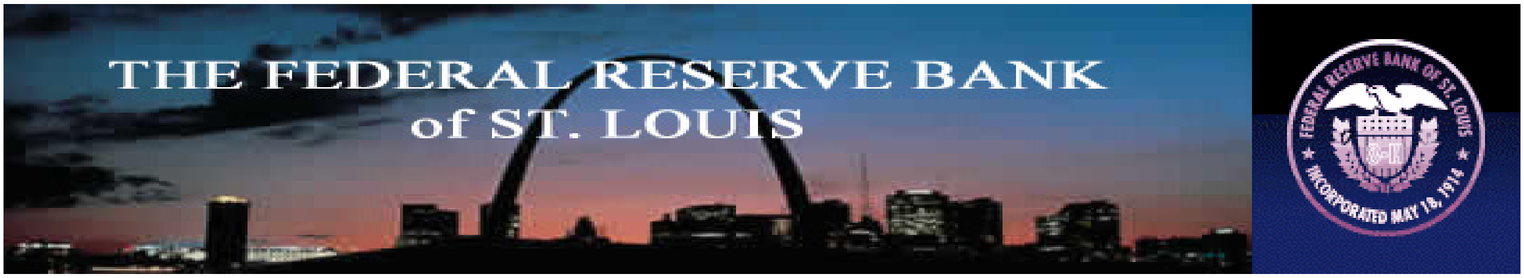

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PASS-THROUGH ESTIMATES AND

THE CHOICE OF AN EXCHANGE RATE INDEX

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We examine exchange rate pass-through into U.S. import prices for 29 manufacturing industries using eight exchange rate indexes. These indexes vary by the number currencies included; whether the weight on each currency is based on total trade with the United States or solely imports; and, whether the weights vary by industry. Our results indicate that pass-through is generally incomplete but varies across industries. Moreover, pass-through is sensitive to the exchange rate index. Using bootstrapped J tests we show that major currency indexes perform better than their broad currency counterparts. When using a major currency index, industry-specific exchange rate indexes are preferred to aggregate indexes.

JEL Codes: F14, F31
Keywords: pass-through, exchange rate index choice

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1. Introduction

Numerous studies have examined the extent to which exchange rate changes affect the prices of internationally traded goods. Few of these studies, however, have examined the role of the exchange rate index. For many pass-through studies researchers face the choice of using a readily available aggregate index or constructing an industry- specific index. Our goal is to provide some guidance regarding the choice of an exchange rate index.

Previous studies generally have found that pass-through is incomplete, supporting the observation that import prices are less volatile than exchange rates. In their literature review, Goldberg and Knetter (1997) concluded that pass-through into U.S. import prices was centered around 50 percent. Despite the voluminous pass-through literature, few studies have generated pass-through estimates for the U.S. across a broad range of industries. A key finding demonstrated by Antzoulatos and Yang (1996), Yang (1997) and Olivei (2002) is that the rate of pass-through varies across industries. Our study adds to this literature.

Micro-oriented pass-through studies for the United States can be divided into two groups. The first set generally focuses on pass-through from one country's firms into U.S. import prices and uses bilateral exchange rates. Most of these studies concentrate on a particular product or industry. For example, Feenstra (1989) examined the pass-through in Japanese shipments of cars, trucks and motorcycles into U.S. prices of these goods. Gron and Swenson (1996) also focused on shipments of Japanese automobiles to the United States. Bernhofen and Xu (2000) examined the exchange rate pass-through into U.S. petrochemical imports from Germany and Japan. Blonigen and Haynes (2002) concentrated on imports of iron and steel products from Canada.

The second group of studies focuses on U.S. imports from all sources and uses a composite exchange rate. In addition to the present study, these include Feinberg (1989), Yang

(1997), Campa and Goldberg (2004) and Olivei (2002). Research by Woo (1984), Ohno (1989) and Feinberg (1991), which estimates pass-through using two or more composite exchange rate indexes, provides an additional motivation for our study. Their results indicate that the pass-through estimates are sensitive to the exchange rate index utilized.

