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Industry-Specific Exchange Rates for the United States

- The effect of exchange rate movements on U.S. producers and U.S. economic activity has drawn renewed interest lately following the large declines in the trade-weighted dollar.
- At the national level, analyses of exchange rate moves often rely on aggregate trade-weighted exchange rates. However, aggregate indexes can be less effective than industry-specific indexes in capturing changes in industry competitive conditions induced by moves in specific bilateral exchange rates.
- To inform the discussions of the currency valuation changes influencing specific industries, this article constructs three industry-specific real exchange rate indexes for the United States and analyzes the extent to which each index co-moves or diverges from the aggregate economywide measures.
- The study shows how analyses that use aggregate exchange rate indexes instead of industry-specific ones might not recognize the empirical importance of exchange rates for the producer profits of specific U.S. industries.

1. Introduction

Recent significant declines in the trade-weighted U.S. dollar again raise questions about what exchange rate fluctuations mean for U.S. producers and for U.S. economic activity more broadly. When the dollar depreciates, the prices of goods imported into the United States typically rise.[1] All else equal, such exchange-rate-induced import price increases generally improve the competitiveness of U.S. producers in manufacturing and nonmanufacturing industries relative to that of foreign competitors. Although some industries are made worse off by real dollar depreciation, perhaps due to their net reliance on imported productive inputs, on average the profits of U.S. producers rise.

At the national level, discussions of exchange rate movements often rely on aggregate trade-weighted exchange rates, such as the carefully constructed measures computed by the Board of Governors of the Federal Reserve System for the aggregate economy.[2] Those aggregate indexes use weighting schemes applied to trade-partner exchange rates; the weights are based on all imports and exports of the entire U.S. economy. Such indexes are extremely useful at a macroeconomic level—for example, in discussions of the relationships between exchange rates and the aggregate trade balance. Yet this focus on national aggregates necessarily omits industry-specific distinctions concerning trade partners and competition. The importance of particular countries as

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competitors within an industry can differ substantially from their importance in the aggregated trade of the United States. As a consequence, aggregate trade-weighted indexes may be less effective than industry-specific real exchange rate indexes in capturing changes in industry competitive conditions induced by movements in specific bilateral exchange rates.

In this article, we demonstrate how such industry-specific real exchange rates can be constructed and present the recent paths of these indexes. We next present three basic real exchange rate measures for each industry: one using export partner weights only, a second using import partner weights, and a third using an average of export and import weights by industry. After we detail construction methods for these three industry-specific real exchange rates, we present diagnostics on the extent to which each construct co-moves or diverges from aggregate economywide measures. One basic and well-known observation is that there is a large divergence between U.S. exports and imports across country trade partners. Compared with the partners of U.S. exporters, U.S. importers tend to purchase a larger share of goods from less developed countries. Even within an industry, such differences mean that exporting producers may experience an exchange-rate-induced change in competitive conditions quite different from that of U.S. producers facing import competition or using imported components in production.[3] Distinctions across industries are sometimes even larger, and specific bilateral exchange rate changes can trigger vastly different pressures on producers in different industries.

All of these instances underscore the potential for industry-specific exchange rates to follow distinct paths. Those paths in turn depend on whether they are constructed using import or export data. Throughout this discussion, our goal is to emphasize that movements in bilateral exchange rates—for example, between the dollar and the euro, the dollar and the yen, or the dollar and the Chinese yuan—mean different things to different producers. Accordingly, the trade-weighted exchange rate series appropriate for a producer or an industry depends on the industry and the issue under consideration. This idea is borne out by an analysis of the sensitivity of corporate profits and exchange rates. A basic illustration demonstrates how researchers might fail to recognize the empirical importance of exchange rates for the producer profits of specific U.S. industries if their analyses use aggregate exchange rate indexes instead of industry-specific ones. Such qualitative differences are apparent when data on U.S. industries are disaggregated broadly (at the two-digit Standard Industrial Classification [SIC] level), and would presumably be even more pronounced if trade-weighted exchange rates were constructed at finer levels of industry disaggregation.

Using available data and construction methods, we observe that there can be a better matching of exchange rate indexes to industry-specific concerns. The lessons from our discussion and the relevant exchange rate series that we make available should thus encourage more widespread and informed analysis of the effects on U.S. industries of movements in the dollar's real value.[4]

