Additional Appendix for Relative Prices, Hysteresis, and the Decline of American Manufacturing

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Table 1: Falsification Exercises: Input Prices

	(1) Mater.	(2) Energy	(3) Invest.	(4) Mater.	(5) Energy	(6) Invest.
$ln\,\Delta$ Demand	0.0016	0.0081	-0.0017	0.0027	0.0083	-0.0021
	(0.014)	(0.0087)	(0.0017)	(0.014)	(0.0089)	(0.0018)
$ln\Delta$ VA-per-Production Worker	-0.054**	-0.020	-0.0012	-0.054**	-0.020*	-0.0011
	(0.023)	(0.012)	(0.0013)	(0.023)	(0.012)	(0.0013)
L.$ln\,\Delta$ Price of Shipments	-0.049	0.012	-0.0027	-0.049	0.012	-0.0026
	(0.031)	(0.012)	(0.0039)	(0.031)	(0.012)	(0.0038)
L.Relative Openness	0.0023	0.00090	-0.00056			
	(0.0026)	(0.0018)	(0.00050)			
L.ln(WARULC)*Rel.Open.	0.0040	0.00063	-0.00025			
	(0.0098)	(0.0060)	(0.0024)			
Relative Openness				0.00024	0.000036	-0.00090*
				(0.0022)	(0.0018)	(0.00052)
ln(WARULC)*Rel. Openness				0.0058	-0.000061	0.0020
				(0.0072)	(0.0044)	(0.0025)
Observations	12963	12963	12963	12963	12963	12963

Two-way Clustered standard errors in parenthesis, clustered by year and 4-digit SIC sectors. *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$. The dependent variables are the log changes in prices of inputs. All regressions are weighted by initial sectoral value-added, and include 4-digit SIC industry and year fixed effects over the period 1973-2009. Various other controls from the main tables in the paper are omitted for space.

Table 2: Falsification Exercises: Two and Three Year Lags of RERs and Input Prices

	(1) Mater.	(2) Energy	(3) Invest.	(4) Mater.	(5) Energy	(6) Invest.
L2.Relative Openness	0.0025	0.0014	-0.00057			
	(0.0025)	(0.0018)	(0.00053)			
L3.Relative Openness				0.00036	0.00018	-0.00079
				(0.0019)	(0.0020)	(0.00053)
L2.ln(WARULC)*Rel. Openness	-0.0089	-0.0042	-0.00082			
	(0.0098)	(0.0054)	(0.0025)			
L3.ln(WARULC)*Rel. Openness				-0.0050	-0.0044	0.0011
				(0.0073)	(0.0058)	(0.0023)
$ln\,\Delta$ Demand	0.0072	0.0079	-0.0012	0.0022	0.0034	-0.0012
	(0.013)	(0.0087)	(0.0017)	(0.011)	(0.0069)	(0.0018)
$ln\Delta$ VA-per-Production Worker	-0.053**	-0.020*	-0.0013	-0.051**	-0.021*	-0.0012
	(0.023)	(0.012)	(0.0013)	(0.022)	(0.013)	(0.0014)
L.$ln\,\Delta$ Price of Shipments	-0.055*	0.013	-0.0017	-0.039	0.016	-0.00097
	(0.031)	(0.013)	(0.0036)	(0.028)	(0.013)	(0.0035)
Observations	12611	12611	12611	12259	12259	12259

Two-way Clustered standard errors in parenthesis, clustered by year and 4-digit SIC sectors. *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$. The dependent variables are the log changes in prices of inputs. All regressions are weighted by initial sectoral value-added, and include 4-digit SIC industry and year fixed effects over the period 1973-2009. Various other controls from the main tables in the paper are omitted for space.

Table 3: Falsification Exercises: Four and Five Year Lags of RERs and Input Prices

	(1) Mater.	(2) Energy	(3) Invest.	(4) Mater.	(5) Energy	(6) Invest.
L4.Relative Openness	-0.0012	-0.00092	-0.00078			
	(0.0019)	(0.0019)	(0.00056)			
L5.Relative Openness				-0.00055	-0.000066	-0.00056
				(0.0018)	(0.0015)	(0.00055)
L4.ln(WARULC)*Rel. Openness	0.0023	0.0016	0.0018			
	(0.0070)	(0.0056)	(0.0023)			
L5.ln(WARULC)*Rel. Openness				0.0036	-0.0021	0.0020
				(0.0062)	(0.0040)	(0.0024)
$ln\,\Delta$ Demand	0.0074	0.0057	-0.00091	0.0056	0.0069	-0.0011
	(0.0093)	(0.0068)	(0.0018)	(0.010)	(0.0064)	(0.0019)
$ln\Delta$ VA-per-Production Worker	-0.049**	-0.021	-0.00077	-0.046**	-0.022	-0.00079
	(0.022)	(0.013)	(0.0014)	(0.023)	(0.014)	(0.0014)
L.$ln\,\Delta$ Price of Shipments	-0.027	0.015	-0.0011	-0.014	0.0098	-0.0015
	(0.027)	(0.013)	(0.0037)	(0.029)	(0.013)	(0.0040)
Observations	11907	11907	11907	11555	11555	11555

Two-way Clustered standard errors in parenthesis, clustered by year and 4-digit SIC sectors. *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$. The dependent variables are the log changes in prices of inputs. All regressions are weighted by initial sectoral value-added, and include 4-digit SIC industry and year fixed effects over the period 1973-2009. Various other controls from the main tables in the paper are omitted for space.

Table 4: Falsification Exercises: Leading Values of RERs and Input Prices

	(1) Mater.	(2) Energy	(3) Invest.	(4) Mater.	(5) Energy	(6) Invest.
L2.Relative Openness	0.0025	0.0014	-0.00057			
	(0.0025)	(0.0018)	(0.00053)			
L3.Relative Openness				0.00036	0.00018	-0.00079
				(0.0019)	(0.0020)	(0.00053)
L2.ln(WARULC)*Rel. Openness	-0.0089	-0.0042	-0.00082			
	(0.0098)	(0.0054)	(0.0025)			
L3.ln(WARULC)*Rel. Openness				-0.0050	-0.0044	0.0011
				(0.0073)	(0.0058)	(0.0023)
$ln\,\Delta$ Demand	0.0072	0.0079	-0.0012	0.0022	0.0034	-0.0012
	(0.013)	(0.0087)	(0.0017)	(0.011)	(0.0069)	(0.0018)
$ln\Delta$ VA-per-Production Worker	-0.053**	-0.020*	-0.0013	-0.051**	-0.021*	-0.0012
	(0.023)	(0.012)	(0.0013)	(0.022)	(0.013)	(0.0014)
L.$ln\,\Delta$ Price of Shipments	-0.055*	0.013	-0.0017	-0.039	0.016	-0.00097
	(0.031)	(0.013)	(0.0036)	(0.028)	(0.013)	(0.0035)
Observations	12611	12611	12611	12259	12259	12259

Two-way Clustered standard errors in parenthesis, clustered by year and 4-digit SIC sectors. *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$. The dependent variables are the log changes in prices of inputs. All regressions are weighted by initial sectoral value-added, and include 4-digit SIC industry and year fixed effects over the period 1973-2009. Various other controls from the main tables in the paper are omitted for space.

Table 5: Falsification Exercises: Three and Four Year Leads of RERs and Input Prices

	(1) Mater.	(2) Energy	(3) Invest.	(4) Mater.	(5) Energy	(6) Invest.
F3.Relative Openness	0.0010	-0.00072	-0.00053			
	(0.0019)	(0.0018)	(0.00051)			
F4.Relative Openness				0.0013	-0.00011	-0.00037
				(0.0020)	(0.0019)	(0.00056)
F3.ln(WARULC)*Rel. Openness	-0.0073	-0.0043	0.0023			
	(0.0087)	(0.0052)	(0.0018)			
F4.ln(WARULC)*Rel. Openness				-0.0025	-0.0026	0.0024
				(0.0082)	(0.0054)	(0.0020)
$ln\,\Delta$ Demand	0.00034	0.0083	-0.0023	-0.00050	0.0082	-0.0022
	(0.015)	(0.0092)	(0.0019)	(0.015)	(0.0094)	(0.0019)
$ln\Delta$ VA-per-Production Worker	-0.049**	-0.0098	-0.0012	-0.049**	-0.0093	-0.0010
	(0.019)	(0.0089)	(0.0016)	(0.020)	(0.0091)	(0.0017)
L.$ln\,\Delta$ Price of Shipments	-0.040	0.016	-0.0033	-0.044	0.018	-0.0039
	(0.029)	(0.012)	(0.0038)	(0.029)	(0.013)	(0.0038)
o.year== 2007.0000	0	0	0	0	0	0
	(8.9e-11)	(1.6e-10)	(1.3e-18)	(2.0e-10)	(1.8e-10)	(3.7e-12)
o.year== 2008.0000	0	0	0	0	0	0
	(8.1e-11)	(1.0e-10)	(2.5e-18)	(1.4e-10)	(2.0e-10)	(7.2e-12)
Observations	11936	11936	11936	11593	11593	11593

Two-way Clustered standard errors in parenthesis, clustered by year and 4-digit SIC sectors. *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$. The dependent variables are the log changes in prices of inputs. All regressions are weighted by initial sectoral value-added, and include 4-digit SIC industry and year fixed effects over the period 1973-2009. Various other controls from the main tables in the paper are omitted for space.

	(1)	(2)	(3)	(4)	(5)
	$ln\Delta$ L	$ln\Delta$ L	$ln\Delta$ L	$ln\Delta$ L	$ln\Delta$ L
$ln\,\Delta$ Demand	0.44***	0.43***	0.44***	0.44***	0.45***
	(0.063)	(0.063)	(0.064)	(0.066)	(0.069)
$ln\Delta$ TFP (5 factor)	-0.12	-0.12	-0.12	-0.13	-0.14*
	(0.074)	(0.074)	(0.074)	(0.077)	(0.077)
L.Relative Openness	0.0040				
	(0.0044)				
Relative Openness		-0.0038			
		(0.0065)			
F.Relative Openness			-0.0092*		
			(0.0056)		
F2.Relative Openness				-0.012**	
				(0.0048)	
F3.Relative Openness					-0.017***
					(0.0045)
L.ln(WARULC)*Rel. Openness	-0.080***				
	(0.016)				
ln(WARULC)*Rel. Openness		-0.050**			
		(0.023)			
F.ln(WARULC)*Rel. Openness			-0.031*		
			(0.017)		
F2.ln(WARULC)*Rel. Openness				-0.0078	
				(0.016)	
F3.ln(WARULC)*Rel. Openness					0.0085
					(0.018)
Observations	12963	12963	12623	12279	11936

Table 6: Exchange Rates, Openness, and Manufacturing Employment

	(1)	(2)	(3)	(4)	(5)	(6)
	.2	.3	.4	.6	.7	.8
L.Relative Openness	-0.0065	-0.0059**	-0.0033	0.00077	0.0026	0.0057**
	(0.0040)	(0.0030)	(0.0028)	(0.0026)	(0.0027)	(0.0025)
L.ln(WARULC)*Rel.Open.	-0.060***	-0.061***	-0.056***	-0.055***	-0.052***	-0.050***
	(0.012)	(0.010)	(0.0075)	(0.0076)	(0.0076)	(0.012)
lchtfp5	-0.23***	-0.24***	-0.26***	-0.25***	-0.25***	-0.26***
	(0.038)	(0.029)	(0.028)	(0.029)	(0.033)	(0.041)
$ln\,\Delta$ Demand	0.54***	0.55***	0.55***	0.54***	0.53***	0.53***
	(0.029)	(0.022)	(0.023)	(0.024)	(0.026)	(0.034)
Observations	12963	12963	12963	12963	12963	12963

Standard errors clustered on 4-digit SIC sectors in parentheses. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$. Each regression is a quantile regression at various points in the distribution, and all regressions include 4-digit SIC industry and year dummies over the period 1973-2009. The dependent variable is the log change in sectoral manufacturing employment. Various other controls from previous regressions have been omitted for space, including coefficients on input prices and input prices interacted with the input usage over total shipments, and capital-per-worker and capital-per-worker interacted with the real interest rate.

