Relative Prices, Hysteresis, and the Decline of American Manufacturing

Campbell, Douglas L.

University of California, Davis

2013

Relative Prices, Hysteresis, and the Decline of American Manufacturing[†]

Douglas L. Campbell
dlcampbell@ucdavis.edu
UC Davis
September, 2013

JOB MARKET PAPER

Abstract

This study uses new measures of real exchange rates to investigate the decline of American manufacturing employment in the early 2000s, comparing it to the smaller decline in the 1980s. I find that US manufacturing sectors with greater initial exposure to trade in the 1970s were disproportionately affected by the ensuing dollar appreciation in the 1980s, and that more open sectors in the 1990s also suffered comparative declines in output and employment when US unit labor costs appreciated relative to US trading partners. Employment losses in both the 1980s and in the early 2000s were due to increased job destruction and suppressed job creation, and appear to exhibit hysteresis. Additionally, more open sectors experienced relative declines in shipments, value-added, investment, production worker wages, and total factor productivity as US relative unit labor costs in manufacturing rose. I explain the persistent effects of exchange rate movements on manufacturing using a Melitz model extension with sunk fixed costs, which leads to a dynamic gravity equation whereby shocks to trade have persistent effects that decay over time. The appreciation of US relative unit labor costs can plausibly explain more than two-thirds of the decline in manufacturing employment in the early 2000s.

JEL Classification: F10, F16, F41, N60, L60

Keywords: Exchange Rates, American Manufacturing, Hysteresis, Trade

---

[†]Special thanks are in order for the comments I have received in the lively Macro/International brownbag at UC Davis, at the Economic History Seminar at UC Davis, at Cal State Sacramento, and at the All-UC Economic History Conference at Berkeley. I benefitted enormously from feedback from my thesis advisor, Chris Meissner, and from Paul Bergin, Gregory Clark, Robert Feenstra, Martha Olney, Katheryn Russ, Deborah Swenson, Alan Taylor, and Noam Yuchtman. This research depends on the new and much improved version 8.0 of the Penn World Tables, so I am also indebted to Robert Feenstra, Robert Inklaar, and Marcel Timmer. Thanks also to Wayne Gray both for managing the NBER-CES manufacturing page, a wonderful resource, and for replying graciously to my suggested improvements for the NAICS to SIC concordance. This research project benefitted from the time I spent as a Staff Economist on the President's Council of Economic Advisers, and benefitted immensely from conversations I had with Chad Bown, Lee Branstetter, Michael Klein, and Jay Shambaugh. All opinions and errors herein are my own.

American manufacturing employment suddenly collapsed in the early 2000s, falling by three million (17.4%) from 2000 to 2003 (Figure 1) after having declined by just 3% from the late 1960s to 2000. As the economy grew from 2003-2007, the jobs lost did not return. In the aftermath of the financial crisis in 2008, the manufacturing sector lost an additional 2.3 million jobs. As of July 2012, 500,000 of these jobs had returned, but by September 2013, even as the economy continued to grow, there was no additional growth in manufacturing employment, indicating that many of the jobs lost during the recession are likely to be gone permanently.

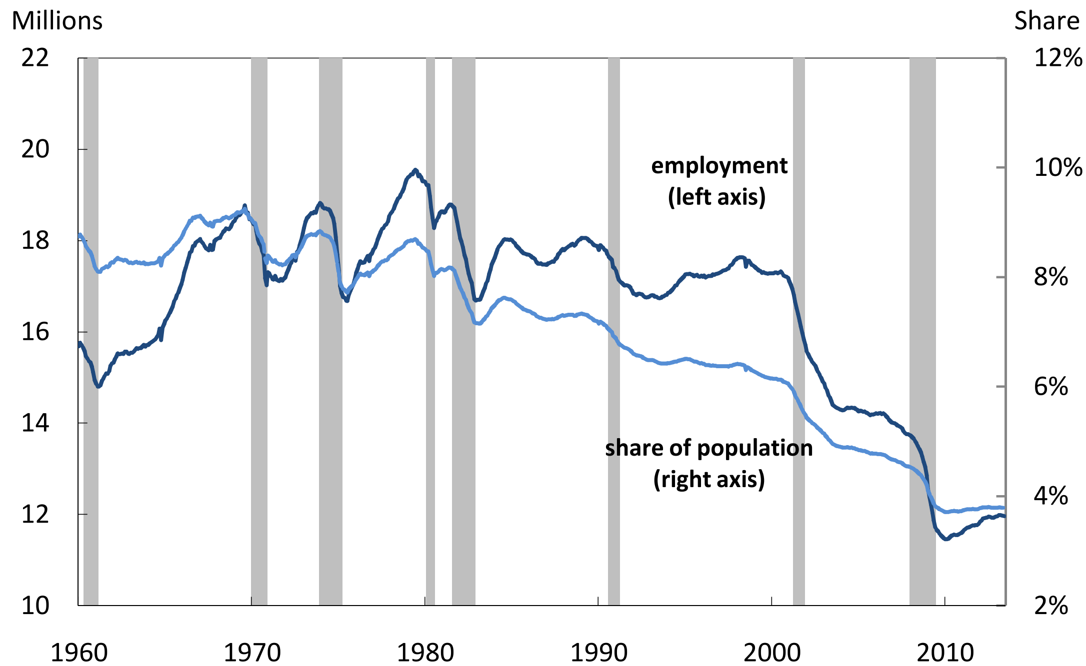


Figure 1: American Manufacturing Employment, 1960-2013.
Source: BEA

What caused the sudden collapse? Economists have generally believed that the public's concern with trade and offshoring as an explanation for the decline of American manufacturing employment is misplaced, and that the real cause is outsized productivity gains in manufacturing and a sectoral shift toward services. If true, this would imply that a decline in manufacturing employment is a sign of progress, and irrelevant due to growing services exports. However, aggregate measured labor productivity growth in manufacturing has been relatively constant over the post-war period, making it a strange explanation for a sudden employment collapse in this sector (Appendix Figure 22(a)).[1]

[1] Houseman *et al.* (2010) present evidence that perhaps one-fifth to one-half of the measured growth in value-added per worker from 1997 to 2007 reflects upward bias due to the dramatic increase of imported

And while the share of services in GDP has long been increasing, the services share of exports has been surprisingly constant over the past few decades (Figure 22(b)). In fact, the services trade surplus actually shrank by one-third over the period 1997-2004, while the goods trade deficit ex-manufacturing also worsened. Thus, the decline in manufacturing in the early 2000s was actually part of a broad-based decline in tradable sectors.[2]

These facts give credence to recent research focusing on trade liberalization and the rise of China as explanations for the collapse of US manufacturing. In a seminal paper, Autor, Dorn and Hanson (2013) find that increasing competition with Chinese imports explains one-quarter of the aggregate loss in manufacturing employment through 2007. Acemoglu *et al.* (2013) argue that the "sag" in *overall* U.S. employment in the 2000s – a decade which began with the Federal Reserve nearly missing the zero lower bound and which ended in a liquidity trap – was partly caused by the collateral damage from increasing Chinese manufacturing imports to other sectors via input-output linkages. In another important contribution Pierce and Schott (2012) argue that China's ascension to the WTO removed trade policy uncertainty and led to a large increase in imports from China, reducing US manufacturing employment.[3]

A second strand of literature studying the impact of real exchange rate movements on manufacturing mostly finds that manufacturing employment is sensitive to currency appreciations (Klein, Schuh, and Triest 2003, see Klein *et al.* 2002 for an overview).[4] Even though the dollar was generally strong in the early 2000s, to my knowledge these two literatures – on the collapse in manufacturing in the early 2000s and the impact of exchange rate movements in this period – do not intersect. This paper is intended to fill the gap by asking how much of the collapse in manufacturing in the early 2000s can be explained by movements in relative prices.

I first use a difference-in-difference research design using substantial variation in lagged openness for 437 manufacturing sectors and in real exchange rates over the period 1972-2009 to identify the impact of currency appreciations on manufacturing sectors

intermediate inputs. This would make productivity growth a less likely cause of the employment collapse over the same period.

[2]There were also declines in the trade balances of agricultural produce, animal husbandry, forestry and fish according to BEA data. Two notable exceptions were natural gas and metal ores, which were likely affected by supply-side factors.

[3]Ebenstein *et al.* (2012) document a series of facts consistent with the idea that Chinese import competition reduced US manufacturing employment.

[4] Other key papers in this literature are Branson and Love (1986), (1987), and (1988), Gourinchas (1999), Campa and Goldberg (2001), for the U.S. and Berman *et al.*, (2012), Moser *et al.*, (2012), and Belke *et al.* (2013) for Europe. Rose (1991) and McKinnon and Schnabl (2006), by contrast, find no impact of real exchange rate movements on trade and so this question is still not settled.

with differential exposure to international trade (similar to Klein *et al.* 2003). I find that when US relative unit labor costs in manufacturing were relatively high, more open sectors experienced a relative decline in employment due to increased job destruction and suppressed job creation, and relative declines in investment, shipments, and value-added, and a modest decline in production worker hourly wages. I did not find evidence for a significant impact on inventory, sectoral prices, non-production worker hourly wages, or on unit labor costs.

Second, I add an international dimension to the "difference-in-difference" framework, asking whether more open manufacturing sectors in the US lose employment when the dollar is strong relative to the same sectors in other major economies.[5] This is an important test, because if the decline in manufacturing employment in the 2000s was caused solely by the rise of China for reasons unrelated to relative prices, then other major economies, such as Canada, should also have seen employment declines in the same sectors at the same time (they did not). In fact, in the early 2000s, as US manufacturing employment was collapsing, Canadian manufacturing employment was increasing. Once the Canadian dollar strengthened sharply later in the 2000s, Canadian manufacturing employment then collapsed.

One aid to research design is the fact that over short time horizons, exchange rates, which are determined mainly by capital flows, are notoriously difficult to predict based on economic fundamentals such as interest rates. In addition, given that relative price movements impact manufacturing with a one period lag, reverse-causality can be ruled out. However, there is still potential for a third factor to cause both currency appreciation and a decline in manufacturing employment. Thus there is a need to understand what caused the dollar to appreciate in both the 1980s and early 2000s. One of the most likely factors in both periods (particularly the 1980s), was the large structural fiscal deficits.[6] Thus, my third approach is to proxy movements in relative prices using changes in defense spending and changes in the US government budget deficit ex-automatic stabilizers, and then to test whether these are correlated with adverse performance of more tradable sectors.

Fourth, I introduce the anecdote of Japan as a quasi-experiment with a large and plausibly exogenous policy-related movement in real exchange rates in the 1980s. I find that while Japanese industries gained market share in the US when the Yen was weak,

[5]I thank Thomas Wu for this suggestion.

[6]This is the implication of a standard textbook Mundell-Fleming model, and is also implied by a portfolio-balance approach to exchange rate determination (Melvin 2000). Empirically, this is hotly debated, with Abell 1991 and Corsetti and Muller 2006, for example, arguing for and Kim and Roubini (2008) arguing against.

after the Yen appreciated sharply vs. the dollar, Japanese industries consolidated their gains but did not make further inroads.

This paper has not already been written likely because of a subtle, but crucially important measurement issue: the Federal Reserve's Broad Trade-Weighted Real Exchange Rate Index, the most commonly-used measure of international competitiveness for the US, was computed as an "index-of-indices," which does not reflect compositional changes in trade toward countries, such as China, with systematically lower price levels (Fahle, Marquez, and Thomas 2008). The Fed's RER index implies that the appreciation in the dollar from 1996 to 2002 was a bit more modest than the dollar appreciation in the 1980s, and yet (ostensibly a paradox) gave rise to a much larger trade deficit as a share of GDP (plotted ex-oil in Figure 2).[7] By contrast, a simple trade-weighted average of relative prices (WARP) using version 8.0 of the Penn World Tables implies a much larger dollar appreciation in the early 2000s, mirroring the trade balance much more closely. The difference is mostly due to two factors: (1) the rising share of trade with countries, such as China, with relatively low price levels, and (2) the multiple benchmarking used in the creation of PWT version 8.0.[8]

Traditionally, economists have thought that real exchange rate indices computed using unit labor costs, which reflect labor costs relative to productivity, are the best price-based measure of international competitiveness (Turner and Van't Dack 1993). However, relative unit labor costs produced by the IMF and OECD have a number of drawbacks (Campbell and Pyun, 2013). One problem is that these measures are also computed as indices-of-indices, and as such do not properly account for compositional changes in trade with countries, such as China, that have systematically lower unit labor costs.[9] Additionally, China and many other developing countries are not even included in the IMF's relative unit labor cost (RULC) index, which also uses fixed trade weights that have become outdated.

In this paper, I address all of these concerns by using a weighted average of relative unit labor costs (WARULC) index computed for the manufacturing sector using data

[7]The Fed's real exchange rate index is: $I_t^d = I_{t-1} \times \Pi_{j=1}^{N(t)} (\frac{e_{j,t} p_t / p_{j,t}}{e_{j,t-1} p_{t-1} / p_{j,t-1}})^{w_{j,t}}$, where $e_{j,t}$ is the price of a dollar in terms of the currency of country j at time t, p_t is the US consumer price index at time t, $p_{j,t}$ is the consumer price index of country j at time t, $N(t)$ is the number of countries in the basket, and $w_{j,t}$ is the trade weight of country j at time t. The base year value of the index is arbitrary.

[8]These factors also suggest the superiority of WARP, although both measures could be useful to look at since they provide different information.

[9]These issues are explained in more detail in Campbell and Pyun (2013). Another important problem with the IMF and OECD series is that manufacturing output is deflated using country-specific deflators (constructed idiosyncratically), which can lead to bias over time without the use of multiple benchmarks. This is the same problem that afflicted older vintages (predating version 8.0) of the Penn World Tables.

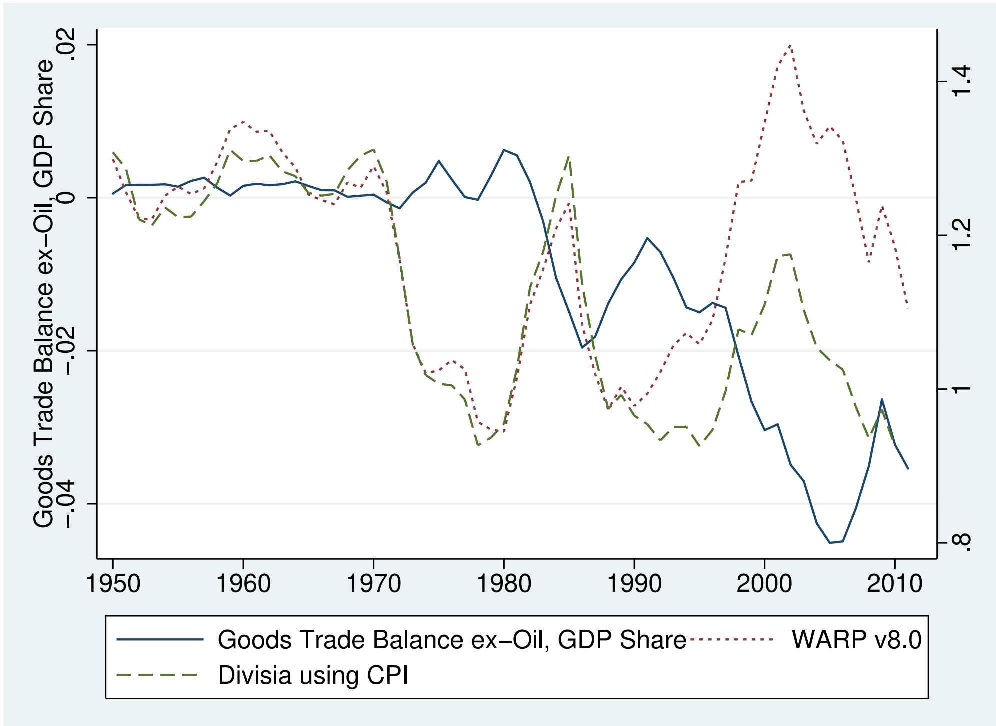


Figure 2: Real Exchange Rate Measures vs. the Current Account
Sources: BEA and Campbell and Pyun (2013)

from all six ICP benchmarks, and which includes developing countries such as China.[10] I find that this index does a remarkably good job of predicting manufacturing employment declines, and in particular does much better than CPI-based real exchange rate indices or the RULC indices created by the Federal Reserve, the IMF and the OECD. I also show that using either of the other "weighted average relative" (WAR) exchange rates such as the WARP index created by Fahle *et al.* (2008) or the Balassa-Samuelson adjusted WARP index created by Campbell and Pyun (2013) will yield very similar results to those using WARULC.[11]

The finding that when US unit labor costs appreciate sharply relative to trading partners, more open sectors are differentially harmed should not be suprising in light of the central tenet of economics, that prices matter. I also propose a corollary: in a world with sunk costs, historical prices can also affect current economic outcomes. Empirically, I find strong evidence that temporary shocks to relative prices have persistent, long-lasting effects on the manufacturing sector. Indeed, the observation that improvements in the US aggregate trade balance lagged the depreciation of the dollar in the late

[10] I am greatly indebted to Professor Paul Bergin for suggesting I apply the Fahle *et al.* (2008) insight to unit labor costs.

[11] The details of the construction of these indices are included in a companion paper, Campbell and Pyun (2013).

