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Centre for Economic Policy Research
77 Bastwick Street, London EC1V 3PZ, UK
Tel: (44 20) 7183 8801, Fax: (44 20) 7183 8820
Email: cepr@cepr.org, Website: www.cepr.org

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ABSTRACT

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JEL Classification: F1
Keywords: north-south trade imbalances, skill premia and skill upgrading

Rosario Crinò
CEMFI
Casado del Alisal 5
28014 Madrid
SPAIN

Email: crino@cemfi.es

For further Discussion Papers by this author see:
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Paolo Epifani
Università Bocconi
via Sarfatti 25
20136 Milano
ITALY

Email: paolo.epifani@unibocconi.it

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The Skill Bias of the US Trade Deficit*

Rosario Crinò† — CEMFI and CEPR

Paolo Epifani‡ — Bocconi University

March 2014

Abstract

We propose a theoretical foundation for a link between North-South trade imbalances and skill upgrading. We provide robust support for our theory using a panel of US manufacturing industries observed between 1977 and 2005. Our results suggest that the impact of the US trade deficit on the relative demand for skills within US industries may dominate that of alternative forces of change, such as trade liberalization, offshoring and technical change.

JEL Classification: F1; *Keywords*: North-South Trade Imbalances; Skill Upgrading; Skill Premia.

1 Introduction

In the past three decades, the US economy and a number of other developed and developing countries have experienced a dramatic rise in wage inequality. This fact has stimulated a vast theoretical and empirical literature pointing at skilled biased technical change (SBTC) and globalization as the basic forces behind the observed trends. Building on this literature, in this paper we illustrate a new mechanism whereby international trade may raise the relative demand for skills, provided that it is accompanied by global imbalances of the type recently experienced by the world economy.

To motivate our analysis, Figure 1 plots the US manufacturing trade balance as a share of GDP (dashed line) and the wage-bill share of non-production workers in manufacturing (solid line) between 1977 and 2005. The latter is a standard proxy for the relative demand

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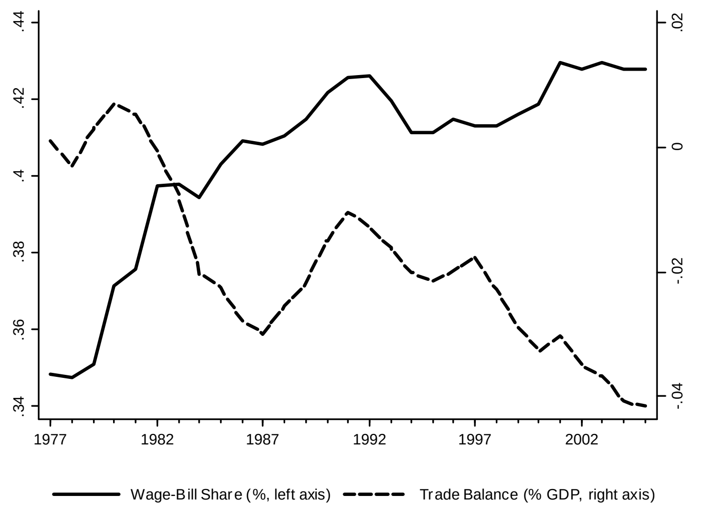
†Centro de Estudios Monetarios y Financieros (CEMFI), Casado del Alisal 5, 28014, Madrid (Spain). E-mail: crino@cemfi.es.

‡Department of Economics and BAFFI, Università Bocconi, Via Röntgen 1, 20136, Milan (Italy). E-mail: paolo.epifani@unibocconi.it.



The dashed line is the manufacturing trade balance of the US in percentage of GDP. The solid line is the average wage-bill share of non-production workers across 380 (6-digit NAICS) US manufacturing industries. Source: NBER Productivity Database and World Development Indicators.

Figure 1: Trade Imbalances and Relative Demand for Skills in US Manufacturing

for skills. The two variables are strongly negatively correlated, perhaps suggesting that the massive trade deficit accumulated by the US economy over the past 30 years may have led to skill upgrading in the manufacturing sector.[1]

In Section 2, building on Feenstra and Hanson (1996, henceforth FH) and Crinò and Epifani (forthcoming, henceforth CE) we formulate a simple general equilibrium theory that can naturally explain a positive association between manufacturing trade deficits and skill upgrading in a skill-rich country such as the US. In particular, we use a Heckscher-Ohlin model with a continuum of goods, as in Dornbusch, Fischer and Samuelson (1980, henceforth DFS80), in which we allow for trade imbalances, modeled as transfers as in Dornbusch, Fischer and Samuelson (1977) and more recently in Dekle, Eaton and Kortum (2007, 2008). In our model, the skill-rich North and the South produce a final nontraded good by assembling physical capital and a range of traded intermediate inputs. The latter are produced using physical capital and different combinations of high-skill and low-skill workers. The model implies that a Southern (Northern) trade surplus (deficit) leads to skill upgrading and a rise of the skill premium in both countries. The intuition behind this

[1] Following a terminology widely used in the empirical trade literature, in this paper we refer to skill upgrading as a within-industry increase in the relative demand for skills.

result is the same as for why North-South capital flows are skill biased in FH: a Southern trade surplus leads the South to expand (at the expense of a deindustrializing North) into a range of traded activities which are more skill intensive than the Southern average but less skill intensive than the Northern average, thereby inducing skill upgrading in both regions.

The mechanics behind our result are the following. A Southern transfer to the North reduces final expenditure in the South and raises it in the North. Given that physical capital is used to produce (also) the final (nontraded) good, and its rental price is therefore increasing in the domestic expenditure for the final good, it follows that a Southern trade surplus reduces the rental price of capital in the South relative to the North. Notice that these mechanics are essentially the same as in FH, where outsourcing reduces the Southern rental rate and increases Southern competitiveness relative to the North.

The empirical (and policy) implications of our analysis are however different. In Section 3, we therefore test our theory and compare it to competing explanations proposed in the empirical trade literature. Following most of this literature, we focus on the US economy, for which higher-quality and more detailed industry-level data are available. Using aggregate data for the overall manufacturing sector, drawn from the *NBER Productivity Database*, we start by showing that, consistent with our model and the evidence reported in Figure 1, our data feature a positive correlation between skill upgrading and the trade deficit, which holds strong even after controlling for standard proxies for offshoring, trade openness and technical change.

Next, following the methodology proposed by Feenstra and Hanson (1996, 1999), we use a panel of 380 (6-digit NAICS) US manufacturing industries observed between 1977 and 2005 to test whether sectorial trade deficits are associated with a systematic within-industry increase in the relative demand for skills. Consistent with the aggregate results, but now taking full advantage of the high level of industry detail in our data, we find a strong impact of sectorial trade deficits on skill upgrading within US industries. Moreover, in our data the estimated impact of trade imbalances on within-industry reallocations is larger and more robust than that of offshoring, trade liberalization and SBTC. Our results therefore suggest that the effect of trade imbalances may be no less relevant than that of competing explanations investigated in the empirical literature.