1.1 Adding and Subtracting Fringe Sectors

One of the key changes in the classification of manufacturing industries from the Standard Industrial Classification (SIC) system to the North American Industrial Classification system (NAICs) was that much of the publishing sector, which includes book and newspaper printing, was reclassified as non-manufacturing. Much of the value-added in these sectors likely revolves around content creation rather than manufacturing per se, and so all of the results reported thus far have not included publishing. To show that this is not influencing the results, in column (1) of Table 7, I repeat the baseline regression in the main text while including the publishing sector, showing that the results are little changed. In column (2), I remove defense-related industries, which includes all sectors with at least 10% of shipments purchased by the department of defense in 1992 according to BEA data. For industries with no BEA defense shipments data, I added in those industries, such as tanks and tank components, which are clearly defense-related. Again, the results are little-changed. In the third column I omit the industries that include “not elsewhere classified” in the title. The logic is that since these sectors tend to be an amalgam of loosely related subsectors, it is prudent to show that these sectors are not driving the results.

1.2 Benchmark Year Regressions

There is no one “correct” measure of the real exchange rate, as each of the measures discussed have their own strengths and weaknesses, but all of the indices share similar broad patterns. Even the divisia-based indices created by the FRB and the IMF imply that the dollar had two periods of appreciations, in the the 1980s and in the late 1990s and early 2000s. Additionally, while it is very plausible that large movements in real exchange rates could impact employment, it is less plausible that small year-to-year adjustments could have an impact. Thus another strategy is to separate the data into periods when all real exchange rate indices show a large appreciation and the periods when the real exchange rate depreciated. The results are listed in Table 8 using the entire post-Bretton Woods period into four periods: 1972-1979, 1979-1986, 1986-1996, and 1996-2005. Instead of using any particular real exchange rate, I now interract openness with a dummy for the periods of large relative price appreciations. The magnitude of the coefficient in column (4) suggests that during the high RER periods, moving from average to twice the average level of openness implied losing an additional 10% of manufacturing employment relative to periods when the dollar fell.

Table 7: Robustness: Add and Subtract Fringe Industries

	(1) Add Publishing	(2) Defense Control	(3) Subtract misc. SICs
L.Openness	-0.0608*	-0.0624*	-0.0628*
	(0.0332)	(0.0358)	(0.0377)
L.WARULC*Openness	-0.338***	-0.341***	-0.358***
	(0.113)	(0.114)	(0.120)
$ln\Delta$ VA-per-Production Worker	-0.215***	-0.214***	-0.199***
	(0.0363)	(0.0365)	(0.0395)
$ln\,\Delta$ Demand	0.461***	0.458***	0.444***
	(0.0625)	(0.0627)	(0.0669)
L.(K/L)	0.000693	-0.000130	-0.00782
	(0.0260)	(0.0280)	(0.0276)
L.(K/L)*Real Interest Rate	-0.373	-0.363	-0.331**
	(0.229)	(0.237)	(0.142)
L.$ln\,\Delta$ Price of Investment	0.334**	0.331**	0.318*
	(0.160)	(0.161)	(0.171)
L.$ln\,\Delta$ Price of Energy	0.0587*	0.0561*	0.0653*
	(0.0315)	(0.0323)	(0.0338)
L.$ln\,\Delta$ PI*(I/S)	-1.168**	-1.208**	-1.038**
	(0.492)	(0.490)	(0.486)
L.$ln\,\Delta$ PE*(E/S)	-0.281*	-0.261*	-0.317*
	(0.155)	(0.158)	(0.167)
Defense*WARULC-1		0.0376	
		(0.0305)	
Observations	13111	12963	10996

Two-way clustered errors (by year and industry) 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 variable is the log change in sectoral manufacturing employment. Lagged shipments and materials prices, and materials-interaction terms suppressed for space.

Table 8: Benchmark Years Only

	(1) $ln\Delta$ L	(2) $ln\Delta$ L	(3) $ln\Delta$ L	(4) $ln\Delta$ L
L.Relative Openness	0.00657	0.00376	0.00882	0.00845
	(0.00450)	(0.0147)	(0.0177)	(0.0178)
Lagged Rel. Openness*High RER Year	-0.0496***	-0.0883***	-0.0988***	-0.0982***
	(0.0136)	(0.0208)	(0.0215)	(0.0216)
1979 Dummy	0.392***	0.0601*	0.116***	0.107***
	(0.0251)	(0.0292)	(0.0302)	(0.0306)
1986 Dummy	0.157***	0.0916***	0.101***	0.0957***
	(0.0221)	(0.0162)	(0.0156)	(0.0167)
1996 Dummy	0.289***	0.137***	0.0912**	0.0899**
	(0.0251)	(0.0258)	(0.0282)	(0.0291)
$ln\Delta$ Demand		0.574***	0.719***	0.693***
		(0.0286)	(0.0395)	(0.0428)
$ln\Delta$ Shipments-per-Worker			-0.694***	-0.666***
			(0.0529)	(0.0573)
Campa-Goldberg Low Markup*High RER			-0.0265	-0.0240
			(0.0168)	(0.0184)
L.K/L			0.270***	0.277***
			(0.0784)	(0.0824)
Change in Tariffs				0.299
				(0.339)
Ch. Ins. & Freight Costs				-0.136*
				(0.0659)
Constant	-0.321***	-0.414***	-0.133***	-0.131***
	(0.0230)	(0.0184)	(0.0304)	(0.0333)
Industries	437	437	437	422
Observations	1687	1635	1635	1433
Within R-squared	0.310	0.605	0.728	0.710
Between R-squared	0.0524	0.603	0.692	0.650
Overall R-squared	0.220	0.587	0.705	0.681

All Regression include fixed effects and errors clustered on 448 4-digit SIC industries (in parenthesis), using data from the benchmark years 1972, 1979, 1986, 1996, and 2005. The dependent variable is the log change in sectoral manufacturing employment from the previous period.

Table 9: Impact of Import Penetration on Employment by Year (no controls)

	(1)	(2)	(3)	(4)
	1979	1986	1996	2005
Lagged Import Penetration	-0.327	-0.684***	-0.240	-0.757***
	(0.180)	(0.166)	(0.136)	(0.119)
Constant	0.0965***	-0.118***	0.0360	-0.178***
	(0.0168)	(0.0173)	(0.0224)	(0.0238)
Observations	440	441	440	388
r2	0.00823	0.110	0.0156	0.161

Standard errors in parentheses

Each column represents a Quantile Regression from an individual year with the log change in Employment from previous benchmark years as the dependent variable. *E.g.*, 1972-1979, 1979-1986, etc.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 10: Explaining the 1980s, high RERs or RIRs?

	(1)	(2)	(3)	(4)
	$ln\Delta$ I, 1983	$ln\Delta$ I, 1986	$ln\Delta$ PW, 1983	$ln\Delta$ PW, 1986
Lagged Import Penetration	0.198*	-0.207*	-0.0799***	-0.151***
	(0.1000)	(0.102)	(0.0162)	(0.00992)
$ln\Delta$ Shipments per Worker	-0.862***	-0.865**	-0.924***	-0.809***
	(0.250)	(0.301)	(0.0264)	(0.0291)
$ln\Delta$ Demand	1.078***	1.158***	0.861***	0.867***
	(0.153)	(0.242)	(0.0162)	(0.0235)
Constant	0.00245	-0.0813***	-0.0128***	-0.0000966
	(0.0180)	(0.0230)	(0.00279)	(0.00223)
Observations	441	442	441	442
r2	0.201	0.0575	0.873	0.789

Standard errors in parentheses

Each Regression is for a single year.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

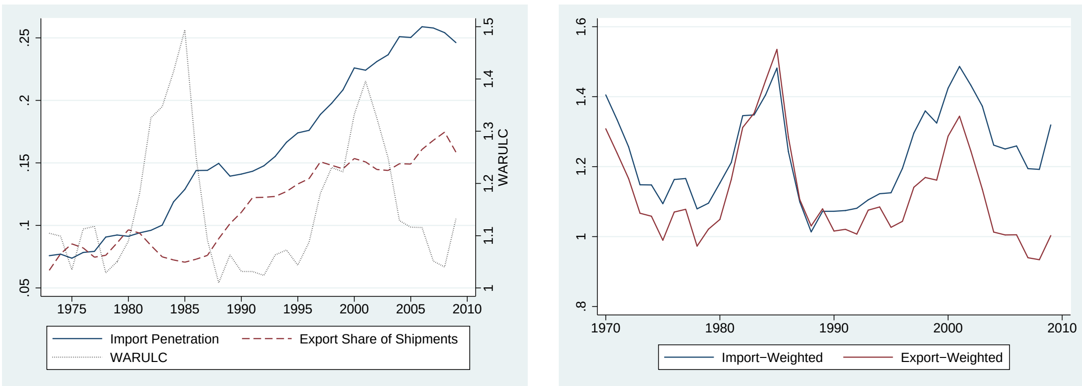
Table 11: Impact of Openness on Employment by Period

	(1) 1972-9	(2) 1979-86	(3) 1986-96	(4) 1996-2005
Lagged Openness	0.107*	-0.806***	0.155	-0.567***
	(0.0507)	(0.108)	(0.0983)	(0.146)
$ln\Delta$ Demand	0.978***	0.991***	0.831***	0.893***
	(0.0138)	(0.0251)	(0.0397)	(0.0590)
$ln\Delta$ Shipments-per-Worker	-0.984***	-1.028***	-0.849***	-0.871***
	(0.0190)	(0.0330)	(0.0467)	(0.0855)
L.K/L	-0.0271	0.0923*	-0.0295	0.0197
	(0.0454)	(0.0433)	(0.0526)	(0.101)
L.Log VA per Worker	0.0134	0.0179	0.00437	0.0261
	(0.00815)	(0.0108)	(0.0151)	(0.0203)
Change in Tariffs		0.124	-0.0202	0.0668
		(0.138)	(0.250)	(0.124)
Ch. Ins. & Freight Costs		0.0154	-0.0871*	0.0110
		(0.113)	(0.0355)	(0.0841)
Constant	0.0911	0.107	0.0422	0.0902
	(0.0562)	(0.0613)	(0.0716)	(0.101)
Observations	440	372	331	379
r2	0.802	0.818	0.455	0.612

Errors clustered at the 2-digit SIC level in parenthesis. Each column represents a Quantile Regression from an individual year with the log change in Employment from previous benchmark year. *E.g.*, 1972-1979, 1979-1986, etc.