For example, Woo estimated pass-through into nonfood and energy import prices using two 10-currency trade-weighted exchange rate indexes. One index assigned a weight to each currency based on that country's share of total trade among all countries in the index.[1] The other index assigned weights based solely on that country's share of U.S imports. Pass-through was 39 percent using the former index and 74 percent using the latter index.

Ohno examined Japanese and U.S. firms' pass-through into export prices for 19 industries using two 16-currency exchange rate indexes -- an index with the weights based on multilateral manufacturing export shares and an industry-specific index with weights based on bilateral export shares.[2] Ohno found that the magnitude of pass-through estimates generally did not depend on the exchange rate index used. Nonetheless, there are a few industries in which pass-through estimates were sensitive to the index used. Pass-through in primary metal products, for example, ranged from 42 percent using an industry index to 19 percent using the aggregate index for the U.S. and 26 percent to 5 percent, respectively, for Japan.

Feinberg (1991) examined pass-through into the domestic prices of 81 industries using three exchange rate indexes—the 10-currency index used by Woo, a 101-currency index and industry-specific indexes.[3] The industry and 10-currency indexes produced similar estimates of pass-through, 13 and 14 percent, respectively. Pass-through using the 101-currency index, however, was 24 percent.

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[1] This index was produced by the Board of Governors of the Federal Reserve System.
[2] The former index was produced by the International Monetary Fund.

Neither Woo, nor Ohno, nor Feinberg addressed systematically the importance of the exchange rate measure. Their comments on the sensitivity of their estimates to the exchange rate index utilized were limited to informed speculation. For example, Woo stated that an import-share index might be best for estimating pass-through into import prices. Feinberg argued that changes in his industry-specific exchange rate index might best measure the demand-side pressures on domestic prices from import competition. Changes in the broader currency index, he argued, might best measure the effects of changes in prices of imported inputs on domestic prices.

To date, Goldberg (2004) has done the only systematic analysis concerning the importance of the exchange rate index. She showed that industry-specific exchange rates, which are not readily available, can move differently over time than an economy-wide exchange rate index that is readily available. Thus, for analyses focused on specific industries, strong consideration should be given to using industry exchange rates.

Our study extends the scrutiny of different exchange rate indexes by examining the effect of specific exchange rate indexes on estimates of pass-through into U.S. import prices. This topic is especially important because the magnitude of pass-through is crucial for quantifying the macroeconomic and microeconomic effects of exchange rate changes. For example, the magnitude of pass-through is crucial for identifying the effect of exchange rate changes on inflation and for analyzing the international transmission of shocks.[4] In addition, the extent of pass-through is important for quantifying the production, employment and international trade effects experienced by individual industries after exchange rate changes.

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[3] The 101-currency index was produced by the Federal Reserve Bank of Dallas. The industry-specific indexes were based on fixed-weight import shares for the 31 countries that had at least a 10 percent share of the import market for one of the 81 industries.

[4] See, for example, Betts and Devereux (2000) and Corsetti and Dedola (2002).

A noteworthy feature underpinning our analysis is the construction of a dataset. The lack of suitable data is undoubtedly the primary reason for the small number of pass-through studies encompassing numerous industries. With respect to exchange rate indexes, Goldberg (2004) noted that the construction of industry-specific exchange rate indexes is both data intensive and cumbersome. As we detail later, not only have we constructed various exchange rate indexes (some of which are industry specific), but we also constructed a number of other variables for our empirical analysis. Using the International Standard Industrial Classification (ISIC) system, we constructed numerous variables at a quarterly frequency over 1978 to 2000 for 9 two-digit and 20 three-digit manufacturing industries.

We explore the sensitivity of pass-through estimates to different exchange rates based on a commonly used model of import prices. We find that pass-through estimates are sensitive to the choice of the exchange rate index. Nevertheless, pass-through varies more across industries than across exchange rate indexes.