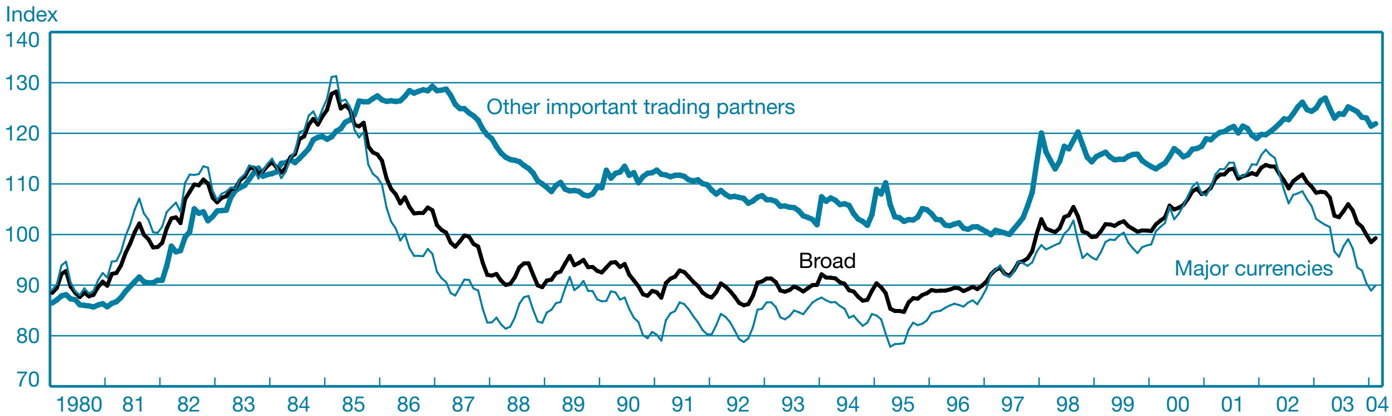
2. Aggregate Real Exchange Rate Indexes

The Board of Governors of the Federal Reserve System constructs a number of very useful and carefully devised aggregate exchange rate indexes that shed light on the overall value of the U.S. dollar (<http://www.federalreserve.gov/releases/h10/summary/>). Among these measures, we focus exclusively on the "real" indexes, meaning that exchange rates used in the calculations are adjusted for aggregate price inflation in the markets of partner countries. The Federal Reserve's Broad Index of the Foreign Exchange Value of the Dollar (the broad index) is a weighted average of the foreign exchange values of the U.S. dollar against the currencies of a large group (approximately thirty-five) of major U.S. trading partners. The index weights change over time and are derived from U.S. export shares and U.S. import shares. Two other real exchange rate series constructed by the Federal Reserve differ from the broad index in terms of the trading partners used. The major currencies index reflects the value of the dollar against the currencies of countries in the euro area, Australia, Canada, Japan, Sweden, Switzerland, and the United Kingdom. The other important trading partners (OITP) index shows the dollar value against other currencies that are not heavily traded outside their home markets. Chart 1 shows the recent paths of those indexes.

The Board of Governors of the Federal Reserve System constructs a number of very useful and carefully devised aggregate exchange rate indexes that shed light on the overall value of the U.S. dollar.

Although they do not yet address the important issue of different trade partners for different U.S. industries, these alternative aggregate series from the Federal Reserve illustrate

Chart 1
Aggregate Real Exchange Rate Indexes



Source: Board of Governors of the Federal Reserve System, monthly data.

the significance of properly measuring the value of the dollar against alternative trading partners of the United States. Since January 2000, the real broad and major currencies indexes have shown substantial movements in the value of the U.S. dollar. The broad index appreciated by 12 percent through January 2002, then depreciated by a cumulative 12 percent through February 2004. The major currencies index, which concentrates more on the industrialized countries than the broad index does, showed more overall volatility during this period, appreciating by 18 percent before depreciating 22 percent overall. By contrast, the dollar appreciated against the currencies in the OITP index through most of the period.

3. Industry-Specific Real Exchange Rates

Just as the differences between country groups are important in computing the weights on currencies used in these real exchange rate series, the distinctions between particular industries are highly revealing. As Table 1 shows, these distinctions arise because industries have different trading partners, and because the export destinations of an industry can differ dramatically from the import sources of products of that same industry. For example, the share of the euro area is 18 percent in U.S. overall imports, but 25 percent in imports of precision instruments and 13 percent in imports of toys and sporting goods (miscellaneous manufacturing).[5] By contrast, while China represents 11 percent of overall U.S. imports, it accounts for 9 percent of imports of precision instruments and 38 percent of imports of toys and sporting goods. Because of these differences, we expect corresponding currencies and their exchange rates relative to the dollar to play distinct roles in the relative competitive conditions for different U.S. industries.

For U.S. manufacturers, industrialized countries are often more important as export markets than as import suppliers. Generally, non-oil-producing developing countries figure more prominently as sources of U.S. imports than as destinations for U.S. exports. Therefore, movements in a major currency like the euro generally have a stronger presence in U.S. exports than imports. As Table 1 shows, euro-area countries account for a large share of U.S. exports, and, with the exception of machinery, a slightly smaller share of U.S. imports in those industrial categories. For Japan and China, however, the comparisons between export markets and import source shares in these industries are far more dramatic. An import-competing producer, therefore, may assign a higher weight to the yen or yuan in its relevant trade-weighted exchange rate compared with producers in noncompeting industries.

Chart 2 also illustrates our general point that some industrialized countries (for example, the euro area, the United Kingdom, Canada, and Japan) have very different representation in the exports than in the imports of U.S. industries. This comparison of the 2001 shares of these

Table 1
Country/Region Shares in Trade by Industry

U.S. Export Destinations by Standard Industrial Classification (SIC), 2001	SIC Number	Euro Area	Japan	China
Electronics	36	13	8	3
Industrial machinery	35	20	8	4
Precision instruments	38	28	15	3
Toys and sporting goods	39	20	10	1
Transportation equipment	37	18	5	3
All U.S. exports	—	18	9	3

U.S. Sources of Imports by SIC, 2001	SIC Number	Euro Area	Japan	China
Electronics	36	8	15	15
Industrial machinery	35	17	20	11
Precision instruments	38	25	23	9
Toys and sporting goods	39	13	11	38
Transportation equipment	37	19	23	1
All U.S. imports	—	18	13	11

U.S. Export Destinations by North American Industry Classification System (NAICS), 2002	NAICS Number	Euro Area	Japan	China
Computer and electronics	334	17	8	4
Machinery	333	16	6	4
Electrical equipment	335	14	5	3
Toys and sporting goods	339	26	11	1
Transportation equipment	336	18	6	3
All U.S. exports	—	17	8	3

U.S. Sources of Imports by NAICS, 2002	NAICS Number	Euro Area	Japan	China
Computer and electronics	334	8	13	16
Machinery	333	27	23	8
Electrical equipment	335	12	9	27
Toys and sporting goods	339	15	7	35
Transportation equipment	336	17	23	1
All U.S. imports	—	17	12	13

Source: Author's calculations.

Note: Figures for the euro area, Japan, and China are in percent.

countries/regions in U.S. exports (denoted by M) and in U.S. imports (denoted by X) shows that these industrialized countries account for 32 percent of total exports for education, and up to 81 percent of U.S. exports for the film sector. The corresponding shares of these countries as sources of U.S. imports range from 12 percent in apparel to 87 percent in repair services.

3.1 Industry-Specific Exchange Rate Construction

We can construct exchange rate measures that reflect these industry-by-industry distinctions by using the time histories of the weights of U.S. trading partners in the exports and imports of each U.S. industry. Each industry is denoted by an index *i* and each country/trade partner of that industry by an index *c*. The *industry-specific* real exchange rate indexes depart from the aggregate indexes in that the weights of each partner currency (country *c*) are the shares of that partner *c* in the U.S. exports or imports of that specific industry *i*. In contrast, aggregate indexes use the weights of each trade-partner country in the total international trade activity of the entire U.S. economy.