1.3 Import Penetration vs. Export Share

While using an interaction of openness with the degree of overvaluation is the most compelling research design, in fact there is a small amount of heterogeneity depending on whether the openness stems from import exposure or export penetration, especially after 1990 (compare the first two columns in Table 12). One explanation for these disparate results is that, over time, the correlation between import penetration and export share has increased, from .095 in 1972 to .555 in 2009. Thus there is a multicollinearity problem in the later years when both variables are included in the same regression. Over the entire period (column three), there is not a statistically different impact on export exposure and import penetration, even though the former is only significant at 10%.



(a) Import Penetration and Export Share Growth (b) Import vs. Export-Weighted Average RULC

Figure 1: Growth of Trade, Divergence of RULC Indices

There are good reasons why one might expect import penetration to do a better job predicting job losses than the export share of trade. The first is that the export-weighted average relative unit labor cost (eWARULC) index has diverged from the import-weighted average relative unit labor cost (iWARULC) index since 1990 (Figure 9). The second reason is that since trade was growing rapidly overall, when the real exchange rate appreciated, exports were generally flat rather than falling, as was the case with domestic shipments, which might entail less of a differential impact on employment as compared with years when exports were growing. Additionally, as mentioned in the theoretical section, firms in sectors which are import-competing but do not export are more likely to have productivity closer to the cutoff productivity for remaining in business, while firms that export in sectors which import little are likely to be further away

Table 12: Import Penetration vs. Export Share

	(1) 1973-1989	(2) 1990-2009	(3) 1973-2009
L.Rel. Import Penetration	-0.00199	0.0129	0.00268
	(0.0103)	(0.0102)	(0.00462)
L.Rel. Import Pen.*ln(iWARULC)	-0.0418**	-0.0810***	-0.0596***
	(0.0208)	(0.0237)	(0.0156)
L.Rel. Export Share	-0.00569***	-0.0204**	-0.00198
	(0.00217)	(0.00984)	(0.00166)
L.Rel. Export Pen.*ln(eWARULC)	-0.0786***	0.0206	-0.0436*
	(0.0276)	(0.0301)	(0.0254)
$ln\Delta$ VA-per-Production Worker	-0.216***	-0.202***	-0.206***
	(0.0371)	(0.0249)	(0.0245)
$ln\,\Delta$ Demand	0.456***	0.434***	0.439***
	(0.0672)	(0.0400)	(0.0456)
L.K/L	0.254***	0.0955*	0.0403*
	(0.0531)	(0.0546)	(0.0224)
L.(K/L)*Real Interest Rate	-1.406***	0.282	-0.543*
	(0.314)	(0.924)	(0.311)
L.$ln\,\Delta$ Price of Shipments	0.0148	0.0297**	0.0328***
	(0.0105)	(0.0146)	(0.00888)
L.$ln\,\Delta$ Price of Investment	0.246**	0.0592	0.116
	(0.115)	(0.159)	(0.0819)
L.$ln\,\Delta$ PI*(I/S)	-1.306***	1.394	-0.869**
	(0.460)	(1.155)	(0.378)
Industries	432	394	437
Observations	7259	7605	14864
Within R-squared	0.567	0.479	0.516
Between R-squared	0.0845	0.0159	0.258
Overall R-squared	0.440	0.416	0.476

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. The dependent variables is the log change in manufacturing employment.

from the cutoff productivity, and thus less likely to go bankrupt merely from a decline in the growth rate of exporting. Thus there are theoretical reasons to suspect that import competition would have a larger impact on the extensive margin of unemployment than export competition.

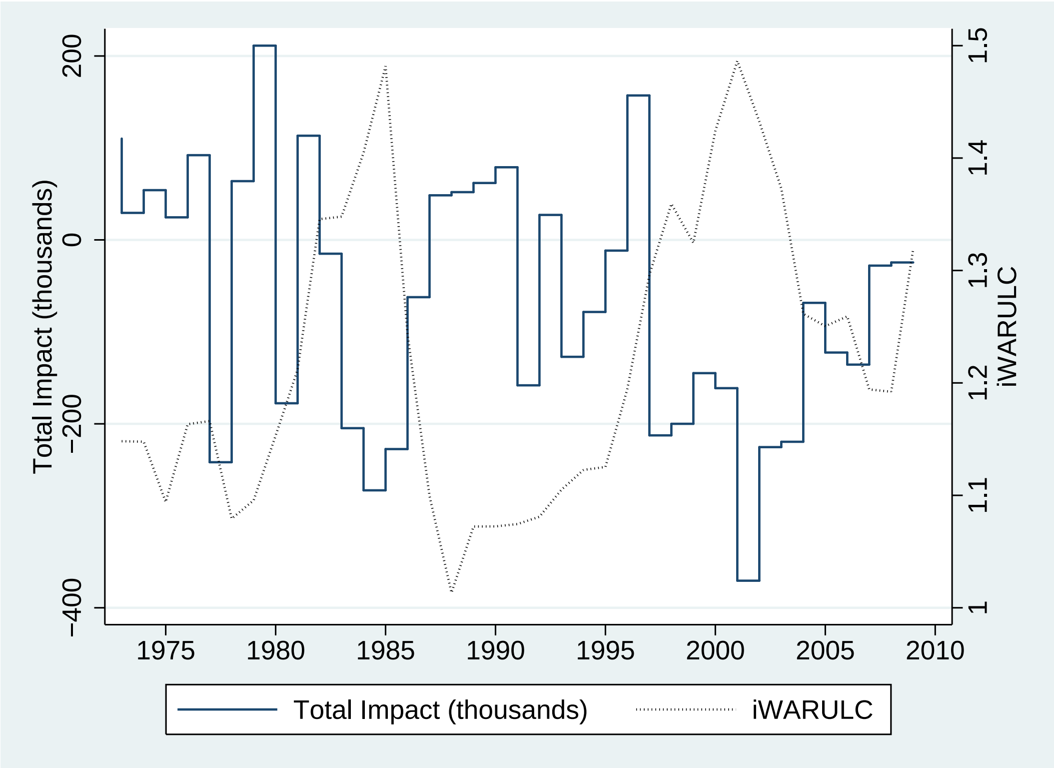


Figure 2: The RER and the Impact of Import Penetration by Year

Table 13: Import Penetration and Manufacturing Employment

	(1) $ln\Delta$ L	(2) $ln\Delta$ L	(3) $ln\Delta$ L	(4) $ln\Delta$ L
L.Import Penetration	-0.129*	-0.0447	0.0529	0.0515
	(0.0663)	(0.0424)	(0.0503)	(0.0543)
L.iWARULC*Import Penetration	-0.0530	-0.263**	-0.439***	-0.434***
	(0.164)	(0.106)	(0.104)	(0.123)
o.yr16	0	0	0	0
	(1.14e-11)	(2.61e-10)	(2.61e-10)	(2.99e-10)
o.yr49	0	0	0	0
	(2.01e-10)	(3.02e-10)	(3.76e-12)	(2.73e-10)
$ln\,\Delta$ Shipments-per-Worker		-0.583***	-0.608***	-0.608***
		(0.0753)	(0.0837)	(0.0838)
$ln\,\Delta$ Demand		0.588***	0.565***	0.564***
		(0.0862)	(0.107)	(0.108)
Change in Tariffs			-0.000602	-0.000556
			(0.00537)	(0.00511)
Change Ins. & Freight Costs			-0.000465	-0.000437
			(0.00259)	(0.00275)
L.K/L			0.0387	0.0381
			(0.0299)	(0.0292)
L.(K/L)*Real Interest Rate			-0.278	-0.363
			(0.279)	(0.261)
L.Import Penetration*Real Interest Rate				-0.0432
				(0.596)
L.$ln\,\Delta$ Wages				-0.00697
				(0.0209)
Campa-Goldberg Low Markup*L.iWARULC				0.0254
				(0.0223)
Intermediate Import Share*L.iWARULC				0.0966
				(0.129)
Observations	13111	13111	10274	10274

Two-way clustered 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 variable is the log change in sectoral manufacturing employment.

1.4 Alternative Explanatory Variables

How do exchange rate movements interacted with lagged openness impact other explanatory variables? In Table 14 it can be seen that the impact on production workers was slightly more pronounced than the impact on non-production workers. However, in column (4) it can be seen that while sectors with higher levels of openness experienced declines in the ratio of production workers to total employees, the impact is not significant.

In Table 15, I show that production hours per worker were not significantly affected, but that investment as a share of shipments, value-added, and shipments all fared worse in sectors with higher levels of openness when relative unit labor costs were higher.

In Table 16, I show that total pay per person for both production workers and non-production workers was not significantly affected, nor was the ratio. However, I do find a slight negative impact on the hourly wages of production workers, a new result for this literature. This impact 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.

In Table 17, I report the impacts for changes in inventory, prices, and two kinds of TFP, one assuming four factors and one assuming five. There does not appear to be any significant relationship between the overvaluation and openness interaction and inventory or price changes. Interestingly, there is a general negative relationship between openness and prices, but this price competition does not appear to become more intense when the real exchange rate increases. There is a significantly negative impact on TFP, which is another new result for this literature.

Lastly, in Figure 18 I show the impact of exchange rate movements on job creation and job destruction. Once again, when unit labor costs in the US rise relative to trading partners, there is suppressed job creation, but the bigger impact is the rise of job destruction. Since job creation varies much less than job destruction overall, this assymmetry is an important “fingerprint” of hysteresis. Nearly four good years of job creation are needed for every bad year of destruction.

Table 14: Impact on Production and Non-Production Workers

	(1) $ln\Delta$ L	(2) $ln\Delta$ PW	(3) $ln\Delta$ non-PW	(4) $ln\Delta$ PW Share
L.Relative Openness	-0.00291	-0.00256	-0.00121	0.000350
	(0.00397)	(0.00434)	(0.00377)	(0.00129)
L.ln(WARULC)*Rel. Openness	-0.0845***	-0.0886***	-0.0810***	-0.00406
	(0.0136)	(0.0145)	(0.0124)	(0.00306)
$ln\Delta$ VA-per-Production Worker	-0.206***	-0.285***	-0.0621***	-0.0790***
	(0.0247)	(0.0287)	(0.0216)	(0.00972)
$ln\,\Delta$ Demand	0.438***	0.491***	0.310***	0.0533***
	(0.0460)	(0.0490)	(0.0369)	(0.00499)
L.K/L	0.0407*	0.0716***	-0.0148	0.0309**
	(0.0225)	(0.0164)	(0.0331)	(0.0132)
L.(K/L)*Real Interest Rate	-0.580*	0.0386	-1.761***	0.619***
	(0.332)	(0.301)	(0.634)	(0.177)
L.$ln\,\Delta$ Price of Shipments	0.0342***	0.0293***	0.0518***	-0.00493
	(0.00883)	(0.00796)	(0.0138)	(0.00463)
L.$ln\,\Delta$ Price of Investment	0.0928	0.158**	-0.0379	0.0654*
	(0.0827)	(0.0760)	(0.116)	(0.0371)
L.$ln\,\Delta$ Price of Energy	0.0275*	0.0337**	0.00678	0.00622
	(0.0161)	(0.0165)	(0.0213)	(0.00644)
L.$ln\,\Delta$ PI*(I/S)	-0.583	-0.689*	-0.0322	-0.106
	(0.413)	(0.383)	(0.720)	(0.189)
L.$ln\,\Delta$ PE*(E/S)	-0.328**	-0.345**	-0.258	-0.0168
	(0.163)	(0.162)	(0.204)	(0.0644)
Industries	437	437	437	437
Observations	14864	14864	14859	14864
Within R-squared	0.514	0.561	0.194	0.133
Between R-squared	0.247	0.263	0.211	0.107
Overall R-squared	0.474	0.512	0.157	0.109

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 log changes in total labor, production workers, non-production workers, and the share of production workers.