1980s spawned a large theoretical literature on hysteresis, with the progenitors of increasing returns and new trade theory, including Dixit (1989a, 1989b, 1991, 1992), Krugman (1987, 1988), Krugman and Baldwin (1987, 1989), and Baldwin (1988, 1990), all weighing in with multiple contributions. By contrast, in the past 15 years, "new trade theory" models often omit sunk costs and make scant reference to path-dependence. Nevertheless, Figure 2 shows that the pattern for the 1980s is also apparent in the 2000s. US relative prices have become steadily more competitive since 2002, but while the trade deficit shrank due to declining domestic demand during the recession, as demand began to recover by 2011, the trade deficit worsened, lagging the improvement in relative prices. The chief contribution of this paper lies in documenting the phenomenon of hysteresis at a disaggregated level for 437 SIC manufacturing sectors for both the 1980s and the 2000s.

A second important finding in this paper is that the measured elasticity of manufacturing employment with respect to changes in relative unit labor costs and the magnitude of the appreciation in relative prices—Campbell and Pyun (2013) show that the shock to WARP in the 1990s and 2000s was the largest in recorded US relative price history, 1820-2011—are large enough to explain the loss of 1.9 to 2.2 million manufacturing jobs directly in the period 1995-2008.[12] Third, while economists have long taught crowding out due the impact of fiscal deficits on real interest rates, the results I present suggest that deficit spending may have the sharpest impact on the most tradable sectors via relative prices. Fourth, I briefly sketch a variation of the Melitz (2003) model, and show that sunk costs lead to a dynamic gravity equation (also a new result).

In the next section, I first introduce a slight variation of the Melitz (2003) model, similar to Chaney's (2008) modification, in order to motivate the empirical sections which follow.

1 Theory

1.1 The Model

In this section, I motivate the empirics using a slight variation of the Chaney (2008) model with sunk costs as in Melitz (2003). In this model, households in the home country consume from a continuum of goods, ω, from a set of goods in H+1 sectors, Ω_h,

[12] In this paper I do not study input-output linkages, but given that every dollar of manufacturing output requires 60 cents of output from other industries used in production seemingly implies that the direct estimates only represent part of the total jobs lost due to relative price movements.

determined in equilibrium. There is a freely traded homogenous numeraire good q_0 as in Chaney (2008), with one unit of labor producing w units of the good.

$$U_t = q_{0t}^{\mu_0} \prod_{h=1}^{H} \left(\int_{\Omega_h} q_h(\omega)_t^{\frac{(\sigma_h - 1)}{\sigma_h}} d\omega \right)^{\frac{\sigma_h \mu_h}{(\sigma_h - 1)}}, \; \sigma_h > 1 \forall h \,. \tag{1.1}$$

Each period this leads to the solution for variety ω, with total income in the home country, Y_t, and the CES price index $P_{ht} = (\int_{\omega \in \Omega_h} p_h(\omega)_t^{(1-\sigma_h)} d\omega)^{\frac{1}{(\sigma_h - 1)}}$:

$$q_h(\omega)_t = \frac{\mu_h Y_t p_h(\omega)_t^{-\sigma_h}}{P_{ht}^{1-\sigma_h}}. \tag{1.2}$$

Firms maximize profits each period after paying a sunk fixed cost to receive a productivity draw (output per unit of labor φ) and begin producing for the home market, and then choose whether to pay a sunk entry cost to enter the foreign market (for simplicity I assume there are only two countries). Profits per period for an existing firm from sales at home are thus[13]

$$\Pi_h(\omega)_t = q_h(\omega)_t p_h(\omega)_t - \frac{q_h(\omega)_t w_t}{\varphi_h(\omega)} - f_{ht} w_t, \tag{1.3}$$

where p is price, q is output sold at home, w is the wage, τ is an iceberg trade cost, f is the per-period overhead cost and $\varphi_h(\omega)$ is the output per unit of labor, supplied inelastically by households. Firms have an exogenous probability of death δ, yet otherwise will always choose to stay in a market they have previously entered, as expected profits are strictly positive going forward. Maximizing profits, firms choose prices marked up over marginal cost $p_h(\omega)_t^*$ (denotes the price of exports)

$$p_h(\omega)_t = \frac{\sigma_h}{\sigma_h - 1} \frac{w_t}{\varphi_h(\omega)}, \qquad p_h(\omega)_t^* = \frac{\sigma_h}{\sigma_h - 1} \frac{w_t \tau_t}{\varphi_h(\omega)}. \tag{1.4}$$

A home firm which has previously paid to receive a productivity draw will pay a sunk fixed cost to export, f^x, if it is less than the expected discounted present value of

[13] And similarly for exports: $\Pi_h(\omega)_t^* = q_h(\omega)_t^* p_h(\omega)_t^* - \frac{q_h(\omega)_t^* w_t \tau_t}{\varphi_h(\omega)}$, where q^* and p^* denote quantities and prices of goods produced at home and sold abroad.

future profits.[14]

$$Foreign\,Entry : E_t\Pi(\omega)^*_{PV,t} = E_t\sum_{s=0}^{\infty}(1-\delta)^s\Pi(\omega)^*_{t+s} - f^x_{ht}w_t \geq 0. \tag{1.5}$$

The baseline empirical approach in the next section will be to use relative price indices to explain the behavior of sectoral manufacturing employment. Thus, we can write sectoral labor demand as:

$$L_{ht} = \underbrace{\int_{\omega\in\Omega}\frac{q_h(\omega)_t}{\varphi_h(\omega)_t}}_{\text{Home Production}} + \underbrace{\int_{\omega\in\Omega^*}\frac{q^*_h(\omega)_t}{\varphi_h(\omega)_t}}_{\text{Export Production}} + \underbrace{M^e_{ht}(f^e_{ht}+f^x_{ht}p^x_{ht})}_{\text{Entry}} + \underbrace{\sum_{s=0}^{\infty}M^e_{h,t-s}(1-\delta)^s f_{ht}p_{h,t,-s}}_{\text{Overhead}} \tag{1.6}$$

Here M^e_{ht} is the mass of potential entrants at time t, $p^x_{ht} = 1-G(\bar{\varphi}_x)$ is the share of new firms in sector h with productivity greater than the cutoff productivity for exporting, $\bar{\varphi}_x$, and $p_{h,t-s} = 1-G(\bar{\varphi}_{f,t,-s})$ is the share of continuing firms with productivity greater than the maximum cutoff for continuing to produce for the home market, $\bar{\varphi}_{f,t,-s}$, in between years t-s and t. The mass of entrants in Chaney (2008) is assumed to be exogenous, and based on country factors (proportional to output).

The cutoff productivity for entering into the export market at time t can be derived from equation (1.5) assuming that firms know the productivity distribution when they decide to invest to receive a productivity draw, and then have perfect foresight of market conditions for the upcoming period when they decide to invest. However, firms make their investment decisions using rules-of-thumb, taking the form of simple expectations about a future they believe will be like today, conditioned on not receiving a "death" draw with probability δ. Thus the cutoff productivity for exporting is

$$\bar{\varphi}_{xt} = \left(\frac{P^{*(1-\sigma_h)}_{ht}w_t^{\sigma_h}}{\mu_h Y^*_t}\lambda_0\delta f^x_{h,t}\right)^{\frac{1}{\sigma_h-1}}\tau_t, \tag{1.7}$$

where $\lambda_0 = \frac{\sigma_h^{\sigma_h}}{(\sigma_h-1)^{\sigma_h-1}}$.

When wages, trade costs, or the sunk fixed costs of exporting rise, or the foreign market either becomes more competitive or has a fall in demand in sector h, the cutoff productivity for exporting will be higher, which means that fewer firms will enter.

[14] Firms will pay a fixed cost to receive a productivity draw and enter the domestic market if the expected profits, home and abroad, are greater than the fixed cost of entry: $E_t\Pi(\omega)_{tot,PV,t} = E_t[\sum_{s=0}^{\infty}(1-\delta)^s\Pi(\omega)_{t+s} + \Pi(\omega)^*_{PV,t}] - f_{e,ht}w_t \geq 0$.

Additionally, existing firms will exit and stop producing if revenue fails to cover per-period fixed costs. The cutoff productivity for staying in business for purely domestic firms is[15]

$$\bar{\varphi}_{ft} = \left(\frac{P_{ht}^{(1-\sigma)} w_t^{\sigma_h}}{\mu_h Y_t} \lambda_0 f_{ht} \right)^{\frac{1}{\sigma_h - 1}}. \tag{1.8}$$

This equation tells us that when labor costs or fixed costs rise, or when the domestic market becomes more competitive or domestic demand in sector h shrinks, fewer firms will be around to employ labor in overhead activities. To the extent that it is the case that more productive firms export (as it is in this model), relative price appreciations, denoted by a rise in wages, or a rise in domestic vs. foreign GDP, would imply that import-competing industries might be more adversely affected than relatively export-intensive industries along the extensive margin, since industries with many firms that do not export may have a more difficult time covering the fixed overhead costs.

The first term in the sectoral labor demand equation (1.6) is the total labor requirement for home production. Plugging in the solutions from above and integrating assuming Pareto-distributed productivity with parameter γ_h (the Pareto distribution is $G(\varphi) = 1 - \varphi^{-\gamma_h}$, where I assume $\gamma_h > \sigma_h - 1$), the first term becomes

$$\frac{\sum_{s=0}^{\infty} \mu_{h,t} Y_t M_{h,t-s}^e \rho^s w_t^{-\sigma_h} \lambda_1 \bar{\varphi}_{mh,t,-s}^{(\sigma_h - 1 - \gamma_h)}}{\sum_{s=0}^{\infty} \rho^s (M_{h,t-s}^e w_t^{(1-\sigma_h)} \lambda_2 \bar{\varphi}_{mh,t-s}^{\sigma_h - 1 - \gamma_h} + M_{h,t-s}^{*e} (w_t^* \tau_{ht}^*)^{(1-\sigma_h)} \lambda_2 \bar{\varphi}_{mxh,t-s}^{*(\sigma_h - 1 - \gamma_h)})}, \tag{1.9}$$

where λ_1 and λ_2 are parameters[16], $\rho = 1 - \delta$ for brevity, $\bar{\varphi}_{mh,t,-s}$ is the maximum cutoff productivity to remain in the market for a firm that entered s periods previously in the intervening years, and variables with an asterisk denote foreign variables. Thus $\bar{\varphi}_{mxh,t,-s}^*$ is the maximum cutoff productivity for a foreign firm that entered s periods previously to export and remain producing during the intervening years, and variables with an asterisk denote foreign variables. The denominator of this equation is the solution to $P_{ht}^{1-\sigma_h}$. Thus, along the intensive margin, labor demand for domestic production depends positively on domestic sectoral demand ($\mu_{ht} Y_t$), negatively on domestic wages, and positively on importing trade costs, τ_{ht}^*. The extensive margin operates via current and lagged cutoff productivities, which negatively impact home sectoral labor demand. Higher home wages, a more competitive home market, higher fixed costs or smaller do-

[15]The constraint for staying in business for firms which also export is $\bar{\varphi}_{fxt} = \left(\frac{\mu_h Y_t}{P_{ht}^{(1-\sigma_h)}} + \frac{\mu_h^* Y_t^* \tau_t}{P_{ht}^{*(1-\sigma_h)}} \right)^{\frac{-1}{\sigma_h - 1}} (\lambda_0 w_t^{\sigma_h} f_{ht})^{\frac{1}{\sigma_h - 1}}$.

[16] $\lambda_1 = \frac{(\sigma_h / (\sigma_h - 1)^{-\sigma_h}}{\gamma_h - (\sigma_h - 1)}$ and $\lambda_2 = \frac{1}{\gamma_h - (\sigma_h - 1)}$

mestic demand will all potentially trigger firm exits (via equation 1.8), which will not necessarily be reversed immediately when these variables return to previous levels. The sole discordant note is that, due to the CES preferences, which serve as a modeling convenience rather than as a statement about the way the world operates, growing productivity in a sector will not imply decreased labor demand as both intuition and data would suggest.

The second term on the right-hand side of equation (1.6) is analagous, as labor devoted to production for exports will be a positive function of foreign demand along the intensive margin, and a negative function of home wages and trade costs for exporting. Additionally, there can be movements along the extensive margin, which will depend on the cutoff productivity for existing firms, equation (1.8). If wages, fixed overhead costs (f_{ht}), iceberg trade costs, or more foreign firms enter, the cutoff productivity for making a profit will rise, and some existing firms will be forced out of the market:

$$\frac{\sum_{s=0}^{\infty} \mu_{h,t}^{*} Y_t^{*} M_{h,t-s}^{*e} \rho^s w_t^{*(-\sigma_h)} \tau_t^{1-\sigma_h} \lambda_1 \bar{\varphi}_{mh,t,-s}^{\sigma_h - 1 - \gamma_h}}{\sum_{s=0}^{\infty} \rho^s M_{h,t-s}^{e} (w_t \tau_{ht})^{(1-\sigma_h)} \lambda_2 \bar{\varphi}_{mh,t-s}^{\sigma_h - 1 - \gamma_h} + \sum_{s=0}^{\infty} \rho^s M_{h,t-s}^{*e} w_t^{*(1-\sigma_h)} \lambda_2 \bar{\varphi}_{mh,t-s}^{*(\sigma_h - 1 - \gamma_h)}}. \tag{1.10}$$

While there is no explicit "exchange rate" in this model, one could proxy it in several ways. One is to stipulate that both wages and output are denomenated in local dollars, and to then treat an exchange rate appreciation as local wages and output rising relative to foreign. A second approach, used by Eichengreen *et. al.* (2011), is to proxy exchange rate movements using the iceberg trade costs. Either would yield the needed result. Also note that since either of these methods imply a constant elasticity of changes in employment in exporting or given movements in wages or iceberg trade costs, that sectors with higher shares of either imports or exports will theoretically see a larger response to movements in exchange rates.

1.2 Implications

Proposition 1: Trade is a Function of History

To simplify matters, the fixed overhead costs will now be set to 0. Total exports in industry h at time t are the sum of exports of each cohort of past entrants, where I borrow Chaney's assumption that the mass of entrants in industry h at time t is $\alpha_{ht} Y_t$:

$$X_{ht} = \sum_{s=0}^{\infty} (1-\delta)^s \alpha_h Y_{t-s} \int_{\bar{\varphi}_{t-s}}^{\infty} x_{h,t}(\varphi) \mu(\varphi) d\varphi. \tag{1.11}$$

Substituting in the solutions for x = pq, plugging in the pricing rules, assuming Pareto-distributed productivity and integrating, I arrive at a dynamic gravity equation:

$$X_{ht} = \frac{\mu_h^* Y_t^* (w_t \tau_t)^{1-\sigma_h}}{P_t^{*(1-\sigma_h)}} \lambda_3 \sum_{s=0}^{t} (1-\delta)^s (\alpha_h Y_{t-s}) \left(\frac{P_{h,t-s}^{*(1-\sigma)} w_{t-s}^{\sigma_h}}{\mu_{h,t-s} Y_{t-s}^*} \lambda_0 \delta f_{h,t-s}^x \tau_{t-s}^{\sigma_h - 1} \right)^{\frac{-\gamma_h + \sigma_h - 1}{\sigma_h - 1}}, \tag{1.12}$$

where $\lambda_3 = \frac{\gamma_h}{\gamma_h - \sigma_h + 1} \frac{\sigma_h^{1-\sigma_h}}{(\sigma_h - 1)^{1-\sigma_h}}$, and where $P_t^{1-\sigma}$ is the denominator of equation (1.10).

The key underlying insight of this equation is that trade today depends on the history of trade costs, both entry and iceberg, in addition to market sizes and contemporaneous variables. Even with the simplifying assumptions, this equation is still fairly complex, so for purposes of clarity, I have summarized the sign of the impact of key variables on exports (foreign variables denoted by an *) at time t:

$$X_t = f(\underbrace{Y_t}_{+}, \underbrace{Y_{t-s}}_{+}, \underbrace{Y_t^*}_{+}, \underbrace{Y_{t-s}^*}_{+}, \underbrace{w_t}_{-}, \underbrace{w_{t-s}}_{-}, \underbrace{\tau_t}_{-}, \underbrace{\tau_{t-s}}_{-}, \underbrace{f_{ht}^x}_{-}, \underbrace{f_{h,t-s}^x}_{-}), s > 0. \tag{1.13}$$

Note that if we were in a one-period world, then, as in Chaney (2008), the elasticity of substitution would not magnify the impact of iceberg trade costs, but that with multiple periods of firm entry, this result would no longer follow. How general is this dynamic gravity formulation? In the Additional Appendix (not for publication), I prove that similar transition dynamics arise when moving from autarky to free trade for assumptions similar to those for key models in the new trade theory canon, including Krugman (1980) and Melitz (2003). Recent related research includes Burstein and Melitz (2011), who provide impulse response functions for shocks to trade costs, and Bergin and Lin (2012), who focus on the dynamic impact of future shocks. The large aforementioned literature on hysteresis from the 1980s carried the same core insight, that trade shocks can have lagged effects, as in equation (1.12). This paper is the first to show that the logic of sunk entry costs naturally leads to a "dynamic gravity" equation which can be derived explicitly.

Empirically, incumbent firms dominate most sectors in terms of market share, which means that the current trade relationship could be determined, in part, by historical factors as emphasized by Campbell (2010), Eichengreen and Irwin (1998), and Head, Mayer and Ries (2010).

