WORKERS BENEATH THE FLOODGATES: LOW-WAGE IMPORT COMPETITION AND WORKERS' ADJUSTMENT

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Abstract—Using employee-employer matched data, I analyze the impact of a low-wage trade shock on manufacturing workers in a high-wage country, Denmark, and how they adjust to the shock over a decade. I derive causal effects by exploiting the dismantling of the Multifiber Arrangement quotas on products from China upon its WTO accession as a quasi-natural experiment and use within-industry, within-occupation heterogeneity in workers' exposure to this shock. I find significant negative long-run effects on earnings and employment trajectories and identify job instability in the service sector as a main adjustment friction, concentrated among workers with manufacturing-specific education and occupation. The results establish the importance of specific human capital in trade adjustment and provide evidence of skill upgrading as workers rebuild lost human capital through education.

I. Introduction

MANUFACTURING jobs, once the main income source for the middle class, are waning, and this causes considerable anxiety in advanced countries. How workers and society can best adjust are important topics of current debate. Recent research has made great progress in understanding the consequences of the rising trade with low-wage countries on firms and industries and documented significant labor reallocation as a result (Bernard, Jensen, & Schott, 2006; Khandelwal, 2010; Autor, Dorn, & Hanson, 2013; Utar & Torres-Ruiz, 2013; Utar, 2014; Pierce & Schott, 2016; Bloom, Draca, & Van Reenen, 2016). But labor does not reallocate instantaneously and costlessly, as predicted by traditional trade theories. The salient question is what happens to workers when they are displaced from their workplaces due to import competition from low-wage countries.[1] If workers can efficiently switch to another job within the same industry, the earnings (and broader welfare) consequences are small. But what options are available to manufacturing workers when facing low-wage import competition? Are the possible paths of adjustment different for workers depending on their individual investments in human capital, reflected in their education and occupation, and how do these differences affect the cost of adjustment?

Addressing this, I study the impact of a Chinese import shock on workers' earnings and employment trajectories in a high-wage country, Denmark, and study workers' adjustment in a quasi-natural experiment that measures the causal effects of a trade policy change affecting a classic manufacturing industry. China benefited from trade liberalization in the form of import quota removals in textiles upon entry into the World Trade Organization (WTO). The event constitutes a suitable setting in which to study the effect of Chinese import competition.[2] By using longitudinal employee-employer matched data from 1999 to 2010 that follows individuals from job to job, sector to sector, but also in and out of education or unemployment, I provide a true-to-life documentation of manufacturing workers' adjustment to the trade shock over the decade that follows.

I measure the exposure to the trade shock at the individual level. I first use detailed product and firm-level domestic production data to identify firms domestically producing products subject to import quotas for China. The matched employee-employer data allow me to identify workers employed in firms that will subsequently be hit by a surge of cheaper imports from China. I then measure differential labor market trajectories of the exposed workers relative to other workers initially employed in the same industry after controlling for potentially unobserved worker and workplace characteristics and aggregate shocks by worker and time fixed effects.

Technological forces are important among factors that cause decline in manufacturing employment in advanced countries (Machin & Van Reenen, 1998). Especially labor-intensive industries have been restructuring since the 1960s due to factors that include both low-wage competition and technological changes. The empirical strategy in this paper disentangles the effects of the trade shock from potentially important technology and demand factors by directly utilizing a discrete change in trade policy and within-industry, within-occupation heterogeneity in exposure to the resulting import competition.

I show that increased competition with China leads to substantial earnings reductions, averaging 89% of the workers' initial annual wage over the nine years after the first removal of quotas for China. The effect on earnings is mainly due to reduction in hours worked instead of hourly wages, which is consistent with a Danish labor market combining

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[1] Job displacement due to plant downsizing can have a lasting negative effect on workers' earnings for years after the event and can even have nonpecuniary effects, such as reduced life expectancy (Jacobson, LaLonde, & Sullivan, 1993; Sullivan & von Wachter, 2009).

[2] The plausibly exogenous increase in import competition due to removal of the Multi-fiber Arrangement quotas for China has been used as an identification strategy before at the industry (Bloom et al., 2016) or firm (Utar, 2014) level. See also Harrigan and Barrow (2009) and Khandelwal, Schott, and Wei (2013) for price and productivity consequences of the event.

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U.S.-style liberal hiring-firing regulations with a high degree of unionization.[3]

Workers exposed to the competition face a higher likelihood of unemployment and shorter future employment spells. The trade shock leads to displacement from the firm exposed to the competition and subsequent job instability. The initial impact of trade is fairly homogeneous across workers regardless of education or occupation. Whether a secretary, machine operator, or manager at the exposed firm and whether college educated or not, the trade shock affects workers similarly at the exposed firm, causing an average reduction in length of employment of more than a full year over the nine years following. For workers of all educations and occupations, the growing service sector provides the most viable path to new employment, and the trade shock significantly increases the likelihood of moving there for all types of workers. But after the move from manufacturing to the service sector, workers' paths of adjustment diverge, resulting in very heterogeneous long-run outcomes. College-educated workers fully recover the initial earnings losses, but high school–educated workers suffer cumulative earnings losses of 143% of a preshock annual wage over the decade.

This paper is part of the recent literature that documents the role of low-wage country trade in the evolution of industry and labor markets in advanced economies and is most closely related to worker-level studies documenting trade adjustment costs.[4] Autor et al. (2014) provide the first worker-level study on Chinese import competition and document that American workers under direct threat from Chinese import competition have lower cumulative earnings and higher risk of exiting the labor force. The costs of adjustment, they find, are disproportionately borne by low-wage workers, who stay within manufacturing, while high-wage workers have a higher likelihood of moving out of manufacturing and adjust successfully. Their results imply that a necessary condition for a successful adjustment is being able to move out of manufacturing. But their results do not answer whether the costs of adjustments are limited to the frictions that slow or prevent workers' move to new sectors and whether moving out of manufacturing in itself is a sufficient condition for a smooth recovery.[5] Studying the experience of workers in a European country with active labor market policies (ALMP) where full-time employment outside manufacturing is within reach for all types of workers, I show that adjustment costs are substantial even after moving out of manufacturing to the service sector. Indeed it is the costs incurred after moving to the service sector that determine the differences in workers' outcome over the medium to long term. And workers' initial investment in human capital as reflected in education and occupation plays a major role in determining the distribution of these costs. A decade after the trade shock, a typical machine operator's earnings loss remains at one year's annual wage, while a typical secretary fully recovers earnings despite the same impact to both occupations at the exposed firm.

I find that the field of education, independent of education level, is also an important determinant of adjustment cost. Workers with manufacturing-focused vocational education face short-term frequent unemployment spells in the service sector, while workers with service-specific vocational education fully avoid trade-induced unemployment. The adjustment problems persist for workers who lose a substantial part of their human capital in their new environment, and the trade adjustment costs are dominated by forgone human capital specific to the initial industry. The results overall show that human capital specificity, and particularly specificity to manufacturing, is the main determinant of workers' cost of adjustment to an import shock from China.

Motivated by trade liberalization episodes in developing countries with rigid markets, much of the trade adjustment literature focuses on mobility frictions that slow down or prevent resources from allocating efficiently in the new environment.[6] Focusing on labor reallocation in response to trade liberalization and employing empirical structural models, some studies aim at recovering mobility costs that workers face to switch sectors (Artuç, Chaudhuri, & McLaren, 2010; Dix-Carneiro, 2014) or analyze the relationship between trade and wage inequality in the presence of search frictions (Helpman et al., 2014). Among them, this paper is most related to Dix-Carneiro (2014), who introduces human capital with differential returns across sectors, finding substantial heterogeneity in adjustment frictions across workers. This paper adds quasi-experimental evidence and shows that taking workers' occupations into account is essential to capture the full role of industry-specific human capital.[7] Contrary to what studies so far suggested, this paper shows that trade-induced adjustment problems do not end once workers find full-time jobs in the growing sectors and brings to the light a new facet of the nature of these frictions.[8]

[3] The Global Competitiveness Report 2013–2014 ranks Denmark sixth among 148 countries at hiring and firing practices, indicating a very deregulated market (the United States is ranked 9th in the same ranking), while it is ranked 93rd for flexibility of wage determination.

[4] Studies also document wage changes in response to the recent wave of globalization within firms (Hummels et al., 2014) or within local labor markets (Hakobyan & McLaren, 2016).

[5] Their results raise the question of why the transition out of manufacturing is easier for high-wage workers than for low-wage workers and what underlying characteristics of workers drive the difference.

[6] See Goldberg and Pavcnik (2007) for a review. Recent examples include Menezes-Filho and Muendler (2011), who use matched data to document sluggish labor reallocation in response to trade liberalization in Brazil. Dix-Carneiro and Kovak (2015) focus on regional dynamics and document transition from the formal to the informal economy in response to trade liberalization in Brazil.

[7] While Dix-Carneiro (2014) finds a dominating role for moving frictions in Brazil, a relative abundance of labor market frictions in Brazil in comparison to Denmark could be one reason for a larger role of moving barriers there.

[8] In a study of structural change induced by trade, Keller and Utar (2016) show a strong pattern of job polarization—decline in midlevel wage jobs and increase in high- and low-wage jobs—in Denmark over 2000 to 2009. They find that import competition from China played an important role in causing polarization. In a related study, Traiberman (2017) estimates

The idea that the specific aspect of human capital could be an important barrier to labor reallocation from shrinking sectors to growing ones is not new. Since Becker (1964), studies focus on human capital that may be specific to firm, industry, and occupation (Topel, 1991; Neal, 1995; Parent, 2000; Poletaev & Robinson, 2008; Kambourov & Manovskii, 2009). This literature either looks at plant closings regardless of reason or focuses on job switches that are endogenous to characteristics of workers and their employers. Exploiting the removal of import quotas that led to a decline in labor demand, I advance this literature by offering a plausibly exogenous driving force for job mobility. I find that industry and occupation specificity of human capital interact.[9] Workers' occupations are a crucial determinant of trade-induced adjustment costs depending on the degree to which occupations are specific to manufacturing. These results show that focusing on the occupation or the industry component of job switching may give an incomplete picture of the underlying determinants of reallocation costs.