Table 15: Impact on Hours, Investment, VA, and Shipments

	(1) $ln\Delta$ PW Hours	(2) $ln\Delta$ Investment	(3) $ln\Delta$ VA	(4) $ln\Delta$ Ship
L.Relative Openness	-0.000641	0.00601	-0.00120	0.000298
	(0.00124)	(0.00820)	(0.00455)	(0.00520)
L.ln(WARULC)*Rel. Openness	0.00606**	-0.144***	-0.0921***	-0.0994***
	(0.00306)	(0.0312)	(0.0153)	(0.0161)
$ln\Delta$ VA-per-Production Worker	0.0483***	-0.0846*	0.655***	0.113***
	(0.00694)	(0.0480)	(0.0388)	(0.0419)
$ln\,\Delta$ Demand	0.0196***	0.594***	0.439***	0.592***
	(0.00522)	(0.0742)	(0.0471)	(0.0596)
L.K/L	0.00202	-0.161	0.0262	-0.0185
	(0.00571)	(0.137)	(0.0368)	(0.0364)
L.(K/L)*Real Interest Rate	0.227	-7.520***	-4.464***	-5.046***
	(0.374)	(1.868)	(0.989)	(0.981)
L.$ln\,\Delta$ Price of Shipments	0.000459	0.230***	0.0103	0.00686
	(0.00536)	(0.0440)	(0.0307)	(0.0237)
L.$ln\,\Delta$ Price of Investment	0.0661***	0.828***	-0.157	-0.318***
	(0.0244)	(0.239)	(0.120)	(0.0991)
L.$ln\,\Delta$ Price of Energy	-0.00272	-0.107	0.00219	-0.00104
	(0.00720)	(0.0841)	(0.0278)	(0.0239)
L.$ln\,\Delta$ PI*(I/S)	0.0289	-32.69***	0.128	0.102
	(0.239)	(3.529)	(1.023)	(0.684)
L.$ln\,\Delta$ PE*(E/S)	-0.0615	2.091***	-0.793***	-0.605**
	(0.0807)	(0.797)	(0.303)	(0.270)
Industries	437	437	437	437
Observations	14864	14864	14864	14864
Within R-squared	0.133	0.209	0.677	0.644
Between R-squared	0.0824	0.0237	0.163	0.244
Overall R-squared	0.0787	0.147	0.595	0.580

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 log changes in production worker hours, investment, value-added, and shipments.

Table 16: Impact on Wages

	(1) $ln\Delta$ PW	(2) $ln\Delta$ non-PW	(3) $ln\Delta$ Ratio	(4) $ln\Delta$ PW hourly
L.Relative Openness	0.00306***	0.00284**	-0.000216	0.00370***
	(0.00107)	(0.00123)	(0.00127)	(0.000995)
L.ln(WARULC)*Rel. Openness	-0.0109***	-0.00149	0.00943	-0.0169***
	(0.00376)	(0.00474)	(0.00593)	(0.00384)
$ln\Delta$ VA-per-Production Worker	0.105***	0.00852	-0.0964***	0.0570***
	(0.0106)	(0.00938)	(0.0113)	(0.00720)
$ln\,\Delta$ Demand	0.0281***	0.0505***	0.0223*	0.00850
	(0.00893)	(0.00905)	(0.0123)	(0.00588)
L.K/L	-0.0479***	-0.0185**	0.0294**	-0.0499***
	(0.0141)	(0.00825)	(0.0124)	(0.0175)
L.(K/L)*Real Interest Rate	-0.863***	-0.489**	0.371	-1.090*
	(0.278)	(0.231)	(0.338)	(0.624)
L.$ln\,\Delta$ Price of Shipments	0.0103	0.0149*	0.00464	0.00979
	(0.00766)	(0.00822)	(0.0119)	(0.00608)
L.$ln\,\Delta$ Price of Investment	0.0845*	-0.0161	-0.101	0.0185
	(0.0505)	(0.0572)	(0.0652)	(0.0495)
L.$ln\,\Delta$ Price of Energy	0.0127	0.00283	-0.00985	0.0154
	(0.0102)	(0.0172)	(0.0166)	(0.0113)
L.$ln\,\Delta$ PI*(I/S)	-0.210	-0.245	-0.0360	-0.239
	(0.387)	(0.363)	(0.361)	(0.387)
L.$ln\,\Delta$ PE*(E/S)	0.167**	0.124	-0.0432	0.229*
	(0.0725)	(0.0936)	(0.0918)	(0.123)
Industries	437	437	437	437
Observations	14864	14856	14856	14864
Within R-squared	0.350	0.120	0.0555	0.307
Between R-squared	0.330	0.161	0.00380	0.325
Overall R-squared	0.233	0.0511	0.0270	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 production worker pay and non-production worker pay per person, non-production pay divided by production worker pay (per person), and hourly production worker pay.

Table 17: Impact on Inventory, Output Prices, and TFP

	(1) $ln\Delta$ Inventory	(2) $ln\Delta$ Prices	(3) $ln\,\Delta$ TFP5	(4) $ln\,\Delta$ TFP4
L.Relative Openness	0.00480	-0.0000144	0.00364	0.00363
	(0.00424)	(0.00214)	(0.00302)	(0.00302)
L.ln(WARULC)*Rel. Openness	-0.0122	-0.00449	-0.0363***	-0.0363***
	(0.0140)	(0.00483)	(0.00678)	(0.00677)
$ln\Delta$ VA-per-Production Worker	-0.759***	-0.0613***		
	(0.0339)	(0.0170)		
$ln\,\Delta$ Demand	-0.0381**	-0.0435***	0.290***	0.290***
	(0.0190)	(0.0126)	(0.0315)	(0.0315)
L.K/L	-0.157***	0.0695*	0.0497**	0.0500**
	(0.0374)	(0.0374)	(0.0237)	(0.0237)
L.(K/L)*Real Interest Rate	0.505	-4.369***	1.088***	1.071***
	(1.003)	(0.889)	(0.371)	(0.369)
L.$ln\,\Delta$ Price of Investment	0.144	-0.278***	0.0741	0.0757
	(0.144)	(0.0964)	(0.0685)	(0.0688)
L.$ln\,\Delta$ Price of Energy	0.0683	-0.0295	-0.00286	-0.00417
	(0.0491)	(0.0205)	(0.0152)	(0.0154)
L.$ln\,\Delta$ PI*(I/S)	-2.202	1.283	-1.397***	-1.392***
	(1.488)	(0.949)	(0.519)	(0.518)
L.$ln\,\Delta$ PE*(E/S)	0.981***	-0.492**	0.265*	0.270**
	(0.325)	(0.232)	(0.137)	(0.137)
Industries	426	426	426	426
Observations	11442	11442	11442	11442
Within R-squared	0.398	0.370	0.399	0.399
Between R-squared	0.113	0.179	0.361	0.361
Overall R-squared	0.285	0.270	0.353	0.354

Standard errors clustered on 4-digit SIC industries 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 variable is the log change in sectoral manufacturing employment. The coefficients on Tariffs and changes in insurance and freight rates are not significant and are omitted for space.

Table 18: Impact on Job Creation and Destruction

	(1) Job Creation	(2) Job Destruction
L.Openness	-0.269	2.445
	(1.483)	(2.148)
L.WARULC*Openness	-12.54***	38.96***
	(2.328)	(9.659)
$ln\Delta$ VA-per-Production Worker	-5.282***	6.646***
	(0.724)	(1.480)
$ln\,\Delta$ Demand	9.156***	-15.29***
	(1.402)	(3.142)
L.(K/L)	5.279**	8.160**
	(2.158)	(3.715)
L.(K/L)*Real Interest Rate	-43.06**	59.27
	(17.05)	(72.72)
L.$ln\,\Delta$ Price of Materials	-7.250***	-9.066**
	(2.732)	(3.929)
L.$ln\,\Delta$ Price of Investment	-9.562	-19.21**
	(6.566)	(8.079)
L.$ln\,\Delta$ Price of Energy	-0.698	-2.412*
	(0.837)	(1.281)
L.$ln\,\Delta$ PM*(M/S)	12.09***	14.34**
	(4.591)	(5.768)
L.$ln\,\Delta$ PI*(I/S)	41.27	149.3***
	(27.20)	(51.06)
L.$ln\,\Delta$ PE*(E/S)	-6.535	8.428
	(9.461)	(14.35)
Industries	448	437
Observations	10985	10729
Within R-squared	0.274	0.330
Between R-squared	0.0156	0.00608
Overall R-squared	0.121	0.147

Standard errors clustered on 4-digit SIC industries 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 1973-1998. The dependent variable are the percentages of job creation and destruction.

Table 19: Impact on Expenditures of Inputs

	(1) Materials	(2) Energy	(3) Total Wages
L.ln(WARULC)*Rel. Openness	-0.090***	-0.079***	-0.077***
	(0.015)	(0.014)	(0.010)
$ln\,\Delta$ TFP (5-factor)	-0.19**	0.047	0.050
	(0.093)	(0.069)	(0.050)
Low Markup*L.ln(WARULC)	-0.054***	-0.069***	-0.043***
	(0.015)	(0.019)	(0.014)
Imported Inputs*L.ln(WARULC)	-0.11	-0.30	-0.16
	(0.17)	(0.27)	(0.14)
L.$ln\,\Delta$ Price of Investment	0.0039	0.12	0.055
	(0.092)	(0.13)	(0.069)
L.$ln\,\Delta$ Price of Energy	0.040		
	(0.052)		
L.$ln\,\Delta$ PI*(I/S)	1.15	0.36	2.41*
	(1.66)	(2.01)	(1.30)
L.$ln\,\Delta$ PE*(E/S)	-0.45		
	(0.49)		
Observations	8380	8380	8380
Overall R-squared	0.50	0.21	0.42

Standard errors clustered on 4-digit SIC sectors in parentheses. *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$. The dependent variables are the log changes in expenditures on inputs. All regressions are weighted by initial sectoral value-added, and include 4-digit SIC industry and year fixed effects over the period 1973-2009. Several other controls from the main tables in the paper are omitted for space.

2 Modeling Imports Using A Panel Vector Error Correction Model

In this section, I test the impact of relative unit labor costs on US imports by sector and destination country using a simple error correction formulation, similar to Fahle *et al.* (2008) and Chinn (2004).

$$\Delta lnM_{h,c,t} = \alpha + \sum_{j=1}^{4} \beta_j \cdot \Delta lnM_{h,c,t-j} + \cdot\psi \Delta lnD_{h,t} + \sum_{k=1}^{7} \mu_k \Delta \cdot ln\, RULC_{c,t-k} \qquad (2.1)$$

$$+\theta(lnX_{t-1} - \varphi \cdot lnY_{t-1} - \eta \cdot lnY^{*}_{t-1} - \epsilon \cdot lnRULC_{t-1}) + u_t^j$$

t = 1979,...,2009 ; c = 41 Major US Trading Partners, h = 448 4-digit SIC Manufacturing Sectors

Where $M_{h,c,t}$ are US imports from country c in sector h at time t, and $D_{h,t}$ is demand in sector h at time t, and $RULC_{c,t-k}$ are the relative unit labor costs between the US and country c at time t-k. As there is potential for simultaneity bias, I helmert-transform the data and posit a panel vector-autoregression model explaining imports, demand, and unit labor costs and apply Love and Ziccino's (2006) panel VAR estimator from Holtz-Eakin, Newey, and Rosen (1988).