We begin by constructing three real exchange rate measures by industry. They differ primarily in the choice of weights applied to bilateral real exchange rates, rer_t^c, with respect to each trading partner *c*. The formulas for these indexes are provided in equations 1-3:

(1) Export-weighted:

$$xer_t^i = \sum_c w_t^{ic} \cdot rer_t^c \text{, where } w_t^{ic} = \frac{X_t^{ic}}{\sum_c X_t^{ic}}$$

(2) Import-weighted:

$$mer_t^i = \sum_c w_t^{ic} \cdot rer_t^c \text{, where } w_t^{ic} = \frac{M_t^{ic}}{\sum_c M_t^{ic}}$$

(3) Trade-weighted:

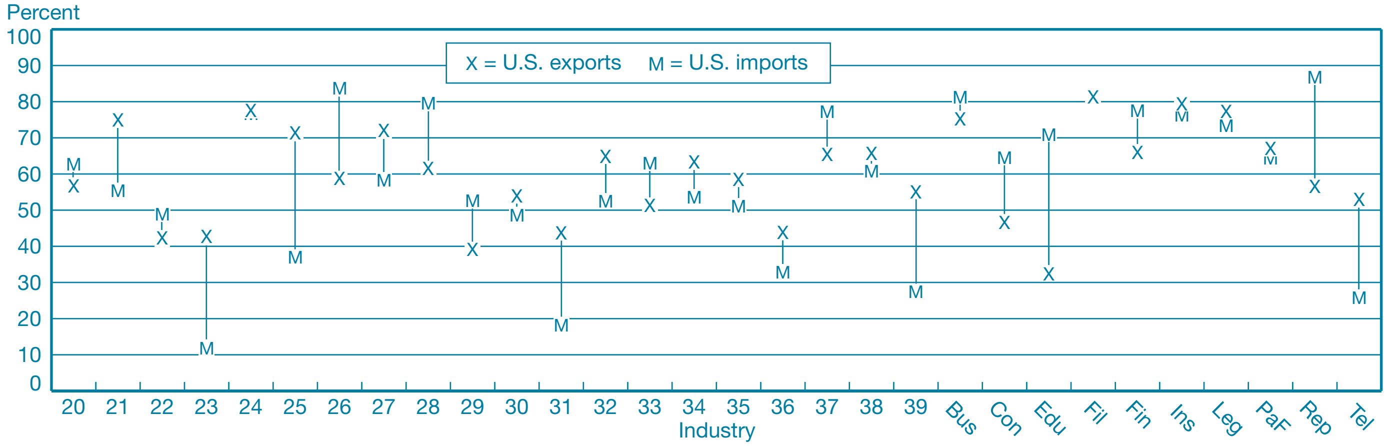
$$ter_t^i = \sum_c \left(\left(.5 \frac{X_t^{ic}}{\sum_c X_t^{ic}} + .5 \frac{M_t^{ic}}{\sum_c M_t^{ic}} \right) \cdot rer_t^c \right),$$

where rer_t^c are the bilateral real exchange rates of each U.S. trading partner *c*. The bilateral real exchange rates are constructed by multiplying a country's nominal exchange rate (local currency per dollar) by the ratio of the consumer price indexes of the United States against that partner country.[6] For any industry indexed by *i*, these constructions define the export real exchange rate xer_t^i, the import real exchange rate mer_t^i, and the trade-average real exchange rate ter_t^i, with each construction using industry-specific and time-varying trade weights.[7] An increase in the value of any index implies a real appreciation of the U.S. dollar in trade-weighted terms.

Our construction method for each industry has the flavor of the method used in the Board of Governors' broad index.[8] Instead of calculating that single aggregate measure, however, we compute separate series for each of the twenty two-digit manufacturing and

Chart 2

Selected Industrialized Country Weights in U.S. Exports and Imports



20	Food and kindred products	30	Rubber and plastic products	Bus	Advertising and computer data
21	Tobacco manufactures	31	Leather and leather products	Con	Construction, engineering, mining
22	Textile mill products	32	Stone, clay, glass, and concrete products	Edu	Educational services
23	Apparel and related products	33	Primary metal products	Fil	Film and tape rental
24	Lumber and wood products	34	Fabricated metal products	Fin	Financial services
25	Furniture and fixtures	35	Machinery, excluding electrical	Ins	Net insurance
26	Paper and allied products	36	Electrical and electronic	Leg	Legal services
27	Printing and publishing	37	Transportation equipment	PaF	Passenger fares
28	Chemicals and allied products	38	Scientific instruments	Rep	Installation, maintenance, repair
29	Petroleum refining	39	Miscellaneous manufactures	Tel	Telecommunications

Source: Author's calculations.

Notes: The constructed shares depict the combined weight in the 2001 trade of specific U.S. industries with European Union countries, the United Kingdom, Canada, and Japan. The manufacturing industries are listed by number and follow Standard Industrial Classification designations; nonmanufacturing industries are identified by letter codes. Where only X is visible, exports are equal or nearly equal to imports.

ten nonmanufacturing U.S. industries (Appendix Table A1 provides the complete industry list). The countries indexed by *c* in equations 1-3 total up to thirty-four trade partners of the United States in manufacturing industries and up to twenty-nine trade partners in nonmanufacturing industries.[9]

4. Do Industry-Specific and Aggregate Real Exchange Rate Indexes Track Each Other?

Because the export and import partners of specific industries can differ substantially, the weights of partner currencies in the industry exchange rates vary correspondingly. These distinctions are apparent both across industries and over time as the importance of different partner-country currencies grows or shrinks.