Since the right skill set to the new environment is important to recover from the trade shock, I examine whether the import shock leads to investment in human capital through education.[10] The trade shock does cause workers to seek further education, and this effect is stronger for lower education levels, but also with a higher level of mismatch of the initial education with the new sector. Thus, this paper shows the first direct evidence that trade with low-wage countries can lead to skill upgrading at the individual level, thereby potentially increasing the supply of skill.[11]

II. Empirical Framework and Worker-Level Data

The removal of Multi-Fiber Arrangement (MFA) quotas for China is used as identification strategy. This section briefly introduces this empirical framework, shows how the removal of import quotas led to increased competition, describes the data used, and provides information on the Danish labor market. Further details are provided in the online appendix.

A. *The Surge of Import Competition from China with the Quota Removals*

The MFA was introduced in 1974 to govern the world trade in textiles with the purpose of protecting high-wage countries against competition from low-wage countries through quantitative restrictions. In 1995 it was agreed that the MFA would gradually be lifted in so-called phases of liberalization. But China's non-WTO status rendered it ineligible to benefit from the liberalization, which changed only when China had joined the WTO in December 2001. The subsequent dramatic surge of Chinese textiles and clothing (T&C) exports to Denmark and the resulting increase in competition provides a plausibly exogenous source of shifts in employment trajectories among Danish workers.

As one of the smaller members of the EU, the coverage of quotas was largely exogenous to Denmark's industrial structure, as it was determined in EU-level negotiations throughout the 1960s and 1970s. The empirical strategy focuses on China because although the removal of the import quotas started in 1995, phase I and II removals did not effectively trigger increased competition. This is because, first, the law allowed the EU to choose the products to be integrated into the normal system, and the EU started with inactive, nonbinding quotas. Then, among the exporting countries subject to the MFA quotas, China stood out as facing the largest number of quotas with the highest quota utilization rates.[12]

There was considerable uncertainty as to whether the negotiations for China's WTO membership would succeed, which they did in December 2001. In January 2002, China's quotas on phase I, II, and III goods were removed immediately, leading to a dramatic surge in Chinese T&C imports into the formerly protected countries. Now a WTO member, China also benefited from the last phase in January 2005.[13] In 1998, China's share of T&C import in Denmark was a little over 10% compared to 2.8%, 0.7%, and 1.3%, respectively, for India, Pakistan and Indonesia—the countries with the highest quota utilization after China. Figure 1 shows the evolution in T&C import shares of China throughout 1999 to 2010 compared to the total shares of all other developing countries subject to MFA quotas. By 2010 China's share reached 32%, while the respective shares of India, Pakistan, and Indonesia were 7%, 1%, and 0.3%. The line with circles in figure 1 illustrates the magnitude of the shock by showing the evolution of the value of Chinese imports in MFA goods expressed in multiples of the 1999 total T&C value added, which was around 1.1 billion current euros. The image of floodgates opening is an apt one.[14]

a structural model of the Danish labor market and finds a large role for occupational reallocation costs in response to lower import prices.

[9] See Poletaev and Robinson (2008) for a related point.

[10] Bartel and Sicherman (1998) show that technological change may induce investment in human capital. Whether trade with low-wage countries alters the demand for skill in advanced countries and their offshore locations is an important related question. Recent evidence supports skill upgrading at the firm and establishment level (Bloom et al., 2016; Utar, 2014; Utar & Torres-Ruiz, 2013).

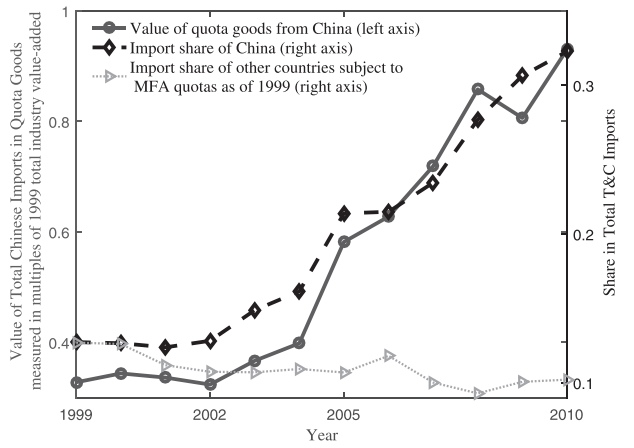
[11] Atkin (2016) looks at a potential effect of trade on the supply of skill from a different angle and shows that export expansion triggered by the trade reforms in Mexico causes school dropouts.

[12] Information on MFA quotas is reported in the Système Intégré de Gestion de Licenses (SIGL) database of the European Commission and is publicly available.

[13] Due to a surge of Chinese imports at EU ports in the first few months of 2005 after the final quota removal phase, the EU retained a few of the quota categories until 2008. Since the sample period extends over 2008, these quotas are also included in the current analysis.

[14] Utar (2014) employs transaction-level import data and shows that the MFA quotas were binding for China and both the 2002 and the 2005 abolishments caused a significant surge of MFA goods from China in Denmark with associated decline in unit prices of these goods. Khandelwal et al. (2013) find that Chinese export prices declined due to efficiency gains in China. Misallocation of the quotas by the Chinese government during the MFA regime played an important role in the subsequent surge of lower-priced Chinese goods.

FIGURE 1.—VALUE OF CHINESE IMPORTS (LEFT AXIS) AND IMPORT SHARES OF CHINA AND OTHER DEVELOPING COUNTRIES SUBJECT TO MFA QUOTAS IN DANISH TEXTILE AND CLOTHING IMPORTS (RIGHT AXIS)



The values of total Chinese imports of MFA quota goods are expressed in units of the 1999 total T&C value-added in Denmark.

B. *Employee-Employer Matched Data*

The main database used in this study is the Integrated Database for Labor Market Research (IDA) of Statistics Denmark. It contains administrative records on all individuals between 15 and 74 years old and all jobs and establishments that are active in the last week of November each year. The IDA database provides a yearly snapshot of the labor market by reporting primary positions of each individual living in Denmark as of November. For each individual, I observe annual labor earnings, hourly wage, annual hours worked, industry, and occupation in the primary employment.[15] I also observe workers' highest attained education, age, gender, immigration status, personal income, and total earnings from all jobs within a year, as well as the overall position with respect to the labor market such as employee, retiree, or in education. Occupation and education information follows the International Standard Classification of Occupations (ISCO) and International Standard Classification for Education (ISCED), and these administrative data influence workers' wages due to a collective bargaining system.

The Danish production database, VARES, is used to identify firms domestically producing goods that were subject to the import quotas for China. VARES provides information on industrial goods produced within the country at the detailed product level and is the basis for the industrial commodity production statistics of Denmark. Firms that in 1999 domestically produce eight-digit Combined Nomenclature (CN) goods subject to the MFA quota removal for China are identified and mapped to worker-level information through the unique firm identification numbers.[16]

[15] The primary employment of a worker is the worker's most important job in terms of earnings and hours worked.

[16] See the online appendix for details on the mapping of the quotas to CN products.

In 1999, textile manufacturing constituted 3% of total manufacturing in terms of employment, turnover, and export and 6% in terms of the number of establishments. There were around 13,000 workers employed in the T&C sector in 1999. I focus here on workers of working age (17 to 67 years) throughout the whole sample period. Table 1 presents sample information from the 1999 cross-section of workers and reports demographic, education, occupation, and workplace characteristics of treated workers in comparison to other workers in the same industry. With an average age of 39, the average worker was roughly in the middle of his or her career span. The share of female workers was 57%, and 6% were immigrants. In 1999, about half of the workers (47%) were exposed to increased import competition by being employed at a firm that would subsequently be affected by quota removals when China joined the WTO. Workers had similar age, experience, education, and wage levels in both the treated and untreated groups. The percentage of machine operators in both groups was the same, at 35%, showing that production workers make up a substantial part of the workforce in both groups. Table 1 also shows that workers' initial firms faced similar employment trends before the shock regardless of whether they produced quota products.

Figure 1 in the online appendix shows the distribution of workers at the end of the sample period over different labor market positions by exposure to the trade shock. By 2010, 33% of the control group had primary employment in the service sector whereas among exposed workers, this ratio was much higher at 44%. Twenty-five percent, of both groups were outside the labor market in 2010. The figure makes clear that the analysis controls for the secular declining trend of the industry and concentrates on the pure trade effect even if this may underestimate the effect of trade, since the secular declining trend in the industry may in part be caused by globalization.