In column (1), when I just run OLS with country-industry fixed effects, I find that the lagged level of RULC impact I find that movements in RULCs impact trade up to seven lags. Column (2) is the first stage of the ECM estimator, and column (3) estimates the second stage. However, with fixed effects and a lagged dependent variable, there is a problem with Nickel bias, and so the panel VAR estimator in equation (4) should be preferred.

In Figure 3 I present graphs of the impulse response functions and the 5% error bounds generated by Monte Carlo simulation. The middle column in the top row shows the impulse response of log changes in imports to movements in relative unit labor costs, with the impact dying off after about six years.

Table 20: Imports and Relative Prices: Error Correction Model Results

	(1) FE	(2) First Stage	(3) Second Stage	(4) GMM
$ln\Delta$ Sectoral Demand	0.721***		0.739***	
	(0.0228)		(0.0249)	
L.Bilateral RULC	0.0648***	0.412***		
	(0.00485)	(0.0297)		
Log Sectoral Demand		0.903***		
		(0.0219)		
L.lchimports			-0.230***	-0.216***
			(0.00525)	(0.0051)
L.lchRULC			0.318***	0.280***
			(0.0163)	(0.0174)
L2.lchRULC			0.255***	0.279***
			(0.0167)	(0.0173)
L3.lchRULC			0.296***	0.291***
			(0.0189)	(0.0197)
L4.lchRULC			0.111***	0.152***
			(0.0174)	(0.0186)
L5.lchRULC			0.150***	0.221***
			(0.0162)	(0.0170)
L6.lchRULC			0.0831***	0.093***
			(0.0174)	(0.0186)
L7.lchRULC			0.0546**	0.109***
			(0.0171)	(0.0167)
L.$ln\Delta$ Sectoral Demand			0.264***	0.264***
			(0.0170)	(0.0170)
L.resid3			-0.0336***	
			(0.000810)	
Country-Industry Combinations	8714			
Observations	234015	241454	177272	177272
R-squared	0.0170			

Errors clustered at the Country-SIC industry level in parenthesis. The Dependent variable in the first and third columns is the log change in US imports from country i in sector j, over the period 1973-2009. The dependent variable in the second column is log imports. The lagged residuals from the second column are then used as a regressor in column 3. Column 4 is a Panel VAR using GMM.

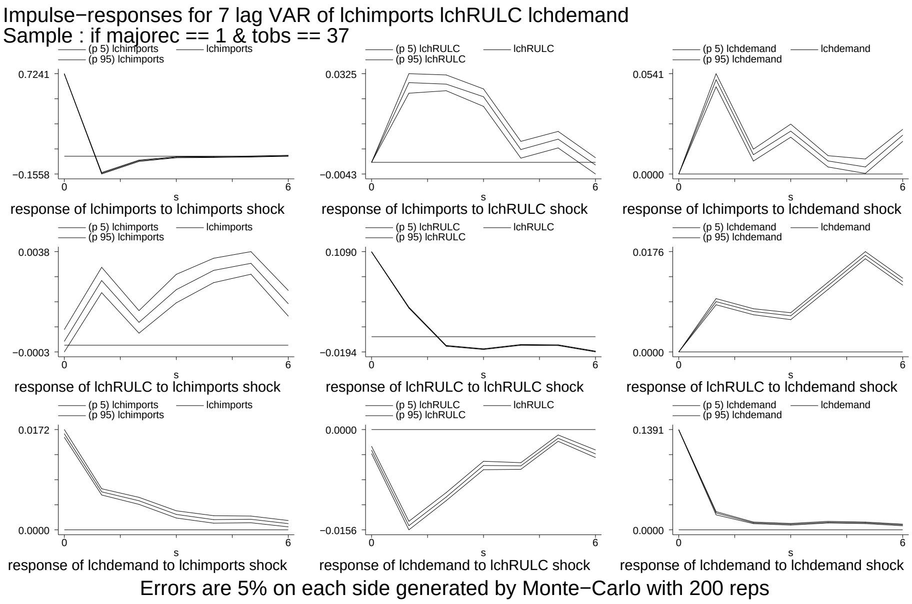
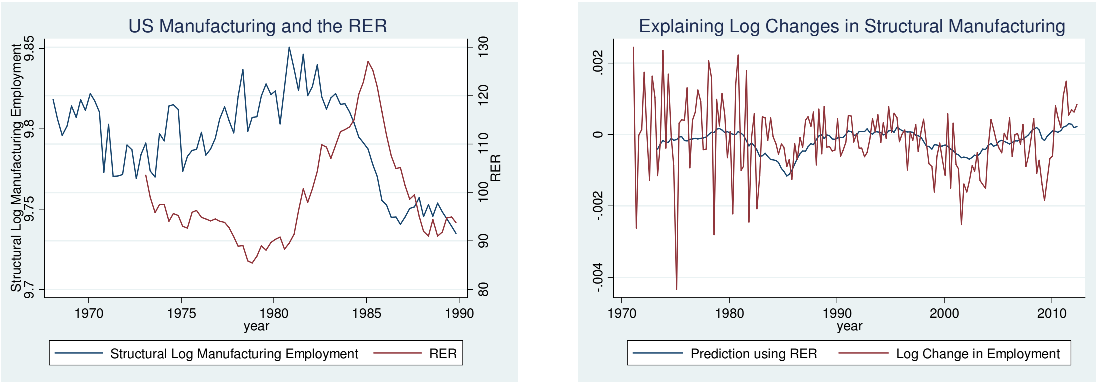


Figure 3: Impulse-Response Functions from Panel VECM

3 Structural Manufacturing Employment

As manufacturing employment has historically been strongly procyclical, it is helpful to plot the "structural" level of manufacturing employment with the cyclical portion deducted vs. the Fed's broad, trade-weighted real exchange rate (Figure 4.a). The structural level of manufacturing employment was derived by regressing log manufacturing on log real GDP lagged one quarter and a trend up until the exchange rate appreciated, and then subtracting out the predicted level of manufacturing employment based on realizations of GDP and adding back in the conditional average, with the levels plotted for the entire period. I find that manufacturing seems to respond to both GDP and the real exchange rate with a lag (as have others), but the key results do not hinge on this. In Figure 5 in the appendix, I do the same for the late 1990s. Note also that there is no apparent correlation between the small quarterly gyrations in the broad, trade-weighted RER and manufacturing employment, but when the RER appreciates substantially, there is a large movement in manufacturing employment and the CA balance.

Figure 6 plots the import share of trade vs. a one year lag of the Fed's RER index. When a simple trend is fit to the data in panel (a), there appears to be only a slight correlation that is not statistically signficant. When the observations are connected by year, in panel (b) however, the relationship appears to be much more systematic.



(a) Structural Man. Employment vs. the RER

(b) Predictions

Figure 4: Structural Manufacturing Employment vs. the RER

Dollar appreciations lead to movements to the northeast. Dollar depreciations move the relationship southwest. Shifts in the curve to the northwest indicate relative declines in ability to produce tradable goods. Sharp dollar appreciations are followed by movements to the northwest, as happened after the 1980s dollar bubble and 2002. The weak dollar period in the late 1970s was followed by a slight shift in the curve to the southeast, and while the curve was stable following a weak dollar period in the 1990s, this was the period which saw rising trade with China and other developing countries. In sum, the relationship of the US dollar since the end of Bretton Woods seems to validate Krugman's (1988) thesis–large exchange rate movements have persistent effects.

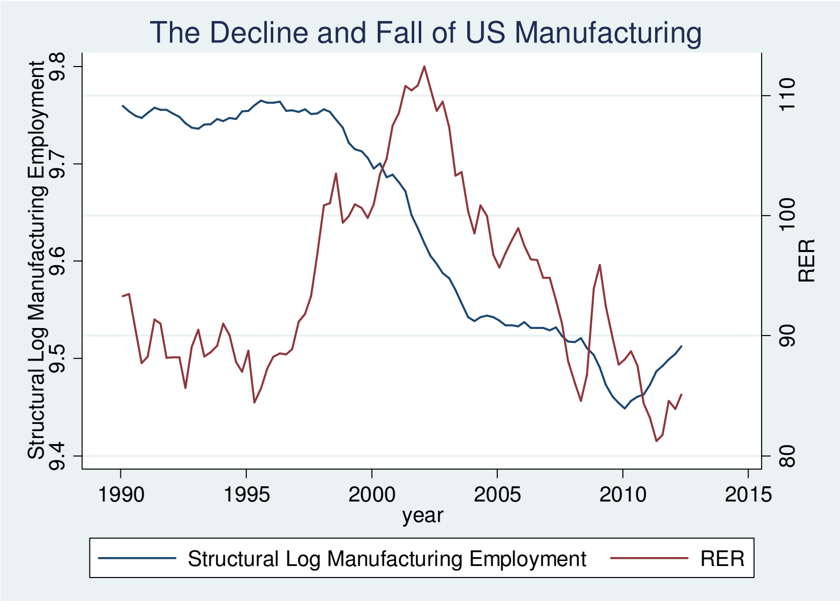
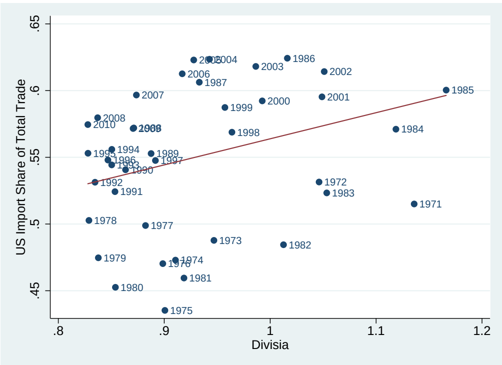
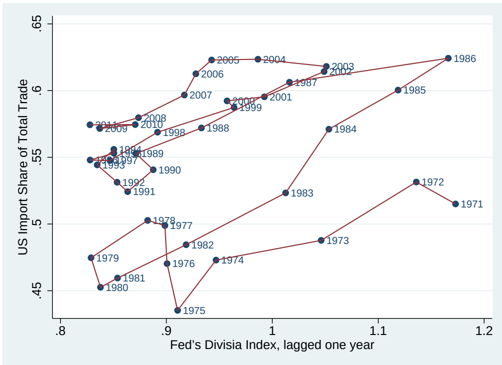