Our paper is related to a vast literature that documents the recent increase in the US skill premium and tries to pin down its main determinants (see Acemoglu and Autor, 2011, for a recent survey). Within this literature, we are not the first to point at the possible role played by the US trade deficit. Indeed, initial studies for the 1980's found the US trade deficit to have a strong impact on the relative demand for skills, thereby concluding that international trade was an important force of change. In particular, Murphy and Welch (1992) found that an increase in the US durable goods deficit equal to one percent of GNP reduces wages for young and less educated workers by roughly 3 percent while increasing the wages of older and more educated workers by 1 to 2 percent. Similarly, Borjas, Freeman and Katz (1991) argued that up to 25 percent of the observed increase in the college premium between 1980 and 1985 is due to the concomitant increase in the US trade deficit. Importantly, however, lacking a theoretical foundation for a link between trade deficits and the relative demand for skills, the early literature interpreted the above findings through the lens of the standard neoclassical trade model. This soon led to discredit the trade explanation in favor of SBTC (e.g., Bound and Johnson, 1992; Berman, Bound and Griliches, 1994), in particular because the Stolper-Samuelson theorem was seemingly inconsistent with the observation of skill upgrading in the US and rising skill premia in most trade liberalizing developing countries (Goldberg and Pavcnik, 2007). Our main aim is therefore to contribute to a recent rehabilitation of the trade explanation (initiated by FH and Bernard and Jensen, 1995, 1997) by illustrating a new mechanism, consistent with the early evidence, whereby trade *cum* imbalances can increase the relative demand for skills.[2]

As mentioned earlier, our paper is more closely related to Feenstra and Hanson (1996) and Crinò and Epifani (2013). FH were the first to notice that North-South capital flows may increase skill premia worldwide in a Heckscher-Ohlin model with a continuum of goods. CE were instead the first to notice that the same logic applies to North-South trade imbalances. Specifically, CE use a model similar the model in this paper (with a continuum of *final* instead of intermediate traded goods, as in Chun Zhu and Trefler, 2005, and without physical capital) to show that a Southern (Northern) trade surplus leads both countries to reallocate resources towards more (less) skill-intensive industries. This prediction is tested using a panel of more than 100 countries observed over three decades. Consistently, CE find strong evidence that a trade surplus leads to between-industry reallocations towards more or less skill-intensive industries depending on whether the country is skill poor or skill rich relative to the world economy. Importantly, CE

[2] Using firm-level data, Bernard and Jensen (1995, 1997) have documented the relevance of trade-induced between-firm reallocations. This has led to a rethinking of the early evidence in support of SBTC (based on highly aggregated industry-level data), according to which trade-induced reallocations were small. Moreover, Bernard and Jensen's findings have led to the new heterogeneous-firm paradigm, which provides new mechanisms whereby trade liberalization, even between identical countries, can increase the relative demand for skills (e.g., Yeaple, 2005; Verhoogen, 2008; Helpman, Itskhoki and Redding, 2010; Bustos, 2011). See also, *inter alia*, Epifani and Gancia (2006, 2008) for an analysis of the distributional implications of intra-industry trade, and Crinò (2009, 2010), Fontagné and d'Isanto (2013), Ebenstein, Harrison and McMillan (2013) and Ebenstein et al. (2013) for evidence on the distributional effects of offshoring. In particular, the latter two papers find trade to have a stronger impact on US wages than offshoring.

also find no evidence of a significant impact of FDI and trade in intermediate goods on between-industry reallocations after controlling for trade imbalances. Their analysis is however silent on the impact of international trade on within-industry reallocations, which instead are the main focus of the empirical trade literature studying the determinants of the recent increase in the relative demand for skills. In this paper we therefore complement our previous work by studying, theoretically and empirically, how trade imbalances may affect within-industry reallocations.

2 Theory

Overview In order to make our point that trade imbalances may lead to skill upgrading, in this section we illustrate a simple Heckscher-Ohlin setup *à la* DFS80 and FH featuring factor price differences (FPD) in the free-trade equilibrium. The model consists of two countries (a skill-poor South and the North, indexed by $c = s, n$) and three primary factors (high-skill labor H, low-skill labor L, and physical capital K). A nontraded final output Y is produced using a continuum of traded intermediate inputs (indexed by $z \in [0, 1]$) and physical capital. Intermediate inputs are instead produced using different combinations of the three primary factors. Finally, we allow for trade imbalances, modeled as a transfer T from the South to the North.

Technology All goods are produced under perfect competition and constant returns to scale. Specifically, final output Y_c is produced by assembling physical capital K_c and a continuum of traded intermediate inputs with the following Cobb-Douglas production function (expressed in logs):

$$\ln Y_c = \theta \int_0^1 \ln d_c(z) dz + (1-\theta) \ln K_{Y,c}, \tag{1}$$

where $d_c(z)$ and $K_{Y,c}$ are the units the of intermediate input z and physical capital used to produce final output, and $(1-\theta)$ is the output elasticity of capital.

Intermediate input z is produced with the following Cobb-Douglas production function:

$$q_c(z) = \left(\frac{H_c(z)}{\theta z}\right)^{\theta z} \left(\frac{L_c(z)}{\theta (1-z)}\right)^{\theta(1-z)} \left(\frac{K_c(z)}{1-\theta}\right)^{1-\theta}, \tag{2}$$

where $q_c(z)$ is the output, and $H_c(z)$, $L_c(z)$ and $K_c(z)$ are, respectively, the units of high-skill labor, low-skill labor and physical capital used to produce input z.

The unit cost function associated with (2) is

$$C_c(z) = w_{H,c}^{\theta z} w_{L,c}^{\theta(1-z)} r_c^{1-\theta} = \left(w_{L,c} s_c^z\right)^{\theta} r_c^{1-\theta},$$

where $w_{H,c}$ is the wage rate of high-skill workers, $w_{L,c}$ is the wage of low-skill workers, r_c is the rental price of capital, and $s_c = w_{H,c}/w_{L,c}$ is the skill premium. The unit cost of input z in the South relative to the North is thus

$$C(z) = \frac{C_s(z)}{C_n(z)} = w^{\theta} s^{\theta z} r^{1-\theta}, \tag{3}$$

where $w = w_{L,s}/w_{L,n}$ is the wage of Southern low-skill workers relative to Northern workers, $s = s_s/s_n$ is the Southern relative skill premium, and $r = r_s/r_n$ is the Southern relative rental price of capital. We assume that $s > 1$ in the free-trade equilibrium, which implies that $C(z)$ is upward sloping for given factor prices (see Figure 2).

Trade Pattern The trade pattern is pinned down by the borderline input z_s, defined by the condition

$$C(z_s) = w^{\theta} s^{\theta z_s} r^{1-\theta} = 1. \tag{4}$$

It follows that country c produces and exports all intermediate inputs $z \in I_c(z_s)$, where

$$I_c(z_s) = \begin{cases} [0, z_s), & c = s \\ (z_s, 1], & c = n \end{cases}.$$

Factor Market Clearing Consider labor markets first. Equation (2) and perfect competition imply industry z's cost (and revenue) shares of factors H, L and K to equal θz, $\theta(1-z)$ and $(1-\theta)$, respectively. Moreover, equation (1) and goods market equilibrium imply industry z's revenue to equal a constant share θ of world expenditure $E_w = E_s + E_n$. Thus, market clearing conditions for factors H_c and L_c can be written in value terms as

$$w_{H,c} H_c = \theta^2 E_w \int_{z \in I_c(z_s)} z dz = \theta^2 E_w z_c \omega_c, \tag{5}$$

$$w_{L,c} L_c = \theta^2 E_w \int_{z \in I_c(z_s)} (1-z) dz = \theta^2 E_w z_c \left(1 - \omega_c\right), \tag{6}$$