C. *Labor Market*

The labor market in Denmark is characterized by liberal hiring and firing regulations for firms combined with a high level of publicly provided social protection for workers. Denmark is one of a few countries with no estimated redundancy/firing costs (World Economic Forum, 2013). The hiring and firing flexibility in combination with a high level of tax-funded social protection is often described as a "flexicurity" system. In particular, Denmark has a comprehensive and large-scale ALMP with a history back to the late 1970s. Any unemployed worker is subject to the ALMP measures, which include job search assistance. Hence, the long-term unemployment rate (in total unemployment) is generally low in Denmark compared to the OECD average. In 2008, it was 13.5%, compared to, for example, 52.5% and 10.6% for Germany and the United States, respectively (OECD Employment Database, 2013). Wage determination is less flexible. There is no minimum wage, but reference

TABLE 1.—WORKER CHARACTERISTICS, 1999

	Age	Female	Immigrant	Union Membership	Unemployment Insurance Membership	College Education	Vocational Education
Mean	38.78	0.57	0.06	0.80	0.90	0.11	0.35
SD	10.26	0.49	0.24	0.40	0.31	0.32	0.48
N	10,511	10,511	10,511	10,511	10,511	10,511	10,511

	Treated		Control		Mean	
	Mean	SD	Mean	SD	Difference	t-test
Number of observations	4,917		5,594			
Age	38.88	10.19	38.70	10.33	0.18	0.89
Immigrant	0.05	0.22	0.07	0.26	−0.02[b]	−4.36
Experience[a]	14.71	5.88	14.16	5.79	0.56[b]	4.85
Past unemployment spells[a]	1.13	1.62	1.40	1.98	−0.27[b]	−7.53
Negative trend at workplace	0.43	0.50	0.45	0.50	−0.02	−1.93
With college education	0.13	0.33	0.10	0.30	0.03[b]	4.07
With vocational education	0.35	0.48	0.35	0.48	0.00	0.47
Machine operator (ISCO 82)	0.35	0.48	0.35	0.48	−0.00	−0.17
Annual (primary) wage	214,968	132,948	215,047	130,459	−79.32	0.03
Total annual wages	228,866	134,376	228,930	128,441	−64.07	0.02
1996–1999 average Annual Wage	203,870	122,648	204,146	122,658	−276.18	0.12

[a] Expressed in years.
[b] Indicates significance at the 5% level.
Values are expressed in year 2000 Danish kroner. Negative trend at workplace is an indicator variable that takes 1 if the total employment of worker i's workplace declined at least 5% compared to year 1998. A worker is "treated" or "exposed" if she or he holds a primary employment in a firm with domestic production of MFA goods as of 1999. A worker is in the control group if employed in other T&C firms as of 1999.

wages are to a great extent determined by collective wage bargaining agreements, covering 85% of all wage and salary earners (Visser, 2013).

III. Empirical Strategy

A causal relationship between trade and workers' outcomes is derived by exploiting the exogenous trade shock due to China's accession to the WTO, which triggered the removal of the MFA quotas for China. I start with measuring differential labor market outcomes among workers under direct threat of increased competition through the quota removals in comparison to other textile workers using a simple difference in differences (DID) analysis as follows:

$$\ln X_{it} = \alpha_0 + \alpha_1 CompExp_i^Z \times Post02_t + \delta_i + \tau_t + \epsilon_{it}, \quad (1)$$

where $Post02_t = 1$ when year $\geqslant 2002$ and 0 otherwise. X_{it} is worker i's outcome in year t. $CompExp_i^Z$ is the worker-level measure of exposure to competition where superscript $Z = \{D, C\}$ indicates whether it is defined as a discrete, D, or a continuous, C, variable. The year 1999 is used to determine workers' subsequent exposure to the quota removal to limit any anticipation effects. The discrete treatment variable, $CompExp_i^D$, takes the value of 1 if in 1999, worker i was employed in a firm that domestically manufactured a product that with China's entry into the WTO was subject to the abolishment of the MFA quotas for China, and 0 otherwise. The continuous treatment variable, $CompExp_i^C$, is the revenue share of these goods at worker i's employer in 1999. This way, exposed workers employed at firms domestically producing quota products with a small share of revenue would be given less weight than exposed workers whose workplaces concentrated heavily on domestic MFA good production. The treatment variable is interacted with a time indicator for China's post-WTO accession years, $Post02_t$, to capture the variation in the outcome variable between pre- and postshock years specific to exposed workers compared to other textile workers.[17]

The aggregate trends in the industry and the labor market are controlled for by using year fixed effects, τ_t. It is possible that workers employed by the exposed firms were systematically different from the rest of the T&C workers or that the exposed firms were different from other T&C firms. All time-invariant differences across workers and across their initial firms such as gender, occupation, age, education, initial wage, and organizational and technological structure of the initial firms were controlled for by worker fixed effects, δ_i. The coefficient estimates for α_1 measure the impact of the trade shock on workers' outcomes due to the textile quota abolishments for China in the years after its entry into the WTO.

In a firm-level analysis, Utar (2014) shows that the MFA quota removal for China leads to a significant decline in employment. In the presence of labor market frictions, the displaced workers from these firms are likely the ones who experience disproportionate decline in their earnings. But they will also switch to other jobs and subsequently partially or fully compensate for their initial loss. Equation (1) is at the worker level, following workers who were employed in

[17] The empirical strategy builds on the observation that firms affected by the two removals largely overlapped. Utar (2014) reports that 87% of the firms that produced goods subject to 2002 quota removal (phases I to III) also produced goods subject to phase IV removal.

the sector as of 1999 wherever they go as they adjust to the shock. However, if workers leave the labor market altogether, the logarithmic transformation of the dependent variables potentially leads to underestimation of the average impact captured by α_1. In order to address this and disentangle the impact across different jobs that workers hold subsequently in different sectors and examine the nature of adjustment frictions, I divide the sample into pre- (1999–2001) and post- (2002–2010) WTO accession periods and use the following baseline regression:

$$\tilde{X}_{is} = \beta_0 + \beta_1 CompExp_i^Z \times Post02_s + \beta_2 Post02_s + \delta_i + \epsilon_{is}, \quad s = 0, 1, \tag{2}$$

where $s = 0$ and $s = 1$ indicate the pre- and postshock periods, respectively. In this regression, $\tilde{X}_{is}$ is the cumulative outcome variable (e.g., the wage earnings of worker i over the 1999–2001 [$s = 0$] and 2002–2010 [$s = 1$] periods). Since zero observations are potentially an important part of the adjustment analysis, instead of taking logarithmic transformations of the earnings and hours variables, all long-run earnings and hours worked variables are expressed in multiples of worker i's own 1996–1999 average annual earnings and hours worked, respectively. More specifically, $\tilde{X}_{i0} = \frac{\sum_{t=1999}^{2001} X_i}{\overline{X_i}}$, $\tilde{X}_{i1} = \frac{\sum_{t=2002}^{2010} X_i}{\overline{X_i}}$, where $\overline{X_i}$ is the average of X_i over 1996 to 1999. As before, $Post02_s$ takes 1 during the postshock period ($s = 1$), and δ_i denotes worker fixed effects.

The cumulative outcome contains the sum of shocks over the periods of abolishment and afterward. The estimates of β_1 will capture the cumulative impact of the low-wage import shock specific to exposed workers over the nine postshock years in comparison to other workers employed in the same initial industry. Once the long-run effect is captured with an estimate of β_1, I examine workers' adjustment by decomposing β_1 across different jobs or labor market positions that workers hold subsequent to the shock.

An important challenge for empirical strategies relying on industry-wide import measures to identify the impact of trade with China is that industries subject to greater import competition may be exposed to other shocks that can be correlated with trade with China. For example, advances in communication technology or in transportation that lower the cost of offshoring would affect labor-intensive industries more, driving up their import from China disproportionately. The empirical strategy here is free from this potential contamination because it uses within-industry across-firm differences in exposure to trade with China due to a discrete policy change. Additionally, I separately estimate equation (2) across smaller subsamples and use only within-occupation, within-education group differences in exposure to the shock among the textile workers. These estimates can be viewed as a lower bound of the impact of low-wage competition because they are conditioned out of the general declining trend of the industry, even if this is partly caused by trade factors.[18]

IV. Import Competition from China and Workers' Adjustment

A. *Average Impact on Workers' Earnings and Employment*

Table 2 presents two DID coefficient estimates of equation (1), discrete and continuous, for every dependent variable. The estimation sample contains workers born between 1943 and 1982 with primary employment in the textile and clothing sector in 1999. I focus on workers with nonzero annual earnings in this analysis and use logarithmic transformation of the dependent variables. These are annual labor earnings, annual income, hourly wages, annual hours worked, and the fraction of time spent as unemployed within a year. The unemployment variable is adjusted by adding 1 before taking the logarithm so that workers with no unemployment are included. The analysis addresses whether workers in the labor market experience decline in earnings due to the shock and if this is through decline in hourly wages or reduced hours worked, or both. However, to the extent that the import shock leads to long-term unemployment or pushes workers out of the labor market, the selection will lead to underestimation of the full impact in equation (1). While equation (2) will address this, to limit the effect of selection in this specification, table 2 presents estimation of equation (1) with data averaged across pre- and postshock periods (panel B) in addition to the estimation with yearly data (panel A). Zero valued income and earnings are included when calculating the averages.[19]

Results in panel A show that workers directly threatened by the removals of import quotas for China experienced a significant decline in annual earnings relative to other textile workers. Focusing on panel B, the decline in annual earnings from workers' primary employment is 5.4% (column 1). When utilizing additional cross-sectional variation in the degree of exposure to the shock with the continuous treatment variable, the coefficient −0.15 (panel B, column 2, hence forth B, 2) shows that a worker in a firm with half its revenue from products subject to the quota removal experiences a 7.5% decline in annual wage compared to a worker whose firm was not producing these products. (Henceforth all letter and number notations, e.g., B, 2, refer to table panel number and column number.) The impact on total labor earnings, the sum of all wages from all jobs held within a year, is also significant, showing a 3.7% decline on average (B,3). Unemployed workers receive

[18] It is also possible that the decline in prices of quota goods as a result of the shock depresses prices of nonquota goods or that labor shed by the quota-producing firms causes decline in labor market opportunities of other textile workers. All of these factors would potentially lead to underestimation of the effect.

[19] See the online appendix, section 4, for an alternative approach, where the analysis is conducted with the dependent variables normalized by the workers' own preshock values of the outcome variables.

