Observations	292167	292153	292167	284922	284935	284922
B. BDV Table 2 Rob. (Textiles)						
5-year Δ Chinese Imports	0.90***			1.63***		
	(0.12)			(0.33)		
5-year Δ Chinese Import Penetration		0.26***	0.50***		2.85*	3.21**
		(0.093)	(0.12)		(1.53)	(1.26)
Sectoral FEs	None	Cty*SIC4	Cty*SIC4	None	SIC3	Cty*SIC4
Regression	OLS	OLS	OLS	IV	IV	IV
Time Period	1999-2005	1999-2005	1995-2005	1999-2005	1995-2005	1995-2005
Observations	20625	20593	55768	20625	55788	55768

*$p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Each regression includes country*SIC 4-digit interactive FEs, and in panel A, errors are clustered at the same level. In panel B, errors are clustered at the 4-digit level (following BDV's Table 2). Panel A is a robustness test for BDV Table 1, and panel B is a robustness check for BDV Table 2.

Table A11: The Impact of Chinese Competition on Value-Added per Worker

	(1)	(2)	(3)	(4)	(5)	(6)
A. BVD Table 1 Robustness						
5-year Δ Chinese Imports	0.087	0.096		0.77**		
	(0.19)	(0.19)		(0.32)		
L5.ln(Patents+1)		0.030				0.037
		(0.021)				(0.022)
5-year Δ Chinese Import Pen.			0.24		-0.25	-0.21
			(0.30)		(0.93)	(0.93)
Notes	Rep.	+Lag	Rob.	+FEs	ADH IV	ADH IV
Sectoral FEs	None	None	SIC3	Cty*SIC3	None	None
Observations	13623	13623	12296	13623	11444	11444
B. BDV Table 2 Rob.: Textiles Only						
5-year Change in Chinese Imports	-0.53	-0.47	0.29	-0.48	-0.34	-0.050
	(0.45)	(0.46)	(1.04)	(1.15)	(1.13)	(5.23)
L5.ln(Patents+1)		0.039			0.040	
		(0.082)			(0.081)	
Notes	Rep.	+Lag	+FEs	IV Rep.	IV+Lag	IV+FEs
Sectoral FEs	None	None	SIC4	None	None	SIC4
Observations	1529	1529	1529	1529	1529	1529
C. BDV Table 3 Rob.: Textiles Only						
Quotas Removal: I(year>2000)	0	0				
	(.)	(.)				
L5.ln(Patents+1)		-0.032		-0.034	0.064	
		(0.090)		(0.090)	(0.086)	
Quotas Removal*# Years after 2000			-0.11	-0.11		
			(0.10)	(0.10)		
5-year Δ Chinese Imports					-0.22	-1.43
					(1.23)	(1.12)
FEs	Firm	Firm	Firm	Firm	Firm	Firm
Replication of:	Rep.,Col.2	Rob.,Col.2	Rep.,Col.4	Rob.,Col.4	IV	Rob., Col.4
Unit of Analysis	2660	2660	2660	2660	1367	2660

*$p < 0.1$, ** $p < 0.05$, *** $p < 0.01$, with errors clustered at the four-digit SIC*country level. The dependent variable for all 18 regressions in this table is the five-year change in log value-added per worker, and all regressions include country*year interactive FEs. Column (1) of panel A is an exact replication of BDV Table 1, Panel A, column (1). Col. (2) of panel A includes the lagged level of patents as a control (with no FEs). Col. (3) uses five-year changes in Chinese import penetration instead, and includes three-digit SIC FEs. Col. (4) includes country-SIC 3 FEs. Columns (5) and (6) instrument for five-year changes in Chinese import penetration using average five-year changes in import penetration for other countries in the sample. Panel B, col. (1) (or, regression B.1) is an exact replication of BDV Table 2, Col. (1). Panel B, Col. (2) adds in the lagged level of patents as a control. Regression B3 includes four-digit SIC FEs. Panel B, col. (4) is an exact replication of BDV Table 2, column (3). Regression B5 adds in the lagged level of patents as a control, and B6 includes four-digits SIC FEs. All of panel C includes firm FEs. Panel C, col. (1) is an exact replication of BDV Table 3, col. 2, which includes firm-specific FEs. C2 adds in the lagged level of patents as a control. Panel C, column 3 is an exact replication of BDV Table 3, column (4). Panel C, Col. (5) adds in the lagged level of patents as a control. Col. (5) uses the quota removal interacted with years since 2000 as an IV instead of as a proxy variable. Col. (6) simply uses the log of five-year changes in Chinese imports as a control directly (no IV or proxy).