Figure 5: Structural Manufacturing Employment

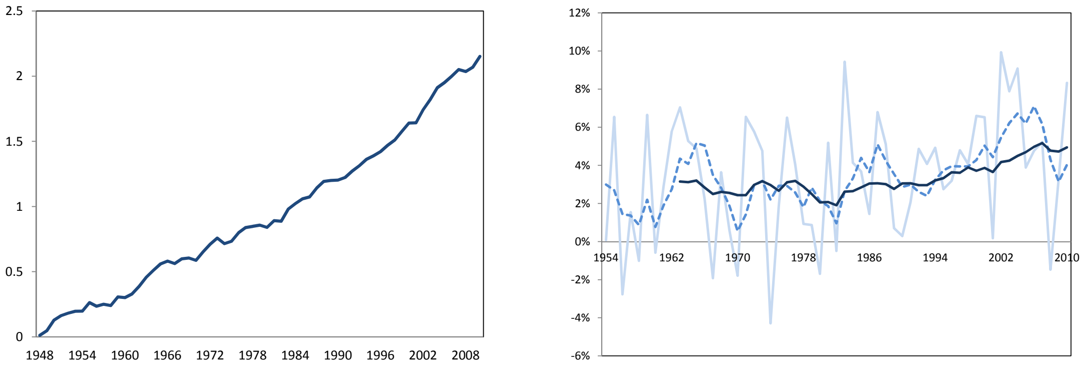


(a) Correlation (not statistically significant)



(b) Movement by Year

Figure 6: Fed's RER Index and the Import Share of Trade



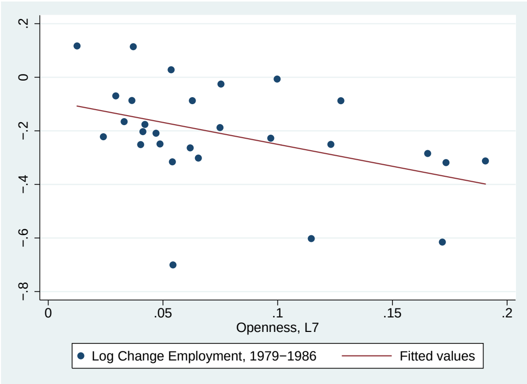
(a) Log Scale (b) Annual, 5 year, and 15 year MAs (% Δ)

Figure 7: Manufacturing Productivity: Chained Quantity Index per Worker

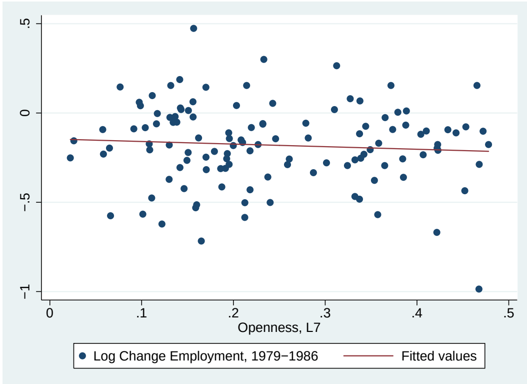
4 Additional Figures

To gauge the impact on specific industries, Figure 10 below shows employment in the 4-digit SIC industry “Motor Vehicles and Car Bodies”. From the 1970s until 1986, imports from Japan as a share of US Value added went from about 5% to over 25%, despite the Voluntary Export Restraint (VER), which Feenstra (1984) shows bound in the mid-1980s. After the Yen’s appreciation, however, imports from Japan actually fell and then leveled off. This is easily explained in the context of the model, as when wages in Japan were cheap relative to the US, Japan sunk investments into expanding capacity and increasing market share in the US, and after the Yen appreciated continued to export, but did not sink further investments into gaining market share.

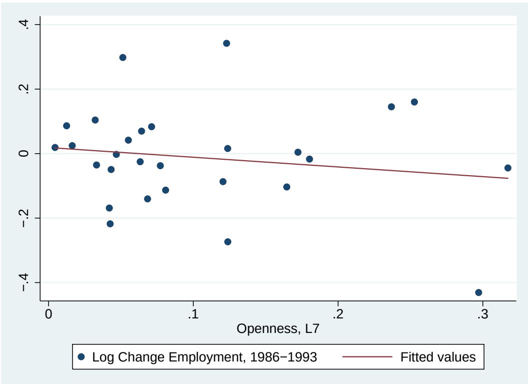
Hence, on balance Krugman (1986) appears to have been correct to guess that the Yen’s appreciation in that year meant that “the Japan problem was over” in the sense that Japanese manufacturers would not continue to increase their market share in the US. He was also correct that Japan’s experience in the 1980s was not special – when the dollar was strong, other countries saw market share increases in the US, and on average this was not reversed after the dollar weakened, although the growth did not continue. For the three countries in this sample which experienced peaks after 1986, the exchange rates of Singapore and Korea appreciated more slowly than other countries after 1985, while Taiwan’s currency appreciated sharply, but not until 1987, after which its share of total US imports began falling.



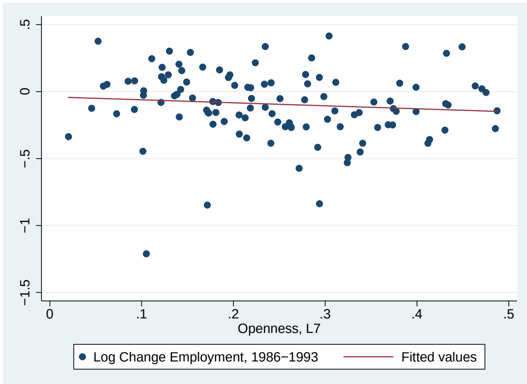
(a) US, 1979-86



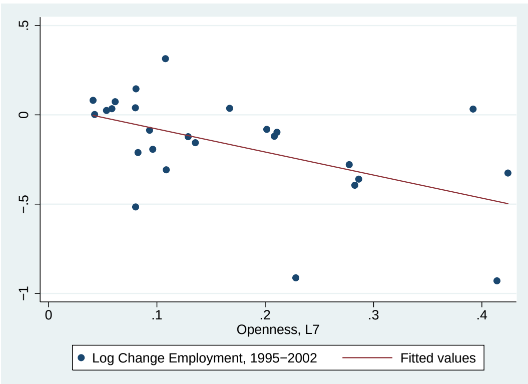
(b) Other Major Economies, 1979-86



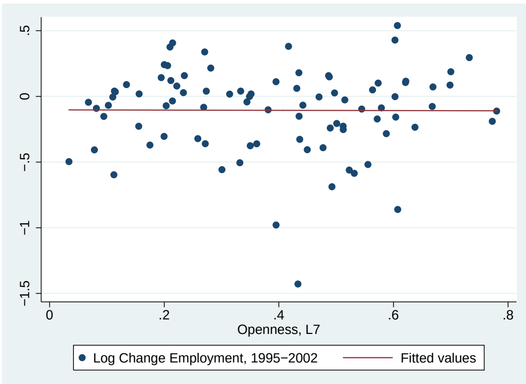
(c) US, 1995-2002



(d) Other Major Economies, 1995-2002

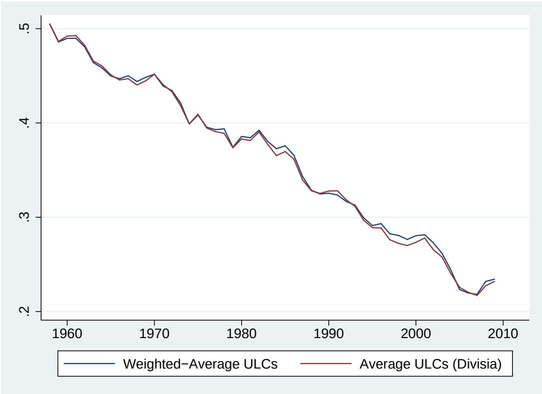


(e) US, 1995-2002

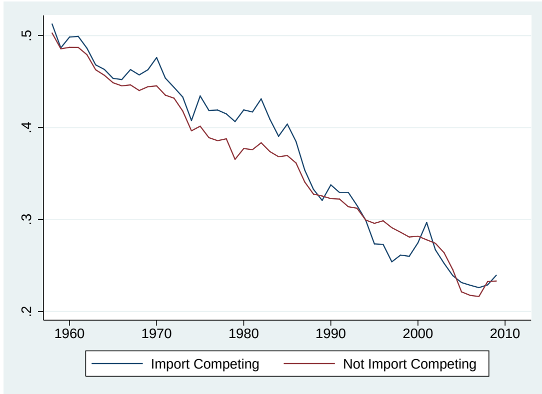


(f) Other Major Economies, 1995-2002

Figure 8: Employment Growth vs. Lagged Openness, 3 digit ISIC, 1979-1986



(a) Divisia vs. WAULC



(b) ULCs by Import Share of Trade, 1975

Figure 9: Unit Labor Costs

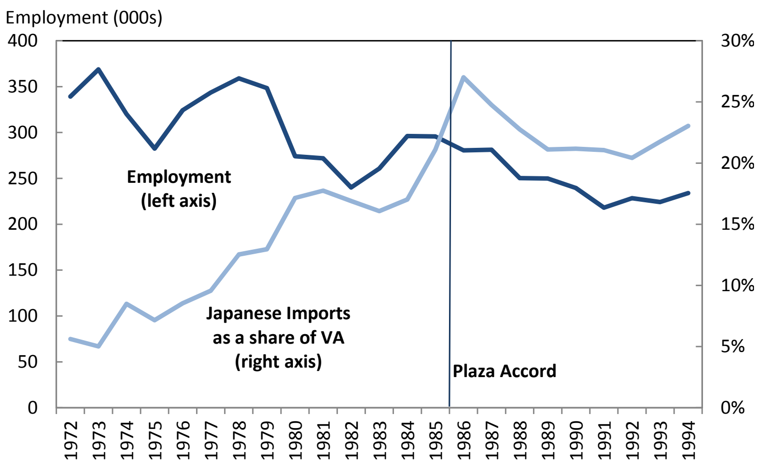
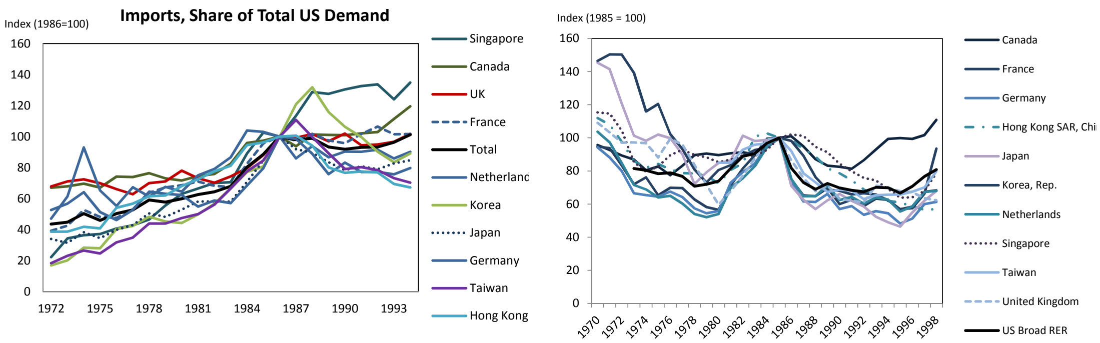


Figure 10: Motor Vehicles and Car Bodies



(a) Imports (b) RERs

Figure 11: US Bilateral Trade and Divisia-RERs

5 Mathematical Appendix

5.1 Proofs

Proposition 1.1: Transition Dynamics with Homogenous Firms

If we impose symmetry among C countries, H industies, and all firms, so that all firms have the same productivity (similar to the Krugman 1980 model) and all markets have the same fixed cost of entry, and assume that we are starting from autarky in the steady state, it is straightforward to derive a simple dynamic gravity equation for exports from country i to j at year t following the move from autarky to free trade at time t=0.

$$X_{ij,t} = \delta \sum_{s=0}^{t} \frac{Y_{j,t-s} Y_{i,t-s}}{Y_{w,t-s}} (1-\delta)^s \tag{5.1}$$

With fixed country sizes, eventually the economy will reach a new steady state:

$$\lim_{t \to \infty} X_{ijt} = \frac{Y_j Y_i}{Y_w} \tag{5.2}$$

Where we have used the fact that, by assumption, all countries are the same size. See below for a proof. The above formulation is for specific parameter values, and while I make no pretense of generality, the implications of dynamic gravity are confirmed in more general, and more complicated, formulations.