TABLE 2.—IMPACT OF THE CHINESE IMPORT SHOCK ON EARNINGS, INCOME, EMPLOYMENT, AND UNEMPLOYMENT

Sample Period, 1999–2009	Dependent Variable											
	Annual Wage		Total Annual Earnings		Personal Income		Annual Hours Worked		Hourly Wage		Annual Unemployment	
$Z =$	(1) D	(2) C	(3) D	(4) C	(5) D	(6) C	(7) D	(8) C	(9) D	(10) C	(11) D	(12) C
A. Annual data												
$CompExp_i^Z \times Dum02_t$	−0.049***	−0.127***	−0.035***	−0.089**	−0.012	−0.015	−0.043***	−0.125***	0.009*	0.043**	0.106***	0.358**
	(0.011)	(0.038)	(0.008)	(0.030)	(0.006)	(0.021)	(0.007)	(0.025)	(0.004)	(0.016)	(0.031)	(0.109)
N	106,752	106,752	106,752	106,752	106,752	106,752	103,024	103,024	103,024	103,024	106,752	106,752
B. Data aggregated into two (pre- and post-) periods												
$CompExp_i^Z \times Dum02_s$	−0.054***	−0.149**	−0.037**	−0.096*	−0.013	−0.014	−0.054***	−0.163***	0.004	0.026	0.179***	0.552***
	(0.016)	(0.057)	(0.013)	(0.048)	(0.007)	(0.023)	(0.007)	(0.025)	(0.005)	(0.018)	(0.046)	(0.162)
N	20,958	20,958	20,958	20,958	20,958	20,958	20,466	20,466	20,466	20,466	20,958	20,958
Sample Period, 1990–1999	Falsification Tests: Presample Period											
C. Annual data												
$CompExp_i^Z \times Dum95_t$	0.011	0.049	0.005	0.020	0.001	−0.002	0.006	0.021	−0.004	−0.016	−0.014	−0.073
	(0.012)	(0.041)	(0.010)	(0.034)	(0.008)	(0.029)	(0.007)	(0.024)	(0.005)	(0.017)	(0.032)	(0.113)
N	89,910	89,910	89,910	89,910	89,910	89,910	84,282	84,282	84,282	84,282	89,910	89,910
D. Data aggregated into two (pre- and post- phases liberalization) periods												
$CompExp_i^Z \times Dum95_s$	0.005	0.019	0.006	0.021	−0.002	−0.020	0.013	0.042	0.002	0.009	−0.050	−0.116
	(0.016)	(0.058)	(0.013)	(0.046)	(0.010)	(0.036)	(0.008)	(0.027)	(0.006)	(0.021)	(0.044)	(0.155)
N	19,848	19,848	19,848	19,848	19,848	19,848	18,742	18,742	18,742	18,742	19,848	19,848

Estimation of equation (1). All regressions include year and worker fixed effects. A constant is included but not reported. All dependent variables are in logarithmic form and are listed in the table. The unemployment variable is defined as the fraction of working time that a person spent as unemployed within a year measured in per mille. One is added to this measure before taking the log. Robust standard errors clustered at worker level are reported in parentheses. Significant at *5%, **1%, and ***0.1%.

compensating benefits from unions and the government, and adjustment to the shock could also involve self-employment or early retirement. Examining the impact on personal income (columns 5 and 6), which includes self-employment, personal business income, pension income, unemployment insurance, government transfers, and other cash benefits, as well as labor income, shows around a 1% decline and indicates that these compensating benefits, on average, largely cover the loss in annual labor earnings caused by the trade shock.

The negative effect on labor earnings could be due to a decline in hourly wages or a decline in the number of hours worked within a year or both. Results on annual hours worked and hourly wages (columns 7–10) show that the trade shock causes decline in labor earnings through a decline in hours worked, not of hourly wages. The reduction in the number of hours worked is not a voluntary development, as evidenced by the significant increase in the annual unemployment (columns 11 and 12).

To ascertain that the results are not driven by potential existing trends that for some reason are felt disproportionately among quota-producing firms or among their employees, I follow the workers backward in time and estimate equation (1) in a presample period of 1990 to 1999. In this analysis, every variable is defined as before except the postshock dummy, which is replaced with a dummy, *Dum*95, that takes 1 on and after 1995. The period 1995 to 1999 spans phase I and II removals, as well as the import liberalization for Eastern European goods, so any potential effects of these events would be captured. As shown in panel C of table 2, there is no disproportionate impact of such events on workers subsequently exposed to the competition with China. In panel D, the same analysis is executed with data averaged over the two periods (pre- and post-1995). The results are not driven by potential pretrends.[20]

The literature on trade adjustment (Artuc et al., 2010; Utar, 2009; Autor et al., 2014) emphasizes frictions that slow workers' movement toward growing sectors. It is also possible that workers face hurdles after making the transition to a growing sector. It is a friction that has not been in focus in the literature so far. In the following, we take a closer look at displaced workers' experience to understand the relative importance of both types of friction.

B. Trade-Induced Moving across Jobs within and between Sectors

I now separate the initial effect of the shock from the subsequent adjustment of workers and focus on workers' adjustment to the shock. In the remainder of the paper, I use the continuous treatment measure to assess the economic magnitudes of the impact of import competition and compare workers at the 25th and the 75th percentile of exposure.[21] First, cumulative variables are constructed for each worker by summing workers' annual earnings, employment, and annual hours worked in their primary employment over the pre- and postshock years of the sample period.[22] To separate the initial impact of the trade shock from workers' subsequent adjustment to it, I decompose the cumulative earnings, employment, and annual hours across different jobs that workers hold throughout the period: at their initial employers, at other employers in the T&C industry, in other manufacturing industries, in the service sector, and in all other sectors, which includes agriculture, fishing, mining, and construction. Changes in workers' cumulative outcomes due to trade are estimated via equation (2). Table 3 shows the estimates of the DID coefficient β_1 in equation (2) for the dependent variables indicated in the panel and column headings. If a worker has kept her initial job throughout 2000 to 2010, the dependent variables in columns 2 to 6 are all 0 for this worker. Since all potential sources of employment and labor earnings are covered, coefficients of the cumulative outcome variables in columns 2 through 6 will sum to the overall trade effect in column 1 by construction.

The results show that the competition from China causes a decline in earnings over the nine years of $-3.133 \times 0.284 = 89\%$ of a preshock annual wage (A,1 of table 3).[23] Results in column 2 show that a much stronger negative effect on earnings of 130% of a preshock annual wage was experienced at the initial employer, which was then partly compensated for over the decade. The partial recovery happened mainly by workers' movement to service sector jobs (A,5). Competition leads to higher earnings from services amounting to $2.376 \times 0.284 = 67\%$ of a preshock annual wage. Earnings recovery within the initial industry, on the other hand, is quite limited (column 3) and statistically insignificant.

To disentangle intersectoral movement frictions from adjustment frictions experienced within the destination sectors, I use two employment measures. The main variable is cumulative hours worked, the sum of annual hours worked in primary employment over pre- and postshock years. Then I use an employment indicator variable that takes 1 if a worker is registered with a primary employment with positive earnings in the November record. The cumulative employment variable shows the number of years a worker is employed

[20] These results are confirmed by the alternative approach in the online appendix, section 4.

[21] The 75/25 percentile difference compares a textile worker initially employed at a firm with 28.4% of the 1999 revenue in domestically produced quota goods with another textile worker whose firm does not produce any quota product. The remainder of the paper uses the 75/25 percentile difference in assessing the magnitude of estimates from the continuous treatment.

[22] Descriptive statistics of these variables are presented in table 3 in the online appendix.

[23] Since the coefficients obtained with the discrete exposure variable show the economic magnitudes transparently, I provide these coefficients in brackets in table 3. In column 1, the coefficient -0.81 in brackets means that on average, exposed workers have 81% of a preshock annual wage less cumulative earnings over the postshock years because of competition.

TABLE 3.—WORKERS' RECOVERY ACROSS JOBS WITHIN AND BETWEEN SECTORS

	All Employers (1)	Initial Firm (2)	Other T&C (3)	Other Manufacturing (4)	Service (5)	Other (6)
A. Cumulative labor earnings (in initial annual wage)						
$CompExp^C \times Post02$	**−3.133*** **	−4.555***	0.256	−0.593	2.376***	−0.617**
	(0.761)	(0.324)	(0.245)	(0.335)	(0.671)	(0.200)
	[**−0.810**]	[−1.191]	[0.039]	[−0.145]	[0.602]	[−0.115]
B. Cumulative employment						
$CompExp^C \times Post02$	**−0.184**	−3.721***	0.474***	−0.032	3.213***	−0.118
	(0.174)	(0.180)	(0.135)	(0.143)	(0.200)	(0.064)
	[**−0.011**]	[−0.924]	[0.098]	[0.008]	[0.823]	[−0.016]
C. Cumulative hours worked (in initial annual hours worked)						
$CompExp^C \times Post02$	**−1.857*** **	−4.180***	0.329	−0.297	2.483***	−0.192
	(0.373)	(0.223)	(0.187)	(0.211)	(0.342)	(0.100)
	[**−0.456**]	[−1.062]	[0.055]	[−0.068]	[0.655]	[−0.036]

Estimations of equation (2). DID coefficient estimates for $CompExp^D \times Post02$ are provided in brackets. All regressions include worker fixed effects, the post-WTO accession period indicator, *Post*02, and a constant. In panels A and B, the number of observations is 21,022. In panel C, the number of observations is 20,860. Cumulatie effect estimates across all jobs are shown in bold and broken down into its components in columns 2 to 6. Robust standard errors clustered at the worker level are reported in parentheses. Significant at *5%, **1%, and ***0.1%.

regardless of how long that employment is within a year, while the measure for cumulative hours worked takes into account the length of that employment if shorter than one full year. The result in B,1 shows that competition makes no significant difference to the number of years employed over nine years after the first abolishment of quotas. On the other hand, the estimate in B,2 shows that the competition from China causes a significant loss of employment of workers at their initial (exposed) employers amounting to one year. Affected workers offset their employment loss at the initial firm by moving across jobs within their initial industry, but to a much larger extent by moving to the service sector (B,3 and B,5). Switching jobs within the initial industry does not help recovery of earnings losses either (panel A).