We also compare systematically the informational content of various exchange rate measures to explain pass-through for a number of industries in the manufacturing sector. We find, based on bootstrapped J tests, that exchange rate indexes using only the major currencies perform better than their broad currency counterparts. Some support is found that exchange rate indexes constructed using exports and imports perform better than do those using imports only. In addition, when using a major currency index, industry-specific exchange rate indexes are preferred to aggregate indexes.

In the next section we discuss the model of import prices used in the analysis. Section three discusses the construction of the database. Section four examines pass-through estimates for each of the exchange rate indexes and across all industries. Section 5 analyzes the choice of the exchange rate index and the methodology to choose the most preferred index. A final section contains a summary of our major findings.

2. Model

Incomplete pass-through is one reason for the failure of the law-of-one price. To see this, recall that the law of one price requires that the price of any good, *x*, denoted in a common currency should be the same in any two markets: $p^H = ep^F$, where *H* is the home country, *F* is the foreign country and *e* is the home currency price of the foreign currency. Given transportation costs and other barriers to trade the absolute version of the law of one price rarely holds. Instead the following relative version may hold

$$p^H = \alpha e p^F, \tag{1}$$

where α indicates the deviation from the law of one price, and is constant over time.

Following Olivei (2002) and Campa and Goldberg (2004), among others, let the foreign price of a good *x*, p^F, be determined by the markup over marginal cost. Markup is a function of industry-specific factors, ϕ, and the general macroeconomic conditions, proxied by the exchange rate, *e*. Marginal cost is determined by demand for good *x* and the cost of inputs, *w*. Demand in turn is a function of the price of substitute goods, *y*, in the home country, p^y, and consumer expenditures on goods *x* and *y* in the home country, I^H.[5] Making these substitutions and rewriting equation (1) in log form yields:

$$\begin{aligned} \ln p^H &= \ln\alpha + e + \ln mkup^F + \ln mc^F \\ &= \ln\alpha + \ln\phi + (1+\delta)\ln e + c_0 \ln p^y + c_1 \ln w + c_2 \ln I^H . \end{aligned} \tag{2}$$

[5] The model assumes that the foreign country produces good *x* solely for the home country's market. Blonigen and Haynes (1999) use a more general model where good *x* is sold in both markets.

If markup over marginal cost is constant (δ=0) , then pass-through is complete.[6] This is the case of perfectly competitive firms. If firms have market power then pass-through typically will be incomplete. If a firm adjusts its markup to fully offset changes in the exchange rate on the home price (δ=-1), then pass-through is zero.[7]

After some minor modifications, we estimate equation (2) to examine pass-through using various exchange rate indexes. Prior to examining our empirical results we discuss the construction of the underlying dataset.

3. Dataset Construction Details and Estimation

Our analysis takes the United States as the home country. We construct a dataset covering 29 International Standard Industrial Classification (ISIC) revision 2 manufacturing industries: 9 industries at the two-digit and 20 industries at the three-digit level of classification, as listed in Table 1.[8] The sample period is 1978.q1 through 2000.q4 for all industries except the following four, which start at later dates: 322 (1980.q4), 352 (1979.q3), 353 (1981.q3) and 356 (1980.q4).

Exchange Rate Indexes

To determine the importance of the exchange rate index choice in pass-through estimates, we consider eight variations of the exchange rate index. The Board of Governors of the Federal Reserve System (Board) produces two of the indexes, while the other six were calculated

[6] More generally, as discussed by Goldberg and Knetter (1997), complete pass-through also requires constant marginal costs.
[7] Our focus on incomplete pass-through is related to the literature examining purchasing power parity. In addition to starting with a law-of-one price equation, our analysis of the choice of exchange rate index is analogous to the choice of the appropriate price index for purchasing power parity tests. See Xu (2003) for an analysis of the latter issue. Note also that our empirical findings do not rule out the existence of purchasing power parity. For example, the use of imported inputs could account for incomplete pass-through.
[8] The dataset is available from the authors upon request.

specifically for the current analysis.[9] The general formula for constructing each exchange rate index is:

$$e_{i,t}^{b} = e_{i,t-1}^{b} \prod_{j=1}^{n} \left(\frac{s_{j,t}}{s_{j,t-1}} \right)^{\omega_{j,i,t}}, \qquad (3)$$

where b denotes the specific index, i is the industry, t is the time period, j is the foreign currency (country), s is the U.S. dollar/ foreign currency bilateral exchange rate, and ω is the weight assigned to each foreign currency. The weights are based on annual trade data. Each index is a Paasche chain, allowing the industry level indexes to reflect changes in U.S. trade patterns over the sample period. In contrast, previous studies using industry level exchange rate indexes have all used fixed weights.