Our basic correlation analysis clearly shows that various industry-specific exchange rates and the aggregate broad index are highly positively correlated. Table 2 presents four sets of correlations, with each figure in a column showing the number of industries in the correlation range depicted in that row. Compared with import exchange rates, the export exchange rate series are more highly correlated with the broad index. These correlations exceed 0.90 for five of the thirty industries and exceed 0.80 for an additional seventeen industries. Across all of the manufacturing and nonmanufacturing industries, roughly a third have correlations with the broad exchange measure that are below 0.8. The industry exchange rate, ter^i, constructed using both export and import shares in partner weights, tracks the broad series more closely than do the indexes that use either export or import weights alone.

Although correlations greater than 0.80 across the exchange rate indexes can be construed as strong, the period-to-period percentage changes in industry-specific and aggregate exchange

Table 2

Correlations between Alternative Industry Exchange Rate Series

Measured Contemporaneous Correlations (corr)	xer^i with Broad (1)	mer^i with Broad (2)	xer^i with mer^i (3)	ter^i with Broad (4)
	Number of Industries in Each Correlation Grouping Out of Thirty Industries			
corr ≥ 0.90	5	6	10	9
0.90 > corr ≥ 0.80	17	14	5	15
0.80 > corr ≥ 0.70	4	7	7	6
0.70 > corr	4	3	8	0

Source: Author's calculations.

Notes: SIC is Standard Industrial Classification; NAICS is North American Industry Classification System. The four data columns report the number of industries in any size range of correlations between:
(1) an industry's export exchange rate and the broad index,
(2) an industry's import exchange rate and the broad index,
(3) an industry's export exchange rate and its import exchange rate,
(4) an industry's trade-weighted exchange rate and the broad index.

Correlations use quarterly data. Manufacturing uses SIC trade data for 1973-96 and NAICS trade data for 1997-2002. Nonmanufacturing data span 1986-2002.

Table 3

Percentage Change in Real Trade-Weighted Exchange Rate from 2002:1

Panel A: To 2003:4, Using SIC Classifications

Industry	xer^i	mer^i	ter^i	Broad Index
Electronics	-8	-6	-7	-11
Industrial machinery	-13	-10	-11	-11
Precision instruments	-15	-13	-14	-11
Toys and sporting goods	-14	-7	-10	-11
Transportation equipment	-14	-15	-15	-11

Panel B: To 2003:4, Using NAICS Classifications

Industry	xer^i	mer^i	ter^i	Broad Index
Computer and electronics	-9	-5	-7	-11
Machinery	-12	-15	-14	-11
Electrical equipment	-10	-6	-8	-11
Toys and sporting goods	-15	-8	-11	-11
Transportation equipment	-15	-14	-15	-11

Source: Author's calculations, quarterly data.

Notes: In panel A, trade weights by Standard Industrial Classification (SIC) designations for calculating industry-specific exchange rates were only available to 2001, so these 2001 weights were assumed in calculating 2002 and 2003 industry-specific exchange rates. In panel B, trade weights by North American Industry Classification System (NAICS) designations for calculating industry-specific exchange rates were only available to 2002, so these 2002 weights were assumed in calculating 2002 and 2003 industry-specific exchange rates.

rates can differ substantially. To illustrate this point, in Table 3 we provide real exchange rate movements since January 2002 using the same subset of industries that we presented in Table 1. Recall that the aggregate broad index peaked in early 2002, marking the end of a prolonged trade-weighted appreciation of the U.S. dollar. Over the recent period, we observe that precision instruments and transportation equipment industries have export and import exchange rates that have depreciated more than the broad index, with each showing a 10 to 11 percent trade-weighted dollar depreciation since 2002:1. However, the movements in the exchange rates for the computer and electronics industries have registered a smaller real dollar depreciation than the broad measure did during this period. This result may occur because the euro area (and the euro) represents a smaller weight in the trade of the computer and electronics industries compared with its weight in the precision instruments and transportation equipment categories. In the case of many import-weighted series and even exports of electronics, industrial machinery, and toys and sporting goods (miscellaneous manufacturing), the broad index can greatly misrepresent the apparent change in currency valuation.

Additional information on the extent of co-movements of different exchange rate measures available for each industry is provided in Appendix Tables A1 and A2. In Table A1, we show the correlations between quarterly data for the broad index and xer^i, mer^i, and ter^i for each industry from 1973 to 2002. In Table A2, we report the percentage of periods in which any two alternative measures move in the same direction over each quarter, with both measures contemporaneously appreciating or depreciating. The broad real exchange rate measure and the xer^i measures tend to co-move more strongly than the broad measure and mer^i exchange rates.

4.1 An Application to Corporate Profit Data

We find the advantage of using industry-specific constructs immediately apparent when analyzing the relationships between U.S. producer profits and exchange rates. The data on corporate profits, compiled by the Bureau of Economic Analysis, cover the period from 1970:1 to 2003:2 and include eight manufacturing industries, plus six nonmanufacturing industries.[10] We convert these profit aggregates into real values by deflating by the seasonally adjusted U.S. consumer price index and run regression specifications of the form

(4) $$\Delta CorporateProfits_t^i = \alpha^i + \beta_0^i \Delta realexchangerate_t^i + \beta_{0,1}^i Trade_t^i \cdot \Delta realexchangerate_t^i + \beta_1 \Delta GDP_t + \beta_2 \Delta rint_t + \varepsilon_t ,$$

where Δ refers to a change in logarithms of all variables except for interest rates (change in levels), and all variables are represented in real terms. The regressions introduce controls for the effects of the business cycle (real GDP) and real interest rates ($rint_t$, ten-year bonds) and use alternative real exchange rates (xer_t^i, mer_t^i, ter_t^i, or $Broad_t$), all defined as foreign currency per dollar so that an upward movement is a real dollar appreciation. In some regression specifications, we introduce only the noninteracted exchange rate term. In other specifications, we add an exchange rate term interacted with the overall level of trade exposure of an industry, $Trade_t^i$. This variable is a slower moving (annual) series constructed as the total trade (exports plus imports) of a specific broad industry i relative to that industry's annual shipments or output.[11] We also had some regression specifications that excluded the non-interacted exchange rate term, but included the exchange rate term interacted with $Trade_t^i$. When the multiplicative variable $Trade_t^i$ is excluded from the regression, the exchange rate term picks up the effects on profits of changes over time in the composition of an industry's trade partners (except in the broad measure) and the relative values of their currencies. By including the $Trade_t^i$ variable, we also capture changes over time in an industry's overall level of exposure to international trade. The latter term permits the influence of exchange rates on profits to grow as the overall role of trade grows relative to an industry's shipments.

