Online Appendix

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Appendix A Empirical Appendix

Appendix A.1 Data Sources

U.S. Imports and Exports Data

The imports data for the United States are obtained from the Center for International Data at University of California, Davis. The c.i.f. (cost, insurance, freight) values of imports are available for the years after 1973. Thus, the first year of my sample is 1974. For years up to 1994, the Center for International Data also provides imports data aggregated to the 4-digit domestic SIC 1972 level. I directly use these aggregated data for the period until 1994. I concord these data at SIC 1972 to the domestic SIC 1987 classification (for uniformity with manufacturing industry data). Also, I group the imports from various countries into two groups - imports from developed, and imports from developing countries using the World Bank Income Classification. For the period 1995-2005, I use the disaggregated imports data. These data are available at the level of 10 digit HS categories. Grouping the source countries as developed and developing, I aggregate the dollar value of imports in each product category from these two sets of countries. The next step is to aggregate these imports to the level of 4-digit industries under the SIC 1987 classification. For this purpose, I first aggregate these imports to the level of 4-digit import based SIC 1987 and then map them into the domestic SIC 1987 classification using the procedure described in Feenstra, Romalis and Schott (2002).

NBER-CES Manufacturing Productivity Database

Data on 459 four digit manufacturing industries in the United States are available from NBER. These data are available for the period 1958 to 2005 at a uniform Standard Industrial Classification of 1987, i.e., the data are adjusted for changes in industry definitions and classifications over time. Many of the variables are taken from the Census Bureau's Annual Survey of Manufactures and the quinquennial Census of Manufactures. The variables that I obtain from this database include nominal values of annual shipments, the number of non-production and production workers employed and their average wages, nominal values of non-energy materials, real values of total capital stocks, and of equipment and structures (calculated according to the perpetual inventory method), and the industry level price indexes for shipments and investment.

Compustat

Compustat is a database that provides data on all publicly traded firms in the United States. From these data, I obtain annual expenditures of public firms on research and development and their annual sales. The R&D data include all non-federally funded expenditures of the firms in any given year for the purpose of producing and improving their products and services. The database includes firms that are not legally incorporated in the U.S. I drop these firms from the sample so as to retain only domestic firms. Each firm is identified uniquely with a GV key. The four digit SIC 1987 industry that a firm belongs to is also provided. I aggregate the R&D expenditures incurred by all firms belonging to the same SIC 1987 industry to create an industry level R&D measure. Similarly, I aggregate the sales of all firms belonging to any given industry to create an industry level sales measure. R&D divided by sales gives me a measure of R&D intensity in an industry. Some firms may belong to more than one 4-digit SIC industry. In this case, Compustat provides only a 2 digit SIC 1987 code. I assign the R&D expenditures of these firms to the constituent 4-digit industries using the following procedure: I calculate the share of each constituent 4-digit industry in the total value of shipments in the broader 2 digit industry for each year. Using these shares as weights I split the R&D expenditures of the firm over all the 4-digit industries it belongs to. Also, for a few firms, the R&D and sales data are reported in Canadian dollars. I convert them to U.S. dollars using the exchange rates prevailing in those years.

Input-Output Tables

The Bureau of Economic Analysis provides detailed benchmark Input-Output (I-O) Accounts (make tables, use tables, and direct requirements coefficients tables) every five years. I use the direct requirement coefficients tables provided every five years for the period 1972-2002. For 1972 and 1977, the direct requirement coefficients are not provided. I construct them from the use tables. The I-O industry codes for various years are based on the Standard Industrial Classification of various years until 1992. The I-O codes for 1997 and 2002 are based on NAICS 1997 and 2002, respectively. I concord the I-O codes for all the years to 4-digit SIC 1987. Direct requirement coefficients are defined as the dollar value of an input required by an industry to produce one dollar of its output. Voigtlander (2010) shows that these coefficients are stable across years. For this reason, and following Feenstra and Hanson (1996), I linearly interpolate the coefficients for the interim years between each pair of years for which the benchmark I-O tables are available. For the period 2003-2005, I linearly extrapolate the coefficients for the year 2002.

Other Data Sources

Penn World Tables: From this database, I obtain the annual averages of the nominal exchange rates of the currencies of foreign countries relative to the U.S. dollar. for the period 1974 to 2005. An increase in the exchange rate implies an appreciation of the U.S. dollar vis-a-vis the foreign currency.