Table A12: The Impact of Chinese Competition on Sales per Worker

	(1)	(2)	(3)	(4)	(5)	(6)
A. BVD Table 1 Robustness						
5-year Δ Chinese Imports	-0.32	-0.32		-0.61		
	(0.38)	(0.38)		(0.51)		
L5.ln(Patents+1)		-0.00039				-0.0088
		(0.0067)				(0.0078)
5-year Δ Chinese Import Pen.			-1.59***		-2.89**	-2.90**
			(0.38)		(1.23)	(1.23)
Notes	Rep.	+Lag	Rob.	+FEs	ADH IV	ADH IV
Sectoral FEs	None	None	SIC3	Cty*SIC3	None	None
Observations	30764	30764	31047	30764	28854	28854

	(1)	(2)	(3)	(4)	(5)	(6)
B. BDV Table 2 Rob.: Textiles Only						
5-year Change in Chinese Imports	-1.63***	-1.63***	-0.36	-5.49***	-5.52***	-4.48
	(0.62)	(0.62)	(0.72)	(1.44)	(1.45)	(3.63)
L5.ln(Patents+1)		-0.00032			-0.013	
		(0.016)			(0.015)	
Notes	Rep.	+Lag	+FEs	IV Rep.	IV+Lag	IV+FEs
Sectoral FEs	None	None	SIC4	None	None	SIC4
Observations	2989	2989	2989	2989	2989	2989

	(1)	(2)	(3)	(4)	(5)	(6)
C. BDV Table 3 Rob.: Textiles Only						
Quotas Removal: I(year>2000)	0	0				
	(.)	(.)				
L5.ln(Patents+1)		0.022*		0.021	-0.0089	
		(0.013)		(0.013)	(0.012)	
Quotas Removal*# Years after 2000			-0.16	-0.16		
			(0.12)	(0.12)		
5-year Δ Chinese Imports					-5.94***	0.43
					(1.70)	(0.85)
FEs	Firm	Firm	Firm	Firm	Firm	Firm
Replication of:	Rep.,Col.2	Rob.,Col.2	Rep.,Col.4	Rob.,Col.4	IV	Rob., Col.4
Unit of Analysis	5373	5373	5373	5373	2719	5373

*$p < 0.1$, ** $p < 0.05$, *** $p < 0.01$, with errors clustered at the four-digit SIC*country level. The dependent variable for all 18 regressions in this table is the five-year change in log sales per worker, and all regressions include country*year interactive FEs. Column (1) of panel A is an exact replication of BDV Table 1, Panel A, column (1). Col. (2) of panel A includes the lagged level of patents as a control (with no FEs). Col. (3) uses five-year changes in Chinese import penetration instead, and includes three-digit SIC FEs. Col. (4) includes country-SIC 3 FEs. Columns (5) and (6) instrument for five-year changes in Chinese import penetration using average five-year changes in import penetration for other countries in the sample. Panel B, col. (1) (or, regression B.1) is an exact replication of BDV Table 2, Col. (1). Panel B, Col. (2) adds in the lagged level of patents as a control. Regression B3 includes four-digit SIC FEs. Panel B, col. (4) is an exact replication of BDV Table 2, column (3). Regression B5 adds in the lagged level of patents as a control, and B6 includes four-digits SIC FEs. All of panel C includes firm FEs. Panel C, col. (1) is an exact replication of BDV Table 3, col. 2, which includes firm-specific FEs. C2 adds in the lagged level of patents as a control. Panel C, column 3 is an exact replication of BDV Table 3, column (4). Panel C, Col. (5) adds in the lagged level of patents as a control. Col. (5) uses the quota removal interacted with years since 2000 as an IV instead of as a proxy variable. Col. (6) simply uses the log of five-year changes in Chinese imports as a control directly (no IV or proxy).