We find the advantage of using industry-specific constructs immediately apparent when analyzing the relationships between U.S. producer profits and exchange rates.

In the full sample of fourteen industries for which we have the BEA corporate profit data, a dollar depreciation on average raises U.S. corporate profits, but this average effect is noisy and generally not statistically different from zero. Table 4 provides the results of time-series panel regressions run using data for the subset of industries with the highest degree of international trade orientation. We report the regression results for specifications where the trade variable is interacted with the exchange rate (the $\beta_0^i \Delta realexchangerate_t^i$ is excluded) and where we have a pooled time-series panel of industries. The regression coefficients reported in Table 4 should be viewed as the average across the included industries.

Table 4

Corporate Profits and Exchange Rates for High-Trade-Exposure Industries

Category	xer^i	mer^i	ter^i	Broad Index
Constant	-0.037***	-0.037***	-0.037***	-0.038***
	(0.008)	(0.008)	(0.008)	(0.008)
$Trade^i \cdot \Delta$ real exchange rate^i	-1.428*	-1.198*	-1.387*	-0.539
	(0.783)	(0.627)	(0.717)	(0.569)
Δ real GDP	3.520***	3.431***	3.468***	3.502***
	(0.742)	(0.742)	(0.742)	(0.743)
Δ real interest rate	0.020*	0.021*	0.021*	0.018*
	(0.011)	(0.011)	(0.011)	(0.011)
Adjusted R^2	0.047	0.048	0.048	0.043
Degrees of freedom	624	624	624	624

Source: Author's calculations.

Note: Standard errors are in parentheses.

* Statistically significant at the 10 percent level.
** Statistically significant at the 5 percent level.
*** Statistically significant at the 1 percent level.

In these five high-trade-orientation industries, the broad exchange rate measure is statistically insignificant in the regressions: a dollar appreciation on average lowers the profits of U.S. corporations, but this effect remains noisy and statistically insignificant. By contrast, the industry-specific exchange rates are all statistically significant. Thus, the profit effects of dollar movements are more precisely identified: dollar appreciations (depreciations) reduce (stimulate) corporate profits. Typical of industry corporate profit regressions, the majority of movements in corporate profits are unexplained by these broad macroeconomic variables. Nonetheless, our industry-specific exchange rates play a statistically significant and noteworthy role.

Still more pointed results are obtained from our analysis of specific industries. Table 5 presents the results of industry-by-industry corporate profit regressions for various manufacturing industries. We report results from regressions that omit the exchange rate term and use only the exchange rate term interacted with industry trade orientation: the most pronounced effects of exchange rates on specific industries generally are evident in regressions that allow for changes over time in industry exposure to international trade. Those results

Table 5
Corporate Profits and Exchange Rates: High-Trade-Oriented Manufacturing Industries

	Chemical and Allied Products		Primary Metal Products		Nonelectrical Machinery		Electrical Machinery and Electronics		Transportation Equipment	
Category	mer^i	Broad Index	mer^i	Broad Index	mer^i	Broad Index	mer^i	Broad Index	mer^i	Broad Index
Constant	-0.020**	-0.020**	-0.039***	-0.038***	-0.042***	-0.043***	-0.025*	-0.026*	-0.059*	-0.061*
	(0.010)	(0.010)	(0.011)	(-1.119)	(0.014)	-(0.014)	(0.013)	(0.013)	(0.033)	(0.033)
Trade ^{i} · *Δ real exchange rate* ^{i}	0.570	-0.598	1.316	-1.119	-1.50*	-0.976	-1.477*	-1.034	-2.016	1.020
	(1.236)	(1.281)	(1.445)	(1.196)	(0.871)	(0.809)	(0.759)	(0.695)	(2.553)	(2.200)
Δ real GDP	1.573*	1.570*	3.443***	3.354***	3.768***	3.880***	2.331*	2.468**	6.087**	6.252**
	(0.895)	(0.895)	(1.002)	(0.998)	(1.268)	(1.274)	(1.197)	(1.203)	(2.997)	(2.995)
Δ real interest rate	0.012	0.014	-0.001	0.002	0.011	0.006	0.005	0.004	0.074	0.065
	(0.013)	(0.013)	(0.015)	(0.015)	(0.019)	(0.019)	(0.017)	(0.018)	(0.074)	(0.044)
Adjusted R^2	0.021	0.021	0.075	0.075	0.078	0.0661	0.042	0.030	0.049	0.045
Degrees of freedom	124	124	124	124	124	124	124	124	124	124
2001 SIC trade share (percent)	0.33		0.34		0.63		0.75		0.58	

Source: Author's calculations.

Notes: Standard errors are in parentheses. SIC is Standard Industrial Classification.

* Statistically significant at the 10 percent level.
** Statistically significant at the 5 percent level.
*** Statistically significant at the 1 percent level.

suggest that the strong relationship between import exchange rates and the profits of specific industries with high trade exposures may have been driven by the nonelectrical machinery, electrical machinery, and electronics industries.

5. Other Considerations in Constructing Industry-Specific Real Exchange Rates

Although we have provided three specific measures of industry-specific exchange rates, alternative constructions of exchange rate indexes may be more useful for answering other questions. In this section, we discuss some relevant issues. First, we consider the possibility that our index construction may be corrupted by contemporaneous changes in the trade orientation or partner weights of an industry as induced by exchange rate changes. If so, it may be appropriate to consider alternative dating schemes on the weights used in exchange rate construction. Second, we address the type of bilateral exchange rate that is most appropriate to use with equations 1-3. Specifically, we note that some analysts may be concerned with underlying *trends* in real exchange rates instead of period-to-period current values, and may prefer to use exchange rate movements decomposed into permanent (trend) and transitory elements.