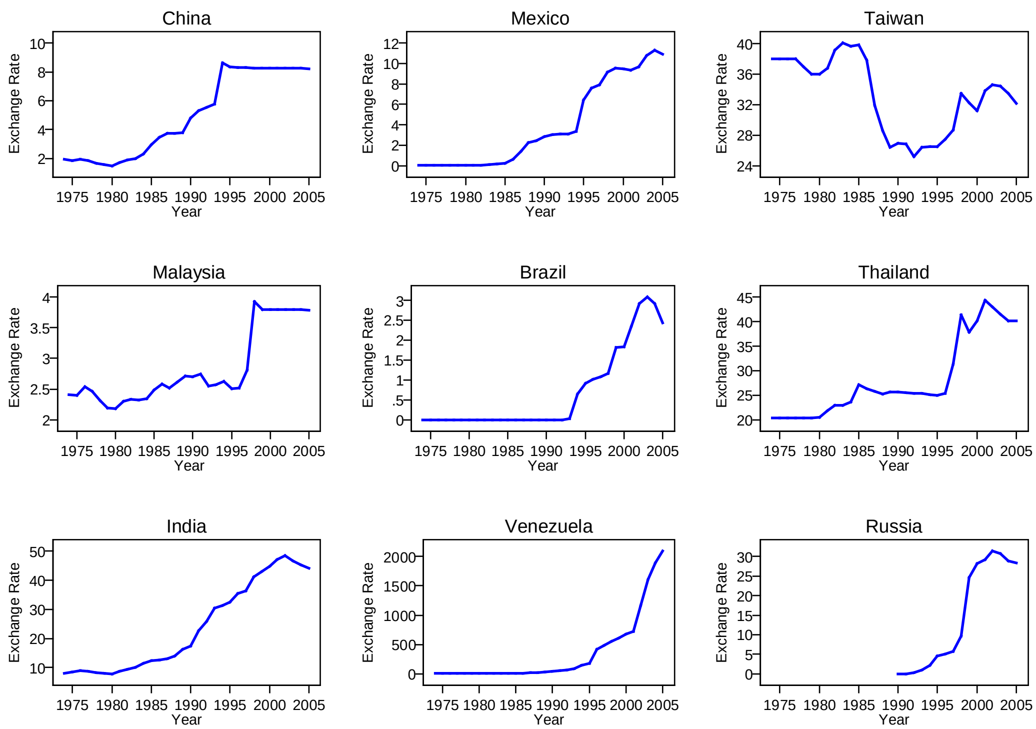
IMF International Financial Statistics: From this database, I obtain price data for developing countries.

World Bank Income Classification: The World Bank classifies all countries into five categories: High Income: OECD, High Income: non-OECD, Upper Middle Income, Lower Middle Income and Low Income. I obtain these classifications from the World Bank. For the empirical analysis in this paper, I group upper middle income, lower middle income and low income countries together as "developing" countries. High income OECD and non-OECD countries are grouped together as "advanced," or "developed," countries.

Tariffs: I construct a series of average tariffs for intermediates imported in an industry using data on the customs value of imports and the duties paid on them. I aggregate the total customs value and total duties paid for all imported product categories belonging to a given 4-digit industry. Taking the ratio of total duties to total customs value, and multiplying by 100, provides a measure of the average tariff rate in the 4-digit industry for each year, separately for imports from developed and developing countries. Between 1974 and 1988, the data provide the four digit SIC 1972 industries that the imported product categories belong to. For the years after 1988, the data provide the import based SIC 1987 industries that the products belong to. I concord the SIC 1972 and import based SIC 1987 classifications to domestic SIC 1987 classification. This provides me with the average tariff rates imposed on imports belonging to all 4-digit SIC 1987 industries. To get a measure of tariffs imposed on imported intermediates, I follow the same procedure as that used for exchange rates.

CPI: The U.S. consumer price index data are obtained from the Bureau of Labor Statistics. The CPI data for developing countries are taken from IMF's International Financial Statistics. These data are used to construct the price-based instrumental variable. This price index for the U.S. is also used to construct a series of real prices for 4-digit industries by dividing the industry level price index by the U.S. CPI.

Appendix A.2 Exchange Rates Based Instruments



Source: Penn World Tables and World Bank Income Classification. Exchange rate is defined as foreign currency relative to U.S. dollar. The figure shows evolution of exchange rates for all developing countries that appear among the top twenty trading partners of the U.S. in 2005. Data for Russia were only available after 1989.

Figure Appendix A.1: Exchange Rates of U.S. Dollar with Top Trading Partner Currencies

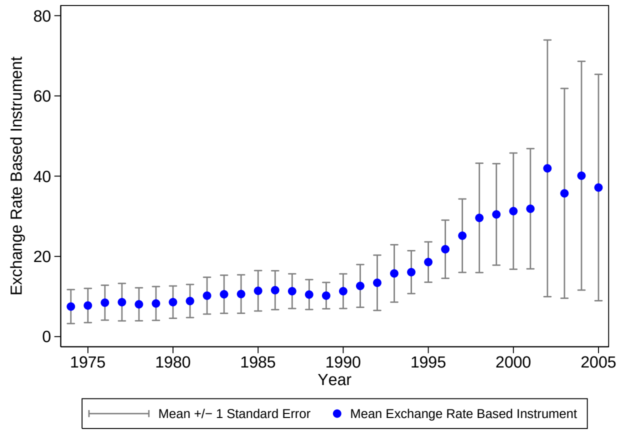


Figure Appendix A.2: Exchange Rates of U.S. Dollar with Top Trading Partner Currencies[b]

[a]The figure shows the mean +/- 1 standard deviation of the exchange rate based instrumental variable for each year in the sample period. 1993 exchange rates for three industries (3292, 3341, and 3915) were outliers and were dropped from the analysis.