Proof: Let Y_j be the GDP of country j in autarky, with a saturation number of firms. Since each firm is the same size, δY_j of output is lost each period by firms naturally going out of business. With resources available, new firms will enter, and since the entry costs into any market are exactly the same, a new firm from country i will be indifferent between entering into any one of C markets. Output will be unchanged, but in the first period, exports from one country to another will be equal to:

$$X_{ij0} = \delta Y_{j0}/C = \delta \frac{Y_{j0} Y_{i0}}{Y_{w0}} \tag{5.3}$$

Where the last equality holds due to our assumption of symmetry. In the next period, again due to our assumption of random firm deaths, more resources are freed up and then randomly distributed over the C markets, so trade in period 1 is equal to:

$$X_{ij1} = \delta \frac{Y_{j1} Y_{i1}}{Y_{w1}} + (1-\delta)\delta \frac{Y_{j0} Y_{i0}}{Y_{w0}} \tag{5.4}$$

The proposition follows from iterating out in this manner.

Note, the "saturation" number of firms comes due to the fact that since most firms survive from one period to the next, if all firms were destroyed (by a war or a tsunami, for example), then in the first period, the total number of firms would be given by:

$$L_j = \sum_{k=1}^{M} l_k = \sum_{k=1}^{M} (\frac{q_k}{\varphi} + f_\epsilon) = M(\frac{q_k}{\varphi} + f_\epsilon) \tag{5.5}$$

Here, q_k will be pinned down by the zero profit conditions for entry. In the next period, however, there will be $M_0(1-\delta)$ firms which no longer need to pay the entry cost. Hence, the full employment condition now gives us:

$$L_j = \sum_{k=1}^{M} l_k = M_0(1-\delta)(\frac{q_k}{\varphi}) + M_1 * (\frac{q_k}{\varphi} + f_\epsilon) \tag{5.6}$$

Clearly, the number of firms should increase in this period for a wide range of parameter values, since the incumbent firms no longer need to pay down the fixed costs of entry. In the "saturated" steady state, the total number of firms will not change each period, giving us the condition that:

$$M^{ss} = M^{ss}(1-\delta) + M^{new} \Rightarrow M^{ss}\delta = M^{new} \tag{5.7}$$

Proposition 1.2: Dynamic Gravity, Heterogenous Firms

Melitz (2003) considers a movement from autarky to free trade, and in the process derives the steady state equilibrium values. While the dynamics of the Melitz model are complicated, with a few minor simplifying assumptions we can derive the transition dynamics. Specifically, assume H=1 as in Melitz, *e.g.*, that there is just one industry (or, alternatively, that each firm is in its own industry), and that the only fixed costs are the equity-financed costs of entry. Thus the home entry fixed costs are inclusive of the costs of beginning production such as from building a factory or buying equipment, and the foreign entry costs are the costs associated with entering a new market, and so one must enter the domestic market in order to sell abroad. The per-period overhead costs in Melitz, for simplicity, will be set to zero – these can be thought of as being comprised by the variable costs. Otherwise, following Melitz (2003), I assume symmetry among countries which move from autarky to free trade at year 0. The inclusion of fixed costs that do not depreciate completely each period give rise to the following "dynamic" gravity equation at time t, where lagged entry costs figure explicitly.

$$X_{ij,t} = \frac{1}{\sigma} \sum_{s=0}^{t-1} (1-\delta)^s \frac{Y_{j,t-s} Y_{i,t-s}}{Y_{w,t-s} f_{x,t-s}} \tilde{x}_{ijt,t-s} \, , \; t \in (0, k) \tag{5.8}$$

Where $\tilde{x}_{ijt,t-s}$ is the average sales per firm in period t of the new exporters from period t-s, which is an average of exports from firms within the cutoff productivities at time t-s-1 and t-s, $\varphi^*_{x,t-s-1}$ and $\varphi^*_{x,t-s}$ (the integral of total exports at each level of productivity divided by the measure of firms at each level of productivity, which cancels), and where in the first period after moving from autarky to free trade there is no upper bound on the integral.

$$\tilde{x}_{ij,t} = \int_{\varphi^*_{x,t-s}}^{\varphi^*_{x,t-s-1}} x_{ijt,t-s}(\varphi) \mu(\varphi) d\varphi \tag{5.9}$$

The economy reaches the new steady state at time k>0, given by:

$$(1-\delta)^k = \frac{f_e}{f_e + n f_x (1 - G(\varphi^*_{x,ss}))} \tag{5.10}$$

The Melitz (2003) model will only have a separating equilibrium where not all firms export with relatively large values for the fixed costs of exporting compared to the overhead costs. While exporting is a relative rarity, it is hard to envision large entry costs arising from trade costs traditionally rendered, unless these entry costs are considered to be inclusive of costs associated with entering a market for the first time and successfully gaining market share from other firms – generally an expensive, difficult, and rare undertaking. Relatively large values for the fixed costs of exporting to a specific market – necessary to match the empirical fact that few firms export – would imply a relatively long transition according to equation 5.10. Note that including fixed overhead costs as in Melitz (2003) would carry the same key implication that current trade depends on historical trade costs as the dynamic gravity equation presented above, although it would change the pace of convergence. Chaney (2005) studies the dynamics of a Melitz type model with different simplifying assumptions (for example, he allows firms to stay in the market but not produce) and, not surprisingly, arrives at a different dynamic relationship.

If we stipulate a Pareto distribution for the productivities following Melitz, Helpman, and Yeaple (2004) and Chaney (2008), we can solve for $\tilde{x}_{ij,t}$, and get an expression which is a direct negative function of both lagged variable trade costs and lagged entry costs.

Proof of Proposition: 1.2 Dynamic Gravity, Heterogenous Firms

We can start from the steady-state labor market clearing condition in autarky:

$$L = \int l_i di = \int (\frac{q(\omega)}{\varphi(\omega)} + f_e)\mu(\omega)d\omega \tag{5.11}$$

Substituting in solutions for $q(\omega)$ from the consumer's problem, using an aggregate steady-state stability condition $M_a^{ss} = \delta M_{a,e}^{ss}$ which ensures that firm births equal firm deaths, and then using the CES price markup, we arrive at the mass of firms at each level of productivity in autarky.

$$L = \int M_a^{ss} \frac{Lp(\omega)^{-\sigma}}{P} \mu(\omega)d\omega + \int M_{a,e}^{ss} f_e \mu(\omega)d\omega$$

$$= \int M_a^{ss} \frac{L(\frac{\sigma-1}{\sigma})^{-\sigma}\varphi^{\sigma-1}}{P} \mu(\omega)d\omega + \delta M_a^{ss} f_e \tag{5.12}$$

$$\implies M_a^{ss} = \frac{L}{\sigma\delta f_e} \tag{5.13}$$

(Note: in the above $P = \int_{\omega\in\Omega} p(\omega)^{1-\sigma}d\omega$ for simplicity.) With similar logic, we get an expression for the steady state free trade mass of firms.

$$\implies M_{ft}^{ss} = \frac{L}{\sigma\delta(f_e + f_x n(1 - G(\varphi_{x,ss}^*))} \tag{5.14}$$

As in Melitz (2003), if any firms export, then the mass of firms at each level of productivity in the free trade steady state must be strictly less than the mass of firms in autarky. Since our duration for each period is arbitrary, we can stipulate that this will take more than one period without loss of generality. Since there are no per-period overhead costs, no incumbent firm would ever want to leave the market, but firms do die naturally at rate δ. In the first period after opening to free trade, the aggregate stability condition will need not hold, so instead we use the labor market clearing condition once again to determine how many firms enter foreign markets.

$$L = \int M_{ft}^1 \frac{Lp(\omega)^{-\sigma}}{P\varphi(\omega)} \mu(\omega)d\omega + M_{ft}^1 n f_x (1 - G(\varphi_{x,1}^*))$$

$$\implies L = \frac{\int M_{ft}^1 L(\frac{\sigma}{\sigma-1})^{-\sigma}\varphi(\omega)^{\sigma-1}\mu(\omega)d\omega}{\int M_{ft}^1 (\frac{\sigma}{\sigma-1})^{1-\sigma}\varphi(\omega)^{\sigma-1}\mu(\omega)d\omega} + M_{ft}^1 n f_x (1 - G(\varphi_{x,1}^*))$$

$$\implies M_{ft}^1 = \frac{L}{\sigma n f_x (1 - G(\varphi_{x,1}^*)} \tag{5.15}$$

Where $M^1_{ft}(1 - G(\varphi^*_{x,1}))$ gives the total number of firms which will enter n export markets in the first year after opening to trade. The mass of firms at each level of productivity will have shrunk at rate δ from the steady state mass in autarky. Total exports to one specific market in the first period after opening up to trade are thus:

$$X_{ij,1} = M^1_{ft}(1 - G(\varphi^*_{x,1})\tilde{x}_{ij1,1} = \frac{L}{\sigma n f_x}\tilde{x}_{ij1,1} = \frac{Y_{i,1}Y_{j,1}}{\sigma Y_{w,1} f_x}\tilde{x}_{ij1,1} \tag{5.16}$$

The last equality holds since, for each country, L = R = PQ = Y, and by taking advantage of the Melitz (2003) assumption of symmetry, which implies that $Y_w = nY_j$ for n countries in the world. Average exports per firm to a specific market, $\tilde{x}_{ijt,t}$ is as before: $\tilde{x}_{ij1,1} = \int_{\varphi^*_{x,1}}^{\infty} x_{ij1}(\varphi)\mu(\varphi)d\varphi$. In the second period, a share of all firms, δ, die, shrinking the mass of firms at each level of productivity, while an equivalent amount of new investment in various export markets takes place. Equation (5.8) soon follows. Note that the cutoff productivity level for exporting must fall each period until the steady state is reached, which concomitantly implies that trade increases fastest just after opening to trade and more slowly thereafter. While this is straightforward from the labor market clearing condition, it can also be seen from the zero profit condition for entry into the export market.

$$\frac{\varphi^{*(\sigma-1)}_{xt}}{P_t} \geq \frac{f_x \delta \sigma^{\sigma}(w\tau_{jk})^{\sigma-1}}{L(\sigma-1)^{\sigma-1}} \tag{5.17}$$

The right hand side of this equation includes wages, which are set to unity in Melitz (2003), variable trade costs τ, and other parameters, which we can hold constant. Since P will depend positively on the number of firms which shrink each period, and negatively on the cutoff productivity for exporting, if φ^*_x were constant than P would fall. If the cutoff productivity were rising, then P would be falling, which implies that the right-hand side of equation (5.17) would not be constant, a contradiction. Intuitively, since the mass of domestic firms in each country is shrinking each period, this should increase the amount exporters can sell, which also lowers the barriers for entry.