Corollary to Proposition 1: The Real Wage is a Function of Historical Market Access

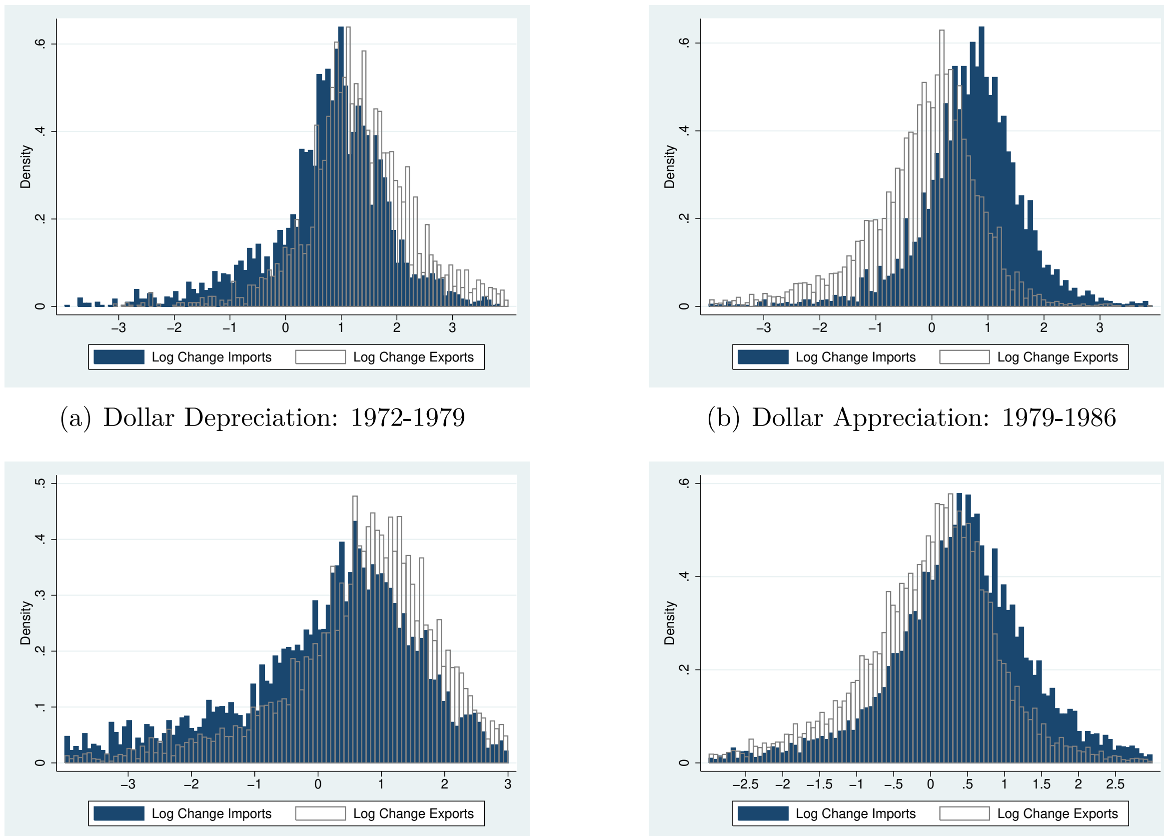
A key insight from New Trade Theory is that the real wage is a function of market access. Krugman (1992) argues that new trade theory can help explain higher wages in the northern manufacturing belt of the US, Redding and Venables (2004) argue that market access can explain cross-country variation in per capita income, and Meissner and Liu (2012) show that market access can help explain high living standards in northwest Europe in the early 20th century. An important corollary is that sunk costs imply that the real wage is also a function of historical market access. This follows from the dynamic gravity equation, as utility is increasing in the number of varieties and the extensive margin increases over time after a decline in trade costs. Figure 20 in the Appendix is a chloropleth map of per capita income by county, which can be compared to the distribution of import-competing manufacturing in Figure 21. It is immediately obvious that both are highly correlated with access to sea-navigable waterways – and that the US north was still much richer than the south in 1979. I posit that this owes more to the past history of trade costs than it does to low shipping costs on Lake Erie today.

Proposition 2: Government Spending Implies Dynamic Crowding Out

Matching the US experience of the 1980s and 2000s, the basic logic of sunk fixed costs implies that government spending, which takes resources from the private sector in this simple model, can cause dynamic crowding out. In the Mathematical Appendix, I show that government spending can cause dynamic crowding out for the autarkic case, and derive an expression for the transition dynamics whereby it takes private agents time to adjust to a cut in government spending. The extension for the symmetric two-country case is trivial.

2 Estimating the Impact of Exchange Rate Movements on US Manufacturing

For exchange rate movements to impact manufacturing employment, a necessary condition is that exchange rates affect trade. Figure 3 shows that when the dollar fell from 1972 to 1979, the entire distribution of log changes in US exports disaggregated by both sector and destination country is significantly larger than the distribution of changes in log imports. When the dollar spiked in the mid-1980s, the distribution of log changes in imports then shifted far to the right of the distribution of exports, with the median log change in imports close to one vs. slightly greater than zero for exports, corresponding to a 72% increase in imports relative to exports. The same pattern holds up over the period of dollar weakness from 1986 to 1996, and dollar strength from 1996 to 2005.[17]



(a) Dollar Depreciation: 1972-1979

(b) Dollar Appreciation: 1979-1986

(c) Dollar Depreciation: 1986-1996

(d) Dollar Appreciation: 1996-2005

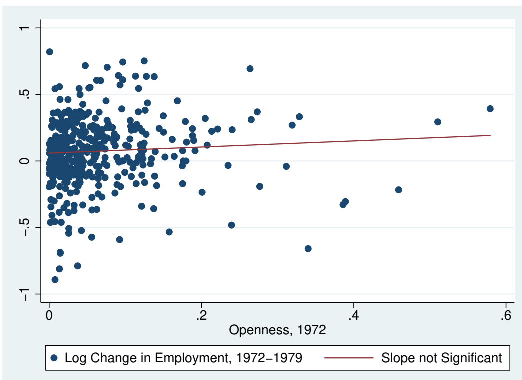
Figure 3: Distribution of Changes in Trade, by Sector and Country

Source: Trade data for 452 SIC sectors and roughly 200 countries are from Comtrade

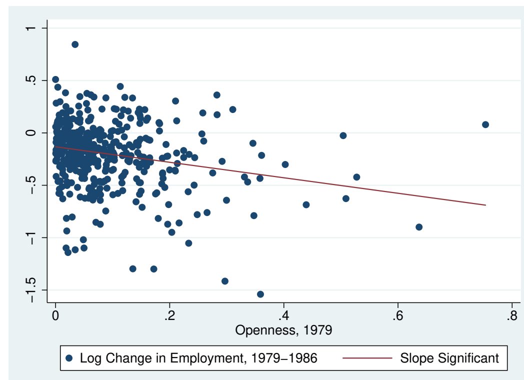
The core research design in this paper is to test whether sectors with higher initial levels of openness do worse when the dollar appreciates relative to how the same sectors do when real exchange rates are low. "Openness" is defined using the average of the share of exports in shipments and the share of imports in domestic consumption (where domestic consumption = shipments + imports - exports). The four panels of Figure 4 confirm that during periods of sharp dollar appreciation, sectors with higher initial trade shares were disproportionately harmed. During periods of dollar depreciation, there was no meaningful difference in performance, but the previous period's losses appeared to be

[17] In the Additional Appendix I present the results from a panel vector error correction model which also indicates that lagged changes in real exchange rates affect the level of trade flows.

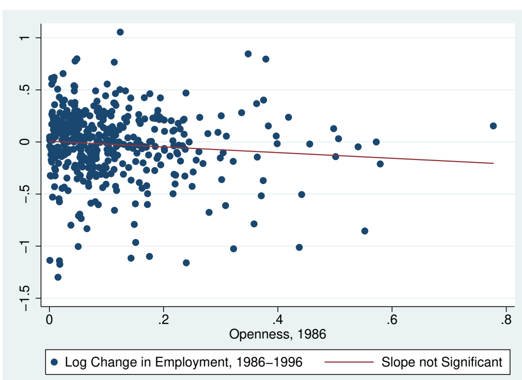
locked in. Openness predicts employment declines over the period 1979-1986, but there is no relationship between openness in 1979 and employment growth over the period 1986-1996 (Figure 5). Note that these periods all end at similar points in the business cycle, which effectively controls for the fact that some manufacturing sectors are much more cyclical than others. These results become slightly stronger when controlling for domestic sectoral demand growth, productivity growth, lagged capital-per-worker ratios, changes in tariffs, and sectoral changes in the cost of insurance and freight. They are also robust to running a quantile regression to reduce the significance of outliers (see the Additional Appendix).



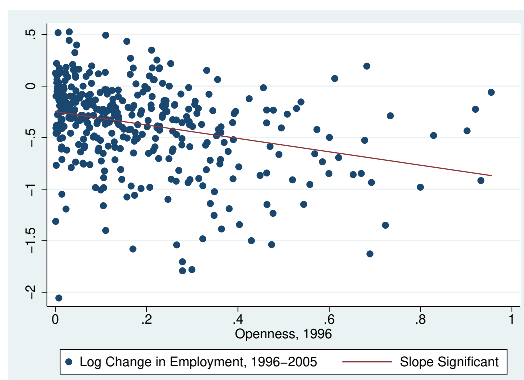
(a) Dollar Depreciation: 1972-1979



(b) Dollar Appreciation: 1979-1986



(c) Dollar Depreciation: 1986-1996



(d) Dollar Appreciation: 1996-2005

Figure 4: Manufacturing Employment vs. Openness
Source: Annual Survey of Manufactures, BEA

The magnitude of the slope for each period of appreciation is large and economically significant. The slope in the 1979-1986 period is -.79 with a standard error clustered on the 2-digit SIC level of .25, which implies that for every 10% increase in trade an industry had in 1979, it approximately lost an additional 7.9% of manufacturing employment during that period, when the Federal Reserve's broad trade-weighted dollar index appreciated 45.4%. Figure 5 shows that import exposure in 1979 is uncorrelated with employment growth from 1986 to 1996, suggesting that the losses experienced by the more open sectors in the mid-1980s persisted into the 1990s. The slope for the 1996-2005 period is similarly large, at -.65, with a clustered standard error of just .19. However, since the mean amount of trade was much larger in the late 1990s than in the 1980s, the later period accounted for a much larger overall decline in employment.

Figure 5: Hysteresis: No Rebound after Collapse

Source: Annual Survey of Manufactures, BEA

Since 2005, the dollar has continued to fall, and in 2011 was close to its long-run average. From 2005 to 2007, when the dollar was still fairly elevated (as measured by weighted average relative prices), there was again a statistically significant relationship between initial openness (in 2005) and employment losses, even though overall manufacturing employment was roughly flat. From 2007 to 2008, when the dollar fell, the relationship disappeared. From 2009 to 2011, as the dollar declined further, there was also no statistically significant relationship (using NAICS data through 2011). In these later years, of course, there were many factors other than exchange rate movements which were likely to have a large impact on manufacturing, but the fact that there appears to have been no rebound in these sectors in 2007-2008 or in 2009-2011 suggests that the employment losses in the high-dollar years had been locked in, just as they had been after the dollar appreciated in the 1980s.

Figure 6 displays the difference-in-difference research design graphically, plotting the

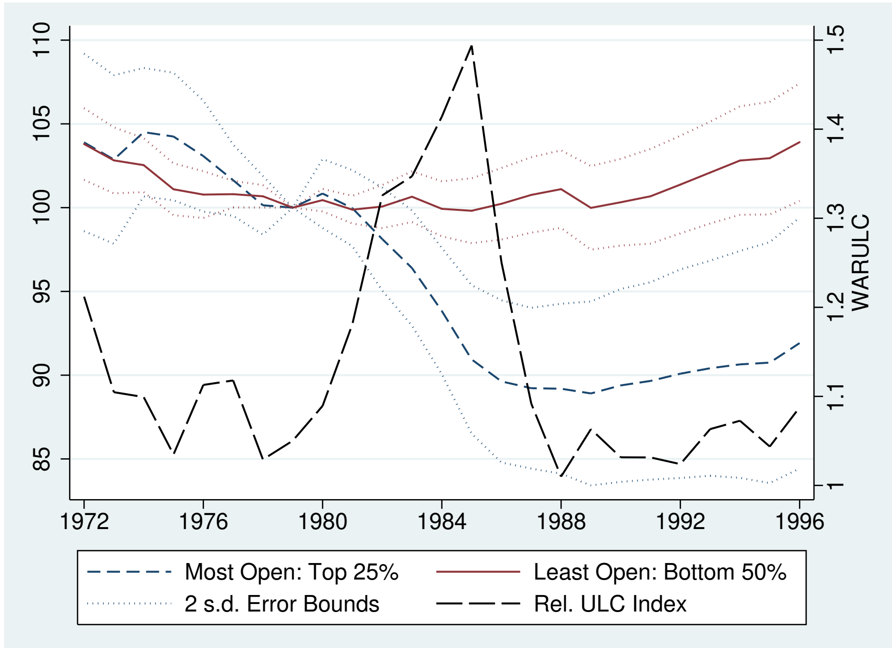


Figure 6: Employment Growth by Degree of Tradability in 1972 (SIC)*

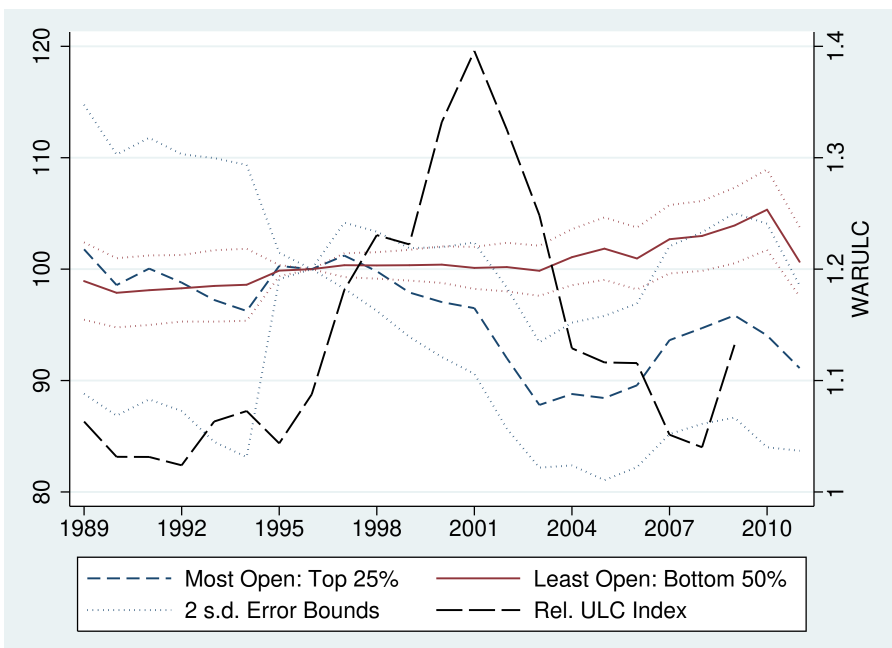


Figure 7: Employment Growth by Degree of Tradability in 1989 (NAICs)*

*Notes: Employment is indexed to 1979 in Figure 6 and to 1996 in Figure 7, and is updated with residuals from a regression controlling for demand, productivity, and year fixed effects. Employment data are from the Annual Survey of Manufactures, and WARULC is from Campbell and Pyun (2013).

evolution of employment indices by fixed categories of tradability in 1972 vs. the main measure of the real exchange rate I use, Weighted Average Relative Unit Labor Costs (WARULC). The employment index for each sector is given a base year value of 100 in 1979, and then the changes in the employment indices not due to changes in demand or shipments, or to general movements in all sectors by year, are plotted over time with error bounds. Comparing the top 25% of sectors by openness as of 1972 vs. the bottom 50%, there was no statistically significant difference in employment growth during the 1970s, but when the dollar appreciated in the 1980s, the more open sectors lost roughly 10% of their employment relative to other sectors. Yet, after the dollar fell in the late 1980s, this differential impact seems to have decayed very modestly. The appreciation in the late 1990s and early 2000s (Figure 7) suggests a similar story – steep losses in the early 2000s which then reverted to previous levels only gradually. While the magnitudes appear smaller here, this is in part a function of the fact that both of these categories of industries contain a large variation in their respective degrees of openness.

2.1 Data

Data on employment, shipments, value-added, wages, investment, and capital, and the prices of shipments, materials, and energy all come from the BEA's Annual Survey of Manufactures, via the NBER-CES Manufacturing Industry Database for the 4-digit SIC data from 1958 to 2009, and directly from the BEA for the NAICS version of the same variables spanning 1989-2011. Trade data from 1991-2011 are from Comtrade WITS when available, and these data were augmented with trade and the cost of insurance and freight data from Feenstra, Romalis, and Schott (2002) from 1972-2005. Sectoral tariff data for 1974-2005 come from Schott (2008) via Feenstra, Romalis, and Schott (2002). Data on intermediate imports are from the BEA's Input/Output tables for the year 1997. The classification of broad industrial sectors by markups is borrowed from Campa and Goldberg (2001).[18]

The main measure of the real exchange rate used in this paper is the Weighted Average Relative Unit Labor Cost (WARULC) index from Campbell and Pyun (2013), plotted in Figure 8 vs. the IMF's RULC index.[19] The IMF's index suggests a steady

[18]The Campa-Goldberg classification of low markup industries at the 2-digit SIC level includes primary metal products, fabricated metal products, transportation equipment, food and kindred products, textile mill products, apparel and mill products, lumber and wood products, furniture and fixtures, paper and allied products, petroleum and coal products, and leather and leather products.