As summarized in Table 2, the exchange rate indexes constructed by equation (5) differ in four dimensions:

1. Number of countries/currencies included
2. Multilateral vs. bilateral weighting
3. Weighting by exports and imports vs. imports only
4. Weighting by industry level trade vs. aggregate (goods) trade.

The Board indexes are the only two that use a multilateral weighting scheme. The weights in these indexes are based not only on U.S. imports from and exports to each country in the index, but also incorporate a measure of the competition between U.S. exports and those of each country in the index in the markets of the other countries.[10] Aggregate merchandise trade data are used. The only difference between the two indexes is the number of countries included.

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[9] See Coughlin and Pollard (1996) for a review of the issues underlying the construction of exchange rate indexes.
[10] See Leahy (1998) for the details.

The Major index includes the currencies of 17 countries, 11 of which adopted the euro in January 1999.[11] The Broad index includes these currencies plus those of 19 additional countries.

Using the same bilateral exchange rates, *s*, as in the Board indexes, we constructed the other six indexes. MajorM and BroadM are identical in construction to the Major and Broad indexes, respectively, with one exception: In the former indexes, the weight, ω, given to each country's currency is based solely on that country's share of U.S. merchandise imports.[12]

Four indexes—MajorInd, BroadInd, MajorIndM and BroadIndM are constructed using industry-level trade data for the weights.[13] ISIC industry trade data were obtained from the World Bank's Trade and Production database from 1978-1999 for all countries except Belgium and Luxembourg in 1999.[14] Data for Belgium and Luxembourg in 1999 and all countries in 2000 were obtained from the United Nation's COMTRADE database and converted from Standard International Trade Classification (SITC) revision 2 to ISIC revision 2 by the authors based on a concordance developed by the OECD.[15]

The weights in each of the 29 industry-level MajorInd and BroadInd indexes are based on each country's trade (exports and imports) in that industry with the United States relative to U.S. trade with all countries in the index. MajorInd and BroadInd use the same countries as in Major and Broad, respectively. MajorIndM and BroadIndM are identical to MajorInd and BroadInd, respectively, except the weights in the former two indexes are based only on the share of U.S. imports from each country.

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[11] For the Euro area countries the fixed conversion rates were used to convert the euro into local currencies from 1999 onward. Greece adopted the euro in January 2001 and was added to the major currency index at that time, which is after the endpoint of our dataset.
[12] These weights may be downloaded from the Board of Governors website.
[13] The idea for constructing industry-level exchange rates came from Linda Goldberg. Goldberg (2004) constructs industry-specific exchange rates based on the 2-digit SIC system.
[14] Data may be downloaded form the World Bank's website.
[15] COMTRADE is the original source of the World Bank data. The concordance used by the authors is available from the World Bank as part of the Trade and Production dataset.

Import Prices

Pass-through studies typically use either import price data, as does this study, or unit value data. Import price data are superior to unit prices data as the latter do not take into account differences in product composition or quality.[16] We obtained U.S. import prices from the U.S. Bureau of Labor Statistics (BLS). The data are based on the free on board foreign port price, which excludes freight, insurance or duties. The BLS data are based on SITC revision 3 and were converted to ISIC revision 2.[17]

Other Variables

Direct estimates of the remaining variables – prices for U.S. substitute goods, foreign input costs and consumer expenditures – are not readily available at the industry level. Our study follows the common practice in the pass-through literature of using industry-level producer price indexes as a proxy for the prices of U.S. substitute goods. For foreign input costs we follow much of the pass-through literature in using foreign producer prices as a proxy.[18] Our work improves on previous studies, however, in that we create industry-specific foreign producer price indexes. For consumer expenditures we create a series that attempt to reflect domestic demand for goods produced by each industry. Although these proxies are an improvement on previous research, we look to future research to develop more accurate measures of these variables at the industry level.