where

$$z_c = \begin{cases} z_s, & c = s \\ 1 - z_s, & c = n \end{cases},$$

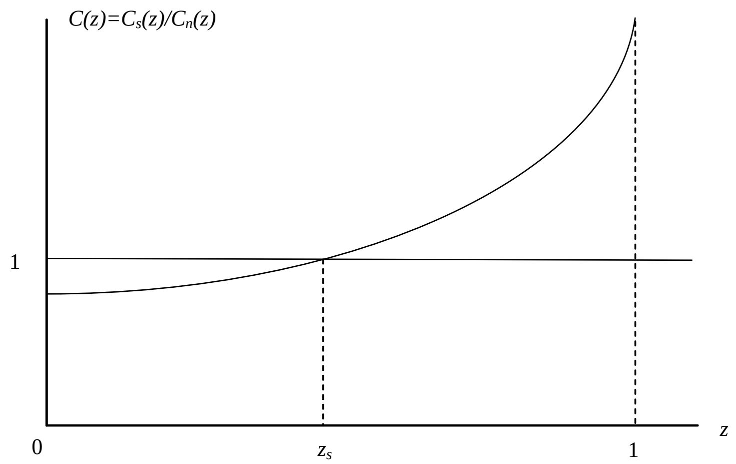


Figure 2: The Borderline Commodity

and

$$\omega_c = \frac{1}{z_c}\int_{z\in I_c(z_s)} z dz = \begin{cases} \frac{1}{2}z_s, & c=s \\ \\ \frac{1}{2}(1+z_s), & c=n \end{cases} \tag{7}$$

is the average wage-bill share of high-skill workers in the traded sector. Equation (7) highlights a key property of the model. Specifically, although Cobb-Douglas production functions in (2) imply that in each traded industry the wage-bill share of high-skill workers is constant and equal to $\theta z/(\theta z + \theta(1-z)) = z$, the average wage-bill share of high-skill workers in the traded sector, ω_c, is endogenous as it depends on z_s. It follows that in this model, consistent with the seminal insight by FH, skill upgrading (a rise in ω_c) does not require an exogenous technical change that increases z, as it can also be induced by a change in the trade equilibrium that leads to a rise in z_s.

Consider now the capital market. Perfect competition and (1) imply that in the final good sector capital expenditure equals a share $(1-\theta)$ of domestic expenditure E_c. Moreover, capital is used to produce intermediate inputs and, by (2), its cost equals a share $(1-\theta)$ of world expenditure on country c's inputs. The latter is equal to $\theta E_w z_c$ by (5) and (6). Hence we can write:

$$r_c K_c = (1-\theta)(E_c + \theta E_w z_c). \tag{8}$$

Finally, total income is given by

$$Y_c = w_{L,c}L_c + w_{H,c}H_c + r_c K_c = w_{L,c}L_c\left(1 + s_c h_c\right) + \left(1-\theta\right)\left(E_c + \theta E_w z_c\right). \tag{9}$$

Trade Imbalances We crucially assume that the South makes a transfer T to the North. A positive transfer ($T > 0$) is therefore equivalent to a trade surplus in the South, whereas a negative transfer ($T < 0$) corresponds to a trade surplus in the North. Trade imbalances also imply that expenditure does not equal income. In particular, we have that $E_s = Y_s - T$ and $E_n = Y_n + T$. Recalling that a share θ of total expenditure is on traded inputs, the trade (im)balance condition can be written as:

$$T = EXP_s - IMP_s = \theta\int_0^{z_s} E_n dz - \theta\int_{z_s}^{1} E_s dz = z_s\theta\left(Y_n + T\right) - \left(1 - z_s\right)\theta\left(Y_s - T\right),$$

where EXP_s (IMP_s) denotes Southern exports (imports). Thus, rearranging,

$$Y_s = \frac{z_s}{1 - z_s}Y_n - \frac{1-\theta}{\theta}\frac{T}{1 - z_s}. \tag{10}$$

General Equilibrium To characterize the general equilibrium properties of the model, we must express countries' incomes and relative factor prices as functions of z_s and model's parameters. To this purpose, note first that, taking the ratio of (5) to (6) and solving for the skill premium using (7) yields:

$$s_c = \frac{1}{h_c}\frac{\omega_c}{1-\omega_c} = \begin{cases} \frac{1}{h_s}\frac{z_s}{2-z_s}, & c = s \\ \\ \frac{1}{h_n}\frac{1+z_s}{1-z_s}, & c = n \end{cases}. \tag{11}$$

Thus,

$$s = \frac{s_s}{s_n} = \frac{z_s\left(1 - z_s\right)}{h\left(2 - z_s\right)\left(1 + z_s\right)}, \tag{12}$$

where $h = h_s/h_n$ is the Southern relative skill ratio.

Next, using (6) and (7) yields an expression for the relative wage of Southern low-skill workers:

$$w = \frac{w_{L,s}}{w_{L,n}} = \frac{z_s\left(1 - \omega_s\right)}{L\left(1 - z_s\right)\left(1 - \omega_n\right)} = \frac{z_s\left(2 - z_s\right)}{L\left(1 - z_s\right)^2}, \tag{13}$$

where $L = L_s/L_n$ is the Southern relative endowment of low-skill workers.

Moreover, using (8) and recalling that $E_s = Y_s - T$, $E_n = Y_n + T$ and $E_w = Y_s + Y_n$, we can express the relative rental rate as a function of the two countries' incomes:

$$r=\frac{r_s}{r_n}=\frac{1}{K}\frac{E_s+\theta E_w z_s}{E_n+\theta E_w\left(1-z_s\right)}=\frac{1}{K}\frac{\left(1+\theta z_s\right)Y_s+\theta z_s Y_n-T}{\left[1+\theta\left(1-z_s\right)\right]Y_n+\theta\left(1-z_s\right)Y_s+T}, \tag{14}$$

where $K=K_s/K_n$ is the Southern relative capital stock.

To find the equilibrium value of Y_s and Y_n note first that, using (11) in (9), and setting $w_{L,n}=1$ by choice of numeraire, we obtain:

$$Y_n=\frac{\frac{2L_n}{(1-z_s)\theta}+\left[\left(1-\theta\right)/\theta\right]T+\left(1-\theta\right)\left(1-z_s\right)Y_s}{1-\left(1-\theta\right)\left(1-z_s\right)}. \tag{15}$$

Solving (10) and (15) for Y_s and Y_n finally yields:

$$Y_n=\frac{2L_n}{\left(1-z_s\right)\theta^2}+\frac{1-\theta}{\theta}T,\quad Y_s=\frac{2L_n z_s}{\left(1-z_s\right)^2\theta^2}-\frac{1-\theta}{\theta}T. \tag{16}$$

Thus, using (16) in (14), gives:

$$r=\frac{1}{K}\frac{z_s-\frac{(1-z_s)^2\theta}{2(1+\theta)}\frac{T}{L_n}}{1-z_s+\frac{(1-z_s)^2\theta}{2(1+\theta)}\frac{T}{L_n}}. \tag{17}$$

Note that r is increasing in z_s. More importantly, r is decreasing in T and K for given z_s, thus implying that transfers and capital flows play a similar role in reducing Southern relative rental rate.

Finally, using (12), (13), and (17) in (4) to eliminate s, w and r from $C(z_s)$, and simplifying, yields:

$$C(z_s)=\frac{F(z_s)^\theta}{AL^\theta K^{1-\theta}h^{\theta z_s}}\left(\frac{z_s-\frac{(1-z_s)^2\theta}{2(1+\theta)}\frac{T}{L_n}}{1-z_s+\frac{(1-z_s)^2\theta}{2(1+\theta)}\frac{T}{L_n}}\right)^{1-\theta}, \tag{18}$$

where

$$F(z_s)=\frac{z_s^{1+z_s}\left(2-z_s\right)^{1-z_s}}{\left(1-z_s\right)^{2-z_s}\left(1+z_s\right)^{z_s}}$$

is a monotonically increasing function. Note that $h^{-\theta z_s}$ and r are also increasing in z_s (recall that $h<1$ and that the expression in brackets in 18 equals rK); it follows that $C(z_s)$ is monotonically increasing in z_s, and thus the equilibrium is unique.