[b]The figure shows the mean +/- 1 standard deviation of the exchange rate based instrumental variable for each year in the sample period. 1993 exchange rates for three industries (3292, 3341, and 3915) were outliers and were dropped from the analysis.

Table Appendix A.1: Changes in Offshoring and Industry Exchange Rates

Industry Code	Description	Change in Offshoring	Change in Exchange Rate	Time Series Correlation Between Offshoring and Exchange Rate
		1974-2005		
20	Food and Kindred Products	0.07	22.21	0.84
21	Tobacco Products	0.12	120.19	0.88
22	Textile Mill Products	0.31	18.46	0.65
23	Apparel and Other Textile Products	0.17	21.04	0.48
24	Lumber and Wood Products	0.09	27.80	0.54
25	Furniture and Fixtures	0.14	14.86	0.84
26	Paper and Allied Products	0.06	27.15	0.94
27	Printing and Publishing	0.05	25.05	0.90
28	Chemicals and Allied Products	0.13	48.73	0.91
29	Petroleum and Coal Products	0.19	104.60	0.96
30	Rubber and Miscellaneous Plastics Products	0.19	23.76	0.93
31	Leather and Leather Products	0.13	26.27	0.85
32	Stone, Clay, and Glass Products	0.21	40.25	0.96
33	Primary Metal Industries	0.11	45.30	0.89
34	Fabricated Metal Products	0.13	30.40	0.78
35	Industrial Machinery and Equipment	0.28	19.61	0.87
36	Electronic and Other Electric Equipment	0.40	18.89	0.76
37	Transportation Equipment	0.37	17.42	0.85
38	Instruments and Related Products	0.36	18.74	0.73
39	Miscellaneous Manufacturing Industries	0.19	20.73	0.66

Changes are averages over all 4 digit industries within each 2 digit industry.

Appendix A.3 Offshoring Descriptive Statistics

Table Appendix A.2: Top Twenty Exporters of Manufactured Goods to United States

1975		1990		2005	
Country	**Share***	**Country**	**Share***	**Country**	**Share***
Canada	23.02	Japan	21.36	**China**	17.79
Japan	17.12	Canada	18.24	Canada	14.84
Germany	7.86	Germany	6.50	Japan	9.61
United Kingdom	5.15	**Taiwan**	5.51	**Mexico**	9.54
Italy	3.60	**Mexico**	4.94	Germany	5.73
Taiwan	2.98	South Korea	4.47	South Korea	3.08
France	2.87	United Kingdom	3.94	United Kingdom	3.05
Mexico	2.59	**China**	3.48	**Taiwan**	2.43
Belgium/Luxembourg	2.36	Italy	3.03	**Malaysia**	2.36
Hongkong	2.32	France	2.87	France	2.18
Venezuela	2.26	Singapore	2.25	Italy	2.15
South Korea	2.15	Hongkong	2.24	Ireland	1.95
Netherlands Antilles/Aruba	1.70	**Brazil**	1.75	**Brazil**	1.56
Australia	1.51	**Thailand**	1.16	**Thailand**	1.34
Netherlands	1.44	**Malaysia**	1.15	**India**	1.30
Bahamas	1.28	Sweden	1.15	Israel	1.15
Sweden	1.27	Belgium/Luxembourg	1.08	**Venezuela**	1.00
Spain	1.23	Netherlands	1.06	Singapore	0.99
Brazil	1.14	Switzerland	1.00	**Russia**	0.97
Switzerland	1.10	**Venezuela**	0.96	Sweden	0.95

Notes: *: Share of country in total imports of the U.S.