5.1 Endogeneity of Trade Weights

Equations 1-3 use contemporaneous weights, meaning that each calculation of an industry-specific exchange rate employs the pattern of trade partners that is in place during that same period of time (for that year, for that industry). Contemporaneous trade weights have the advantage of providing the most current information on real changes in currency values that would be useful in making future production and revenue decisions. One valid concern, however, is whether today's exchange rate movements affect today's trade patterns, so that using weights contemporaneous to the exchange rate movement may introduce undesirable simultaneity biases in the data. In other words, both the left-hand-side and right-hand-side variables in a regression may move together as a result of reactions to some other variable. This objection is theoretically valid if the current trade-partner weights are endogenous to current exchange rates.

For U.S. industries, we observe considerable stability and persistence in trade-partner share weights in annual data. We nonetheless turn to the data to determine how well this observation is supported across industries.[12] We conduct two suggestive exercises. First, we correlate industry-specific exchange rates constructed with contemporaneous trade weights with ones constructed using one-year *lagged* trade shares as weights on the contemporaneous bilateral exchange rates of the thirty-four trading partners of the United States. Second, we construct a trade-weighting scheme that uses a three-year moving average of the shares of each country partner in an industry's international trade. In this measure, export exchange rates for an industry are constructed as

$$(5) \qquad xer_t^i = \sum_c w_t^{ic} \cdot rer_t^c \text{, where } w_t^{ic} = \frac{\sum_{T=t-1}^{t-3} X_T^{ic}}{\sum_{T=t-1}^{t-3} \sum_c X_T^{ic}} .$$

We regress the industry exchange rates constructed using contemporaneous trade weights against industry exchange rates constructed using the two alternative weighting schemes. Most of the year-on-year variability in industry-specific exchange rates results from fluctuations in the component bilateral real exchange rates. Accordingly, Table 6 suggests that such small changes in weighting have very little effect on the final real exchange rate series for each industry. Contemporaneous and lagged constructions of industry-specific exchange rates are highly correlated, typically in excess of 0.95. The data suggest marginally more potential for instability of trade-partner shares in import exchange rates than in export exchange rates.

Table 6

Correlations between Contemporaneous and Lagged Trade Weight Constructs of Industry Exchange Rates

Measured Contemporaneous Correlations (corr)	Number of Industries in Each Correlation Grouping Out of Thirty Industries		
	xer^i with $xler^i$	mer^i with $mler^i$	ter^i with $tler^i$
corr ≥ 0.98	25	21	24
0.98 > corr ≥ 0.95	2	3	3
0.95 > corr	3	6	3

Source: Author's calculations.

Notes: $xler^i$ is constructed as in equation 1, except using w_{t-1}^{ic} in place of w_t^{ic}. Analogous construction methods are used for $mler^i$ and $tler^i$.

5.2 Permanent versus Transitory Changes in Exchange Rates

Some analyses might focus on industry adjustments when fluctuations in exchange rates are perceived as "permanent" (expected to persist), as opposed to those perceived as "transitory" (expected to reverse soon). In pricing, employment, and investment decisions, producers may make choices that have a fixed-cost component only in response to the part of an exchange rate fluctuation expected to persist. Producers would make other adjustments to more transitory fluctuations, as in the Campa and Goldberg (2001) finding that overtime hours and earnings in the United States are highly sensitive to the transitory component of the exchange rate. Permanent fluctuations, by contrast, have a greater effect on regular employment and hours of U.S. workers.

There are many techniques available to decompose exchange rate movements into transitory or permanent elements. The bilateral exchange rates may pass through a filter that delivers a permanent component, $rer_t^{c,p}$, or a transitory component. The relevant component is substituted back into the exchange rate formulas of equations 1-3 and weighted up using the import or export weights, yielding a variant such as

$$(6) \qquad xer_t^{i,p} = \sum_c w_t^{ic} \cdot rer_t^{c,p} \text{, where } w_t^{ic} = \frac{X_t^{ic}}{\sum_c X_t^{ic}} .$$

Note that this construction considers the permanent versus transitory components of the bilateral exchange rates, but does not decompose trends in the underlying trade weights.[13]

6. Conclusion

The industry-specific measures that we describe, although data-intensive and cumbersome to construct, enable us to take important steps forward in analyses of exchange rate effects on U.S. industries. Despite such progress, these indexes are not perfect indicators of changes over time in the competitiveness of U.S. producers relative to foreign competitors. Our measures do not adjust for industry-specific changes in productivity or the strategic pricing actions attributable to specific industries or partners. These measures also do not directly track changes in the third-country competitiveness of U.S. producers—for example, how the United States competes with non-euro-area competitors within the euro-area market. In addition, alternative methods of constructing industry-specific exchange rates are sometimes appropriate for understanding the effects of exchange rate fluctuations on specific U.S. industries.[14]

Our overall purpose has been to provide a range of construction methodologies and make available the underlying data in order to promote more informed discussions of the currency valuation changes influencing specific industries. Although other methods may also be useful to that end, our contributions offer a number of concrete advances in data availability and tools for analyzing the real and financial effects of exchange rate movements.