Trade Imbalances, Offshoring and Skill Upgrading Equation (18) allows us to immediately show our main results. First, as in FH, a reallocation of capital from a capital-abundant North to the South (an increase in K) shifts the curve $C(z_s)$ downwards, inducing an increase in the equilibrium value of z_s and thus leading, by (7) and (11), to skill upgrading (a higher ω_c) and a higher skill premium s_c in both regions. The reason is that North-South capital flows reduce the Southern relative rental rate r, thereby increasing the competitiveness of Southern industry and allowing the South to produce and export a broader range of inputs.

Second, and more importantly, (18) implies that a transfer from the South to the North ($T > 0$) also shifts the curve $C(z_s)$ downwards, thereby producing similar effects. The reason is that a transfer reduces Southern expenditure on domestic capital, thereby reducing the rental rate. Conversely, a transfer from the North to the South ($T < 0$) shifts the curve $C(z_s)$ upwards, thus reducing z_s. The model therefore suggests a close and so far neglected relationship between trade imbalances, skill upgrading and skill premia.

3 Empirical Evidence

In this section, we look for a systematic relationship between trade imbalances and within-industry reallocations, as implied by our theory. To this purpose, we focus on a skill-rich country, the United States, and use data for a large panel of manufacturing industries observed over the last three decades (see Section 3.1). We start by showing that, in the overall manufacturing sector, larger trade deficits are associated with skill upgrading (Section 3.2). Then, we implement a well-established framework introduced by Feenstra and Hanson (1996, 1999), in order to fully exploit the industry detail of our data and provide more systematic evidence on the effects of trade imbalances on the relative demand for skills within industries (Section 3.3).

3.1 Data and Variables

In the spirit of FH, in our model there is one final-good sector, and all trade is in intermediate inputs produced with different skill intensities by countries endowed with different skill ratios. A rigorous test of the model would require highly disaggregated data on the traded activities, so as to proxy for the borderline input z_s. Unfortunately, as pointed out by Chun Zhu and Trefler (2005), at the level of detail at which trade data are usually reported, aggregation bias prevents from observing the borderline activity z_s in practice. Importantly, however, a crucial feature of our model is that, by (7), the average wage-bill share of high-skill workers in the traded intermediate activities, ω_c, only depends on the equilibrium value of the borderline input z_s, and is monotonically increasing. It follows that, even if we do not observe z_s, we can proxy for it using ω_c. This allows us to test our mechanism by studying how trade imbalances affect skill upgrading in a certain country.

To construct ω_c for the US, we use data on employment and wages of low-skill (production) and high-skill (non-production) workers, sourced from the *NBER Productivity Database*. Overall, we have information for 380 (6-digit NAICS) manufacturing industries between 1977 and 2005. For a given industry i and year t, the wage-bill share of high-skill workers is defined as $\omega_{i,t} = \left(\frac{w_H H}{w_H H + w_L L}\right)_{i,t}$, where H and L denote employment of non-production and production workers, respectively, while w_H and w_L indicate their wages. The same database provides us with a number of other variables used in our empirical analysis, namely real output, value added, capital stock, non-energy input purchases, and an index of Total Factor Productivity (TFP), which we use as a proxy for SBTC.

To measure trade imbalances, we merge these data with information on exports and imports at the industry level. In particular, we first retrieve trade data at the 4-digit level of the SITC Rev. 2 classification, from Feenstra et al. (2005) for the period 1977-2000 and from *UN Comtrade* for more recent years. Then, we convert these data into the 6-digit NAICS classification, using a correspondence table produced by Feenstra, Romalis and Schott (2002). The conversion leaves us with 380 industries spanning the entire manufacturing sector of the US.

Using these trade data, we compute the (normalized) trade deficit of each industry as the difference between imports and exports divided by value added, $T_{i,t} = \left(\frac{IMP-EXP}{VA}\right)_{i,t}$. In addition, we construct proxies for other factors that may lead to skill upgrading according to complementary theories. In particular, we proxy for trade liberalization using the openness ratio $OPEN_{i,t}$, defined as imports plus exports over industry value added. Moreover, following Feenstra and Hanson (1999), we proxy for offshoring using $MOS_{i,t}$, defined as the share of imported inputs in total non-energy input purchases.[3]

3.2 Results for the Aggregate Manufacturing Sector

We start by providing evidence of a strong positive association between trade deficits and skill upgrading using aggregate data for the overall manufacturing sector. In column (1) of Table 1, we regress the average wage-bill share of non-production workers in manufacturing on the average normalized trade deficit, using 29 yearly observations between 1977 and 2005. For comparability, we standardize the variables to have mean zero and standard deviation equal to 1. Consistent with our model, the coefficient on T_t is positive, precisely estimated and large, implying that a 1 standard deviation increase in the manufacturing trade deficit is associated with a rise of roughly 0.6 standard deviations in the average

[3] As standard in the empirical literature, we measure imported inputs as imports of products classified in Section 5 ("Chemicals and Related Products, NES"), Section 6 ("Manufactured Goods Classified Chiefly by Material"), or Section 7 ("Machinery and Transport Equipment") of the SITC Rev. 2 classification.

wage-bill share of high-skill workers.

In columns (2)-(4) we replace T_t with MOS_t, TFP_t and $OPEN_t$, respectively. The coefficients on these variables are positive and significant, suggesting that offshoring, SBTC and trade liberalization may also be associated with skill upgrading in manufacturing. In column (5), we repeat instead our baseline specification after adding linear and quadratic time trends, in order to check that the correlation between T_t and ω_t is not driven by underlying trends in the data, and to account for possible skill upgrading due to within-industry specialization driven by comparative advantage. Reassuringly, the coefficient on the trade deficit remains positive and highly significant. Finally, in column (6) we include all variables jointly. Strikingly, the coefficient on T_t is still positive and very precisely estimated, whereas the coefficients on the other variables become negative and, with the exception of MOS_t, statistically insignificant.

Overall these results suggest that, consistent with our theory, trade imbalances may be a crucial determinant of skill upgrading in the US. In the next section, we provide more systematic evidence using a well-consolidated approach that takes full advantage of the high level of industry detail in our data.

3.3 Industry-Level Analysis

As pointed out by Feenstra (2004, Ch. 4), the approach used in the previous section raises a degrees-of-freedom issue, as only one observation on ω_c is available in each year. The empirical literature therefore suggests to expand on the degrees of freedom by using detailed industry-level data instead of aggregate data for the traded sector, an approach to which we now turn.