Though there is no significant impact on the cumulative years of employment, the coefficient in C,1 shows that the China shock causes a significant decline in the cumulative number of hours worked, amounting to 53% (1.857×0.284) of initial annual hours worked.[24] What is the reason for that? Exposed workers experience a disproportionate decline in hours worked at the initial, exposed firms amounting to 1.2 preshock years of hours worked, which is similar to the loss experienced at the initial firm in terms of years of employment. Exposed workers also work relatively more hours in service sector jobs following the trade shock. However, comparing the estimates in B,5 and C,5 indicates that exposed workers work fewer hours per year of employment in the service sector. Results presented in the online appendix on hours worked per year of employment confirm this. Workers' earnings per year of employment also decreases once workers move to the service sector due to competition, as a comparison of the earnings and employment effects at the initial firm and at the service sector indicates. Although the service sector is the main destination for the displaced workers, workers move to a less well-paying situation there. They earn less due to a lower number of hours worked in service sector jobs (A,5 and C,5).[25]

Next, equation (2) is estimated separately for each postshock year from 2002 on. In these regressions, the cumulative outcome variable for the preabolishment years is the same as before, but the cumulative outcome for the post-WTO accession years is the cumulative sum of the outcome variables from 2002 until the year of the regression. The DID coefficient estimates from the decomposition analysis are displayed in Figure 2a. After the first few years, finding employment in the initial industry is not a viable option for workers to compensate for their initial employment loss, and from 2005 onward, the service sector rises as the main absorber of displaced workers. It is also clear that other manufacturing jobs are never, even initially, an important source of employment recovery.

Figure 2b shows that as opposed to the effect of trade on cumulative employment, the overall effect on cumulative hours worked declines continuously over the nine postshock years. When the effects on cumulative employment and hours worked at the service sector in figure 2 are seen together, the important adjustment friction comes into sharper focus. Moving to the service sector is not a smooth transition. It does not secure a full recovery in hours worked.

Where do workers move within the service sector? In the online appendix (table 6), I show that workers overwhelmingly move to the wholesale and retail trade sectors. Results in the online appendix on reallocation between detailed manufacturing industries show that there is no major reallocation toward any specific manufacturing industry.

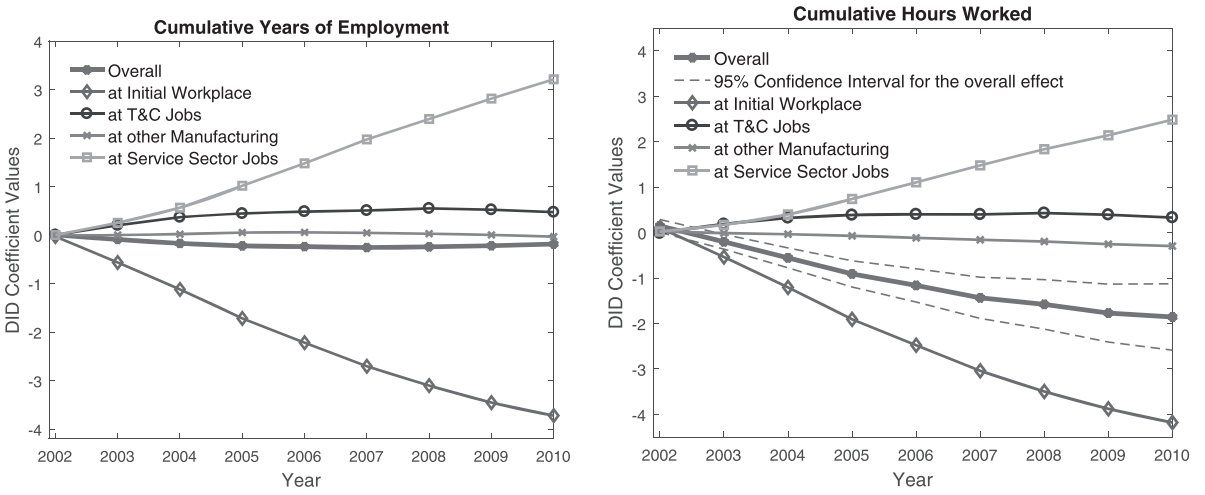
C. *The Service Sector: A Safe Shore, Fraught with Perils*

Despite increased employment in the service sector in response to increased import competition, workers experience reduced hours worked per year of employment in these jobs, so either the service jobs that exposed workers take

[24] The discrete difference between exposed and nonexposed workers amounts to 46% of initial annual hours worked (the coefficient −0.46 in the brackets).

[25] Also see table 5 in the online appendix.

FIGURE 2.—YEAR-BY-YEAR IMPACT OF TRADE ON THE CUMULATIVE EMPLOYMENT



(a) Impact on Cumulative Years with Employment (b) Impact on Cumulative Hours Worked

Estimation of equation (2) using the continuous exposure measure, $CompExp^C$.

TABLE 4.—PART-TIME JOBS OR FREQUENT UNEMPLOYMENT DISRUPTIONS IN THE SERVICE SECTOR?

	(1)	(2)	(3)	(4)
Panel A	All Types Service Jobs	Full-Time Service Jobs	Part-Time Service Jobs	Unknown Types Service Jobs
Dependent variable: Cumulative earnings in the service sector				
$CompExp^C \times Post02$	2.376***	2.508***	−0.134	0.002
	(0.671)	(0.650)	(0.106)	(0.002)
Dependent variable: Cumulative employment in the service sector				
$CompExp^C \times Post02$	3.213***	3.128***	0.076	0.008
	(0.200)	(0.193)	(0.055)	(0.005)
Dependent variable: Cumulative total labor income in the service sector				
$CompExp^C \times Post02$	3.265***	3.296***	−0.146	0.054
	(0.647)	(0.614)	(0.124)	(0.033)
		Depending on the sector of last employment		
Panel B	All Unemployment Spells	Textile	Manufacturing	Service
Dependent variable: Cumulative Unemployment Spells (expressed in months)				
$CompExp^C \times Post02$	3.368***	0.671	−0.323	3.185***
	(0.677)	(0.455)	(0.236)	(0.451)

Estimations of equation (2). The number of observations is 21,022 in all regressions. All regressions include a constant, the postshock period indicator, and worker fixed effects. Robust standard errors clustered at worker level are reported in parentheses. Significant at *5%, **1%, and ***0.1%.

must be mostly part-time or the displaced exposed workers must experience frequent unemployment in the service sector, or both.[26] I use IDA information on job types to further decompose the cumulative earnings and employment obtained in the service sector into full-time and part-time service jobs and estimate the effect of import competition on these job types using equation (2) (table 4, panel A). Here, estimates in column 1 will be equivalent to column 5 of table 3 for the respective variables. Since part-time workers may hold several jobs simultaneously, in addition to primary earnings, the total labor income in the service sector is also added in this analysis. This shows that the competition-induced earnings and employment gain in the service sector is entirely driven by full-time jobs. The trade shock thus leads to movement of workers toward full-time, not part-time, service sector jobs.

Next I estimate the impact on cumulative unemployment spells: the summation of unemployment spells within a year (measured in months) during pre- and postshock years for each worker (panel B of table 4). The competition causes unemployment (B,1). The increase in cumulative unemployment spells for a textile worker at the 75th percentile of exposure a decade after the shock amounts to one month more than the increase experienced by a textile worker at the 25th percentile. I then decompose the cumulative unemployment spells depending on the last sector of employment before the unemployment spell and estimate the effect separately across sectors (columns 2 to 4). This shows that import

[26] Farber (2005) uses the U.S. Displaced Workers Survey and documents that from 2001 to 2003, 13% of workers displaced from full-time jobs were reemployed in part-time jobs.

competition induces unemployment spells especially within the service sector.[27]

In the online appendix, figure 2 shows the yearly evolution of the impact of the trade shock on the cumulative unemployment spells. Trade-induced cumulative unemployment increases until 2007 and then starts declining. This shows that the trade effect is not convoluted by the effects of the Great Recession. Unemployment after moving to the service sector increases rapidly through 2003 to 2005 and becomes the only source of trade-induced unemployment by 2010.[28]

Thus, the results so far show that import competition causes (a) workers to move to the service sector, predominantly to (b) full-time jobs in the service sector, with (c) fewer hours worked annually in the service sector, and (d) with spells of unemployment within the service sector. A picture emerges that exposed workers have difficulty in keeping stable employment in the service sector and that the main problem is frequent unemployment spells between full-time service sector jobs. These findings put a spotlight on the adjustment frictions that workers face, as they seek to adapt to a new type of work following a trade shock and highlight the difficulty in making such a transition even in an environment with a relatively low unemployment rate and full-time jobs available.

V. Heterogeneity in Workers' Adjustment to the Trade Shock

A broad sector switch is likely to render the part of a worker's human capital tied to the original sector obsolete (Neal, 1995; Parent, 2000; Poletaev & Robinson, 2008), and this may be behind the problem experienced after moving to the service sector. To pin down the determinants of workers' adjustment frictions, in this section I study heterogeneity in the adjustment paths of workers with different sensitivity to the potential loss of human capital reflected in their education and occupation.[29]

A. Education and Workers' Adjustment

Workers are sampled according to their highest attained education, and equation (2) is estimated separately across workers with different education levels: college education, vocational education, and at most a (nontechnical) high school diploma. The DID coefficient estimates are presented in column 1 of table 5. As in section IVB, the impact on cumulative earnings and hours worked is decomposed into its additive components at the initial firm, other T&C jobs, non-T&C manufacturing jobs, service sector jobs, and other sectors (columns 2–6).

The impact of the low-wage import shock is not homogeneous across workers with different education levels. The negative impact increases with lower education (panels A–C, column 1). College-educated textile workers exposed to the shock do not have significant long-run changes in earnings and hours worked, but exposed workers with vocational and high school education experience significant declines in cumulative earnings of 44% and 143% of a pre–shock annual wage.