Bold indicates developing country

Table Appendix A.3: Average Offshoring by Industries and Their Characteristics

		1975							2005						
Industry Code	Description	Rank	Offshoring**	Employment Ratio*	Wage Bill Ratio*	Production Workers Wage Bill***	Equipment/ Labor	R&D***	Rank	Offshoring**	Employment Ratio*	Wage Bill Ratio*	Production Workers Wage Bill***	Equipment/ Labor	R&D***
39	Miscellaneous Manufacturing Industries	1	0.027	0.313	0.612	454.504	10.889	11.178	7	0.216	0.539	0.996	476.796	41.459	82.260
36	Electronic and Other Electric Equipment	2	0.026	0.524	0.923	757.355	18.721	261.780	1	0.421	0.823	1.515	697.647	147.257	12564.700
20	Food and Kindred Products	3	0.026	0.526	0.703	1005.170	35.933	34.561	18	0.100	0.427	0.619	937.449	105.670	63.110
38	Instruments and Related Products	4	0.022	0.789	1.250	1270.843	11.526	323.590	3	0.379	1.453	2.486	794.693	59.252	1161.296
25	Furniture and Fixtures	5	0.022	0.252	0.439	627.374	8.411	6.530	11	0.168	0.313	0.542	610.365	28.288	54.666
31	Leather and Leather Products	6	0.019	0.159	0.340	374.217	5.841	0.560	12	0.156	0.295	0.599	51.102	26.216	6.960
28	Chemicals and Allied Products	7	0.018	0.712	1.036	933.303	65.684	761.459	13	0.153	0.752	1.126	974.888	220.471	3644.444
33	Primary Metal Industries	8	0.017	0.282	0.380	4694.232	64.594	125.505	15	0.125	0.270	0.377	1395.793	221.256	27.356
37	Transportation Equipment	9	0.015	0.519	0.710	4460.612	26.909	2063.363	2	0.394	0.657	0.852	4118.491	97.797	6564.820
23	Apparel and Other Textile Products	10	0.014	0.161	0.349	724.737	5.085	2.703	9	0.195	0.326	0.667	192.797	23.747	0.798
22	Textile Mill Products	11	0.013	0.166	0.330	826.519	22.742	9.735	4	0.325	0.204	0.366	252.130	89.472	9.657
24	Lumber and Wood Products	12	0.010	0.181	0.327	1004.426	22.731	31.399	16	0.120	0.250	0.414	1039.375	39.223	33.580
32	Stone, Clay, and Glass Products	13	0.008	0.294	0.413	685.631	36.895	17.471	6	0.226	0.285	0.442	718.814	125.268	11.065
34	Fabricated Metal Products	14	0.008	0.329	0.501	1063.771	22.328	17.744	14	0.143	0.368	0.602	920.393	72.703	22.744
29	Petroleum and Coal Products	15	0.008	0.442	0.592	1522.310	151.425	758.420	8	0.197	0.619	0.742	1459.754	651.776	377.665
35	Industrial Machinery and Equipment	16	0.007	0.558	0.857	1226.434	18.493	93.849	5	0.290	0.757	1.196	1027.952	84.300	18132.040
26	Paper and Allied Products	17	0.007	0.308	0.453	1261.191	57.051	79.485	19	0.072	0.283	0.451	1108.512	220.512	207.160
27	Printing and Publishing	18	0.005	1.091	1.457	2190.654	13.795	4.214	20	0.059	0.403	0.614	3075.353	51.368	8.599
30	Rubber and Miscellaneous Plastics Products	19	0.005	0.304	0.513	1581.401	29.893	80.364	10	0.193	0.299	0.519	2859.820	76.973	173.268
21	Tobacco Products	20	0.003	0.184	0.275	653.400	28.268	55.919	17	0.120	0.337	0.585	294.028	194.832	260.351
	Correlation with Offshoring			0.053	0.163	-0.175	-0.240	0.058			0.608	0.621	0.547	-0.079	0.531

Notes: All numbers are averages over all 4 digit industries within each 2 digit industry.
*: Ratios are for non-production workers relative to production workers.
**: Sum of imported inputs as a proportion of non-energy materials.
***: Millions of dollars (1987=1)

Appendix A.4 Fixed Effects Estimates

Table A.4 presents the fixed effects estimates of the relationship between offshoring and several outcome variables. For the sake of uniformity of presentation, the results in this table are categorized on the basis of whether I expect the dependent variables to be influenced via the technology channel only (columns 1 to 2(b)) or also through other mechanisms (columns 3 to 11). The coefficients on offshoring in these regressions are within industry within year correlations, and do not have a causal interpretation.

The negative, albeit small, coefficient in column 2(b) is consistent with the negative correlation of offshoring with equipment/labor presented in Table A.3. The negative coefficient on R&D intensity in column 1 is not consistent with the positive correlation in Table A.3, but may reflect the fact that more high-tech industries offshore less. The labor market outcomes, on the other hand, are affected via both technology and other channels. Consistent with both channels, columns 3 and 4, show that offshoring is positively associated with employment and wage ratios. Next consider the absolute outcomes, i.e., the levels of employment, wage-bills, and wages of both groups of workers. Both channels predict positive effects of offshoring on the levels of non-production employment and wage-bills. The positive coefficients on imports in columns 5 and 6 are consistent with this prediction. As for the levels of production workers' employment and wage-bills, the substitution channel implies a negative effect and the technology channel implies a positive effect. The positive coefficients on imports in columns 8 and 9, may suggest that the positive influence of the technology channel more than offsets the negative substitution effect. However, the estimated coefficient on offshoring is negative, although small, in regressions for both non-production and production wages. Gross output is also affected by both channels. The positive coefficient on imports in column 11 is consistent with this intuition.

These fixed effects estimates are small and statistically insignificant, and indicate that the sources of downward bias discussed in section 2 are strong.