Empirical Model As in Feenstra and Hanson (1996, 1999), we use our panel of 6-digit manufacturing industries to estimate fixed-effects regressions of the following form:

$$\omega_{i,t} = \phi_i + \phi_t + \phi_s \ln\left(w_H/w_L\right)_{i,t} + \phi_Y \ln Y_{i,t} + \phi_K \ln\left(K/Y\right)_{i,t} + \phi_T T_{i,t} + \varepsilon_{i,t}, \qquad (19)$$

where ϕ_i and ϕ_t denote industry and time fixed effects, respectively, $(w_H/w_L)_{i,t}$ is the skill premium, $Y_{i,t}$ is real output, $(K/Y)_{i,t}$ is the capital/output ratio, and $\varepsilon_{i,t}$ is a random disturbance. As is well know (see e.g. Feenstra, 2004, Ch. 4), (19) can be obtained by applying Shephard's lemma on a short-run translog cost function (a flexible functional form encompassing the Cobb-Douglas as a special case), where high-skill and low-skill labor are variable inputs, capital is a fixed production factor, and the trade deficit acts as a cost shifter.[4]

Before presenting our estimates, we note that this approach, while helping us to address a statistical problem, requires two important qualifications concerning the interpretation of the results. First, the general equilibrium mechanism whereby trade imbalances (or capital mobility), by changing factor prices, affect skill upgrading in our model (and in models *à la* Feenstra and Hanson more generally) may not be identifiable at the industry level if labor is highly mobile across industries. Although this may be a concern in the long run, it is less so in the short run, as intersectorial labor mobility seems sluggish in the US (Artuc et al., 2010).[5] It follows that sectorial imbalances are likely to induce temporary deviations of sectorial factor prices from the national norm that mimic on a smaller scale the aggregate long-run effects.

Second, our model implies that a trade deficit (surplus) induces skill upgrading in a skill-rich (skill-poor) country. When using disaggregated data to test this prediction for the US, we will thus search for a positive association between industry-level trade deficits and skill upgrading (i.e., our prior is that $\phi_T > 0$). Note, however, that industry-level trade imbalances may also reflect comparative advantage, given that manufacturing industries feature different skill intensities. Specifically, trade liberalization and specialization according to comparative advantage imply larger trade deficits in comparative disadvantage industries and larger trade surpluses in comparative advantage industries, and therefore no systematic industry-level correlation between imbalances and skill upgrading. Conversely, our theory suggests a systematic positive correlation between trade deficits and skill upgrading in a skill-rich country like the US.

Baseline Estimates The baseline estimates are reported in Table 2, where all variables are standardized to have mean zero and standard deviation equal to 1. In column (1) we estimate (19) by including only $T_{i,t}$. Consistent with our model and the results for the overall manufacturing sector, the trade deficit enters with a positive and statistically significant coefficient at the 1% level.

In columns (2)-(4) we include instead $MOS_{i,t}$, $TFP_{i,t}$ and $OPEN_{i,t}$, respectively. As expected, the coefficients on these variables are positive and significant. The results are broadly similar when including $T_{i,t}$ jointly with one of these variables (see columns 5-7), but the coefficient on offshoring is now smaller and significant only at the 10% level.

[4] Following a large empirical literature (e.g., Berman, Bound and Griliches, 1994, and Feenstra and Hanson, 1999), we will omit the skill premium $(w_H/w_L)_{i,t}$ from most of our specifications, in order to avoid introducing endogeneity. However, we will show that controlling for $(w_H/w_L)_{i,t}$ does not affect our main results.

[5] See also the discussion in Autor, Dorn and Hanson (2013) on this point.

In column (8), we include the four variables in the same specification. Except for the coefficient on offshoring, which is now insignificantly different from zero, the coefficients on the other variables are all significant at the 1% level and roughly similar in magnitude. Finally, in column (9) we show that the results are unchanged when also including the skill premium $(w_H/w_L)_{i,t}$. Interestingly, across all specifications, the coefficient on $T_{i,t}$ is close in size to that on $OPEN_{i,t}$ and $TFP_{i,t}$ and much larger than that on $MOS_{i,t}$.

Overall, these results suggest that trade imbalances matter a great deal for skill upgrading, and that their impact is empirically no less relevant than that of trade liberalization, offshoring or technical change. In the next sections, we submit these results to a number of robustness checks, using the regression in column (8) as our baseline specification.

Robustness Checks We start by addressing endogeneity concerns. In this respect, even if in our model trade imbalances are exogenous, in the real world they may either be jointly determined with the wage-bill share of high-skill workers (simultaneity bias) or arise as a consequence of skill upgrading (reverse causality). In particular, simultaneity bias may occur if $T_{i,t}$ and $\omega_{i,t}$ are jointly driven by variables that are omitted from our baseline specifications. An important concern in this respect is that changes in trade imbalances and skill upgrading may reflect underlying trends in the data, such as ongoing specialization driven by comparative advantage in more finely disaggregated industries. We deal with this issue in Table 3. In columns (1)-(7), we control for possible heterogeneous trends based on pre-existing industry characteristics. To this purpose, following Goldberg et al. (2010), we add full sets of interaction terms between the time dummies and the initial value of the industry characteristics indicated in columns' headings. The results are largely unchanged, except that $MOS_{i,t}$ enters with the wrong sign in one specification. In column (8) we follow instead a complementary approach by controlling for industry-specific linear trends. Note that the coefficients on $TFP_{i,t}$ and $OPEN_{i,t}$ are now imprecisely estimated, implying that both variables are dominated by a time trend. More importantly, the coefficient on $T_{i,t}$ remains positive and statistically significant at the 5% level.

Reverse causality may instead arise if some unobserved shocks induce skill upgrading within industries, and this in turn leads to the emergence of trade deficits. To fully control for these shocks we would need to include a whole set of industry-year dummies, but this would clearly be unfeasible as these dummies would be collinear with $T_{i,t}$. However, assuming that unobserved shocks are correlated with observed changes in some industry characteristics, we can implement a simple empirical strategy to assess how these shocks may affect our main results. In particular, following CE, we can divide industries into ten bins of equal size, based on the average change during the sample period in a number of observable characteristics. Then, we can create a dummy for each of these bins and interact it with the year dummies. By adding the full set of interactions to our specification, we thus control for shocks affecting in a similar way all industries that experienced similar developments in a given characteristic. Our coefficients of interest are identified only from the remaining variation within a given year across all industries that belong to the same bin. The results of these exercises are reported in columns (1)-(7) of Table 4. Each column's heading indicates the variable we use to construct the bins for that specification. Strikingly, our main results are confirmed across all these very demanding specifications. In column (8), we use instead a complementary approach by including a full set of 2–digit industry-year dummies. Our main evidence is preserved also in this case.

US-China Imbalances A final concern is that our results may be entirely driven by the US trade deficit with China, which accounts for more than one-third of the total manufacturing trade deficit of the US (see e.g. Deckle, Eaton and Kortum, 2007, 2008). To account for this, in Tables 5 and 6 we repeat our main specifications and robustness checks after dividing the normalized trade balance of each industry into the components accounted for by China ($TCH_{i,t}$) and the rest of the world ($TROW_{i,t}$). To construct $TCH_{i,t}$ and $TROW_{i,t}$, we rely on import and export data disaggregated by country of origin and destination, which are sourced from Schott (2008). These data are available for the period 1977-2005 at the 4-digit level of the SIC classification. Accordingly, we match them with the SIC-based version of the *NBER Productivity Database*. After merging the two data sets we are left with information for 333 4-digit SIC industries. As shown in column (1) of Table 5, the results for the overall trade deficit $T_{i,t}$ obtained on this sample of industries are similar to those obtained on the sample of 6-digit industries used in Tables 2-4. More importantly, across all specifications, the coefficients on $TCH_{i,t}$ and $TROW_{i,t}$ are positive, precisely estimated and similar in size. This implies that our findings are not driven by China, but hold true also for the US trade deficit with other countries.