The impact of the shock at the initial employer is negative and significant for workers of all levels of education (column 2). In fact college-educated workers incur larger earnings losses at the initial employer than workers with less education (table 5, A.I,2). The coefficient −7.10 means that if not for the trade shock, exposed college-educated workers would have earned an additional 200% of a preshock annual wage at their initial firms. For workers with vocational and high school education, the effects are 122% and 111%, respectively. The effect on earnings may be larger for the college educated because, absent the shock, they would have experienced a steeper earnings profile at the initial workplace.[30]

For all education levels, the main reason for the negative effect on earnings at the initial firm is shortened tenure there, as evidenced by the results on the cumulative hours worked. For college-educated workers, the trade shock causes a decline in hours at the exposed firm of 140% of preshock annual hours worked (A.II,2), and for vocational and high-school-educated workers, the effects are 120% and 110%, respectively.

If the shock affects workers similarly at their exposed employer regardless of education level, the difference in outcome over the following decade stems from their ability to compensate afterward. The shock increases the likelihood of switching to service sector jobs regardless of workers' education (column 5), and service sector employment is the main source of employment recovery for workers at all education levels. For the college educated, the estimates in A.I,2 and A.I,5 indicate that the trade-induced sector switch may even be a blessing in disguise, as the earnings gain in the service sector due to competition amounts to 235% of a preshock annual wage, slightly more than the wage loss due to shortened tenure in the initial firm (200%). But for workers without a college education, employment in the service sector does not offer a full recovery from the initial impact. As the broad sector switch involves organizational and technological changes, these results are in line with the idea that highly educated workers have a comparative advantage in adjusting to new knowledge and technologies

[27] Additional analysis, available on request, shows that most of the unemployment spells experienced in the service sector are short term.

[28] The online appendix also contains average annual evolutions of unemployment spells across sectors (see figures 5 and 6), showing that the trade-induced unemployment within the initial industry started subsiding after 2003.

[29] Results on additional dimensions of heterogeneity including workers' age are presented in the online appendix.

[30] Topel (1991) emphasizes the importance of firm-specific human capital and the idea that such firm-specific knowledge is more important among the higher-educated workers.

TABLE 5.—TRADE ADJUSTMENT COSTS AND WORKERS' EDUCATION

	(1) All Employers	(2) Initial Firm	(3) Other T&C	(4) Other Manufacturing	(5) Service	(6) Other
Sample: College Educated Workers ($N = 2{,}398$)						
A.I Cumulative Labor Earnings (in initial annual wage)						
$CompExp^C \times Post02$	**0.18**	−7.10***	0.84	−1.92*	8.36***	0.01
	(2.323)	(1.350)	(1.453)	(0.900)	(1.634)	(0.173)
A.II Cumulative Hours Worked (in initial annual hours worked)						
$CompExp^C \times Post02$	**1.03**	−4.98***	0.51	−0.77	6.21***	0.06
	(1.453)	(0.694)	(1.037)	(0.817)	(1.060)	(0.162)
Sample: Workers with Vocational Schooling ($N = 7{,}352$)						
B.I Cumulative Earnings (in initial annual wage)						
$CompExp^C \times Post02$	**−1.55***	−4.30***	0.56	−0.20	2.66***	−0.26
	(0.636)	(0.435)	(0.343)	(0.382)	(0.570)	(0.196)
B.II Cumulative Hours Worked (in initial annual hours worked)						
$CompExp^C \times Post02$	**−2.08*****	−4.14***	0.60*	−0.31	2.06***	−0.29
	(0.456)	(0.365)	(0.286)	(0.288)	(0.429)	(0.183)
Sample: Workers with at most a High School Diploma ($N = 10{,}774$)						
C.I Cumulative Earnings (in initial annual wage)						
$CompExp^C \times Post02$	**−5.04*****	−3.91***	−0.25	−0.70	0.79	−0.97**
	(1.264)	(0.372)	(0.277)	(0.539)	(1.168)	(0.358)
C.II Cumulative Hours Worked (in initial annual hours worked)						
$CompExp^C \times Post02$	**−2.66*****	−3.91***	−0.00	−0.25	1.68**	−0.17
	(0.554)	(0.305)	(0.215)	(0.293)	(0.539)	(0.145)
Sample: Workers with Manufacturing Specific Vocational Schooling ($N = 2{,}590$)						
D.I Cumulative Earnings (in initial annual wage)						
$CompExp^C \times Post02$	**−2.67**	−5.04***	−0.63	−1.64**	4.64***	−0.01
	(1.644)	(0.694)	(1.322)	(0.624)	(1.052)	(0.212)
D.II Cumulative Hours Worked (in initial annual hours worked)						
$CompExp^C \times Post02$	**−2.65***	−4.43***	−0.40	−1.20**	3.41***	−0.02
	(1.133)	(0.592)	(0.975)	(0.452)	(0.755)	(0.181)
Sample: Workers with Service Related Vocational Schooling ($N = 5{,}366$)						
E.I Cumulative Earnings (in initial annual wage)						
$CompExp^C \times Post02$	**0.70**	−3.80***	0.95*	0.01	3.67***	−0.13
	(0.767)	(0.538)	(0.373)	(0.455)	(0.736)	(0.213)
E.II Cumulative Hours Worked (in initial annual hours worked)						
$CompExp^C \times Post02$	**−0.40**	−3.71***	0.85**	0.08	2.49***	−0.12
	(0.589)	(0.439)	(0.313)	(0.445)	(0.538)	(0.176)

All regressions include worker fixed effects, the post-WTO accession period indicator, *Post*02, and a constant. Cumulatie effect estimates across all jobs are shown in bold and broken down into its components in columns 2 to 6. Robust standard errors clustered at the worker level are reported in parentheses. Significant at *5%, **1%, and ***0.1%.

(Bartel & Lichtenberg, 1987). This all suggests that results at the region, industry, and firm level can lead to the erroneous conclusion that college-educated workers are immune to the negative employment effect of trade shocks. What I show here is that successful adjustment to the shock is the primary reason for the different long-run outcomes between college and non-college-educated workers.[31]

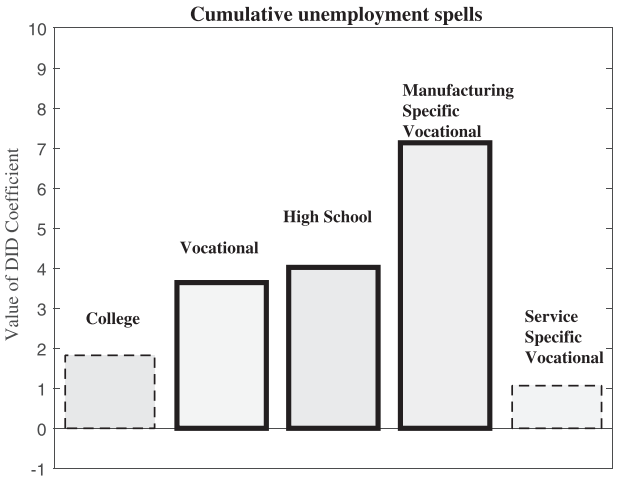
Vocationally educated workers adjust better in the service sector than high-school-educated workers. They compensate for 50% (2.06/4.14) of their initial earnings losses and 62% (2.66/4.30) of their initial employment in terms of hours worked; these numbers are 43% and 20% for the high-school-educated. As in many other European countries, vocational education is an important institution for nonacademic education in Denmark. After nine years of obligatory schooling, typically three to four years of education is offered in a wide variety of vocations. It combines formal school periods with practical apprenticeships, giving an intermediate level of education for specific vocations. While college education increases the adaptability of workers, vocational education carries a risk for workers of losing their investment in human capital if it is specific to their initial industry. But these are highly skilled workers, and the education could help them adapt to new environments, especially if their training is not specific to the manufacturing industry.

I further partition the sample of vocationally educated workers and analyze their adjustment depending on whether the field of vocational education is specific to manufacturing (e.g., textile operator, cutting machine operator, garment technician) or service related (e.g., office worker, technical designer, decorator, IT technician).[32] The results in the last four rows of table 5 reveal substantial heterogeneity among

[31] Autor, Dorn, and Hanson (2015) show at the aggregate level that the effect of Chinese imports on local labor markets tends to be stronger for non-college-educated employment. At the firm level, Utar (2014) finds that the negative effect of the import shock is concentrated on non-college-educated employees.

[32] Not all vocational education topics can be unambiguously classified as manufacturing or service focused, and the analysis excludes such cases.

FIGURE 3.—TRADE-INDUCED UNEMPLOYMENT AND WORKERS' EDUCATION



The dependent variable is the cumulative unemployment spells expressed in months. Estimation of equation (2) with the continuous exposure measure, $CompExp^C$, across education samples as indicated by bar headings. Bars with solid frames indicate statistical significance at or below the 5% level. All regressions include worker and period fixed effects.

vocationally trained workers. Workers educated for manufacturing specific vocations incur large earnings losses due to forgone opportunities not only at the initial firm but also at other manufacturing jobs, where their human capital is a better fit. A decade after the shock, these workers still have significantly less employment because of the competition, amounting to 75% of preshock annual hours worked. In contrast, workers with service-focused vocational education suffer no significant change in cumulative hours despite a substantial loss of employment at the initial firm. This is not only because of more successful adjustment in the service sector but also because other T&C jobs provide a path of compensation for them, which resonates with the trade-induced restructuring in this industry away from manufacturing toward service activities (Utar, 2014).

Figure 3 shows the effect of the shock on the cumulative unemployment spells across workers with different education. Workers with service-focused vocational education fare best in avoiding unemployment, followed by college-educated workers. Competition-induced unemployment is the most severe not on the least educated (workers with at most a high school diploma) but on workers with manufacturing-focused vocational education. Results presented in the online appendix decompose the unemployment effect depending on the last sector of employment and show that unemployment is mainly experienced following a service sector employment, and only workers with service-specific vocational education fully escape the trade-induced unemployment in the service sector. These results establish that not only the level (Dix-Carneiro, 2014) but also the field of education are important determinants of trade-induced adjustment costs.