Table Appendix A.4: Fixed Effects Estimates for Various Outcome Variables

	Technology Channel			Both Channels								
	(1)	**(2a)**	**(2b)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**
	R&D Intensity[1]	Equipment	Equipment / Labor	Employment Ratio[2]	Wage Bill Ratio[2]	Non-Production Wage Bill	Non - Production Employment	Non - Production Wages	Production Wage Bill	Production Employment	Production Wages	Gross Output
Imported Intermediates[3]	-0.085***	0.007	-0.003	0.009	0.010	0.013	0.015	-0.002	0.003	0.005	-0.003	0.004
	(0.030)	(0.015)	(0.012)	(0.007)	(0.008)	(0.013)	(0.013)	(0.003)	(0.013)	(0.013)	(0.004)	(0.025)
Observations	13,746	14,570	14,570	14,569	14,568	14,568	14,569	14,570	14,570	14,570	14,570	14,570
R-squared	0.124	0.587	0.762	0.259	0.326	0.122	0.162	0.1	0.272	0.302	0.015	0.260
Number of 4 digit industries	456	459	459	459	459	459	459	459	459	459	459	459

Notes:

*** p<0.01, ** p<0.05, * p<0.10

[1]: Real R&D Expenditure/Total Sales for the firms for which data on R&D expenditures and sales are available.

[2]: Ratios are for non-production workers relative to production workers.

[3] As a proportion of total non-energy materials used in the industry.

All regressions include year fixed effects, 4-digit industry fixed effects and interactions of two digit industry dummies with an indicator for whether the year is post-1996. All observations are weighted by constant indsutry size.

Heteroskedasticity-robust standard errors are in parentheses. Standard errors are clustered at the level of 4-digit industries.

All variables are in natural logs.

Appendix A.5 Robustness

The construction of the exchange rates based instrument takes into consideration several potential factors that could lead to a violation of the exclusion restriction. I examine robustness of results to accounting for other factors that can still render the instrument invalid.

It is possible that some sources of variation in the exchange rates (besides those already accounted for in the baseline results) also directly impact the outcome variables. For example, a trade agreement like NAFTA impacts exchange rates of the U.S. dollar with the Mexican Peso, and also directly impacts wage-bills and employment of skilled and unskilled workers in U.S. industries that directly compete with imports from Mexico. Three major trade agreements took place over my sample period - NAFTA, the Uruguay round, and the multi-fiber trade agreement. To the extent that these trade agreements affected industries similarly, their effects are already captured in year fixed effects. But, we do expect that their effects are heterogeneous across industries. Thus, not controlling for these trade agreements may cause an omitted variable bias in the estimates. To address this possibility, I include a vector of pre- and post-NAFTA (or Uruguay rounds) indicator variables with two digit industry fixed effects. While the NAFTA came into effect in 1994 and continued through 2005, the Uruguay round of trade agreements stayed in effect between 1995 and 2004. The multi-fiber agreement was in place throughout my sample period and, hence, does not need to be controlled for in addition to the year and industry fixed effects.

Second stage results from regressions that control for NAFTA and the Uruguay round are presented in Table A.5.[1] The estimates of the coefficients on offshoring in regressions for both technology and labor market outcomes remain similar to the baseline results. Results that control for NAFTA indicate that doubling offshoring in an industry leads to 29% increase in equipment-labor ratio and 31% increase in the R&D intensity. Production workers' employment and wage-bills also increase by 26.2% and 28.3% when offshoring increases by 100% in an industry. Similarly, regressions that control for the Uruguay round show that doubling offshoring in an industry is associated with 13.3% increase in capital-embodied technology adoption (smaller than the baseline results but still large and statistically significant) and about 40% increase in R&D intensity. The labor market effects of offshoring also remain similar.

Another factor that I consider is pegging of exchange rates. Policies to peg currencies

[1] Excluded instruments include contemporaneous and one year lagged exchange rate and relative price constructs. The first stage F statistic is 15.35 and 13.71 for the regressions controlling for NAFTA and the Uruguay round, respectively.

Table Appendix A.5: FE-IV Estimates for Regressions Controlling for NAFTA and Uruguay Trade Agreements

	Technology Outcomes		Labor Outcomes			
	(1)	(2)	(3)	(4)	(5)	(6)
	Equipment/ Labor	R&D Intensity	Employment Ratio	Wage Bill Ratio	Production Employment	Production Wage Bill
	Results from regressions including interactions of NAFTA indicator with 2-digit industry fixed effects					
Imported Intermediates[1]	0.294***	0.310***	0.072*	0.081**	0.262***	0.283***
	(0.079)	(0.117)	(0.037)	(0.037)	(0.085)	(0.089)
Observations	14,097	13,287	14,096	14,095	14,097	14,097
Number of industries	459	456	459	459	459	459
	Results from regressions including interactions of Uruguay round indicator with 2-digit industry fixed effects					
Imported Intermediates[1]	0.133*	0.402**	0.095**	0.110***	0.218***	0.233***
	(0.070)	(0.161)	(0.040)	(0.041)	(0.084)	(0.088)
Observations	14,097	13,287	14,096	14,095	14,097	14,097
Number of industries	459	456	459	459	459	459

Notes:
*** p<0.01, ** p<0.05, * p<0.10
[1]: As a proportion of total non-energy materials used in the industry.
Excluded instruments: Contemporaneous and one year lagged exchange rates and relative prices.
All regressions include year fixed effects, 4-digit industry fixed effects and interactions of 2 digit industry dummies with an indicator for whether the year is post-1996. All observations are weighted by constant industry size.
Heteroskedasticity-robust standard errors are in parentheses. Standard errors are clustered at the level of 4-digit industries.
All variables are in natural logs.