[19]Specifically, the WARULC index from Campbell and Pyun is computed as $I_{US,t}^{WARULC} = \prod_{i=1} \left(\frac{ULC_{US,t}}{ULC_{i,t}} \right)^{\omega_{i,t}}$, where $ULC_{i,t} = \frac{w_{i,t}}{e_{i,t}} / \frac{Y_{i,t}}{PPP_{i,t}}$, and where $w_{i,t}$ are manufacturing wages of country i at time t, $e_{i,t}$ is the local currency price of a dollar, and $Y_{i,t}$ is manufacturing production, converted to

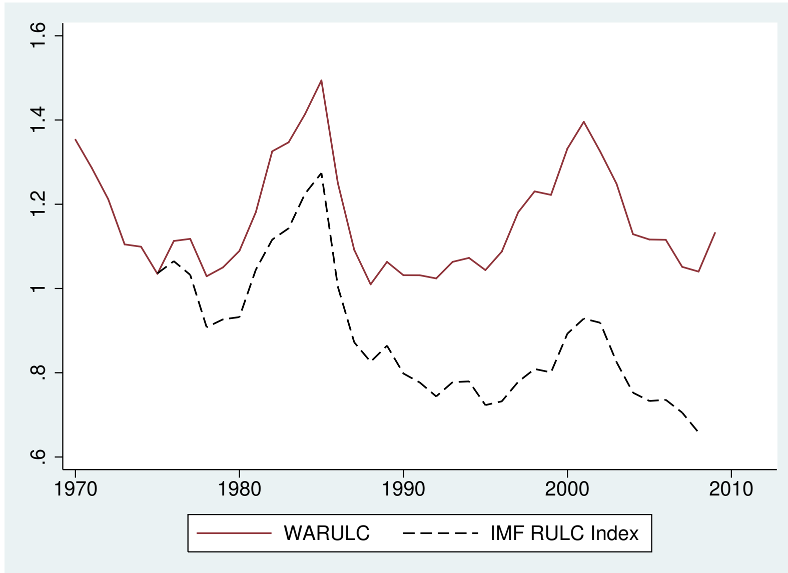


Figure 8: WARULC vs. IMF RULC Index

Sources: Campbell and Pyun (2013) and the IMF

depreciation of US unit labor costs over the period, a feature largely corrected by the multiple benchmarking used in the construction of WARULC (in the IMF's measure, manufacturing value-added is deflated using country-specific deflators alone), and also by the inclusion of China and different indexing method. Panel (a) of Figure 9 shows the distribution of openness by sector in 1997, and Panel (b) demonstrates the rise in import penetration and export share versus WARULC. In 1974, manufacturing trade was roughly balanced and unit labor costs for US manufacturing were on average about 10% higher than ULCs of US trading partners, but after the dollar's appreciation in the mid-1980s left US relative ULCs an additional 40% higher, manufacturing imports became twice as large as exports.

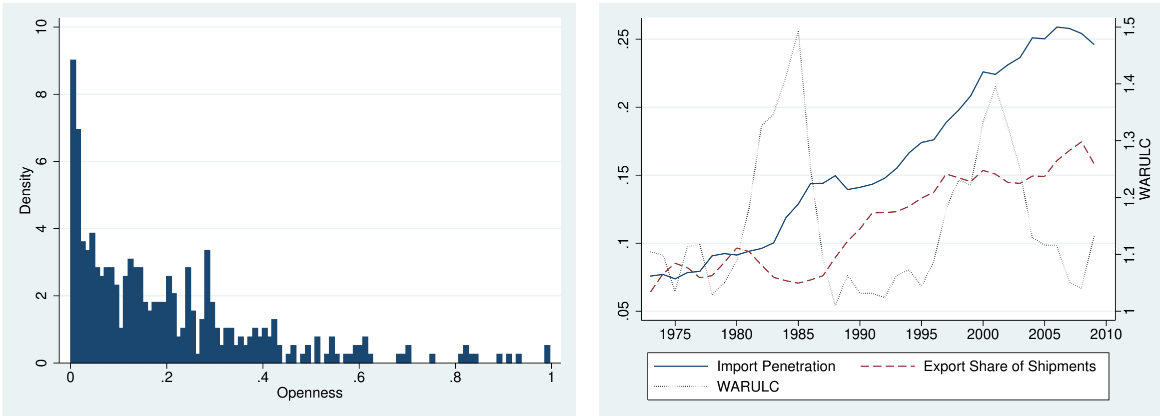
The summary statistics for the most relevant variables in select years are reported in Table 1. Openness increased from about 7% in 1972 to 24% in 2001 and 27.9% by 2005. It can be seen that labor costs are a large, but declining, share of value-added over the period, declining from 42.6% of value-added to just 32%. Chinese import penetration increased from almost nothing in the 1980s to 12.4% by 2005. The average applied tariff was about 8.2% in 1974, and fell to just 2.4% by 2005. By contrast, the cost of insurance and freight was about 9.6% of customs costs in 1974, and was still 9.8% in 2005. The last two entries in Table 1, capital-per-worker and the 5-factor TFP index, also come

dollars at PPP (which equals one for the US). The key difference here is that the ULCs are actual unit labor costs rather than indices of unit labor costs.

Table 1: Data Summary for Select Years

	(1) 1974	(2) 1985	(3) 1993	(4) 2001	(5) 2005
Openness	0.0862	0.115	0.174	0.238	0.279
	(0.112)	(0.119)	(0.174)	(0.241)	(0.265)
Value Added, Millions	1099.3	2273.4	3475.4	4551.3	5443.2
	(1687.9)	(3429.0)	(5497.0)	(8030.1)	(10989.7)
Hourly Wages, Prod. Workers	4.366	9.572	11.99	15.10	17.48
	(1.008)	(2.782)	(3.354)	(4.145)	(4.739)
Payroll/Value-Added	0.426	0.413	0.373	0.364	0.320
	(0.115)	(0.112)	(0.118)	(0.120)	(0.115)
Investment/Value-Added	0.0669	0.0750	0.0622	0.0647	0.0502
	(0.0427)	(0.0752)	(0.0654)	(0.0426)	(0.0298)
Energy Costs/Value-Added	0.0405	0.0729	0.0488	0.0491	0.0468
	(0.0596)	(0.128)	(0.0856)	(0.0689)	(0.0663)
Materials Costs/Value-Added	1.234	1.327	1.119	1.147	1.118
	(0.954)	(1.408)	(0.716)	(0.700)	(0.678)
Chinese Import Penetration	0.000181	0.00285	0.0256	0.0808	0.124
	(0.00143)	(0.00893)	(0.115)	(0.545)	(0.628)
Shipments per Worker, (1000s)	61.43	143.1	197.6	267.6	374.9
	(60.72)	(151.5)	(165.6)	(278.9)	(477.7)
Duties %	0.0831	0.0553	0.0505	0.0306	0.0242
	(0.0709)	(0.0564)	(0.108)	(0.0420)	(0.0317)
Ins., Freight Costs %	0.0747	0.0736	0.0969	0.0913	0.0956
	(0.0668)	(0.0750)	(0.0471)	(0.0494)	(0.0555)
K/L, (1000s)	51.04	78.01	84.43	115.3	145.3
	(56.95)	(89.27)	(90.95)	(130.7)	(160.8)
5-factor TFP index 1987=1.000	0.974	0.974	1.018	1.078	1.216
	(0.214)	(0.0818)	(0.131)	(1.444)	(2.585)

Mean coefficients; sd in parentheses.



(a) Openness

(b) Trade Growth vs. WARULC

Figure 9: Trade Growth and the Distribution of Openness in 1997

Sources: BEA, Comtrade, and Campbell and Pyun (2013)

from the NBER-CES manufacturing data set. The details of their creation are described in Bartelsman and Gray (1996).

2.2 Empirics

The first empirical approach is to compare how employment in relatively more open sectors does when unit labor costs in the US are relatively high compared to when these costs at home are close to a weighted average of trading partners. Figure 10 displays the results from regressing the log change in employment on lagged relative openness by year, controlling for demand growth and shipments-per-production worker.[20] The annual coefficients are plotted in blue vs. WARULC, along with two standard deviation upper and lower error bounds (errors clustered at the 2-digit SIC level). The results suggest a strong correlation between the level of relative unit labor costs and the annual coefficient on lagged openness.[21]

Figures 6, 7, and 10 suggest a functional form for the relationship between relative unit labor costs and the evolution of sectoral manufacturing employment. When unit

[20]This regression is $ln(L_{ht}/L_{h,t-1}) = \alpha_t + \beta_0 Rel.Openness_{h,t-1} + \beta_2 ln(D_{h,t}/D_{h,t-1}) + \beta_3 ln((TFP)_{h,t}/(TFP)_{h,t-1} + \epsilon_{ht}$, $h = 1, ..., 353$, $for\, each\, year = 1973, ..., 2009$.

[21]The one period that appears to be slightly anomalous is 2005-2007. One explanation may be that during this period, the WARULC index implies lower relative prices than either WARP or the Balassa-Samuelson adjusted WARP index from Campbell and Pyun (2013), even though the three series are broadly similar and yield similar results on the whole (although WARULC does well predicting the decline in 2002). Nonlinearities in the impact of relative price misalignment are also possible, as large overvaluations relative to China may have trumped mild undervaluation relative to Canada and Europe during this period.

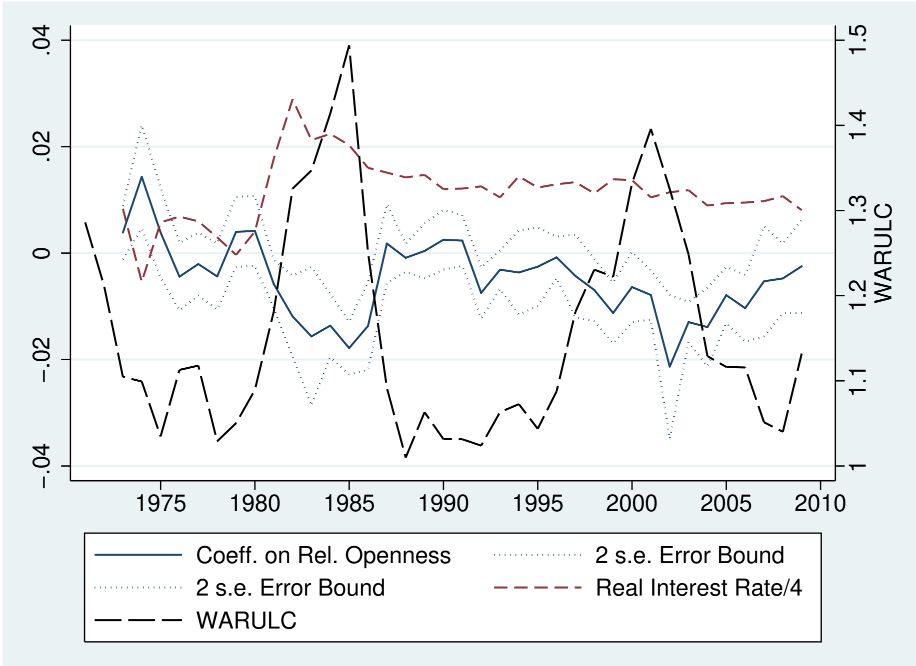


Figure 10: Impact of Relative Openness by Year

Notes: Real interest rate data are from FRED, WARULC is from Campbell and Pyun (2013), and the coefficients on relative openness are from annual regressions of log changes in employment on changes in demand and productivity with standard errors clustered at the 2-digit SIC level.

labor costs are higher in the US relative to trading partners, more open sectors lose employment. When the level of WARULC is close to one, there does not appear to be a differential change in jobs for more open sectors. This makes intuitive sense, as when unit labor costs are roughly the same at home and abroad, there is no large advantage of foreign firms over domestic firms, nor would there be a reason for domestic firm to incur the costs of moving production abroad, and so we should not expect differential employment changes in more open sectors.

The next step is to pool the data and run a panel regression of the log change in employment on lagged relative openness, while including controls from equation (1.6), for instance sectoral demand, changes in trade costs and changes in relative prices in addition to other intuitive controls such as productivity in terms of value-added-per-production worker by sector.

$$ln(L_{ht}/L_{h,t-1}) = \alpha_t + \beta_0 R.Openness_{h,t-1} + \beta_1(\varphi(L)ln(RER_{t-1}))*R.Openness_{h,t-1} + \quad (2.1)$$

$$\beta_2 ln(D_{h,t}/D_{h,t-1}) + \beta_3 ln((TFP)_{h,t}/(TFP)_{h,t-1} + \textstyle\sum_{i=4}^{n} \beta_i C_{i,t} + \alpha_h + \nu_t + \epsilon_{ht},$$

$$\forall h = 1, ..., 353, \; t = 1973, ..., 2009,$$

where L_{ht} is employment in sector h at time t, $R.Open_{h,t-1}$ is relative openness in sector h at time t-1, RER is a measure of the real exchange rate, such as WARULC, $D_{h,t}$ is real sectoral demand, $(TFP)_{h,t}$ is a measure of TFP (I use 4 and 5-factor measures of productivity in addition to value-added or shipments divided by production worker or total employment), and the Cs are various other controls. $\varphi(L)$ is a lag polynomial: $\varphi(L) = 1 - \sum_{i=1}^{p} \varphi_i L^i$, which allows for a flexible functional form for the real exchange rate. Each regression also includes sectoral fixed effects α_h, year fixed effects ν_t, and standard errors clustered at the industry level, and is weighted on initial period value-added. The results do not appear to be sensitive to the choice of weights, as qualitatively similar results attain when weighting by average value-added, employment, or shipments, although the key coefficient is the largest when weighting by employment or when not weighting. Additionally, one gets very similar results by simply using openness rather than relative openness.[22]

I test various functional forms for WARULC, such as using the level of the log of WARULC (equivalent to setting $\varphi_i = 0, \forall i$) vs. an alternative specification using log changes in weighted average relative unit labor costs (equivalent to setting $\varphi_1 = -1$, and $\varphi_i = 0, \forall i > 1$). The most intuitive alternative would be to include log changes interacted with openness and a dummy variable for appreciations, and a second control for log changes interacted with openness and a dummy for depreciations (following Klein, Schuh, and Triest, 2003). This flexible specification allows different impacts for appreciations and depreciations.

Table 2, column (1) shows that appreciations in relative unit labor costs are associated with a decline in employment for more open sectors, but that depreciations are not. Column (2) uses the log of the level of WARULC instead as a control, and has a higher R-squared than column (1) despite one less control. Column (3) includes controls for productivity, demand, capital-per-worker and capital-per-worker interacted with the real interest rate, defined as the interest rate on 30-year mortgages less the Core CPI, and lagged log changes in wages and the price of shipments. Once again, appreciations are associated with employment declines for more open sectors, but depreciations are not significantly correlated with job gains. In column (4), I also include the log of the level of WARULC interacted with relative openness, and find that the appreciation and depreciation variables lose significance. I then use the level of WARULC for the remain-

[22]These controls, and others, are contained in the Additional Appendix. For instance, the results would not change significantly using a geometric rather than an arithmetic average of export share and import penetration as a measure of openness. Also, changes in import penetration and export share also predict changes in employment—a necessary condition for lagged relative openness interaction with the real exchange rate to predict innovations in employment.

der of the paper. Since the level of WARULC impacts the log change, this specification by itself implies hysteresis.

The results in this table include 353 sectors with complete, balanced data, and exclude all sectors in the 2-digit SIC category publishing, which is not classified as manufacturing in NAICS. The results are robust to including both publishing and the unbalanced sectors, for a total of 448 industries. The coefficient of -.082 suggests that in 1985, when US ULCs were 50% (or 1.5, for a log value of .4) above a weighted average of ULCs of US trading partners, an industry with an openness twice that of the average industry would have lost an additional 6.5% of employment from 1985-1986 (=exp(-.083*1.4*2)-1) as compared with a completely closed industry, and 3.2% more than an industry with average openness. Over the entire 1982-1986 period, this industry would have lost a cumulative 23% of employment relative to a closed industry, and 11% more than an industry with average openness.

The further robustness checks provided in Table 3 include all the controls from Table 2, but the results are suppressed due to space constraints. Column (1) adds controls for low-markup industries (as used by Campa and Goldberg, 2003) interacted with the level of WARULC, and shares of intermediate imports interacted with WARULC. Neither are consistently significant across specifications, and are not significant in column (1). This regression also includes lagged log changes in the price of energy, and this variable interacted with energy costs as a share of shipments lagged one period (lagging one period seems to work better for all price movements). Column (2) includes lagged log changes in the price of investment and in materials costs, and these input price changes interacted with the input share of shipments. Column (3) runs a regression with the same variables, only it minimizes the sum of absolute deviations, which is much less sensitive to outliers. Minimizing the sum of absolute deviations is arguably preferable to OLS, since the latter arbitrarily assigns more weight to outliers. For that reason, all the results in this paper are robust to minimizing the sum of absolute deviations. Column (4) includes controls for lagged changes in tariffs and changes in the cost of insurance and freight (results omitted due to space constraints), but neither of these controls are significant. Lastly, it also includes a control for relative openness interacted with the real interest rate, defined as the rate on 30-year mortgages minus the core CPI. This coefficient is fairly large and significant at 95%, as industries which are more capital intensive do comparatively worse when real interest rates are higher, although the significance disappears in some specifications.