Appendix Tables

Table A1

Correlations of Industry-Specific Exchange Rate Measures

Industry Code	Industry Title	xer^i Broad RER	mer^i Broad RER	xer^i mer^i	ter^i Broad RER
20	Food and kindred products	0.917	0.827	0.833	0.904
21	Tobacco manufactures	0.897	0.869	0.792	0.933
22	Textile mill products	0.802	0.910	0.862	0.897
23	Apparel and related products	0.647	0.885	0.743	0.821
24	Lumber and wood products	0.734	0.557	0.336	0.793
25	Furniture and fixtures	0.564	0.817	0.784	0.723
26	Paper and allied products	0.913	0.587	0.686	0.793
27	Printing and publishing	0.782	0.909	0.792	0.895
28	Chemicals and allied products	0.907	0.929	0.953	0.930
29	Petroleum refining	0.880	0.523	0.478	0.770
30	Rubber and plastic products	0.822	0.902	0.804	0.909
31	Leather and leather products	0.868	0.900	0.868	0.915
32	Stone, clay, glass, and concrete products	0.816	0.890	0.756	0.912
33	Primary metal products	0.886	0.876	0.920	0.899
34	Fabricated metal products	0.773	0.853	0.638	0.901
35	Machinery, excluding electrical	0.878	0.875	0.782	0.928
36	Electrical and electronic	0.851	0.774	0.688	0.881
37	Transportation equipment	0.802	0.836	0.695	0.890
38	Scientific instruments	0.936	0.741	0.840	0.860
39	Miscellaneous manufactures	0.935	0.940	0.970	0.945
Bus	Advertising and computer data	0.869	0.791	0.934	0.837
Con	Construction, engineering, mining	0.623	0.745	0.472	0.787
Edu	Educational services	0.840	0.770	0.723	0.870
Fil	Film and tape rental	0.857	0.831	0.952	0.853
Fin	Financial services	0.879	0.789	0.927	0.851
Ins	Net insurance	0.789	0.841	0.922	0.834
Leg	Legal services	0.878	0.875	0.989	0.879
PaF	Passenger fares	0.854	0.879	0.970	0.874
Rep	Installation, maintenance, repair	0.822	0.825	0.944	0.835
Tel	Telecommunications	0.591	0.790	0.623	0.771

Source: Author's calculations.

Notes: The manufacturing industries are listed by number and follow Standard Industrial Classification (SIC) designations; nonmanufacturing industries are identified by letter codes. Correlations use quarterly data. Manufacturing uses SIC trade data for 1973-96 and North American Industry Classification System trade data for 1997-2002. Nonmanufacturing data span 1986-2002.

Table A2

Co-Movement of Industry-Specific Exchange Rate Measures

Industry Code	Industry Title	xer^i Broad RER	mer^i Broad RER	xer^i mer^i	ter^i Broad RER
20	Food and kindred products	0.924	0.790	0.765	0.874
21	Tobacco manufactures	0.899	0.756	0.756	0.874
22	Textile mill products	0.765	0.849	0.765	0.824
23	Apparel and related products	0.731	0.714	0.664	0.782
24	Lumber and wood products	0.891	0.672	0.647	0.874
25	Furniture and fixtures	0.672	0.731	0.790	0.731
26	Paper and allied products	0.866	0.697	0.714	0.798
27	Printing and publishing	0.765	0.874	0.807	0.857
28	Chemicals and allied products	0.874	0.874	0.899	0.874
29	Petroleum refining	0.790	0.739	0.731	0.798
30	Rubber and plastic products	0.739	0.916	0.723	0.849
31	Leather and leather products	0.798	0.706	0.639	0.824
32	Stone, clay, glass, and concrete products	0.807	0.857	0.815	0.874
33	Primary metal products	0.824	0.840	0.832	0.832
34	Fabricated metal products	0.706	0.908	0.731	0.840
35	Machinery, excluding electrical	0.874	0.924	0.832	0.950
36	Electrical and electronic	0.840	0.874	0.815	0.899
37	Transportation equipment	0.773	0.899	0.807	0.891
38	Scientific instruments	0.874	0.891	0.849	0.916
39	Miscellaneous manufactures	0.891	0.849	0.857	0.916
Bus	Advertising and computer data	0.776	0.851	0.776	0.866
Con	Construction, engineering, mining	0.746	0.776	0.731	0.791
Edu	Educational services	0.896	0.731	0.776	0.791
Fil	Film and tape rental	0.746	0.731	0.896	0.731
Fin	Financial services	0.836	0.776	0.881	0.806
Ins	Net insurance	0.806	0.806	0.881	0.791
Leg	Legal services	0.896	0.866	0.940	0.881
PaF	Passenger fares	0.881	0.866	0.896	0.866
Rep	Installation, maintenance, repair	0.851	0.776	0.836	0.881
Tel	Telecommunications	0.672	0.701	0.701	0.761

Source: Author’s calculations.

Notes: Co-movement is defined as the percentage of quarters in which the two exchange rate measures both depreciated, without regard to the actual size of the depreciations or appreciations. The manufacturing industries are listed by number and follow Standard Industrial Classification (SIC) designations; nonmanufacturing industries are identified by letter codes. Correlations use quarterly data. Manufacturing uses SIC trade data for 1973-96 and North American Industry Classification System trade data for 1997-2002. Nonmanufacturing data span 1986-2002.

TABLE A3

Correlations between Contemporaneous and Lagged-Weight Exchange Rates

Industry Code	Industry Title	xer^i / $xler^i$	mer^i / $mler^i$	ter^i / $tler^i$
20	Food and kindred products	0.990	0.997	0.996
21	Tobacco manufactures	0.995	0.956	0.989
22	Textile mill products	0.984	0.995	0.995
23	Apparel and related products	0.988	0.994	0.996
24	Lumber and wood products	0.995	0.999	0.998
25	Furniture and fixtures	0.989	0.998	0.996
26	Paper and allied products	0.997	0.999	0.999
27	Printing and publishing	0.998	0.998	0.999
28	Chemicals and allied products	0.994	0.999	0.999
29	Petroleum refining	0.986	0.987	0.989
30	Rubber and plastic products	0.994	0.998	0.999
31	Leather and leather products	0.990	0.994	0.995
32	Stone, clay, glass, and concrete products	0.995	0.999	0.999
33	Primary metal products	0.993	0.992	0.997
34	Fabricated metal products	0.992	0.999	0.998
35	Machinery, excluding electrical	0.997	0.998	0.999
36	Electrical and electronic	0.997	0.993	0.997
37	Transportation equipment	0.995	0.997	0.997
38	Scientific instruments	0.997	0.999	0.999
39	Miscellaneous manufactures	0.995	0.996	0.998
Bus	Advertising and computer data	0.978	0.978	0.984
Con	Construction, engineering, mining	0.930	0.915	0.968
Edu	Educational services	0.993	0.750	0.942
Fil	Film and tape rental	0.904	0.766	0.852
Fin	Financial services	0.996	0.813	0.952
Ins	Net insurance	0.963	0.833	0.911
Leg	Legal services	0.996	0.994	0.999
PaF	Passenger fares	0.997	0.998	0.999
Rep	Installation, maintenance, repair	0.988	0.960	0.985
Tel	Telecommunications	0.589	0.681	0.964

Source: Author's calculations.