to the U.S. dollar or other major currencies impact exchange rates as well as outcome variables through channels other than offshoring. Over the sample period, several developing countries followed policies to peg their currencies according to a fixed or crawling regime. But many of them accounted for a negligible share of U.S. imports over the entire time period. I consider countries that accounted for at least 0.5% of total U.S. imports in any year during the sample period. For each of these countries, I include indicators for the years during which they managed the values of their currencies according to fixed or crawling exchange rate pegging regimes. Results from these regressions are presented in Table A.6. Controlling for fixed and crawling exchange rate pegging regimes followed by a subset of developing countries does not affect results. Offshoring continues to have economic and statistically significant positive technology effects. Similarly, the impacts of offshoring on unskilled workers' employment and wage-bills remain close to the baseline results.

The exclusion restriction for the exchange rates based instrument could also be rendered invalid if exchange rates impact the outcome variables through mechanisms other than offshoring. Examples for these mechanisms include final good imports and exports.

Table Appendix A.6: FE-IV Estimates for Regressions Controlling for Pegged Exchange Rates

	Technology Outcomes		Labor Outcomes			
	Equipment/ Labor	R&D Intensity	Employment Ratio	Wage Bill Ratio	Production Employment	Production Wage Bill
Imported Intermediates[1]	0.385***	0.422***	0.111**	0.132**	0.240**	0.249**
	(0.117)	(0.155)	(0.049)	(0.051)	(0.103)	(0.106)
Observations	14,105	13,287	14,096	14,095	14,097	14,097
Number of industries	459	456	459	459	459	459
R-squared	0.534	0.047	0.139	0.170	0.133	0.084
Hansen's J statistic (p-value)	14.64 (0.00)	10.69 (0.01)	2.46 (0.48)	4.28 (0.23)	3.43 (0.33)	3.21 (0.36)

Notes:
*** p<0.01, ** p<0.05, * p<0.10
[1]: As a proportion of total non-energy materials used in the industry.
Excluded instruments: Contemporaneous and one year lagged exchange rates and relative prices.
All regressions include year fixed effects, 4-digit industry fixed effects, interactions of 2 digit industry dummies with an indicator for whether the year is post-1996, and country-specific indicators that equal 1 for the years that a country pegged its exchange rate. All observations are weighted by constant industry size.
Heteroskedasticity-robust standard errors are in parentheses. Standard errors are clustered at the level of 4-digit industries.
All variables are in natural logs.

Not controlling for these possible channels would again cause an omitted variable bias in the estimates. To address this concern, I consider two specifications. In the first specification, I include the natural log of industry-year specific import penetration ratio as a control variable. In the second specification, I include the natural log of real dollar values of exports and imports in each industry as additional controls. Table A.7 presents the results. In both specifications, results remain qualitatively similar to the baseline results. While controlling for import penetration ratios does not affect the estimates much, controlling separately for imports and exports slightly reduces the magnitudes of estimates.

Note, however, that in these regressions exports and imports (or import penetration) are also endogenous regressors. To overcome this problem, I run another robustness check. I divide the sample of industries into two halves based on the average import penetration from developing countries in these industries. The top half industries have above-median import penetration from low-wage countries and the industries in the bottom half have below-median import penetration from low-wage countries. If the final good imports and exports are driving the main results, I expect to see that the results are very similar to the main results for the industries in the top half but much less so for the industries in the bottom half. This is not what the results show, however, further confirming the main results. The results in the bottom half of the industries that face less import competition from developing countries than the median industry still show a similar pattern as for the full sample of industries, as in the baseline results. All the outcome variables are impacted positively and significantly by increased offshoring.[2]

Table Appendix A.7: FE-IV Estimates for Regressions Controlling for Exports and Imports

	Technology Outcomes		Labor Outcomes			
	(1)	(2)	(3)	(4)	(5)	(6)
	Equipment/ Labor	R&D Intensity	Employment Ratio	Wage Bill Ratio	Production Employment	Production Wage Bill
	Results from regressions including import penetration					
Imported Intermediates[1]	0.437***	0.430***	0.125**	0.145**	0.293**	0.314***
	(0.131)	(0.162)	(0.054)	(0.057)	(0.116)	(0.119)
Observations	13,568	12,823	13,567	13,566	13,568	13,568
Number of industries	451	446	451	451	451	451
	Results from regressions including exports and imports					
Imported Intermediates[1]	0.423***	0.354**	0.115**	0.139***	0.172*	0.175*
	(0.126)	(0.148)	(0.052)	(0.054)	(0.099)	(0.101)
Observations	13,568	12,823	13,567	13,566	13,568	13,568
Number of industries	451	446	451	451	451	451

Notes:
*** p<0.01, ** p<0.05, * p<0.10
[1]: As a proportion of total non-energy materials used in the industry.
Excluded instruments: Contemporaneous and one year lagged exchange rates and relative prices.
All regressions include year fixed effects, 4-digit industry fixed effects, interactions of 2 digit industry dummies with an indicator for whether the year is post-1996. All observations are weighted by constant industry size.
Heteroskedasticity-robust standard errors are in parentheses. Standard errors are clustered at the level of 4-digit industries.
All variables are in natural logs.