4 Conclusion

It is well known that, according to the standard trade theory, international trade cannot directly increase the relative demand for skills within the manufacturing industries of a skill-rich country. Consequently, the vast literature documenting skill upgrading within US manufacturing industries pointed at skill-biased technical change as the main culprit. Yet, an early literature for the 1980s found trade deficits to strongly affect the relative demand for skills and the skill premium in the US. Building on Feenstra and Hanson (1996) and our earlier work (Crinò and Epifani, forthcoming), we have provided a theoretical underpinning for such a link. Specifically, we have argued that, just as offshoring in Feenstra and Hanson's framework, a Southern trade surplus leads the South to acquire (and the North to dismiss) a range of activities that are more (less) skill intensive than the Southern (Northern) average, thereby acting as a sort of skill-biased technical change which induces skill upgrading in both regions. Using data for a panel of US industries, we have found robust support for our theory. Moreover, we have found that the impact of trade deficits on the relative demand for skills seems stronger than that of trade liberalization, offshoring and TFP growth.

References

[1] Acemoglu, D. and D. Autor, 2011, "Skills, tasks and technologies: implications for employment and earnings," in (D. Card and O. Ashenfelter eds.) *Handbook of Labor Economics*, 4B, pp. 1043-1171.

[2] Artuc, E., S. Chaudhuri, and J. McLaren, 2010, "Trade shocks and labor adjustment: a structural empirical approach," *American Economic Review*, 100, pp. 1008-1045.

[3] Autor, D., D. Dorn and G. H. Hanson, 2013, "The China syndrome: local labor market effects of import competition in the United States," *American Economic Review,* forthcoming.

[4] Berman E., J. Bound and Z. Griliches, 1994, "Changes in the demand for skilled labor within U.S. manufacturing: evidence from the Annual Survey of Manufactures," *Quarterly Journal of Economics*, 109, pp. 367-397.

[5] Bernard, A. and J. B. Jensen, 1995, "Exporters, jobs, and wages in US manufacturing: 1976–87," *Brookings Papers on Economic Activity*: *Microeconomics*, pp. 67-112.

[6] Bernard, A. and J. B. Jensen, 1997, "Exporters, skill upgrading and the wage gap," *Journal of International Economics*, 42, pp. 3-31.

[7] Borjas, G., R. Freeman and L. Katz, 1991, "On the labor market effects of immigration and trade," *NBER Working Paper 3671.*

[8] Bound, J. and G. Johnson, 1992, "Changes in the structure of wages in the 1980's: an evaluation of alternative explanations," *American Economic Review*, 82, pp. 371-392.

[9] Bustos, P., 2011, "The impact of trade liberalization on skill upgrading. Evidence from Argentina," *Working Paper, CREI.*

[10] Chun Zhu, S. and D. Trefler, 2005, "Trade and inequality in developing countries: a general equilibrium analysis," *Journal of International Economics*, 65, pp. 21-48.

[11] Crinò, R., 2009, "Offshoring, multinationals and labour market: a review of the empirical literature," *Journal of Economic Surveys*, 23, pp. 197-249.

[12] Crinò, R., 2010, "Service offshoring and white-collar employment," *Review of Economic Studies*, 77, pp. 595-632.

[13] Crinò, R. and P. Epifani, "Trade imbalances, export structure and wage inequality," forthcoming in *The Economic Journal*.

[14] Dekle, R., J. Eaton and S. Kortum, 2007, "Unbalanced trade," *American Economic Review P&P,* 97, pp. 351-55.

[15] Dekle, R., J. Eaton and S. Kortum, 2008, "Global rebalancing with gravity: measuring the burden of adjustment," *IMF Staff Papers*, 55, pp. 511-540.

[16] Dornbusch, R., S. Fischer and P. Samuelson, 1977, "Comparative advantage, trade and payments in a Ricardian model with a continuum of goods," *American Economic Review*, 67, pp. 823-839.

[17] Dornbusch, R., S. Fischer and P. Samuelson, 1980, "Heckscher-Ohlin trade theory with a continuum of goods," *Quarterly Journal of Economics*, 95, pp. 203-224.

[18] Ebenstein, A., A. Harrison and M. McMillan, 2013, "Why are American workers getting poorer? China, trade and offshoring," paper presented at the *Factory-Free Economy Conference* (CEPREMAP, Paris, June 2013).

[19] Ebenstein, A., A. Harrison and M. McMillan and S. Phillips, 2013, "Estimating the impact of trade and offshoring on American workers using the Current Population Surveys," *Review of Economics and Statistics*, forthcoming.

[20] Epifani, P. and G. Gancia, 2006, "Increasing returns, imperfect competition and factor prices," *Review of Economics and Statistics*, 88, pp. 583-598.

[21] Epifani, P. and G. Gancia, 2008, "The skill bias of world trade," *Economic Journal*, 118, pp. 927-960.

[22] Feenstra, R. C., 2004, *Advanced International Trade: Theory and Evidence*, Princeton University Press

[23] Feenstra, R. C. and G. H. Hanson, 1996, "Foreign investment, outsourcing and relative wages," in (R. C. Feenstra *et al.* eds.) *The Political Economy of Trade Policy: Papers in Honor of Jagdish Bhagwati*, MIT Press, pp. 89-127.

[24] Feenstra, R. C. and G. H. Hanson, 1999, "The impact of outsourcing and high-technology capital on wages: estimates for the United States, 1979-1990," *Quarterly Journal of Economics*, 114, pp. 907-940.

[25] Feenstra, R. C., R. E. Lipsey, H. Deng, A. C. Ma, and H. Mo, 2005, "World trade flows: 1962-2000," *NBER Working Paper 11040*.

[26] Feenstra, R. C., J. Romalis, and P. K. Schott, 2002, "U.S. imports, exports and tariff data," *NBER Working Paper 9387*.

[27] Fontagné, L. and A. d'Isanto, 2013, "Fragmentation: survey-based evidence for France," paper presented at the *Factory-Free Economy Conference* (CEPREMAP, Paris, June 2013).

[28] Goldberg, P. K., A. K. Khandelwal, N. Pavcnik and P. Topalova, 2010, "Imported intermediate inputs and domestic product growth: evidence from India," *Quarterly Journal of Economics*, 125, pp. 1727-1767.

[29] Goldberg, P. K. and N. Pavcnick, 2007, "Distributional effects of globalization in developing countries," *Journal of Economic Literature*, 45, pp. 39-82.

[30] Helpman, E., O. Itskhoki and S. Redding, 2010, "Inequality and unemployment in a global economy," *Econometrica*, 78, pp. 1239-1283.

[31] Murphy, K. and F. Welch, 1992, "The structure of wages," *Quarterly Journal of Economics*, 107, pp. 285-326.

[32] Schott, P.K., 2008, "The relative sophistication on Chinese exports," *Economic Policy*, 23, pp. 5–49.

[33] Verhoogen, E., 2008, "Trade, quality upgrading and wage inequality in the Mexican manufacturing sector," *Quarterly Journal of Economics*, 123, pp. 489-530.

[34] Yeaple, S. R., 2005, "A simple model of firm heterogeneity, international trade and wages," *Journal of International Economics*, 65, pp. 1-20.

Table 1 - Estimates for the Aggregate Manufacturing Sector

Dependent Variable: Wage-Bill Share of Non-Production Workers, ω_t

	(1)	(2)	(3)	(4)	(5)	(6)
	Trade Deficit	Offshoring	TFP	Trade Openness	Trade Deficit & Time Trends	All Variables
T_t	0.584***				0.333***	0.688***
	(0.147)				(0.075)	(0.183)
MOS_t		0.809***				-1.763**
		(0.128)				(0.673)
TFP_t			0.630***			-0.154
			(0.139)			(0.093)
$OPEN_t$				0.880***		-0.092
				(0.104)		(0.443)
Observations	29	29	29	29	29	29
R-squared	0.34	0.65	0.40	0.77	0.92	0.95
Linear trend	no	no	no	no	yes	yes
Quadratic trend	no	no	no	no	yes	yes

All specifications are estimated on 29 yearly observations for the aggregate manufacturing sector of the US. The sample period is 1977-2005. *T* is trade deficit over value added. *MOS* is the share of imported inputs in total non-energy input purchases. *TFP* is the log TFP index, obtained as the weighted average of the industry-specific indexes, with weights given by the industries' shares in total manufacturing shipments. *OPEN* is log imports plus exports over value added. All coefficients are beta coefficients. Robust standard errors are reported in round brackets. ***, **, *: indicate significance at the 1, 5, and 10% level, respectively.