Table A13: The Impact of Chinese Competition on Profits

	(1)	(2)	(3)	(4)	(5)	(6)
A. BVD Table 1 Robustness						
5-year Δ Chinese Imports	-0.055	-0.058		-0.30		
	(0.43)	(0.43)		(0.45)		
L5.ln(Patents+1)		-0.0046				-0.0041
		(0.029)				(0.034)
5-year Δ Chinese Import Pen.			-0.39		-1.64	-1.64
			(0.41)		(1.58)	(1.59)
Notes	Rep.	+Lag	Rob.	+FEs	ADH IV	ADH IV
Sectoral FEs	None	None	SIC3	Cty*SIC3	None	None
Observations	16896	16896	15114	16896	13878	13878
B. BDV Table 2 Rob.: Textiles Only						
5-year Change in Chinese Imports	-1.53	-1.53	-1.72	-5.81**	-5.84**	-7.20
	(1.06)	(1.07)	(1.45)	(2.44)	(2.46)	(17.7)
L5.ln(Patents+1)		0.0012			-0.011	
		(0.042)			(0.041)	
Notes	Rep.	+Lag	+FEs	IV Rep.	IV+Lag	IV+FEs
Sectoral FEs	None	None	SIC4	None	None	SIC4
Observations	1775	1775	1775	1775	1775	1775
C. BDV Table 3 Rob.: Textiles Only						
Quotas Removal: I(year>2000)	0	0				
	(.)	(.)				
L5.ln(Patents+1)		0.032		0.032	0.0064	
		(0.052)		(0.051)	(0.039)	
Quotas Removal*# Years after 2000			-0.20	-0.20		
			(0.24)	(0.24)		
5-year Δ Chinese Imports					-5.44**	1.21
					(2.30)	(1.85)
FEs	Firm	Firm	Firm	Firm	Firm	Firm
Replication of:	Rep.,Col.2	Rob.,Col.2	Rep.,Col.4	Rob.,Col.4	IV	Rob., Col.4
Unit of Analysis	3386	3386	3386	3386	1693	3386

*$p < 0.1$, ** $p < 0.05$, *** $p < 0.01$, with errors clustered at the four-digit SIC*country level. The dependent variable for all 18 regressions in this table is the five-year change in firm-level profits, and all regressions include country*year interactive FEs. Column (1) of panel A is an exact replication of BDV Table 1, Panel A, column (1). Col. (2) of panel A includes the lagged level of patents as a control (with no FEs). Col. (3) uses five-year changes in Chinese import penetration instead, and includes three-digit SIC FEs. Col. (4) includes country-SIC 3 FEs. Columns (5) and (6) instrument for five-year changes in Chinese import penetration using average five-year changes in import penetration for other countries in the sample. Panel B, col. (1) (or, regression B.1) is an exact replication of BDV Table 2, Col. (1). Panel B, Col. (2) adds in the lagged level of patents as a control. Regression B3 includes four-digit SIC FEs. Panel B, col. (4) is an exact replication of BDV Table 2, column (3). Regression B5 adds in the lagged level of patents as a control, and B6 includes four-digits SIC FEs. All of panel C includes firm FEs. Panel C, col. (1) is an exact replication of BDV Table 3, col. 2, which includes firm-specific FEs. C2 adds in the lagged level of patents as a control. Panel C, column 3 is an exact replication of BDV Table 3, column (4). Panel C, Col. (5) adds in the lagged level of patents as a control. Col. (5) uses the quota removal interacted with years since 2000 as an IV instead of as a proxy variable. Col. (6) simply uses the log of five-year changes in Chinese imports as a control directly (no IV or proxy).