I also examine robustness to sample period, set of exporting countries, choice of base year for weights used in construction of instruments, and time trends. In particular, I estimate regressions for the period 1974-1997 (before the acceleration in offshoring), as well as 1974-2001 (before China's entry into WTO). Results remain similar to those for the period 1974-2005. I also estimate results considering imports from all countries except China, and find that results remain qualitatively similar to the baseline results. Results are also robust to controlling for hyperinflation episodes in various countries over the sample period. Results remain similar when I change the base year for weights that are used in the construction of instrumental variables. I also estimate results including flexible time trends. In addition to the year and industry fixed effects, I include a quadratic in time, fully interacted with two-digit industry dummies. This allows industries to have different time trends. Results remain similar.

[2]Results are available upon request.

Table Appendix A.8: Dynamic Effects of Offshoring

	Total Capital / Labor	Equipment / Labor	R&D Intensity	Non Production Wage Bill	Non Production Employment	Production Wage Bill	Production Employment
				One Year Lag			
Imported Intermediates[1]	0.282***	0.354***	0.517***	0.323***	0.282***	0.204**	0.193**
	(0.086)	(0.098)	(0.149)	(0.099)	(0.092)	(0.090)	(0.087)
				Two Years Lag			
Imported Intermediates	0.260***	0.326***	0.373***	0.270***	0.229***	0.172**	0.165**
	(0.071)	(0.081)	(0.131)	(0.079)	(0.073)	(0.076)	(0.072)
				Three Years Lag			
Imported Intermediates	0.279***	0.330***	0.392***	0.207***	0.162***	0.110*	0.095
	(0.064)	(0.071)	(0.129)	(0.066)	(0.061)	(0.067)	(0.063)

Notes:
*** p<0.01, ** p<0.05, * p<0.10
Excluded instruments: Current and lagged exchange rates and relative prices.
[1]: As a proportion of total non-energy materials used in the industry.
All regressions include year fixed effects, 4-digit industry fixed effects and interactions of two digit industry dummies with an indicator for whether the year is post-1996.
Heteroskedasticity-robust standard errors are in parentheses. Standard errors are clustered at the level of 4-digit industries.
All variables are in natural logs.

In Table A.8, I present results for estimations in which current values of various outcome variables are regressed on lagged values (1-3 years) of offshoring.[3] Results are qualitatively similar to the baseline results. As expected, innovation is more responsive to lagged than to contemporaneous offshoring. The magnitudes for capital deepening are close to those obtained from contemporaneous regressions. Offshoring also impacts the future non-production and production workers' wage bills. The falling coefficient magnitudes, show, as expected, that workers' employment and wage-bills adjust to changes in offshoring faster than capital and innovation, and more so for production than for non-production workers.

[3]Results for 5 or 10 year changes are estimated imprecisely due to the reduced sample size.

Appendix B Model Appendix

Appendix B.1 Numerical Method

The steady state equations are solved numerically. The method to solve involves two inner loops and an outer loop. The two inner loops are used to solve the systems of equations in the South and the North, respectively. These two economies are linked through trade in intermediate and final goods. The outer loop serves to solve for the unique set of prices and quantities in which the two economies are simultaneously in a steady state equilibrium.

In the first inner loop, I start with an initial guess of the total quantity of intermediates exported from the South to the North, M_u. Then, I use fixed point iteration to solve the system of equations for the South. In the second inner loop I solve for the system of equations in the North. Fixing the value for the trade cost, d and import price, p_u^*, I provide the system with guesses for three more variables - capital used in innovation, k_n, skilled labor used in innovation, s_n, and the imported intermediates used per firm, m_u. The second loop is solved using a combination of fixed point iteration and the Newton-Raphson algorithm. With the initial guesses, I obtain the values for the other variables in the system of equations. This leaves me with three equations that cannot provide me with closed form solutions for the initially guessed variables. I solve these three equations using the Newton-Raphson method. The resulting values for the three variables are again used as the initial guesses and the loop runs again until the system converges.

In the outer loop, the systems for the North and the South are solved together. The loop for the North yields a new value for M_u that is used as an initial guess to solve the system for the South using the first inner loop. This provides me with a value for the price at which the intermediates are exported to the North. This value, marked up by the trade cost - $(1 + d) * p_u^*$, serves as an initial guess for the second loop that solves the system for the North. The outer loop runs until the systems for the North and South converge simultaneously at a unique set of prices and quantities.