Education is not the only component of human capital; occupational experience is another. The effect of the occupational experience component of workers' human capital on their adjustment to the trade shock is studied next.

B. *Occupation-Specific Human Capital and Workers' Adjustment*

The sample is partitioned according to workers' 1999 occupations, and equation (2) is estimated separately for managers, professionals and technicians, clerks, craft workers, machine operators, and laborers. Figure 4a presents the DID coefficient estimates for cumulative earnings from all employment (top) and from the initial employer (bottom).[33] Over the decade following the import shock, competition from China causes large significant declines in earnings among craft workers and machine operators, but not among clerks and service workers or managers (top). Professionals and technicians even benefit from this shock, as witnessed by significantly higher cumulative earnings amounting to 120% of a preshock annual wage. Workers with elementary occupations incur large negative earnings losses, but the effect is statistically insignificant, implying heterogeneous outcomes within the group. These results reveal substantial heterogeneity in the impact of the low-wage import shock on workers with different occupations.

The overall effect of the shock on workers with different occupations clearly depends on differences in success of adjustment to the initial shock rather than differences in initial impact (compare top and bottom of Figure 4a). The initial impact of the shock ranges across all occupations between 84% and 200% of an initial annual wage. The effects of the shock experienced by clerks and service workers, as well as operators and assemblers, at their initial exposed workplaces are, for example, almost all the same—around 130% of a preshock annual wage. But while clerks recover this initial loss over the decade, machine operators incur an overall loss of 100% of a preshock annual wage (coefficient −3.7).[34]

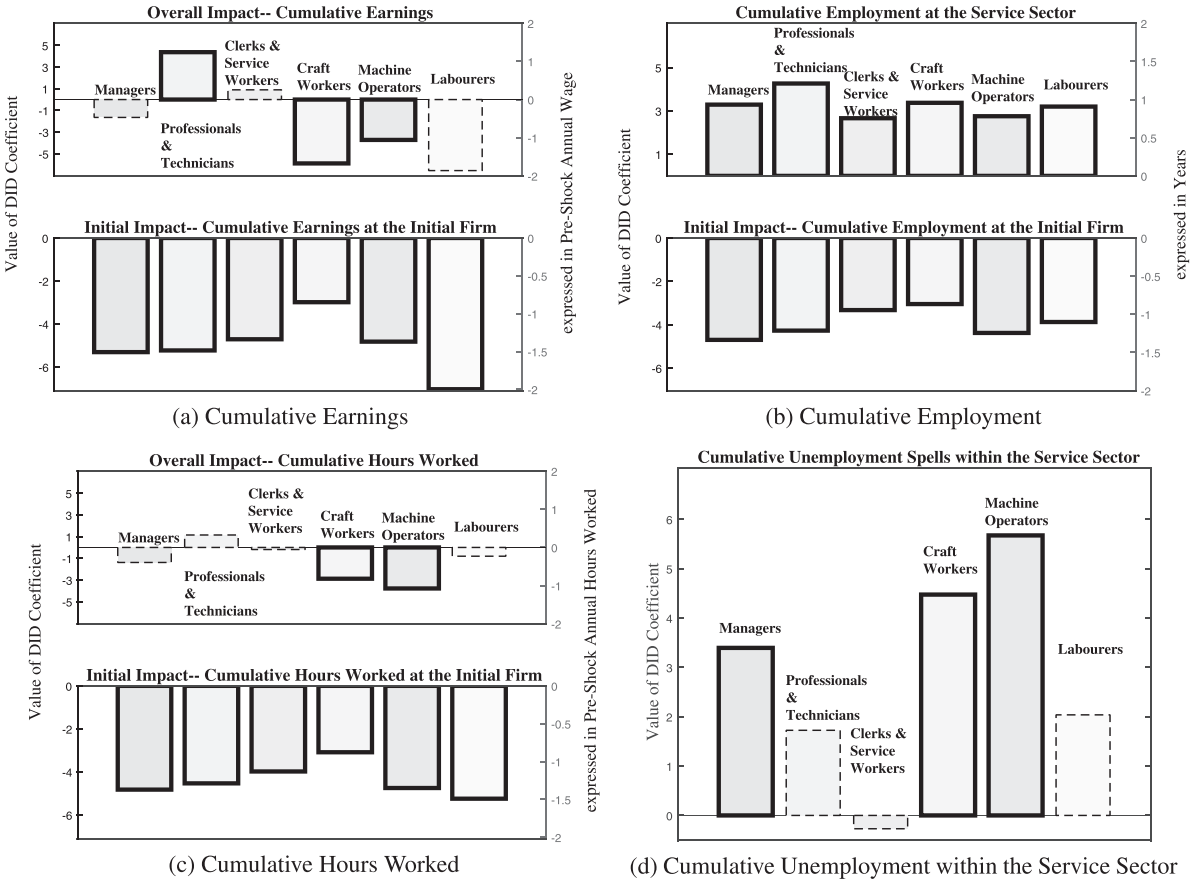
Competition also causes a significant decline in cumulative employment at the initial firm for all occupations (Figures 4b and 4c, bottom). Craft workers experience the smallest employment decline at the initial firm of 88% of preshock annual hours worked (Figure 4c, bottom). The largest effect is on manufacturing laborers with a decline of 150% of preshock annual hours worked.[35] At the same time, movement to the service sector is strong and similar across all occupations (Figure 4b, top). However, the success of workers in these service sector jobs varies across occupations. Professionals and technicians as well as clerks and service workers fully recover the hours lost at the exposed

[33] Occupation classifications follow International Standard Occupational Classification (ISCO-88) major groupings. Details are provided in the online appendix.

[34] Clerks and service workers include secretaries, office clerks, and security service personnel. Operators and assemblers include weaving, knitting, cutting operators, other machine operators, and assemblers. The vast majority are operators.

[35] This is in line with trade-induced decline in mass production and increased customization as documented in Utar (2014).

FIGURE 4.—WORKERS' OCCUPATION AND THEIR ADJUSTMENT



(a) Cumulative Earnings (b) Cumulative Employment

(c) Cumulative Hours Worked (d) Cumulative Unemployment within the Service Sector

Estimation of equation (2) with the continuous exposure measure, $CompExp^C$, across occupation samples as indicated by bar headings. Bar heights show the value of the DID coefficient for the corresponding sample. The dependent variables are given as the plot titles. Bars with solid frames indicate statistical significance at or below the 5% level. The numbers of observations are 1,066, 2,948, 2,730, 1,780, 9,106, and 1,812 from left (managers) to right (labourrs), respectively. All regressions include worker and period fixed effects. The right axis shows the coefficient values based on the 75/25 percentile exposure difference.

employer (Figure 4c), while machine operators and craft workers suffer significant cumulative loss of hours worked.

The occupations with the most successful recoveries are clerks and service workers. They were affected as badly as machine operators and assemblers at the exposed workplace, and yet their subsequent recovery was much better. Workers in this group compensate for their initial loss similarly well in other T&C jobs, other manufacturing firms, or in the service sector, as shown in detail in the online appendix. If the human capital accumulated through work experience is substantially specific to a firm or an industry, workers displaced from their jobs are likely to experience larger losses. Clerks are probably the occupation with the least industry-specific skills and have a high level of transferability especially compared to craftsmen and machine operators.[36]

The dependent variable in Figure 4d is the cumulative unemployment spells experienced within the service sector measured in months. It shows that unemployment after moving to the growing sector is concentrated among machine operators, craft workers, and managers—occupations sensitive to losing industry-specific human capital.

Autor et al. (2014) show that low-wage workers tend to stay within manufacturing, where they are repeatedly exposed to the import shock and identify being able to move out of manufacturing jobs as an important factor in determining the success of American workers' adjustment to the Chinese import shock. I show here that even if workers are able to move out of manufacturing jobs, they continue to incur significant costs in the form of job instability. That the match of workers' occupation-specific skills to subsequent service jobs is important to their recovery suggests that policies such as ALMP, which could facilitate entry into a new sector, may not be enough to provide smooth adjustments for all workers.

C. *Industry-Specificity of Occupation*

The previous results show that how specific a worker's occupation is to the exposed industry is critical to recovery. To pin down this effect, I construct a measure of

[36] Neal (1995) finds industry-specific knowledge to be an important part of human capital. My results show that the importance of industry-specific human capital in trade adjustment is occupation dependent. Some occupations are more sensitive to the loss of industry-specific knowledge than others.

TABLE 6.—TRADE ADJUSTMENT AND SPECIFIC HUMAN CAPITAL

Cumulative Labor Earnings (expressed in preshock annual wage) Obtained From:	All Employers (1)	Initial Firm (2)	Service (3)
Panel A			
$CompExp^C \times Post02$ (β_1)	1.42	−5.39***	6.23***
	(1.79)	(0.82)	(1.61)
$Post02 \times ManuSpec$ (β_3)	−3.69***	−1.22***	−2.98***
	(0.57)	(0.27)	(0.48)
$CompExp^C \times Post02 \times ManuSpec$ (β_4)	−7.33**	0.75	−6.61**
	(2.54)	(1.16)	(2.23)
N	19,550	19,550	19,550
Panel B			
$CompExp^C \times Post02$ (β_1)	−0.52	−4.75***	4.47***
	(1.03)	(0.46)	(0.92)
$Post02 \times TexSpec$ (β_3)	−4.26***	−1.08***	−3.03***
	(0.42)	(0.22)	(0.35)
$CompExp^C \times Post02 \times TexSpec$ (β_4)	−5.28*	−0.45	−4.78**
	(2.10)	(1.00)	(1.85)
N	19,550	19,550	19,550

Estimation of equation (3). All regressions include worker fixed effects, the postshock period indicator, Post02, and a constant. Robust standard errors clustered at worker level are reported in parentheses. Significant at *5%, **1%, and ***0.1%.

industry specificity for each four-digit ISCO occupation, j. I define an occupation's specificity to workers' initial industry, $IndSpec_j$, as the ratio of the number of workers with occupation j in the industry to the total number of workers with occupation j in the overall economy in the initial year, 1999. Since the adjustment frictions are mainly observed to be associated with the switch from the manufacturing to the service sector, I define two measures: one for the T&C industry, $TexSpec_j$, and the other for the overall manufacturing sector, $ManuSpec_j$.[37] I then map this information to the workers via their four-digit occupation in 1999 and estimate the following triple-difference equation.[38]

$$\tilde{X}_{is} = \beta_0 + \beta_1 CompExp_i \times Post02_s + \beta_2 Post02_s + \beta_3 Post02_s \times IndSpec_i + \beta_4 CompExp_i \times Post02_s \times IndSpec_i + \delta_i + \epsilon_{is}, \quad s = 0, 1. \tag{3}$$

The coefficient of interest, β_4, measures the variation in the cumulative outcome variable, $\tilde{X}_{is}$, of worker i particular to exposed workers with an initial occupation that is specific to the initial industry (relative to exposed workers with an industry nonspecific occupation) in the period after the shock.