Table 2: Exchange Rates, Openness, and Manufacturing Employment

	(1)	(2)	(3)	(4)
	$ln\Delta$ L	$ln\Delta$ L	$ln\Delta$ L	$ln\Delta$ L
L.Relative Openness	-0.0096***	-0.0048	-0.0091**	-0.0036
	(0.0036)	(0.0034)	(0.0044)	(0.0041)
L.Rel.Open*ln Δ WARULC*Pos.	-0.090**		-0.20*	-0.098
	(0.042)		(0.11)	(0.11)
L.Rel.Open*ln Δ WARULC*Neg.	-0.0057		0.011	0.0012
	(0.030)		(0.038)	(0.038)
L.ln(WARULC)*Rel. Openness		-0.057***		-0.068***
		(0.011)		(0.0076)
$ln\Delta$ VA-per-Production Worker			-0.21***	-0.21***
			(0.027)	(0.027)
$ln\,\Delta$ Demand			0.44***	0.45***
			(0.051)	(0.050)
L.K/L			0.046*	0.047**
			(0.024)	(0.023)
L.(K/L)*Real Interest Rate			-0.19	-0.31
			(0.29)	(0.30)
L.$ln\,\Delta$ Wages			0.021	0.018
			(0.020)	(0.019)
L.$ln\,\Delta$ Price of Shipments			0.038***	0.036***
			(0.0088)	(0.0090)
Industries	353	353	353	353
Observations	12963	12963	12963	12963
Within R-squared	0.23	0.23	0.52	0.53
Between R-squared	0.047	0.051	0.35	0.34
Overall R-squared	0.16	0.17	0.49	0.49

Standard errors clustered on 4-digit SIC industries in parentheses. *$p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. All regressions are weighted by initial sectoral value-added, and include 4-digit SIC industry and year fixed effects over the period 1973-2009. The dependent variable is the log change in sectoral manufacturing employment. Tariff and CIF data span 1974-2005.

Table 3: Exchange Rates, Openness, and Manufacturing Employment

	(1)	(2)	(3)	(4)
	$ln\Delta$ L	$ln\Delta$ L	$ln\Delta$ L	$ln\Delta$ L
L.ln(WARULC)*Rel.Open.	-0.082***	-0.082***	-0.071***	-0.091***
	(0.014)	(0.010)	(0.011)	(0.013)
Low Markup*L.ln(WARULC)	0.022	-0.029**	0.016	0.0094
	(0.020)	(0.012)	(0.011)	(0.021)
Imported Inputs*L.ln(WARULC)	0.079	-0.22**	-0.11	0.13
	(0.16)	(0.11)	(0.11)	(0.17)
L.$ln\,\Delta$ Price of Energy	0.042**	0.024*	0.0053	0.033*
	(0.016)	(0.014)	(0.013)	(0.019)
L.$ln\,\Delta$ PE*(E/S)	-0.36**	-0.52***	-0.19	-0.16
	(0.15)	(0.15)	(0.14)	(0.15)
$ln\Delta$ TFP (5 factor)		-0.13***	-0.26***	-0.11
		(0.041)	(0.027)	(0.079)
L.$ln\,\Delta$ Price of Materials		0.16***	0.088**	0.11**
		(0.030)	(0.035)	(0.044)
L.$ln\,\Delta$ Price of Investment		0.13***	0.081*	-0.16
		(0.049)	(0.049)	(0.11)
L.$ln\,\Delta$ PM*(M/S)		-0.22***	-0.14**	-0.13*
		(0.046)	(0.056)	(0.068)
L.$ln\,\Delta$ PI*(I/S)		0.080	-0.27	-1.23**
		(0.45)	(0.50)	(0.51)
Change in Tariffs				0.00026
				(0.0042)
L.Rel.Openness*RIR				0.0088**
				(0.0041)
Observations	12963	12963	12963	10165
Overall R-squared	0.49	0.43		0.39

Standard errors clustered on 4-digit SIC sectors in parentheses. *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$. Column (3) minimizes the sum of absolute deviations, the others are OLS. The other regressions are weighted by initial sectoral value-added, and all regressions include 4-digit SIC industry and year fixed effects over the period 1973-2009. The dependent variable is the log change in sectoral manufacturing employment. Tariff and CIF data (included in column (4) but omitted for space) span 1974-2005. The coefficients on shipments per production worker in column (1), and the other controls from the previous table are omitted for space.

2.3 Relative Difference-in-Difference

A second empirical approach is to use international data to create an additional dimension to the difference-in-difference estimation above, and ask whether more open manufacturing sectors in the US tend to lose more jobs when the currency appreciates relative to the same sectors in other large manufacturing countries. Figure 11 displays the idea graphically. From 1979 to 1986 and from 1995 to 2002, the 3-digit ISIC sectors which were more open tended to experience larger declines in employment in the US, but there was no such relation in other major economies.[23] This indicates that the job losses in the US in the early 2000s were not simply due to a flood of Chinese imports, but rather must be something specific to the US in that period. From the perspective of economic geography, Canada should have been just as exposed to Chinese import competition as the US. But from 1999 to 2004, a period when the Canadian dollar was weak relative to its American counterpart, Canadian manufacturing employment actually *increased* even as American manufacturing employment collapsed.[24] As Canadian unit labor costs have increased sharply relative to trading partners including the US since 2004, Canadian manufacturing has lost more than twice as many manufacturing jobs as the US as a share of 2004 employment.

Thus, we now estimate:

$$ln(\frac{L_{US,h,t}}{L_{US,h,t-1}}) - ln(\frac{L_{G5,h,t}}{L_{G5,h,t-1}}) = \alpha_t + \beta_1((WARULC - 1) * Openness)_{h,t-1} + \tag{2.2}$$

$$\beta_2(ln(\frac{D_{US,h,t}}{D_{US,h,t-1}}) - ln(\frac{D_{G5,h,t}}{D_{G5,h,t-1}})) + \beta_3(ln(\frac{(S/L)_{US,h,t}}{(S/L)_{US,h,t-1}}) - (ln(\frac{(S/L)_{G5,h,t}}{(S/L)_{G5,h,t-1}})) + \alpha_h + \nu_t + \epsilon_{ht},$$

$$\forall h = 1, ..., 29,\ t = 1978, ...1995, 1998, ..., 2003,$$
$$G5 = (Canada, France, Germany, Italy, UK).$$

The dependent variable is now the log change in sectoral US employment minus the average log change in employment in Canada, France, Germany, Italy and the UK. The data are 3-digit ISIC Rev. 2 data from UNIDOs, which does not report data for the US for 1996. The first column in Table 4 runs the difference-in-difference regression using just US data as in previous tables. It demonstrates that the main results are not due

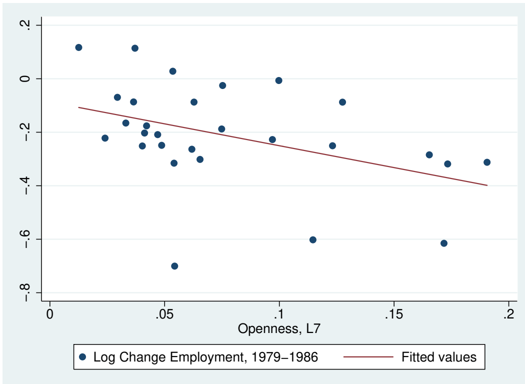
[23] In the Additional Appendix, I also show that there is no correlation between openness and employment for years when the dollar was weak.

[24] Canadian manufacturing employment also increased over the 1990-2004 period, suggesting that Canada was not more exposed to trade competition with China despite the lack of a threat of returning to Smoot-Hawley level tariffs as there was in the US.

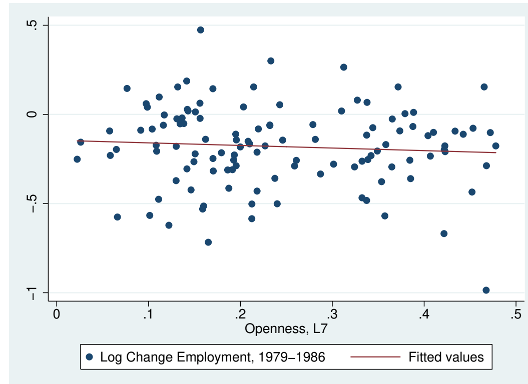
Table 4: Difference-in-Difference Relative to Other Major Economies

	(1) ln Δ L	(2) ln ΔL (Relative)
L.Openness	0.062**	0.092**
	(0.029)	(0.046)
L.Openness*(WARULC-1)	-0.49***	-0.63***
	(0.059)	(0.10)
ln $\Delta(Y/L)$	-0.90***	
	(0.041)	
ln Δ Demand	0.89***	
	(0.041)	
ln $\Delta(Y/L)$ (Relative)		-0.52***
		(0.064)
ln Δ Demand (Relative)		0.58***
		(0.058)
Observations	606	606

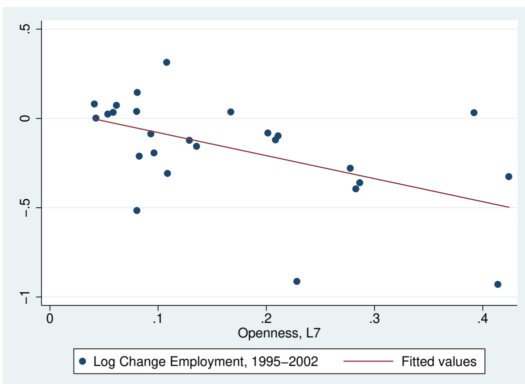
Clustered standard errors in parentheses. *$p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Both quantile regressions include year and 3-digit ISIC industry fixed effects for 29 ISIC Rev. 2 sectors over the periods 19771995 and 1998-2003. The dependent variable in column 1 is the log change in sectoral manufacturing employment. In column 2, the dependent variable is the log change in manufacturing employment relative to the log change in employment in the same sector in other major economies.



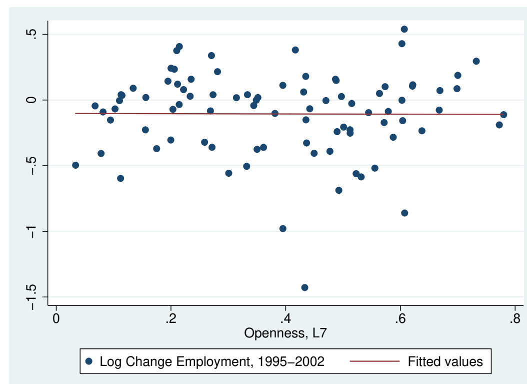
(a) US, 1979-86



(b) Other Major Economies, 1979-86



(c) US, 1995-2002



(d) Other Major Economies, 1995-2002

Figure 11: Employment Growth vs. Lagged Openness

Source: UNIDOs (3-digit ISIC manufacturing sectors). Other major economies include Canada, France, Germany, Italy, and the UK.

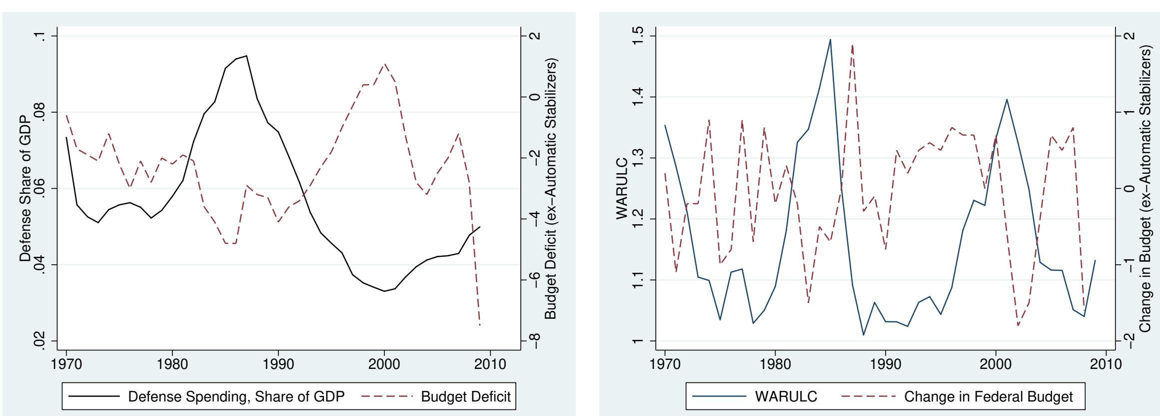
to any specific factors related to the construction of the SIC dataset used previously, and shows that the results are robust to lumping sectors into broader categories. In the second column, I estimate the relative difference-in-difference regression in equation (2.2) with standard errors clustered at the industry level, and year and industry dummies in a quantile regression minimizing the sum of absolute deviations. Here, the magnitude of the results even increases compared to column (1), although the estimate also becomes less precise.

2.4 Defense Spending, the Budget, and the Crowding Out of Tradable Sectors

In the Mathematical Appendix, I show that government spending can lead to dynamic crowding out of more tradable sectors. Although the mechanism is not fully spelled out in this simple model, a larger government deficit can affect the tradables sector in at least three ways. First, even in a closed economy setting, higher government spending could induce more resource allocation to service sectors. Secondly, larger government deficits can lead to higher real interest rates, which can cause currency appreciation. Thirdly, a larger supply of US Treasuries may induce foreign purchases, given that there is a globally limited supply of very safe, positive-yielding assets whose value appreciates during recessions and financial crises. Additionally, higher interest rates could have a direct effect on more-tradable sectors if these sectors are also more sensitive to interest rate movements, although this does not appear to be the case on average.

In this section, I estimate reduced-form regressions using changes in defense spending and the budget deficit ex-automatic stabilizers to predict differential changes in employment in more tradable sectors. The benefit of this research design is that the changes in defense spending and budget posture hinged on the outcomes of presidential elections, and thus are arguably exogenous.

Figure 12(a) shows that defense spending as a share of GDP increased dramatically after the US election of 1980, and then increased again after the election in 2000. Changes in the US budget deficit appear to be related to changes in WARULC (Figure 12(b)), although the correlation with other measures of the real exchange rate, such as WARP or the Fed's index is even more pronounced.



(a) Defense Spending vs. Budget Deficit

(b) Structural Budget Deficit vs. WARULC

Figure 12: Defense Spending, the Structural Budget Deficit, and RULCs
Sources: FRED and CBO

In Table 5 column (1), I regress lagged relative openness interacted with log changes in defense spending over GDP (divided by ten to normalize the coefficient). Once again, I get a negative, statistically significant coefficient, which implies that in 1985, when

Table 5: Government Spending and Crowding Out

	(1)	(2)	(3)	(4)
	$ln\Delta$ L	$ln\Delta$ L	$ln\Delta$ L	$ln\Delta$ L
L1.Relative Openness	-0.011***	-0.0096***	-0.012***	-0.0079***
	(0.0040)	(0.0037)	(0.0043)	(0.0020)
$ln\Delta$ VA-per-Production Worker	-0.21***	-0.21***	-0.21***	-0.30***
	(0.025)	(0.024)	(0.025)	(0.016)
$ln\,\Delta$ Demand	0.45***	0.45***	0.45***	0.60***
	(0.047)	(0.046)	(0.046)	(0.016)
L.(K/L)	-0.0072	-0.0089	-0.016	-0.0095
	(0.022)	(0.022)	(0.023)	(0.012)
L.(K/L)*L.Real Interest Rate	-0.54*	-0.58*	-0.45	-0.034
	(0.32)	(0.31)	(0.32)	(0.33)
L.$ln\,\Delta$ Price of Shipments	0.033***	0.032***	0.035***	0.021**
	(0.011)	(0.011)	(0.011)	(0.0090)
L.$ln\,\Delta$ Price of Materials	0.13***	0.13***	0.12***	0.077***
	(0.034)	(0.033)	(0.033)	(0.028)
L.$ln\,\Delta$ PI*(I/S)	-0.94**	-0.90*	-1.06**	-0.50
	(0.47)	(0.47)	(0.44)	(0.46)
L.$ln\,\Delta$ PE*(E/S)	-0.41**	-0.42**	-0.41**	-0.29*
	(0.17)	(0.17)	(0.16)	(0.15)
L.Rel.Open* $ln\Delta$ (Defense/GDP)	-1.18***			
	(0.15)			
L.Rel.Open* $ln\Delta$ (Defense/Ship.)		-1.17***		
		(0.17)		
L.1. Rel.Open*Δ Struct. Budget			0.63***	0.37***
			(0.23)	(0.088)
Observation	14864	14864	14864	14864
Overall R-squared	0.47	0.47	0.46	

Clustered standard errors in parentheses. *$p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The first three regressions are weighted by initial sectoral value-added, and include 4-digit SIC industry and year fixed effects over the period 1973-2009. The fourth column minimizes the sum of absolute deviations, and includes clustered errors and year and industry dummies. The dependent variable is the log change in sectoral manufacturing employment. Lagged log changes in the price of investment and materials have been omitted to save space.

defense spending as a share of GDP increased by 10%, a sector with a relative openness of twice the average would have experienced a decline in employment by two percent relative to a closed sector. This effect is not driven by GDP as the denominator, since if we deflate defense spending with total manufacturing shipments instead, as in column (2), the results only get stronger. In column (3), I use the interaction of relative openness with changes in the budget deficit ex-automatic stabilizers and find that increases in the budget balance are also good for relatively more tradables sectors. This result is not driven by outliers, as it is robust to minimizing the sum of absolute values as in column (4).

2.5 Impact Using Alternative Measures of Relative Prices

There are many measures of "the" real exchange rate. Figure 13 compares several state-of-the-art measures of relative prices which use PWT v8.0 data and methodology to more commonly used measures provided by the Federal Reserve Board and IMF. Indexing the IMF's RULC series to begin at the same level as the WARULC index in 1975, the IMF's index implies that US ULC's were nearly 40% lower than trading partners by the 2000s, which sounds implausible. I have also plotted an updated version of Fahle *et al.*'s (2008) Weighted Average Relative Prices (WARP) using PWT v8.0, and Balassa-Samuelson Adjusted Weighted Average Relative Prices (BSWARP) described in Campbell (2013b). The Federal Reserve's CPI-based Broad Trade-Weighted Real Exchange Index, plotted in yellow, also implies a steady dollar depreciation over the period. The three "weighted average relative" indices all yield broadly similar results, although there are certainly differences in the details and in the implied degree of overvaluation. One of the major differences, the more negative overall slope of WARULC, is due to the declining share of labor income in manufacturing in the US relative to many other developed countries, which appears to be a broad-based phenomenon in manufacturing not caused by outsized changes in a small number of sectors.