Table 2 - Industry-Level Regressions: Baseline Estimates

Dependent Variable: Wage-Bill Share of Non-Production Workers, $\omega_{i,t}$

	(1) Trade Deficit	(2) Offshoring	(3) TFP	(4) Trade Openness	(5) Trade Deficit and Offshoring	(6) Trade Deficit and TFP	(7) Trade Deficit and Trade Openness	(8) All Variables	(9) Controlling for the Skill Premium
$T_{i,t}$	0.080***				0.078***	0.071***	0.075***	0.067***	0.066***
	(0.012)				(0.012)	(0.012)	(0.012)	(0.011)	(0.011)
$MOS_{i,t}$		0.040***			0.026*			0.016	0.012
		(0.015)			(0.015)			(0.015)	(0.013)
$TFP_{i,t}$			0.071***			0.060***		0.053***	0.063***
			(0.011)			(0.011)		(0.011)	(0.010)
$OPEN_{i,t}$				0.083***			0.067***	0.056***	0.067***
				(0.019)			(0.018)	(0.017)	(0.016)
$\ln(K/Y)_{i,t}$	0.137***	0.133***	0.247***	0.131***	0.138***	0.234***	0.137***	0.224***	0.241***
	(0.018)	(0.018)	(0.025)	(0.018)	(0.018)	(0.025)	(0.018)	(0.025)	(0.023)
$\ln(Y)_{i,t}$	0.132***	0.098***	0.073**	0.094***	0.134***	0.112***	0.133***	0.118***	0.137***
	(0.029)	(0.030)	(0.029)	(0.029)	(0.029)	(0.028)	(0.029)	(0.029)	(0.027)
$\ln(w_H/w_L)_{i,t}$									0.200***
									(0.011)
Observations	10,875	10,875	10,875	10,770	10,875	10,875	10,770	10,770	10,770
R-squared	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Year FE	yes	yes	yes	yes	yes	yes	yes	yes	yes
Industry FE	yes	yes	yes	yes	yes	yes	yes	yes	yes

All specifications are estimated on a panel of 380 (6-digit NAICS) US manufacturing industries. The sample period is 1977-2005. T is trade deficit over value added. MOS is the share of imported inputs in total non-energy input purchases. TFP is the log TFP index. $OPEN$ is log imports plus exports over value added. K/Y is the capital/output ratio. Y is real output. w_H/w_L is the relative wage of non-production workers. All coefficients are beta coefficients. All regressions are weighted by the industries' shares in total manufacturing wage-bill in the year 1977. Robust standard errors are reported in round brackets. ***, **, *: indicate significance at the 1, 5, and 10% level, respectively.

Table 3 - Industry-Level Regressions: Controls for Underlying Trends

Dependent Variable: Wage-Bill Share of Non-Production Workers, $\omega_{i,t}$

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Wage-Bill Share	Trade Deficit	Capital-Output Ratio	Real Output	Offshoring	Trade Openness	TFP	Industry-Specific Time Trends
$Ti_{,t}$	0.066***	0.073***	0.044***	0.055***	0.067***	0.052***	0.063***	0.031**
	(0.012)	(0.012)	(0.010)	(0.011)	(0.011)	(0.011)	(0.011)	(0.013)
$MOS_{i,t}$	0.013	0.027*	0.027*	0.013	0.016	-0.028*	0.015	-0.036**
	(0.015)	(0.014)	(0.015)	(0.015)	(0.016)	(0.016)	(0.015)	(0.015)
$TFP_{i,t}$	0.054***	0.056***	0.116***	0.038***	0.053***	0.050***	-0.016	-0.005
	(0.011)	(0.011)	(0.012)	(0.011)	(0.011)	(0.011)	(0.016)	(0.011)
$OPEN_{i,t}$	0.047***	0.053***	0.052***	0.029*	0.058***	0.151***	0.036**	0.016
	(0.015)	(0.017)	(0.016)	(0.016)	(0.017)	(0.017)	(0.017)	(0.013)
$\ln(K/Y)_{i,t}$	0.193***	0.227***	0.221***	0.183***	0.224***	0.224***	0.189***	0.124***
	(0.025)	(0.025)	(0.023)	(0.024)	(0.025)	(0.025)	(0.025)	(0.022)
$\ln(Y)_{i,t}$	0.048	0.115***	0.035	0.060**	0.118***	0.137***	0.089***	-0.034
	(0.031)	(0.029)	(0.027)	(0.028)	(0.029)	(0.030)	(0.030)	(0.040)
Observations	10,770	10,770	10,770	10,770	10,770	10,770	10,770	10,770
R-squared	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.98
Year FE	yes	yes	yes	yes	yes	yes	yes	yes
Industry FE	yes	yes	yes	yes	yes	yes	yes	yes

Columns (1)-(7) include controls for heterogeneous trends based on pre-existing industry characteristics (coefficients unreported). These controls are obtained by interacting the time dummies with the initial value of the characteristics indicated in columns' headings. Column (8) includes instead a full set of industry-specific linear trends. All coefficients are beta coefficients. All regressions are weighted by the industries' shares in total manufacturing wage-bill in the year 1977. Robust standard errors are reported in round brackets. ***, **, *: indicate significance at the 1, 5, and 10% level, respectively. See also notes to previous tables.

Table 4 - Industry-Level Regressions: Controls for Contemporaneous Shocks

Dependent Variable: Wage-Bill Share of Non-Production Workers, $\omega_{i,t}$

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Wage-Bill Share	Trade Deficit	Capital-Output Ratio	Real Output	Offshoring	Trade Openness	TFP	Industry-Time Effects
$Ti_{,t}$	0.013*	0.037***	0.050***	0.044***	0.059***	0.066***	0.060***	0.062***
	(0.007)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
$MOS_{i,t}$	-0.020**	-0.038**	0.010	0.010	0.033*	0.013	0.014	0.006
	(0.008)	(0.015)	(0.015)	(0.014)	(0.018)	(0.013)	(0.015)	(0.015)
$TFP_{i,t}$	0.056***	0.053***	0.046***	0.029***	0.041***	0.051***	0.074***	0.059***
	(0.008)	(0.011)	(0.010)	(0.010)	(0.010)	(0.011)	(0.012)	(0.011)
$OPEN_{i,t}$	0.021**	0.045***	0.043***	0.049***	0.044***	0.068***	0.034**	0.027
	(0.009)	(0.015)	(0.015)	(0.014)	(0.016)	(0.021)	(0.015)	(0.017)
$\ln(K/Y)_{i,t}$	0.129***	0.245***	0.212***	0.148***	0.203***	0.204***	0.254***	0.251***
	(0.015)	(0.025)	(0.026)	(0.028)	(0.023)	(0.022)	(0.024)	(0.025)
$\ln(Y)_{i,t}$	0.003	0.146***	0.148***	-0.009	0.116***	0.095***	0.138***	0.140***
	(0.015)	(0.032)	(0.031)	(0.054)	(0.026)	(0.026)	(0.031)	(0.029)
Observations	10,770	10,770	10,770	10,770	10,770	10,770	10,770	10,770
R-squared	0.97	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Year FE	yes	yes	yes	yes	yes	yes	yes	yes
Industry FE	yes	yes	yes	yes	yes	yes	yes	yes

Columns (1)-(7) include controls for contemporaneous shocks (coefficients unreported). These controls are obtained by dividing industries into ten bins of equal size, based on the average change (over the estimation period) in the characteristics indicated in columns' headings. A dummy for each bin is then interacted with a full set of year dummies. Column (8) includes instead a full set of 2-digit industry-time effects. All coefficients are beta coefficients. All regressions are weighted by the industries' shares in total manufacturing wage-bill in the year 1977. Robust standard errors are reported in round brackets. ***, **, *: indicate significance at the 1, 5, and 10% level, respectively. See also notes to previous tables.