Table 6 presents these results for cumulative earnings. Workers under direct exposure to the import shock have significantly larger losses the more specific their occupations are to the entire manufacturing sector. Columns 2 and 3 present the effect at the initial firm and the service sector. The impact at the initial firm does not depend on whether a worker's occupation is specific to manufacturing, but the earnings recovery at the service sector does not materialize with a purely manufacturing specific occupation. The significant differences in cumulative earnings between manufacturing specific occupations and other, less specific, occupations are entirely due to the difference in adjustment to the shock. Results in panel B on the T&C specificity of occupations show similar but not stronger patterns.

These results show that an occupation's specificity to manufacturing in general is a more important determinant of adjustment costs than the specificity of occupations to their initial industry within manufacturing.[39] They establish that a worker's successful adjustment depends crucially on the degree to which her human capital is either relevant to work in the service sector or is lost because of the trade shock.

D. Trade-Induced Skill Upgrading at the Worker Level

So far I have shown that workers' adjustment costs are very heterogeneous with respect to workers' educations and occupations, and the lack of the right skill set is an impediment to recovery for workers whose human capital is specific to the sector they left. As the opportunity costs of time spent out of the labor market decrease for workers with depreciated human capital, this may induce workers to rebuild human capital through education. Workers can enroll in short-term or part-time education while partly being in the labor market or enroll in full-time education outside the labor market. In Denmark, workers receive an education allowance from the unemployment insurance (UI) if they enroll in school to increase their job prospects. Making use of this information, I analyze the effect of increased import competition with China on the number of years with school enrollment and estimate equation (2) with the dependent variable being cumulative years with education allowance. These results are shown in figure 5 with full results presented in the online appendix.

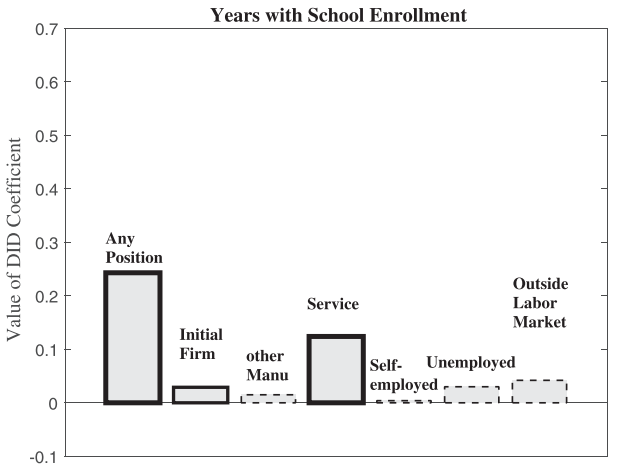
The first bar in Figure 5a shows that trade causes an increase in workers' school enrollment amounting to about a month. The dependent variable is then decomposed depending on the worker's primary labor market position in a given year and equation (2) is estimated separately across mutually exclusive positions. Trade induces workers to further their education mostly after they move to the service sector (figure 5a). This suggests that workers seek education to become better suited for jobs in their new work environment and implies that the trade shock's effect on school enrollment may depend on their existing education and skill gap. I test that by partitioning workers according to education and conducting the analysis separately across college, vocational, and high-school-educated workers (figure 5b). Workers increasingly seek further education the less educated they are initially. To further examine the role of skill

[37] More formally, $TexSpec_j = \frac{\text{Number of workers in occupation } j \text{ employed in T\&C as of 1999}}{\text{Total number of workers in occupation } j \text{ in 1999}}$, and $ManuSpec_j = \frac{\text{Number of workers in occupation } j \text{ employed in manufacturing as of 1999}}{\text{Total number of workers in occupation } j \text{ in 1999}}$.

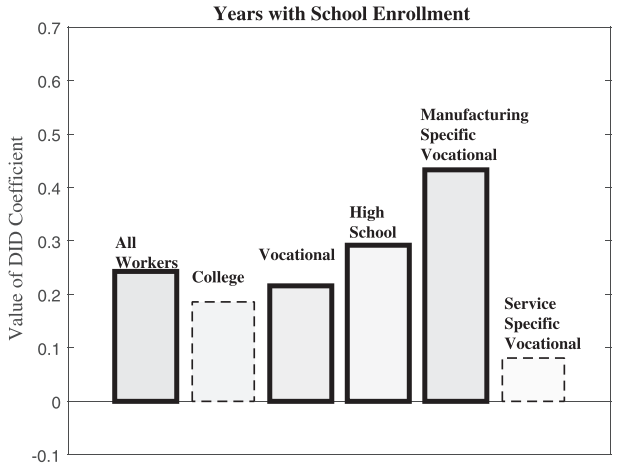
[38] The number of observations is fewer than the whole sample in this analysis because not all workers' four-digit occupation codes can be identified by administrative sources.

[39] See the online appendix for the full decomposition result, as well as the results on the cumulative years of employment and annual hours worked.

FIGURE 5.—IMPACT OF TRADE SHOCK ON SCHOOL ENROLLMENT



(a) Impact across different labor market positions



(b) Impact across workers with different initial education

In both panels, the height of each bar represents the value of the DID coefficient estimate of equation (2) with the continuous exposure variable. (a) The dependent variables are the cumulative years with education allowance conditional on worker's primary labor market position in that year. (b) Equation (2) is run across different education samples with the dependent variable is the cumulative years with education allowance. Bars with solid frames indicate statistical significance at or below the 5% level. All regressions include worker and period fixed effects.

mismatch, the sample of vocationally educated workers is divided as in section VA according to field of education, and the analysis is conducted separately for the manufacturing focused and service focused vocationally educated (the last two bars in the figure). Indeed the skill mismatch with the service sector is the main driver of trade-induced school enrollment. The import shock induces significantly more school enrollment among workers with manufacturing-specific vocational education, while it does not cause an increase among workers who already have service-focused vocational education. The impact among manufacturing-specific vocationally educated workers is almost twice the average effect. The incentive to rebuild human capital is strongest for those who are least able to retain their human capital in the service sector.

While recent studies provide evidence of skill upgrading at the firm level as a result of increased Chinese imports (Bloom et al., 2016; Utar, 2014), whether import competition can lead to skill upgrading at the individual level is an important unanswered question. My findings here point to a new and interesting channel through which imports from low-wage countries can shape the structure of advanced economies as not only firms but also individuals respond by upgrading their skills. Looking at a potential effect of trade on the supply of skill from a different angle, a recent study shows that export expansion triggered by the trade reforms in Mexico causes school dropouts (Atkin, 2016). Complementing this, my results provide evidence that the decline in labor demand due to increased import competition has caused increased school enrollment in Denmark.

An important question, which is out of scope of this paper, is what policies could ease such a response to a trade shock. Education is free in Denmark, and workers receive income support when unemployed. Table 2 indicates that workers were compensated by government transfers despite significant earnings losses. This is further confirmed by estimating equation (2) on personal income and government transfers across different labor market positions of workers (see the online appendix). Together these findings suggest that trade adjustment policies should particularly target workers with outdated skills. The role of such policies, however, would be best evaluated in a comparative study using harmonized cross-country data.

VI. Summary and Conclusion

The effect of increasing trade with China and other low-wage countries on advanced-country manufacturing industries and workers is a prominent topic of current public debate. With the decline of manufacturing employment in advanced economies, whether and how the transition of the most affected workers can be eased has become an important economic policy question. This paper studies the impact of a Chinese import shock on workers' earnings and employment trajectories in a European country with a generous social net and active labor market policies in a quasi-natural experiment that measures the causal effects of a trade policy change affecting a classic manufacturing industry. By directly comparing a clerk to a clerk or a machine operator to a machine operator that are all initially employed in the same industry but differ only by exposure to the trade shock, this study disentangles the effects of the trade shock from potentially important technology factors.

The increased import competition resulting from the abolishment of quotas for China had substantial negative effect on Danish workers' earnings and employment trajectories. Shorter employment spells at the initial firm and unstable subsequent employment interrupted by frequent unemployment are the main channels through which workers are affected by the trade shock. The service sector is the main absorber of displaced workers, and the ability of workers to

recover from the trade shock depends on how well suited they are for service sector jobs. Adjustment problems do not end once workers find full-time jobs in the growing sectors. Workers' ability to recover from the shock depends on the degree to which their human capital is either relevant to work in the service sector or is lost because of the trade shock. The results bring the distributional consequences of trade with low-wage countries into light. By showing that the trade shock increases incentives to acquire further education, this paper also provides the first worker-level evidence on skill acquisition in response to increased competition from China.

ALMPs combined with a relatively well-functioning unemployment insurance system may be one reason behind the mobility of Danish workers. The results suggest that effective ALMPs may ensure faster movement toward growing sectors, but this itself does not guarantee smooth adjustment. These findings shed light on the nature of difficulties that advanced countries face on the path of employment deindustrialization and inform policy makers about the most vulnerable.

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