As argued in Campbell (2013b), unit labor cost-based relative price measures are not necessarily *a priori* better measures of competitiveness than Balassa-Samuelson Adjusted Weighted Average Relative Price (BSWARP) indices. This is because manufacturing requires many more inputs, including nontraded inputs, than just labor, as labor costs fell to just 16% of shipment revenue by 2007. Thus broader measures of prices may be just as appropriate to gauge competitiveness as ULC indices.

In Table 6, I show that the results hold for all three of the "weighted average relative" exchange rate indices. The first column illustrates the results using Weighted Average

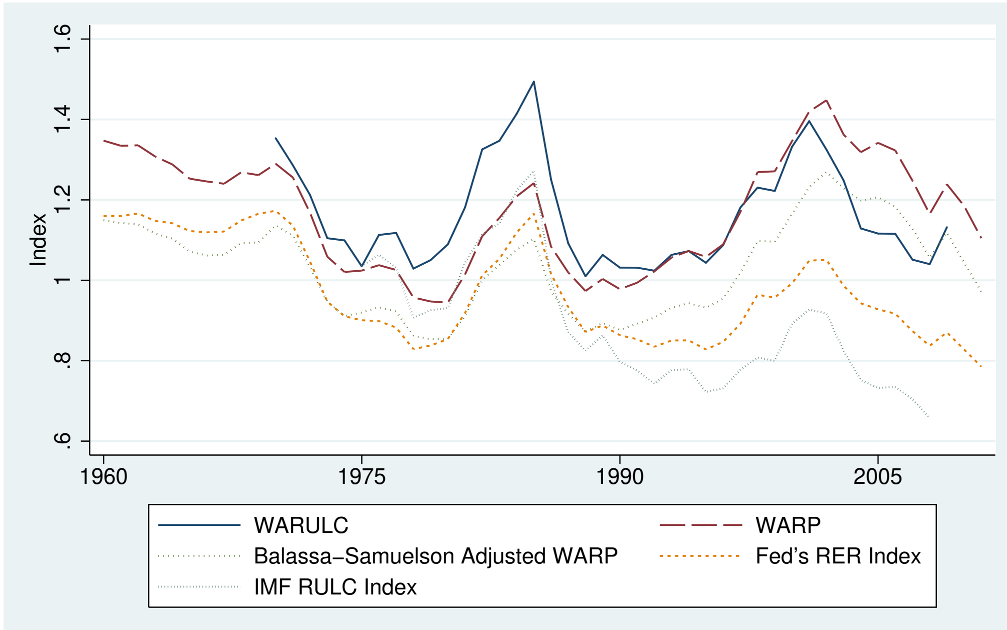


Figure 13: Comparing Various Exchange Rate Measures

Source: Campbell and Pyun, 2013 and the IMF

Relative Prices (WARP) for the manufacturing sector as a whole. In column (2), I use the lagged log of the WARP index, and in column (3) I use the log of the BSWARP index. In each case, the results are little-changed.

Additionally, in column (4), I use sector-specific trade weights, with the difference being only that the trade weights are simply imports plus exports at the sectoral level, as complete unit labor cost data, including for manufacturing PPP, and only available internationally for manufacturing as a whole. Sectoral real exchange rates may *a priori* seem like a vast improvement over using real exchange rates for the manufacturing sector as a whole, and, indeed, the "between" R-squared nearly doubles, while the overall R-squared also increases, providing further evidence that relative prices affect manufacturing employment. However, the magnitude is much smaller in part because the variance of the sector-specific exchange rate is much higher. Estimating with this index implies more jobs lost in periods when the overall WARULC index is low, but also implies fewer jobs lost when relative prices are high.[25]

[25] While using either the overall WARULC or the sectoral version yields broadly similar results, there are subtle complications with the sectoral version of WARULC which are reasons why one may prefer the overall WARULC index. The wider dispersion of sectoral WARULC values, ranging from .52 to 6.35 (over six times higher than trading partners) implies movements in the dollar will lead to proportionally smaller changes in these high-WARULC indices relative to the difference between the high-value WARULC sectors and the low-value WARULC sectors. Thus the sectoral WARULC index will tend to predict a more constant rate of job losses, while the overall WARULC index will not

Table 6: Comparing Various Measures of Relative Prices

	(1)	(2)	(3)	(4)
	$ln\Delta$ L	$ln\Delta$ L	$ln\Delta$ L	$ln\Delta$ L
L.Relative Openness	-0.0041	-0.0092*	-0.017***	-0.0035
	(0.0041)	(0.0054)	(0.0060)	(0.0041)
$ln\,\Delta$ VA-per-Prod. Worker	-0.21***	-0.21***	-0.21***	-0.21***
	(0.025)	(0.025)	(0.024)	(0.025)
$ln\,\Delta$ Demand	0.46***	0.45***	0.46***	0.45***
	(0.045)	(0.046)	(0.046)	(0.047)
L.(K/L)	-0.016	0.0019	0.0043	-0.010
	(0.023)	(0.019)	(0.018)	(0.022)
L.(K/L)*L.Real Interest Rate	-0.52*	-0.51*	-0.52*	-0.46
	(0.29)	(0.30)	(0.30)	(0.30)
L.$ln\,\Delta$ Price of Shipments	0.028***	0.025**	0.024**	0.032***
	(0.010)	(0.011)	(0.011)	(0.012)
L.$ln\,\Delta$ PI*(I/S)	-1.19***	-1.11***	-1.10***	-0.84**
	(0.41)	(0.39)	(0.38)	(0.42)
L.ln(WARULC)*Rel. Openness	-0.074***			
	(0.014)			
L.Rel.Openness*ln(WARP)		-0.071***		
		(0.010)		
L.Rel.Openness*ln(BSWARP)			-0.078***	
			(0.011)	
L.ln(Sectoral WARULC)				0.013
				(0.0083)
L.Rel.Openness*ln(Sectoral WARULC)				-0.033***
				(0.0077)
Industries	437	437	437	437
Observations	14864	14864	14864	14861
Overall R-squared	0.47	0.47	0.47	0.48

Clustered standard errors in parentheses. *$p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. All regressions are weighted by initial sectoral value-added, and include 4-digit SIC industry and year fixed effects over the period 1973-2009. The dependent variable is the log change in sectoral manufacturing employment. Lagged log changes in the price of investment has been omitted to save space.

2.6 Alternative Explanatory Variables

Movements in relative prices impact manufacturing employment, but if they were to only affect manufacturing employment and not other variables such as output and investment, this would imply that the previous results may be spurious. In this section, I test the impact of relative price movements on a multitude of other variables. In Table 7, I compare the impact of exchange rate movements on the employment of production workers in column (1) with the impact on non-production workers in column (2). The measured impact is a bit larger for production workers, but the difference is not statistically significant. Column (3) shows that the decline in the ratio of production workers to total workers is not significant. In column (4), I show that total pay per person for production workers falls slightly in more open sectors when real exchange rates rise, but that non-production worker wages were not significantly affected, nor was the ratio. I also find a slight negative impact on the hourly wages of production workers in column (6), a new result for this literature. The impact on wages is likely mitigated by compositional changes during periods of job destruction – low productivity workers, who likely also have low wages, are probably more likely to be laid off first. Even so, the relatively small impact on wages seems to suggest that trade is unlikely to be a major cause of the rise in inequality in pay within manufacturing as compared to institutional changes (see Levy and Temin, 2007). In addition, faster productivity growth in manufacturing is actually associated with a *reduction* in inequality.

In Table 8, I show that production hours per worker do increase modestly but significantly in more open sectors when relative prices are elevated, and that investment, value-added and shipments all fared worse. There was no significant impact on inventory or on the log change in prices.

predict any jobs lost when the overall unit labor costs are the same at home and abroad. The larger sectoral WARULC values also give rise to a multicollinearity issue for some sectors, as the interaction term between lagged relative openness and sectoral WARULC will not vary as much for high-index value sectors compared to lower-index value sectors. Additionally, there is incomplete ULC data for developing countries, which implies that some of the movements in the sectoral WARULC index may be spurious, as China's share of trade increased in certain sectors at the expense of countries, such as Thailand, with missing data. This is much less of a problem for the overall index.

Table 7: Impact on Production and Non-Production Workers

	Employment			Wages		
	(1)	(2)	(3)	(4)	(5)	(6)
	$ln\Delta$ PW	$ln\Delta$ non-PW	$ln\Delta$ PW Share	$ln\Delta$ PW	$ln\Delta$ non-PW	$ln\Delta$ PW hourly
L1.Relative Openness	-0.00256	-0.00121	0.000350	0.00306***	0.00284**	0.00370***
	(0.00434)	(0.00377)	(0.00129)	(0.00107)	(0.00123)	(0.000995)
L.ln(WARULC)*Rel.Open.	-0.0886***	-0.0810***	-0.00406	-0.0109***	-0.00149	-0.0169***
	(0.0145)	(0.0124)	(0.00306)	(0.00376)	(0.00474)	(0.00384)
$ln\,\Delta$ VA-per-Prod. Worker	-0.285***	-0.0621***	-0.0790***	0.105***	0.00852	0.0570***
	(0.0287)	(0.0216)	(0.00972)	(0.0106)	(0.00938)	(0.00720)
$ln\,\Delta$ Demand	0.491***	0.310***	0.0533***	0.0281***	0.0505***	0.00850
	(0.0490)	(0.0369)	(0.00499)	(0.00893)	(0.00905)	(0.00588)
L.K/L	0.0716***	-0.0148	0.0309**	-0.0479***	-0.0185**	-0.0499***
	(0.0164)	(0.0331)	(0.0132)	(0.0141)	(0.00825)	(0.0175)
L.(K/L)*Real Interest Rate	0.0386	-1.761***	0.619***	-0.863***	-0.489**	-1.090*
	(0.301)	(0.634)	(0.177)	(0.278)	(0.231)	(0.624)
Industries	437	437	437	437	437	437
Observations	14864	14859	14864	14864	14856	14864
Within R-squared	0.561	0.194	0.133	0.350	0.120	0.307
Between R-squared	0.263	0.211	0.107	0.330	0.161	0.325
Overall R-squared	0.512	0.157	0.109	0.233	0.0511	0.211

Clustered standard errors in parenthesis. *$p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. All regressions weighted by initial sectoral value-added, and include 4-digit SIC industry and year fixed effects over the period 1973-2009. The dependent variables are (1) production workers, (2) non-production workers, (3) the share of production workers, (4) production worker pay, (5) non-production worker pay per person, and (6) hourly production worker pay.

Table 8: Impact on Hours, Investment, VA, Shipments, Inventory and Prices

	(1) $ln\Delta$ PW Hours	(2) $ln\Delta$ Investment	(3) $ln\Delta$ VA	(4) $ln\Delta$ Ship	(5) $ln\Delta$ Inventory	(6) $ln\Delta$ Prices
L.Relative Openness	-0.000641	0.00601	-0.00120	0.000298	0.00438	-0.0000144
	(0.00124)	(0.00820)	(0.00455)	(0.00520)	(0.00422)	(0.00214)
L.ln(WARULC)*Rel.Open.	0.00606**	-0.144***	-0.0921***	-0.0994***	-0.0109	-0.00449
	(0.00306)	(0.0312)	(0.0153)	(0.0161)	(0.0137)	(0.00483)
$ln\,\Delta$ VA-per-Prod. Worker	0.0483***	-0.0846*	0.655***	0.113***	-0.757***	-0.0613***
	(0.00694)	(0.0480)	(0.0388)	(0.0419)	(0.0330)	(0.0170)
$ln\,\Delta$ Demand	0.0196***	0.594***	0.439***	0.592***	-0.0397**	-0.0435***
	(0.00522)	(0.0742)	(0.0471)	(0.0596)	(0.0186)	(0.0126)
L.K/L	0.00202	-0.161	0.0262	-0.0185	-0.150***	0.0695*
	(0.00571)	(0.137)	(0.0368)	(0.0364)	(0.0387)	(0.0374)
L.(K/L)*Real Interest Rate	0.227	-7.520***	-4.464***	-5.046***	0.819	-4.369***
	(0.374)	(1.868)	(0.989)	(0.981)	(1.223)	(0.889)
L.$ln\,\Delta$ Price of Shipments	0.000459	0.230***	0.0103	0.00686	0.0499	
	(0.00536)	(0.0440)	(0.0307)	(0.0237)	(0.0431)	
Industries	437	437	437	437	426	426
Observations	14864	14864	14864	14864	11442	11442
Within R-squared	0.133	0.209	0.677	0.644	0.398	0.370
Between R-squared	0.0824	0.0237	0.163	0.244	0.110	0.179
Overall R-squared	0.0787	0.147	0.595	0.580	0.284	0.270

Clustered standard errors in parentheses. *$p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. All regressions weighted by initial sectoral value-added, and include 4-digit SIC industry and year fixed effects over the period 1973-2009. The dependent variables are log changes in (1) production worker hours, (2) investment, (3) value-added, (4) shipments, (5) inventories, and (6) prices.

In addition, I find an impact of exchange rate movements on job creation, job destruction, and TFP, but not on unit labor costs (the regression results for these variables are reported in the Additional Appendix). When unit labor costs in the US rise relative to trading partners, there is suppressed job creation, but the impact on job destruction is much larger. Since job creation varies much less than job destruction overall, this asymmetry is an important "fingerprint" of hysteresis. Nearly four good years of job creation are needed for every bad year of destruction. Lastly, while recent research (Elsby *et. al.*, 2013) has found that offshoring is partly responsible for the decline in the overall US share of income, I did not find a differential impact of exchange rate movements on the unit labor costs of more open sectors. In fact, there is a broad-based, steady decline in unit labor costs since 1958 which appears to be at best tangentially related to trade.

3 A Tale of Two Rising Powers: Japan vs. China

As US trade with China has increased rapidly since 1980, regaining the level of trade the two countries shared in 1820s as a share of US GDP only in the early 2000s (Figure 14), Chinese growth has become the center of focus for those wishing to explain the decline of US manufacturing. Similarly, in the 1980s many Americans blamed manufacturing job losses on Japan's rise, as imports from Japan displayed an astonishing increase from the 1950s to the mid-1980s, only slightly less dramatic than China's later rise. In the 1980s, it was widely thought that Japan's dominance owed to superior Japanese business practices such as *Kaizen* costing and *Kanban* scheduling, support from MITI, and innate features of Japanese culture. While these factors may have been important, it turns out that relative prices alone can largely explain Japan's ascent and then stagnation in the US market.

Japan is a particularly good case study since the yen was heavily managed and then appreciated substantially shortly after the full liberalization of Japanese capital markets. First, the yen was fixed until the early 1970s, when President Nixon, worried about what were very small trade deficits by recent standards, imposed a 10% tariff to force other countries, namely Japan and Germany, to revalue their currencies (Irwin, 2013). In the 1970s, the yen continued to be managed in a dirty float, with most controls on capital lifted in 1980. At that point the dollar began its appreciation for reasons unrelated to Japan. In 1984 Japan, under intense pressure from the US Treasury, added substantial additional liberalization measures in the Yen-Dollar Agreement (Frankel, 1990). As the dollar continued to soar in 1985, the Reagan Administration responded with the Plaza Accord, an agreement among major nations to reduce fiscal imbalances and intervene in

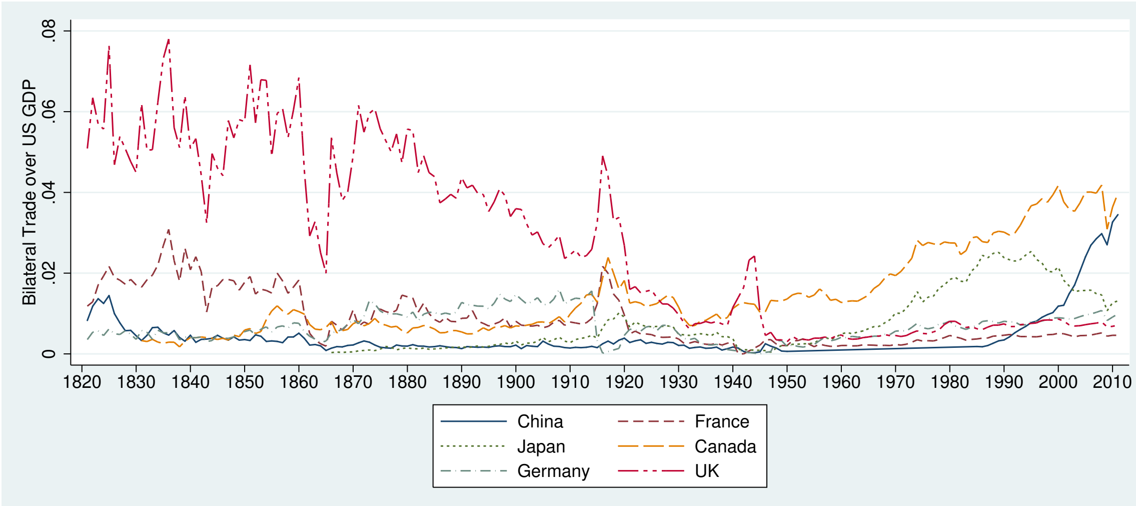
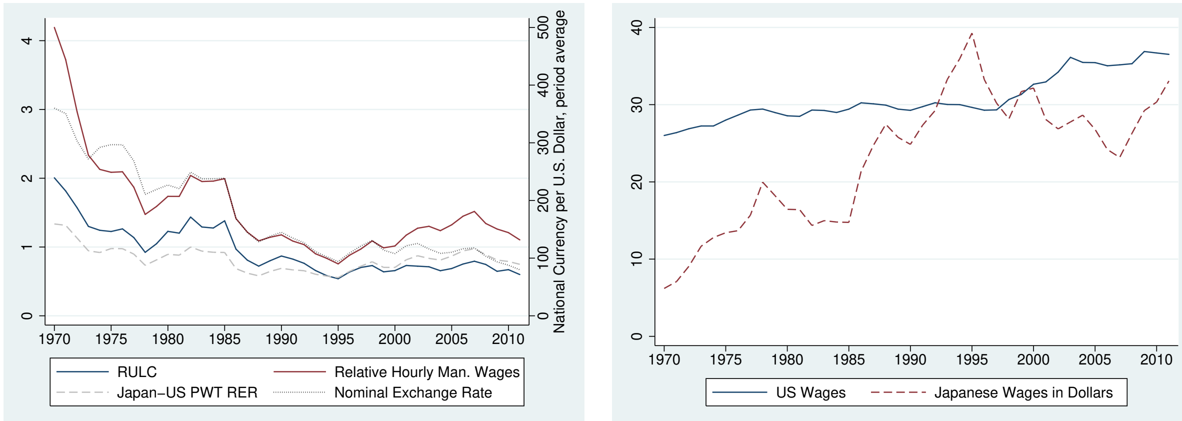


Figure 14: US Trade Patterns, 1820-2010
Source: Campbell and Pyun (2013)

the currency markets to weaken the dollar.