Table 5 - Industry-Level Regressions: US Trade Balance with China and the Rest of the World, Baseline Estimates

Dependent Variable: Wage-Bill Share of Non-Production Workers, $\omega_{i,t}$

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Trade Deficit (Overall)	Trade Deficit (China & RoW)	Offshoring	TFP	Trade Openness	Trade Deficit and Offshoring	Trade Deficit and TFP	Trade Deficit and Trade Openness	All Variables	Controlling for the Skill Premium
$T_{i,t}$	0.128***									
	(0.017)									
$TCH_{i,t}$		0.097***				0.094***	0.092***	0.084***	0.090***	0.096***
		(0.017)				(0.015)	(0.017)	(0.019)	(0.019)	(0.018)
$TROW_{i,t}$		0.065***				0.056***	0.063***	0.050***	0.055***	0.060***
		(0.012)				(0.012)	(0.012)	(0.018)	(0.017)	(0.015)
$MOS_{i,t}$			0.087***			0.050***			0.045**	0.039**
			(0.018)			(0.017)			(0.019)	(0.017)
$TFP_{i,t}$				0.041***			0.027***		0.044***	0.060***
				(0.010)			(0.010)		(0.014)	(0.013)
$OPEN_{i,t}$					0.130***			0.031	-0.004	-0.010
					(0.016)			(0.025)	(0.026)	(0.023)
$\ln(K/Y)_{i,t}$	0.188***	0.189***	0.187***	0.238***	0.186***	0.193***	0.227***	0.189***	0.259***	0.266***
	(0.018)	(0.018)	(0.019)	(0.023)	(0.018)	(0.019)	(0.023)	(0.018)	(0.028)	(0.027)
$\ln(Y)_{i,t}$	0.249***	0.250***	0.251***	0.166***	0.246***	0.279***	0.214***	0.251***	0.255***	0.243***
	(0.030)	(0.030)	(0.039)	(0.034)	(0.030)	(0.037)	(0.033)	(0.030)	(0.036)	(0.035)
$\ln(w_H/w_L)_{i,t}$										0.188***
										(0.012)
Observations	7,425	7,425	7,213	7,425	7,425	7,213	7,425	7,425	7,213	7,213
R-squared	0.97	0.97	0.96	0.97	0.97	0.96	0.97	0.97	0.96	0.97
Year FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Industry FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

All specifications are estimated on a panel of 333 (4-digit SIC) US manufacturing industries. The sample period is 1977-2005. *TCH* is the trade deficit with China over value added. *TROW* is the trade deficit with the rest of the world over value added. All coefficients are beta coefficients. All regressions are weighted by the industries' shares in total manufacturing wage-bill in the year 1977. Robust standard errors are reported in round brackets. ***, **, *: indicate significance at the 1, 5, and 10% level, respectively. See also notes to previous tables.

Table 6 - Industry-Level Regressions: US Trade Balance with China and the Rest of the World, Robustness Checks

Dependent Variable: Wage-Bill Share of Non-Production Workers, $\omega_{i,t}$

	Controls for Underlying Trends						Controls for Contemporaneous Shocks					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Real Output	Capital-Output Ratio	Offshoring	Trade Openness	TFP	Industry-Specific Time Trends	Real Output	Capital-Output Ratio	Offshoring	Trade Openness	TFP	Industry-Time Effects
$TCH_{i,t}$	0.075***	0.079***	0.085***	0.093***	0.099***	0.048*	0.086***	0.086***	0.080***	0.041***	0.089***	0.048***
	(0.019)	(0.019)	(0.020)	(0.020)	(0.019)	(0.027)	(0.018)	(0.020)	(0.019)	(0.015)	(0.019)	(0.016)
$TROW_{i,t}$	0.065***	0.044***	0.049***	0.046***	0.064***	0.046**	0.069***	0.061***	0.047***	0.036**	0.054***	0.034**
	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.018)	(0.016)	(0.017)	(0.017)	(0.017)	(0.017)	(0.016)
$MOS_{i,t}$	0.036*	0.050***	0.065***	0.055***	0.057***	-0.010	0.045***	0.034*	0.036*	0.002	0.033*	0.049***
	(0.019)	(0.018)	(0.019)	(0.019)	(0.018)	(0.018)	(0.017)	(0.019)	(0.021)	(0.016)	(0.018)	(0.017)
$TFP_{i,t}$	0.010	0.062***	0.043***	0.037***	0.022	-0.020	0.015	0.035***	0.028**	0.017	0.054***	0.029**
	(0.013)	(0.014)	(0.014)	(0.013)	(0.018)	(0.016)	(0.012)	(0.013)	(0.012)	(0.012)	(0.015)	(0.014)
$OPEN_{i,t}$	-0.029	-0.002	0.007	0.011	-0.032	-0.070**	-0.046*	-0.010	0.013	-0.025	-0.001	-0.024
	(0.025)	(0.027)	(0.027)	(0.027)	(0.027)	(0.032)	(0.025)	(0.026)	(0.025)	(0.026)	(0.026)	(0.025)
$\ln(K/Y)_{i,t}$	0.170***	0.249***	0.258***	0.247***	0.233***	0.154***	0.165***	0.216***	0.200***	0.196***	0.229***	0.169***
	(0.027)	(0.029)	(0.028)	(0.027)	(0.031)	(0.031)	(0.030)	(0.024)	(0.024)	(0.024)	(0.025)	(0.026)
$\ln(Y)_{i,t}$	0.202***	0.203***	0.261***	0.264***	0.216***	0.079	0.113**	0.255***	0.226***	0.272***	0.193***	0.177***
	(0.035)	(0.037)	(0.036)	(0.036)	(0.038)	(0.058)	(0.055)	(0.033)	(0.031)	(0.033)	(0.035)	(0.034)
Observations	7,213	7,213	7,213	7,213	7,213	7,213	7,213	7,213	7,213	7,213	7,213	7,213
R-squared	0.96	0.96	0.96	0.96	0.96	0.98	0.97	0.97	0.97	0.97	0.97	0.97
Year FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Industry FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

Columns (1)-(5) include controls for heterogeneous trends based on pre-existing industry characteristics (coefficients unreported), which are constructed as explained in the footnote to Table 3. Column (6) includes a full set of industry-specific linear trends. Columns (7)-(11) include controls for contemporaneous shocks (coefficients unreported), which are constructed as explained in the footnote to Table 4. Column (12) includes a full set of 2-digit industry-time effects. All coefficients are beta coefficients. All regressions are weighted by the industries' shares in total manufacturing wage-bill in the year 1977. Robust standard errors are reported in round brackets. ***, **, *: indicate significance at the 1, 5, and 10% level, respectively. See also notes to previous tables.