Notes: The manufacturing industries are listed by number and follow Standard Industrial Classification (SIC) designations; nonmanufacturing industries are identified by letter codes. Correlations use quarterly data. Manufacturing uses SIC trade data for 1973-96 and North American Industry Classification System trade data for 1997-2002. Nonmanufacturing data span 1987-2002.

Endnotes

1. The response of dollar prices is small if foreign producers absorb the exchange rate movements in their profit margin in order to sustain their U.S. market share. Exchange rate "pass-through" into import prices may be complete, as occurs under "producer currency pricing;" partial; or negligible, as occurs under "local currency pricing." Campa and Goldberg (2002) analyze the degree of exchange rate pass-through into import prices for the United States and other Organization for Economic Co-operation and Development countries. Campa and Goldberg (2004) explore the reasons behind the relative stability of consumer prices with respect to exchange rates.

2. Available at <http://www.federalreserve.gov/releases/h10/summary/>.

3. Campa and Goldberg (1995, 1997, 1999, 2001) show that a "net external orientation" measure accounting for both the export orientation and use of imported inputs by producers is appropriate in some analyses, including studies of investment sensitivity to exchange rates.

4. The industry-specific exchange rate database constructed by the author is available at <http://www.newyorkfed.org/research/global_economy/industry_specific_exrates.html>.

5. The U.S. Census Bureau recently adopted the North American Industry Classification System (NAICS) and has dropped reporting by SIC. Industry-level trade data are available only up to 2001 by SIC and available up to 2002 by NAICS. Both systems are reported in Table 1.

6. The resulting series are converted into indexes (based at 100 in 1990:1).

7. The averaging of export and import weights in equation 3 is an *ad hoc* convention. Another variant would be to use as weights the sum of bilateral exports and imports, relative to total exports plus imports of a particular industry.

8. Available at <http://www.federalreserve.gov/releases/h10/summary/>. From the *Federal Reserve Bulletin*, October 1998: "The currencies of all foreign countries or regions that had a share of U.S. non-oil imports or nonagricultural exports of at least 1/2 percent in 1997 are included in the broad indices, as rankings of U.S. trading partners by share of U.S. trade in that year show."

9. The countries are: Canada, euro area (Germany, France, Italy, Netherlands, Belgium, Luxembourg, Spain, Ireland, Austria, Finland, Portugal), Japan, Mexico, China, United Kingdom, Taiwan, Korea, Singapore, Hong Kong, Malaysia, Brazil, Switzerland, Thailand, Australia, Indonesia, Philippines, Russia, India, Sweden, Saudi Arabia, Israel, Argentina, Venezuela, Chile, and Colombia. The trade data treat Belgium and Luxembourg as one country; this article also references them as one country. Problems with the time-series price data led us to remove Russia from this sample. The nonmanufacturing indexes do not include Austria, Colombia, Ireland, Portugal, Russia, and Finland because disaggregated data on these countries are absent in our source data from the *Survey of Current Business*, published by the Bureau of Economic Analysis (BEA).

Industry-specific export and import data for twenty manufacturing industries and thirty-four major U.S. trading partners from 1972-94 were downloaded from <http://www.econ.ucdavis.edu/faculty/fzfeens/>, with 1970, 1971, and 1972 manufacturing trade weights set at 1972 shares. Post-1994 data are from the U.S. International Trade Commission website (<http://dataweb.usitc.gov/>). Some weighting observations for some countries in some years have been suppressed for confidentiality reasons. Manufacturing sector data are from the U.S. Department of Commerce and the International Trade Commission and nonmanufacturing data are from the BEA as reported in the *Survey of Current Business* for 1986 onward. For lack of appropriate earlier data, we assume the 1986 country-partner weights for nonmanufacturing industries apply to pre-1986 years. We use economywide price indexes to deflate bilateral exchange rates. Post-2001 weights use NAICS conversions in industry definitions.

10. Profits from current production are estimated by the BEA as the sum of profits before tax, the inventory valuation adjustment, and the capital consumption adjustment. For a discussion of these data, see the BEA's *Survey of Current Business*, September 2003, pp. 13-4.

The manufacturing industries are: primary metal industries, fabricated metal products, industrial machinery and equipment, electronic and other electrical equipment, food and kindred products, chemicals and allied products, petroleum and coal products, and transportation equipment. The nonmanufactuting industres are: financial services, passenger fares, telecommunications, electricity and gas, retail trade, and wholesale trade.

11. For nonmanufacturing industries, we use the industry Gross Product Originating data.

12. The database posted with this article (<http://www.newyorkfed.org/research/global_economy/industry_specific_exrates.html>) provides export and import data that permit researchers to choose their own weighting schemes and timing decisions for these weights.

13. Consistent with an extensive literature on dollar exchange rates against major currencies, the permanent component we construct using standard Beveridge and Nelson (1981) or Hodrick and Prescott (1997) methodologies closely tracks the actual real exchange rate over most dates. The intuition behind the Beveridge and Nelson definition is that expected growth in the exchange rate should be higher than average when the exchange rate is below its trend level. The Hodrick-Prescott filter assumes an alternative definition of the cycle in the underlying data, and "removes a smooth trend as one would draw it with a free hand drawing" (Pedersen 2001).

14. This statement is confirmed in our own work and in recent work by Pollard and Coughlin (2003) on the topic of import prices and exchange rates. They show that industry-specific exchange rate measures statistically outperform aggregate trade-weighted exchange rates in explaining patterns in industry-level import price adjustment.

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