Figure 15 demonstrates that the combination of the end of capital controls, the move toward fiscal balance in the US in late 1985, and the Plaza Accord had a major impact on relative prices between the US and Japan. US manufacturing workers went from enjoying hourly wages twice that of their Japanese counterparts in 1985 to earning wages that were close to parity three years later. US unit labor costs relative to Japan fell 47% and the real exchange rate using PPP from the Penn World Tables, v8.0, implies an appreciation of Japanese relative prices of 37%. Thus the case of Japan yields a relatively clean quasi-natural experiment for the impact of currency undervaluation and large exchange rate adjustments.

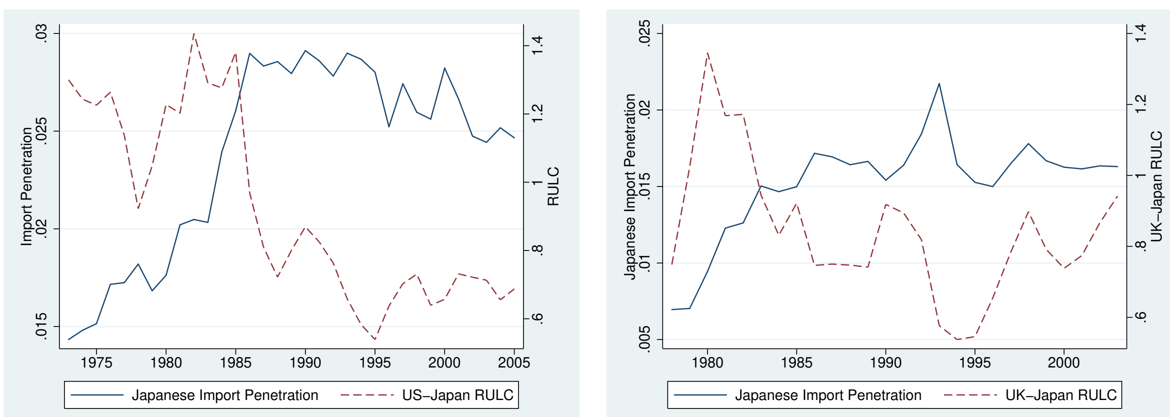
The result of this real appreciation was that as wages in the Japanese manufacturing sector suddenly increased substantially relative to their American counterparts, the meteoric Japanese export growth from 1946 to 1986 suddenly ground to a halt (Figure 16(a)). However, Japan kept the gains in market share it had made even though it did not make further inroads—another validation of hysteresis. Japan's gains through 1986 were also not purely due to domestic factors in Japan, such as government encouragement to increase market share in export markets, since the same trends are not evident in other markets. In the UK case, Japanese exports grew very quickly in the early 1980s, when the yen was weak relative to the pound, but Japanese import penetration into the UK market did not grow at all from 1983 to 1985, when Japanese unit labor costs were higher than UK unit labor costs. Hence, on balance Krugman (1986) appears to have been correct in guessing that the yen's appreciation in that year meant that "the Japan



(a) US-Japan Exchange Rates (b) Manufacturing Wages (2011 Dollars)

Figure 15: Relative Prices and Sticky Manufacturing Wages
(Sources: PWT v8.0, CP 2013, BLS)

problem was over."



(a) US (b) UK

Figure 16: RULCs and Japanese Import Penetration
(Sources: CP 2013, UNIDOs, Comtrade)

The parallels with China today are striking. China, like Japan several decades ago, has a heavily managed currency and capital controls supporting export-led growth (US-China relative prices, including relative hourly wages in manufacturing, are featured in Figure 17(a)), and a growing mass of official foreign reserves, at $3.6 trillion as of June, 2013. Figure 14 demonstrates that the explosion of trade between the US and China in the past several decades was unprecedented in US history. As large as this rise was, China's growing role in trade was only part of the reason for the dramatic increase in US Weighted Average Relative Prices (WARP), as seen in Figure 17, which plots WARP with and without China. While China is often seen as being the sole source of jobs lost in the early 2000s, even if China is excluded from WARP, the US price level was generally high during this period relative to other trading partners.

When log changes in sectoral employment by year are regressed on lagged Chinese relative import penetration and relative import penetration ex-China with other controls, both variables predict job losses in the early 2000s.[26] The annual coefficients are seemingly predicted by "Chinese Exposure", effectively an employment-weighted average of the log of WARULC times Chinese import penetration for each sector. In the 1980s and early 1990s, Chinese imports were growing quickly but they were still too small to have a measurable effect on manufacturing employment. By the early 2000s, Chinese imports had become large enough to affect US employment, while Chinese relative prices were still very competitive. While this measure of "Chinese Exposure" seems to do a relatively good job of explaining the coefficient on relative Chinese import penetration by year, there is still room for other factors, such as the awarding of permanent MFN status or China's ascension to the WTO, to have had an impact in the 2000s, when outsourcing became a fad in the American business community.[27]

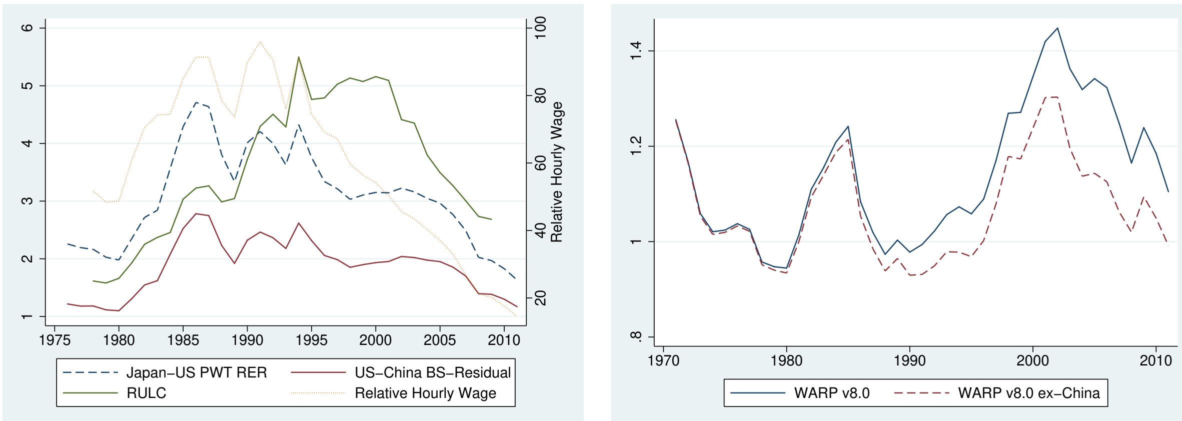
Figure 19 presents the results from two counterfactuals which add back the cumulative jobs lost from the dollar's strength in the late 1990s and early 2000s (blue dashes), using the regression coefficients displayed in Figure (18) and a second estimate using the panel data from Column (2) of Table 3. The estimates using the annual regressions imply that 2.2 million jobs were lost due to trade competition over the period 1995-2008, while the panel estimates suggest only 1.9 million jobs were lost. Both of these are substantially *lower* than the 3.9 million jobs lost according to a straightforward accounting approach (Table 9).[28] However, what is clear is that even both of these counterfactuals imply a substantial fall in manufacturing employment after 2000. What accounts for this decline?

Figure 19(b) displays the changes in manufacturing employment due to changes in demand and productivity (using the regression coefficients from Column (2) of Table 3 multiplied by the actual changes in demand and labor productivity for each sector). While the jobs lost due to productivity gains after 2000 look unimpressive, demand

[26] *I.e.*, for each year from 1973-2009, I run: $ln(L_h/L_h) = \alpha + \beta_1 L1.Rel.ChineseImportPen_h + \beta_2 L1.Rel.OtherImportPen_h + \beta_3 ln(D_h/D_h) + \beta_4 ln((TFP)_h/(TFP)_h + \epsilon_h$. The errors are clustered at the 2-digit SIC level.

[27] Handley and Limao 2013, for example, argue that awarding China permanent MFN status had an incredibly large impact on trade.

[28] This table "accounts" for manufacturing jobs lost due to trade by dividing the increase in the manufacturing trade deficit after 1995 by observed labor productivity as a crude estimate of jobs lost due to increases in the deficit.



(a) Relative Prices, US vs. China

(b) WARP vs. WARP ex-China

Figure 17: Relative Prices, US vs. China and WARP ex-China

Sources: PWT v8.0, CP 2013, BLS

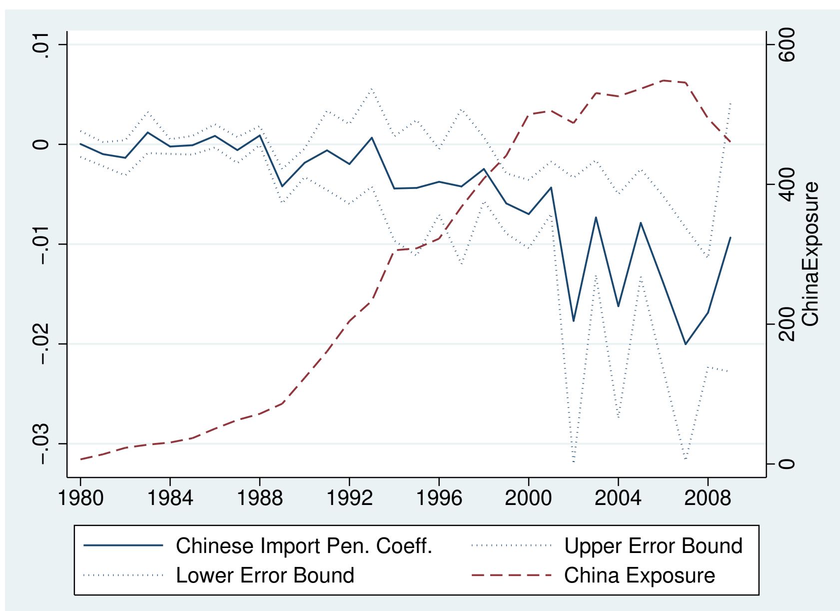
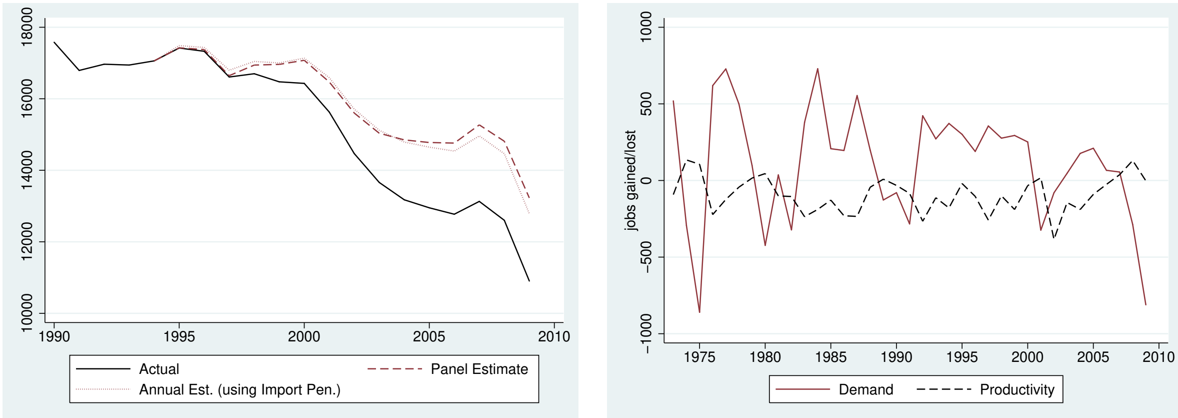


Figure 18: Chinese Import Penetration vs. Exposure (RULC*Import Pen.)

Sources: Author's calculations based on data from ASM, Comtrade, and Feenstra *et al.* (2002), and Campbell and Pyun (2013)



(a) Manufacturing Employment Counterfactuals

(b) Impact of Demand and Productivity

Figure 19: Accounting for Labor Lost

Notes: In Panel (a), the "Panel Estimate" counterfactual is computed using the coefficient on relative openness from the regression in Column (2) of Table 3. The "Annual Estimate" uses regression coefficients plotted in Figure 18, and also adding in the implied jobs lost from lagged import penetration (ex-China). The coefficient on lagged import penetration is multiplied by lagged sectoral employment and then summed by year.

growth stands out as being particularly sluggish in this period. While this may have been the result of an exogenous sectoral shift in consumption patterns toward services, another possibility is that the decline in demand was itself caused by trade via input-output linkages. Every dollar of output of apparel manufacturing requires 30 cents of output from textile mills.[29] Every dollar of industrial machinery requires 6.9 cents worth of the output from iron and steel mills. Overall, every dollar of aggregate manufacturing output generally requires about 60 cents worth of additional output from other manufacturing industries. This suggests that it is quite likely that more than 2 million jobs were lost from the dollar's appreciation and the rise of China, and that the toll may may be closer to 3 million.

4 Conclusion

In this paper, I document that when nominal real exchange rates move, nominal wages are sticky, leading to large changes in competitiveness as proxied by Weighted Average Relative Unit Labor Costs, a new measure of competitiveness. Dollar appreciations appear to lead to increased imports, decreased exports, and declines in investment and employment in the manufacturing sector. The effects appear to be persistent, an indi-

[29]Data come from the BEA's Total Requirements Input-Output table.

cation of the surprising extent to which current economic relationships are the product of history. The shock to trade in the early 2000s was large enough to explain at least two-thirds of the decline in American manufacturing employment in this period, and perhaps substantially more if input-output linkages are taken into account. The job losses were potentially large enough to have had a macroeconomic impact. As the "Lesser Depression" continues, the US experience with Japan in the 1980s provides an example of what presidential leadership might accomplish regarding the ongoing Bretton Woods II system of managed exchange rates, developing country capital controls, and large-scale accumulation of official dollar reserves.[30] And the lesson of hysteresis reminds us that the consequences of continued slow-growth will be diminished economic possibilities for years to come.

5 Appendix

5.1 Figures and Tables

Table 9: Manufacturing Employment Accounting

Year	Manufacturing Consumption (billions)	Manufacturing Trade Deficit (billions)	Productivity (1 million workers)	Deficit Δ from 1995 over Productivity	Actual Jobs Lost in Man. Since 1995
1995	1340	159	68	0.00	0
1996	1361	152	70	-0.09	-0.01
1997	1432	155	73	-0.05	0.17
1998	1542	215	76	0.75	0.32
1999	1661	293	79	1.70	0.08
2000	1780	364	82	2.50	0.02
2001	1688	344	82	2.26	-0.80
2002	1760	404	89	2.76	-1.99
2003	1822	448	95	3.05	-2.74
2004	2023	540	104	3.68	-2.93
2005	2158	590	110	3.92	-3.02

Source: BEA. Manufacturing "Consumption" is defined as manufacturing GDP plus imports minus exports.

[30]See Dooley *et al.* 2004, 2005, 2007, and 2009.