Proposition 2.1: Dynamic Crowding Out From Government Spending in Autarky

Let L^o_g be the initial level of government employment in autarky. Using the same assumptions as in Proposition 1.1 (no overhead costs, equity-financed fixed costs, and there is just one industry), we can solve for the steady-state mass of firms from the labor market clearing condition.

$$\frac{L - L^o_g}{\sigma \delta f_e} = M^o_{ss} \tag{5.18}$$

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

$$M_1^e - M_{ss}^o\delta = \frac{L - L_g^1}{\sigma f_e} - \frac{L - L_g^o}{\sigma\delta f_e} = \frac{L_g^o - L_g^1}{\sigma f_e} \tag{5.19}$$

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:

$$M_{ss}^1 - M_{ss}^o = \frac{L_g^1 - L_g^o}{\sigma\delta f_e} > \frac{L_g^o - L_g^1}{\sigma f_e} \tag{5.20}$$

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

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

$$M_t = \sum_{j=1}^{t}(1-\delta)^{t-j}\frac{(L - L_g^1)}{\sigma f_e} + (1-\delta)^t\frac{(L - L_g^0)}{\sigma\delta f_e} \tag{5.21}$$

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.

5.2 Melitz Model Variation

In this section, I review a slight variation on the Melitz (2003) model with Pareto-distributed productivity and no per-period fixed overhead costs. In this model, households in the home country consume from a continuum of goods, ω, from a set of goods, Ω, determined in equilibrium:

$$U_t = (\int_{\omega\in\Omega} q(\omega)_t^{\frac{(\sigma-1)}{\sigma}}\, d\omega)^{\frac{\sigma}{(\sigma-1)}},\ \sigma > 1\,. \tag{5.22}$$

This leads to the solution each period for variety ω, with total income in the home country of Y_t, and the CES price index $P_t = (\int_{\omega\in\Omega} p(\omega)_t^{(1-\sigma)} d\omega)^{\frac{1}{(\sigma-1)}}$:

$$q(\omega)_t = \frac{Y_t p(\omega)_t^{-\sigma}}{P_t^{1-\sigma}}. \tag{5.23}$$

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. Profits per period for a firm which has previously chosen to enter the foreign market at home[1] are thus

$$\Pi(\omega)_t = q(\omega)_t p(\omega)_t - \frac{q(\omega)_t w_t}{\varphi(\omega)}. \tag{5.24}$$

Where p is price, q is output sold at home, q^* and p^* denote quantities and prices of goods produced at home and sold abroad, w is the wage, τ is an iceberg trade cost, and $\varphi(\omega)$ 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 they will have strictly positive expected profits going forward. Maximizing profits, firms choose prices marked up over marginal cost

$$p(\omega)_t = \frac{\sigma}{\sigma-1}\frac{w_t}{\varphi(\omega)}, \qquad p(\omega)^*_t = \frac{\sigma}{\sigma-1}\frac{w_t \tau_t}{\varphi(\omega)}. \tag{5.25}$$

And CES markups lead to the per-period profits[2] from exporting:

$$Foreign: \Pi(\omega)^*_t = \frac{Y^*_t(\sigma-1)^{(\sigma-1)}}{P_t^{*(1-\sigma)}\sigma^\sigma} w_t^{1-\sigma}\tau_t^{1-\sigma}\varphi^{\sigma-1}. \tag{5.26}$$

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 future profits.

$$Foreign\,Entry: E_t\Pi(\omega)^*_{PV,t} = E_t\sum_{s=0}^{\infty}(1-\delta)^s\Pi(\omega)^*_{t+s} - f_{x,t}w_t \geq 0. \tag{5.27}$$

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.

$$Domestic\,Entry: E_t\Pi(\omega)_{tot,PV,t} = E_t[\sum_{s=0}^{\infty}(1-\delta)^s\Pi(\omega)_{t+s}+\Pi(\omega)^*_{PV,t}] - f_{et}w_t \geq 0. \tag{5.28}$$

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 have simple expectations about the

[1]And similarly for foreign: $\Pi(\omega)^*_t = q(\omega)^*_t p(\omega)^*_t - \frac{q(\omega)^*_t w_t \tau_t}{\varphi(\omega)}$.

[2]And for the Home Market: $\Pi(\omega)_t = \frac{Y_t(\sigma-1)^{(\sigma-1)}}{P_t^{1-\sigma}\sigma^\sigma} w_t^{1-\sigma}\varphi^{\sigma-1}$,

future – they believe the future will be like today, conditioned on not receiving a "death" draw with probability δ. In that case, we can derive a simple cutoff productivity for entering into the export market at time t from equation (5.27):

$$\varphi_{xt}^{*} = \left(\frac{f_{x,t} P_t^{*(1-\sigma)}}{Y_t^{*}} w_t^{\sigma} \tau_t^{\sigma-1} \delta \lambda_0 \right)^{\frac{1}{\sigma-1}}, \tag{5.29}$$

where $\lambda_0 = \frac{\sigma^{\sigma}}{(\sigma-1)^{\sigma-1}}$. Adding a non-critical simplifying assumption that firms only make the export decision in their first period of producing, then given a distribution of productivities $G(\varphi)$, and a probability of exporting $p_{xt} = (1 - G(\varphi_{xt}^{*})$, the labor market clearing condition yields a simple expression, familiar to students of new trade theory, for the mass of entrants each period for the symmetric two-country case[3]

$$M_t^{e} = \frac{L_t}{\sigma(f_{et} + f_{xt} p_{xt})}. \tag{5.30}$$

The total number of entrants into the export market each period is then

$$M_t^{xe} = M_t^{e} p_{xt}. \tag{5.31}$$

Proposition 1: Trade is a Function of Lagged Variables

Total exports from home to the foreign country at time t are equal to the average exports of the sum of all previous surviving entrants into the export market,

$$X_t = \sum_{s=0}^{\infty} M_{t-s}^{e} (1-\delta)^{s} \bar{x}_{t,-s}, \tag{5.32}$$

where $\bar{x}_{t,-s}$ are the average exports from a firm which entered s periods previously, and $M_{t-s}^{e}(1-\delta)^{s}$ is the mass of surviving incumbent firms from s periods previously. I follow the literature and assume a Pareto distribution for productivity with shape parameter $\gamma > \sigma - 1$, distributed over $[1, +\infty)$, and use the fact that in a symmetric two-country case wages will be the same in both countries and can be set to unity. Then, inserting the solutions from the consumer's problem, the mass of entrants, and the cutoff productivity yields a tractable "dynamic gravity" formulation

$$X_t = \frac{L_t^{*} \tau_t^{1-\sigma}}{P_t^{*(1-\sigma)}} \lambda_1 \sum_{s=0}^{\infty} \frac{L_{t-s}(1-\delta)^{s}}{(f_{e,t-s} + f_{x,t-s} p_x)} \left(\frac{f_{x,t-s} P_t^{*(1-\sigma)}}{L_{t-s}^{*}} \tau_{t-s}^{\sigma-1} \delta \right)^{\frac{\sigma-1-\gamma}{\sigma-1}}, \tag{5.33}$$

[3]In the Appendix, I show the case where incumbent firms can later decide to enter.

where $\lambda_1 = \lambda_0^{\frac{-\gamma}{\sigma-1}} \frac{\gamma}{\gamma-(\sigma-1)}$.

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

$$X_t = f(\underbrace{L_t}_{+}, \underbrace{L_{t-s}}_{+}, \underbrace{L_t^*}_{+}, \underbrace{L_{t-s}^*}_{+}, \underbrace{\tau_t}_{-}, \underbrace{\tau_{t-s}}_{-}, \underbrace{f_{xt}}_{-}, \underbrace{f_{x,t-s}}_{-}), s > 0. \tag{5.34}$$

The key idea that the empirical section of this paper tests is that if trade costs rise from a shock, then the negative impact of this shock will decay over time. Note that if we were in a one-period world, then, as in Chaney (2008), the elasticity of substitution will not magnify the impact of iceberg trade costs, but that with multiple periods of firm entry, this result no longer follows. How general is this dynamic gravity formulation? In the Appendix, I prove a similar transition dynamics arise when moving from autarky to free trade for assumptions similar to key models in the new trade theory cannon, including Krugman (1980), Melitz (2003), and Chaney (2008). Burstein and Melitz (2011) also provide the impulse response for a similar scenario, while Bergin and Lin (2012) present a model in a similar vein focusing on the dynamic impact of future shocks. The large aforementioned literature on hysteresis in the 1980s also carried the same core insight, that trade shocks can have lagged effects, as equation (5.33). The contribution here is that this is the first paper which shows that the logic of sunk costs naturally leads to a "dynamic gravity" equation which can be derived explicitly, even with heterogenous firms.

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: Real Wage 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, 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 **??** in the Appendix shows a chloropleth map of per capita income by county, which can be compared to the distribution of import-competing manufacturing in Figure **??**. 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 can cause dynamic crowding out. On page 38 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.

Proposition 3: Hysteretic Impact of Exchange Rate Movements

Eichengreen *et. al.* (2012) argue that an undervalued exchange rate is equivalent to imposing an iceberg import cost and export subsidy. If so, then one could use equation (5.33) to argue that an undervalued exchange rate at time t-1 would have an impact at time t. Another option is to introduce international capital flows and a nominal exchange rate, although the latter will have no effect in this model when prices and wages are fully flexible. When prices and wages are sticky in the short run (in Figure **??** in the next section, it can be seen that manufacturing wages are in fact sticky), capital inflows can lead to exchange rate appreciation. Over time, this may lead to resources shifting from the tradables to the non-tradables sectors, which may return slowly.

If we allow for international capital flows, then government may finance part of its deficit from "abroad" (which will henceforth be aggregated into one country): $B_t^g = B_t + B_t^*$. To simplify matters, I assume that capital flows and government finances are completely exogenous. Assume consumers face a lump-sum tax financed out of their labor income, supplied inelastically, and that consumers can also purchase risk-free government bonds, which is also supplied inelastically, leading to the budget constraint (in units of consumption):

$$L_t w_t - T_t + (1 + r_t)B_t = C_t + B_{t+1} \tag{5.35}$$

Government revenue and borrowing equal spending and payments of past debts.

$$T_t + B_{g,t+1} = G_t + (1 + r_t)B_{g,t} \tag{5.36}$$

Combining these equations, we arrive at an expression for the current account.

$$B_t^* - B_{t-1}^* = -Y_t + C_t + G_t + B_{t-1}^* r_{gt} \tag{5.37}$$

Each period, the balance of payments between home and abroad must equal zero, where now we stipulate that prices are demarked in local currencies converted into dollars at the nominal exchange rate, e.

$$B_t^* + M_x \tilde{x} \tilde{p} e = M_x^* \tilde{x}^* \tilde{p}^* \tag{5.38}$$

This equation says that net capital inflows and dollar revenue from exports equals expenditures on imports (the foreign mass of exports times the average exports per firm times the price). However, if prices and wages are fixed in the short run, then, totally differentiating equation (5.38), I have:

$$dB_t^* + d\tilde{x}(M_x \tilde{p} e) + de(\tilde{x} M_x \tilde{p}) = d\tilde{x}^* M_x^* \tilde{p}^* \tag{5.39}$$

Hence, an increase in capital flows must lead either to a fall in exports, a rise in imports, a dollar appreciation, or some combination thereof. As discussed, higher government spending leads to less firm creation in this model, while a pricing wedge would increase the cutoff productivity for exporting, and decrease the cutoff productivity for foreign firms to enter the home market. Having entered, in this model, these foreign firms will stay even once the budget is balanced.[4]

[4] Proof Forthcoming.