Appendix B.2 Transition Dynamics

Figure B.1 presents the transition dynamics for a few key outcomes of interest in the baseline model. In each graph, the red line represents the initial steady state in the North that corresponds to the low offshoring level of 1.8%. The blue line represents the new steady state that the variables converge to when trade cost declines enough to

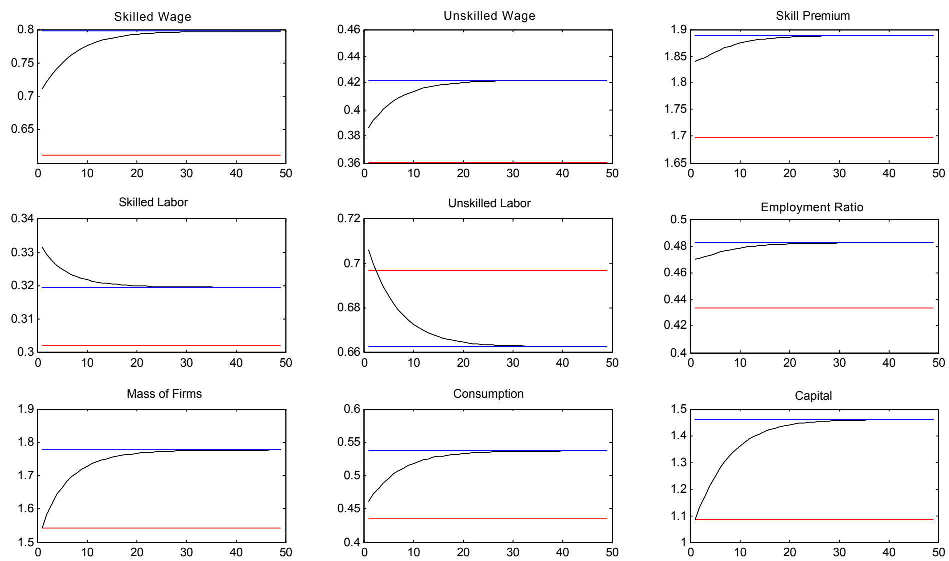


Figure B.1: Transition Paths of Key Variables[a]

[a]The red line in all graphs in the figure represents the initial steady state corresponding to an offshoring level of 1.8%. The blue line represents the new steady state in which offshoring is 19%. The curves show how various variables in the model transition from the old steady state to the new.

induce an increase in offshoring to 19%. The figure shows that skilled wage increases more than the unskilled wage leading to an increase in the skill premium. Skilled employment increases substantially at first but then slowly declines by approximately 1 percentage point to settle at a higher level than at the initial steady state. Unskilled employment falls after initially jumping up to settle at 66%. As a result, employment of skilled relative to unskilled labor increases. The mass of firms in the economy, consumption, and capital also increase gradually to settle at their higher steady state values.

Appendix B.3 Alternative H-O Model

I write an alternative model that captures only the H-O channel and recalibrate it to the data. I briefly describe the model and its parameterization below.

In the North, every period there is a fixed mass of firms, indexed by $i \in (0, 1)$. These firms produce final products $g_t(i)$ in period t with the following technology:

$$g_t(i) = K_t(i)^{\mu}(I_{ut}(i)^{\sigma} + M_{ut}(i)^{\sigma})^{\frac{\gamma}{\sigma}} I_{st}(i)^{1-\mu-\gamma} \qquad \text{(Appendix B.1)}$$

where K_t is capital, and I_{ut} and I_{st} denote unskilled and skilled intermediates that are produced by perfectly competitive firms with linear technologies using unskilled and skilled labor, respectively. The final good producing firms take the rental rate on capital, R_t, and the prices, p_{ut} and p_{st}, of unskilled and skilled intermediates, as given. The unskilled intermediates can also be offshored to the South for a price, p^*_{ut}. These imports are denoted by M_{ut}. The final good and intermediate good producing firms face the standard profit maximization problems.

The households aggregate the firm level goods into a composite (numeraire) good, Y_t, before using it for consumption and investment. This aggregate is given by:

$$Y_t = \left[\int_0^1 g_t(i)^\omega \, di\right]^{\frac{1}{\omega}}, \omega < 1 \qquad \text{(Appendix B.2)}$$

The households solve the following problem:

$$\underset{C_t, S_t, U_t, K_{t+1}}{\text{Max}} \mathcal{U} = \sum_{t=0}^{\infty} \beta^t \left(\log C_t - \theta_s \frac{S_t^{1+\chi_s}}{1+\chi_s} - \theta_u \frac{U_t^{1+\chi_u}}{1+\chi_u} \right)$$

subject to

$$C_t + I_t = W_{st} S_t + W_{ut} U_t + R_t K_t \qquad \text{(Appendix B.3)}$$

$$K_{t+1} = (1 - \delta^K) K_t + I_t \qquad \text{(Appendix B.4)}$$

While taking their decisions, households take the rental rate on capital, R_t, and the skilled and unskilled wages, W_s and W_u, as given.

The economy for the South remains the same as in the baseline. The trade balance equation also remains the same as in the baseline. The overall resource constraint in the North is:

$$Y_t = C_t + I_t + C^*_{mt} \qquad \text{(Appendix B.5)}$$

where C^*_{mt} is the quantity of final composite good exported to the South.

I calibrate the share, μ, of capital in the production of firms' output at 0.3 and the share of unskilled labor, γ, at to match the skill premium of 1.6 in the data in 1974. The rest of the parameter values are the same as in the baseline model.