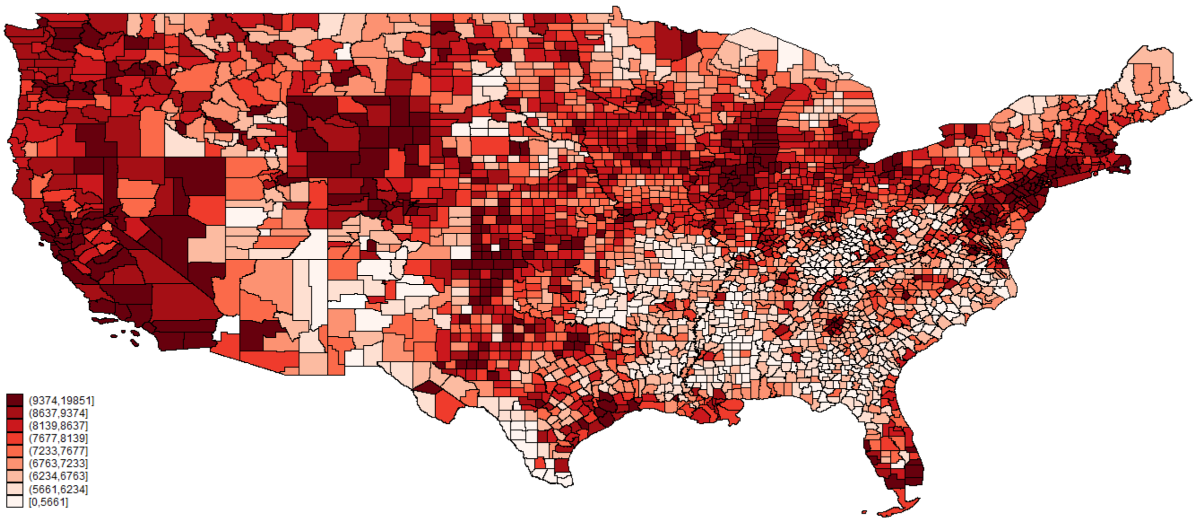


Figure 20: Income per Capita, 1979

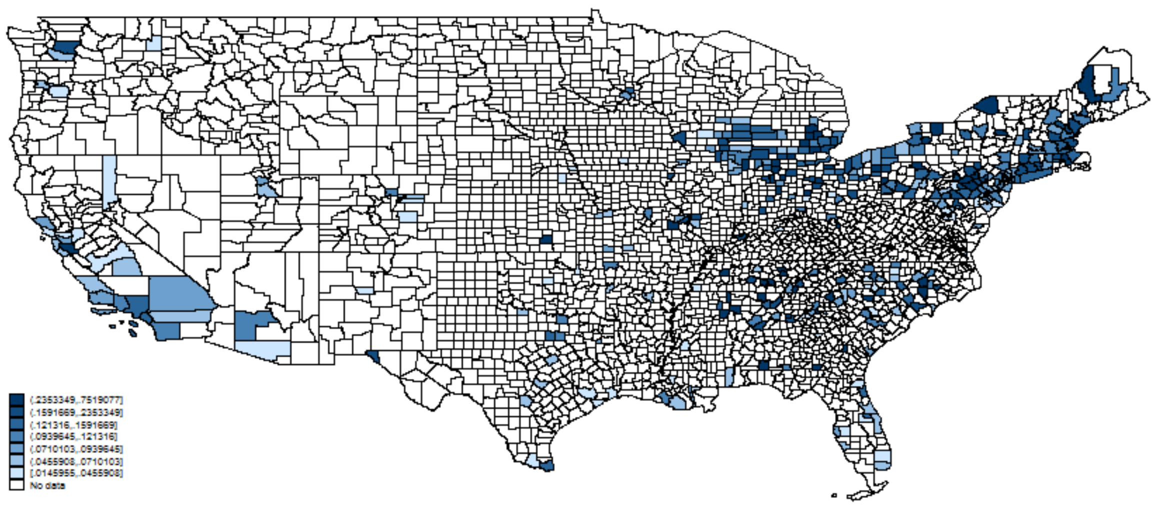
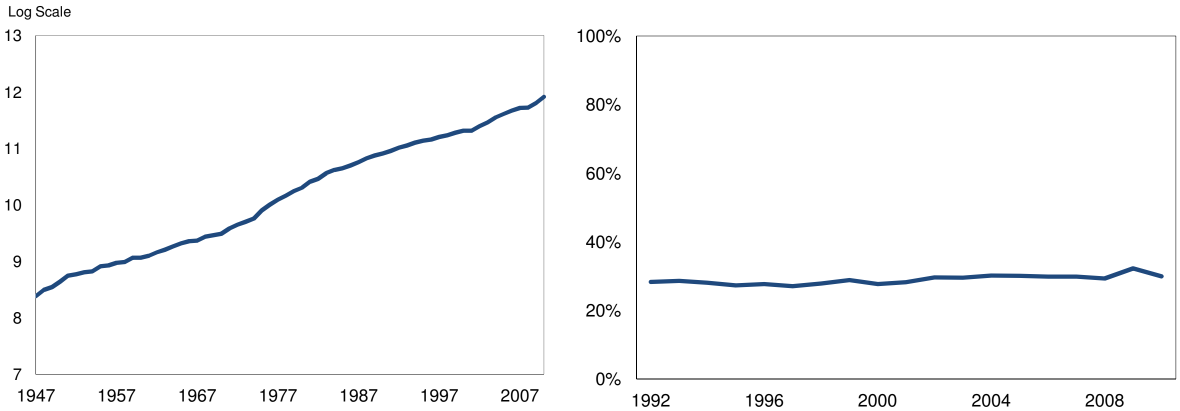


Figure 21: Import-Competing Manufacturing Employment, Share of Total Employment, 1979

Notes: 1,500 worker minimum. Sources: BEA and WITS



(a) Value-Added per Worker

(b) Services Share of Exports

Figure 22: The Usual Suspects: Explanations for the Decline of Manufacturing
Source: BEA

5.2 Mathematical Appendix

Proposition: Government Spending can Lead to Dynamic Crowding Out

Let L_g^o be the initial level of government employment in autarky. Simplifying the model by assuming no overhead costs and just one industry, with the potential entrants now exogenous as in Melitz (2003), we can solve for the steady-state mass of firms from the labor market clearing condition.

$$\frac{L - L_g^o}{\sigma \delta f_e} = M_{ss}^o \tag{5.1}$$

If the labor devoted to government falls, then the equilibrium mass of firms will rise. However, each period the share δ of firms dies out, which means that the net mass of new entrants in the first year after a cut in government spending is:

$$M_1^e - M_{ss}^o \delta = \frac{L - L_g^1}{\sigma f_e} - \frac{L - L_g^o}{\sigma \delta f_e} = \frac{L_g^o - L_g^1}{\sigma f_e}, \tag{5.2}$$

Where M_1^e is the mass of new entrants in the first period after government spending falls. The total mass of new firms gained to reach the new steady state is:

$$M_{ss}^1 - M_{ss}^o = \frac{L_g^1 - L_g^o}{\sigma \delta f_e} > \frac{L_g^o - L_g^1}{\sigma f_e}, \tag{5.3}$$

If government spending stays at its new level, we can iterate out to solve for the mass of firms at t.

$$M_t = \sum_{j=1}^{t} (1-\delta)^{t-j} M_j^e + (1-\delta)^t M_{ss}^o$$

$$M_t = \sum_{j=1}^{t} (1-\delta)^{t-j} \frac{(L - L_g^1)}{\sigma f_e} + (1-\delta)^t \frac{(L - L_g^0)}{\sigma \delta f_e} \tag{5.4}$$

The new steady state will be reached in the limit. By contrast, if government spending increases, the mass of firms will shrink at rate δ until the new steady state is reached.

References

Abell, J. D., "Twin Deficits During the 1980s: An Empirical Investigation," *Journal of Macroeconomics* 12 (1991), 81–96.

Acemoglu, D., D. Autor, D. Dorn, G. H. Hanson and B. Price, "Import Competition and the Great US Employment Sag of the 2000s," Technical Report, National Bureau of Economic Research, Inc, 2013.

Autor, D., D. Dorn and G. H. Hanson, "The China Syndrome: The Local Labor Market Effects of Import Competition in the US," *American Economic Review* 103 (2013), 2121–68.

Baldwin, R., "Hyteresis in Import Prices: The Beachhead Effect," *American Economic Review* 78 (September 1988), 773–85.

———, "Hysteresis in Trade," *Empirical Economics* 15 (1990), 127–42.

Baldwin, R. and P. Krugman, "Persistent Trade Effects of Large Exchange Rate Shocks," *The Quarterly Journal of Economics* 104 (November 1989), 635–54.

Bartlesman, E. and W. B. Gray, "The NBER Manufacturing Productivity Database," (1996).

Belke, A., M. Göcke and M. Günther, "Exchange Rate Bands of Inaction and Play – Hysteresis in German Exports – Sectoral Evidence for Some OECD Destinations," *Metroeconomica* 64 (2013), 152–179.

Bergin, P., "Should We Worry About the Large U.S. Current Account Deficit?," *FRBSF Economic Letter* (2000).

Bergin, P. R. and C. Y. Lin, "The Dynamic Effects of Currency Union on Trade," *Journal of International Economics* (2012).

Bergin, P. R. and S. M. Sheffrin, "Interest Rates, Exchange Rates and Present Value Models of the Current Account," *Economic Journal* 110 (April 2000), 535–58.

Berman, N., P. Martin and T. Mayer, "How do Different Exporters React to Exchange Rate Changes?," *The Quarterly Journal of Economics* 127 (2012), 437–492.

Bernard, A. B., J. B. Jensen and P. K. Schott, "Survival of the Best Fit: Exposure to Low-Wage Countries and the (Uneven) Growth of U.S. Manufacturing Plants," *Journal of International Economics* 68 (January 2006), 219–237.

Branson, W. H. and J. P. Love, "Dollar Appreciation and Manufacturing Employment and Output," NBER Working Papers 1986, National Bureau of Economic Research, Inc, 1986.

———, "The Real Exchange Rate and Employment in U.S. Manufacturing: State and Regional Results," NBER Working Papers 2435, National Bureau of Economic Research, Inc, November 1987.

———, "The Real Exchange Rate, Employment, and Output in Manufacturing in the U.S. and Japan," NBER Working Papers 2491, National Bureau of Economic Research, Inc, February 1988.

Burstein, A. and M. J. Melitz, "Trade Liberalization and Firm Dynamics," NBER Working Papers 16960, National Bureau of Economic Research, Inc, April 2011.

Campa, J. M. and L. S. Goldberg, "Employment Versus Wage Adjustment and the US Dollar," *Review of Economics and Statistics* 83 (2001), 477–489.

Campbell, D. L., "History, Culture, and Trade: A Dynamic Gravity Approach," MPRA Paper 24014, University Library of Munich, Germany, July 2010.

———, "Estimating the Impact of Currency Unions on Trade: Solving the Glick and Rose Puzzle," *The World Economy* (2013a).

———, "Through the Looking Glass: A WARPed View of Real Exchange Rate History," Working paper, 2013b.

Chaney, T., "Distorted Gravity: The Intensive and Extensive Margins of International Trade," *American Economic Review* 98 (September 2008), 1707–21.

Corsetti, G. and G. J. Müller, “Twin Deficits: Squaring Theory, Evidence and Common Sense,” *Economic Policy* 21 (2006), 597–638.

Dixit, A., “Entry and Exit Decisions Under Uncertainty,” *Journal of Political Economy* 97 (June 1989a), 620–38.

———, “Hysteresis, Import Penetration, and Exchange Rate Pass-Through,” *The Quarterly Journal of Economics* 104 (May 1989b), 205–28.

———, “Analytical Approximations in Models of Hysteresis,” *Review of Economic Studies* 58 (January 1991), 141–51.

———, “Investment and Hysteresis,” *Journal of Economic Perspectives* 6 (Winter 1992), 107–32.

Dooley, M., D. Folkerts-Landau and P. Garber, “The Revived Bretton Woods System: The Effects of Periphery Intervention and Reserve Management on Interest Rates & Exchange Rates in Center Countries,” NBER Working Papers 10332, National Bureau of Economic Research, Inc, March 2004.

———, “An Essay on the Revived Bretton Woods System,” *Proceedings* (2005).

———, “Direct Investment, Rising Real Wages and the Absorption of Excess Labor in the Periphery,” in *G7 Current Account Imbalances: Sustainability and Adjustment*NBER Chapters (National Bureau of Economic Research, Inc, 2007), 103–132.

———, “Bretton Woods II Still Defines The International Monetary System,” *Pacific Economic Review* 14 (08 2009), 297–311.

Ebenstein, A., M. McMillan, Y. Zhao and C. Zhang, “Understanding the Role of China in the “Decline” of US Manufacturing,” *Working Paper* (2012).

Eichengreen, B. and D. A. Irwin, “The Role of History in Bilateral Trade Flows,” in *The Regionalization of the World Economy* (National Bureau of Economic Research, Inc, 1998), 33–62.

Elsby, M. W. L., B. Hobijn and A. Sahin, “The Decline of the US Labor Share,” *Brookings Papers on Economic Activity* (2013).

Fahle, S., J. Marquez and C. Thomas, “Measuring US International Relative Prices: A WARP View of the World,” *FRB International Finance Discussion Paper* (2008).

Feenstra, R. C., "Globalization and Its Impact on Labour," wiiw Working Papers 44, The Vienna Institute for International Economic Studies, wiiw, July 2007.

Feenstra, R. C., R. Inklaar and M. Timmer, "The Next Generation of the Penn World Table," Working paper, April 2013.

Feenstra, R. C., H. Ma, J. P. Neary and D. P. Rao, "Who Shrunk China? Puzzles in the Measurement of Real GDP," NBER Working Papers 17729, National Bureau of Economic Research, Inc, January 2012.

Feenstra, R. C. and S.-J. Wei, "Introduction to China's Growing Role in World Trade.," in *China's Growing Role in World Trade.* (National Bureau of Economic Research, Inc, 2010), 1–31.

Gourinchas, P.-O., "Exchange Rates and Jobs: What Do We Learn From Job Flows?," in *NBER Macroeconomics Annual 1998, volume 13* (MIT Press, 1999), 153–222.

Grossman, G. M., "Imports as a Cause of Injury: The Case of the U.S. Steel Industry," *Journal of International Economics* 20 (May 1986), 201–223.

Handley, K. and N. Limão, "Policy Uncertainty, Trade and Welfare: Theory and Evidence for China and the US," Technical Report, National Bureau of Economic Research, Inc, 2013.

Head, K., T. Mayer and J. Ries, "The Erosion of Colonial Trade Linkages after Independence," *Journal of International Economics* 81 (May 2010), 1–14.

Irwin, D. A., "The Nixon Shock After Forty Years: The Import Surcharge Revisited," *World Trade Review* 12 (2013), 29–56.

Kim, S. and N. Roubini, "Twin Deficit or Twin Divergence? Fiscal Policy, Current Account, and Real Exchange Rate in the US," *Journal of International Economics* 74 (2008), 362–383.

Klein, M. W., S. Schuh and R. K. Triest, "Job Creation, Job Destruction, and International Competition: A Literature Review," Technical Report, 2002.

———, "Job Creation, Job Destruction, and the Real Exchange Rate," *Journal of International Economics* 59 (March 2003), 239–265.

Krugman, P., "Scale Economies, Product Differentiation, and the Pattern of Trade," *American Economic Review* 70 (December 1980), 950–59.

———, "Is the Strong Dollar Sustainable?," *Proceedings* (1985), 103–155.

———, "Is the Japan Problem Over?," NBER Working Papers 1962, National Bureau of Economic Research, Inc, June 1986.

———, "The Narrow Moving Band, the Dutch Disease, and the Competitive Consequences of Mrs. Thatcher: Notes on Trade in the Presence of Dynamic Scale Economies," *Journal of Development Economics* 27 (October 1987), 41–55.

———, "Deindustrialization, Reindustrialization, and the Real Exchange Rate," NBER Working Papers 2586, National Bureau of Economic Research, Inc, May 1988.

———, *Geography and Trade*, volume 1 of *MIT Press Books* (The MIT Press, 1992).

Krugman, P. R. and R. E. Baldwin, "The Persistence of the U.S. Trade Deficit," *Brookings Papers on Economic Activity* 18 (1987), 1–56.

Levy, F. and P. Temin, "Inequality and Institutions in 20th Century America," NBER Working Papers 13106, National Bureau of Economic Research, Inc, May 2007.

Liu, D. and C. Meissner, "Market Potential and Economic Performance in the Early 20th Century," Working papers, University of California at Davis, Department of Economics, 2012.

McKinnon, R. and G. Schnabl, "China's Exchange Rate and International Adjustment in Wages, Prices and Interest Rates: Japan deja vu?," *CESifo Economic Studies* 52 (2006), 276–303.

Meese, R. A. and K. Rogoff, "Empirical Exchange Rate Models of the Seventies: Do They Fit Out of Sample?," *Journal of international economics* 14 (1983), 3–24.

Meissner, C. M. and A. M. Taylor, "Losing our Marbles in the New Century? The Great Rebalancing in Historical Perspective," NBER Working Papers 12580, National Bureau of Economic Research, Inc, October 2006.

Melitz, M. J., "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity," *Econometrica* 71 (November 2003), 1695–1725.

Melvin, M. and S. Norrbin, *International money and finance* (Access Online via Elsevier, 2012).

Moretti, E., "Local Multipliers," *The American Economic Review* 100 (2010), 373–377.

Moser, C., D. Urban and B. W. di Mauro, "International Competitiveness, Job Creation and Job Destruction–An Establishment-Level Study of German Job Flows," *Journal of International Economics* 80 (March 2010), 302–317.

Nino, V. D., B. Eichengreen and M. Sbracia, "Real Exchange Rates, Trade, and Growth: Italy 1861-2011," Quaderni di storia economica (Economic History Working Papers) 10, Bank of Italy, Economic Research and International Relations Area, October 2011.

Pierce, J. R. and P. K. Schott, "The Surprisingly Swift Decline of U.S. Manufacturing Employment," Working Paper 18655, National Bureau of Economic Research, December 2012.

Redding, S. and A. J. Venables, "Economic Geography and International Inequality," *Journal of international Economics* 62 (2004), 53–82.

Rose, A. K., "The Role of Exchange Rates in a Popular Model of International Trade: Does the 'Marshall–Lerner' Condition Hold?," *Journal of International Economics* 30 (1991), 301–316.

Turner, P. and J. Van't Dack, "Measuring International Price and Cost Competitiveness," Technical Report 39, Bank for International Settlements, Monetary and Economic Department, 1993.