Our estimates for foreign input costs use industry-level producer price data for each country where available, and weight these data by those used in the corresponding exchange rate

[16] See Alterman (1991) for a detailed analysis.
[17] Data were first converted from SITC revision 3 to SITC revision 2 based on the concordance obtained from the Center for International Data at the University of California, Davis.
[18] See for example, Feenstra, Gagnon and Knetter (1996), Olivei (2002) Pompelli and Pick (1990), Wickremasinghe and Silvapulle (2003) and Yang (1998).

index. Industry-level producer price data were obtained from the OECD Indicators of Industrial Activity database, Eurostat and country sources.[19] Where industry-level data were unavailable, a general producer price index was used.[20]

For each index *b* (where b=1 to 8, and corresponds to the eight exchange rate indexes) and industry *i*:

$$w_{i,t}^{b} = \sum_{j=1}^{n} \omega_{i,j,t}^{b} PPI_{i,j,t} \qquad (4)$$

where PPI is the producer price index for industry i in country j at time, and ω is the weight used in equation (3). The producer price index for each country j equals 100 in 1998. As equation (4) indicates, even in the cases where the exchange rate does not vary by industry (i.e. Major, MajorM, Broad and BroadM) the foreign producer price index is industry specific.

In most previous studies, consumer expenditures are proxied by output.[21] In contrast, we measure consumer expenditures as industry-level output plus imports minus exports. Output is measured by industry shipments data obtained from the Census Bureau. Industry trade data were obtained from the Census Bureau and the U.S. International Trade Commission. Data were converted from an SIC basis to an ISIC basis.[22]

To summarize, domestic data for the United States — U.S. import prices, domestic substitute prices and consumer expenditures series — vary by industry, but not by the exchange rate index used. The foreign producer price series varies both by industry and by the exchange rate index used, as the weights given to the individual country data and the number of countries included are determined by the weights used in each exchange rate series.

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[19] Data for 1999 and 2000 are available only on an ISIC revision 3 basis. These were converted to an ISIC revision 2 basis using a concordance from the UN Statistics Division.
[20] Industry-level producer price indexes were unavailable for Chile, Colombia, Israel, Saudi Arabia, Malaysia, Singapore, and Venezuela. For some countries industry-level data are not available over the whole sample period, so a general producer price index, or consumer price index was used in early years.

For estimation purposes, we express equation (2) in first differences and add quarterly dummies to account for the lack of seasonally adjusted data. Taking the United States as the home country gives the basic regression equation:

$$\Delta \ln p_t^{US} = \beta_1 + \underset{+}{\beta_2 \Delta \ln e_t} + \underset{+}{\beta_3 \Delta \ln p_t^y} + \underset{+}{\beta_4 \Delta \ln w_t} + \underset{+}{\beta_5 \Delta \ln I_t^{US}} + \beta_6 q1 + \beta_7 q2 + \beta_8 q3 + \varepsilon_t \quad (5)$$

where *i* refers to the industry and *t* is the quarter. The expected signs of the key independent variables are given under the equation. An increase in *e* (depreciation of the dollar) at time *t* should raise the import price of the good produced by industry *i*. An increase in p^y, the dollar price of the U.S. substitute good, should raise the import price, as should an increase in foreign input costs. An increase in consumer expenditures holding the price of substitute goods constant, might raise the price of imports, but the import price response is less certain than for the other variables.

4. Does the Exchange Rate Index Matter?

To examine how the choice of an exchange rate index will affect pass-through, we first examine correlations in the log first differences of these indexes. As shown in Table 3, when the exchange rate index does not vary across industries, changes in the indexes are highly correlated (0.90 and above) regardless of the number of currencies or the weighting scheme. When the exchange rate index is industry specific, the number of currencies in the index may make a difference. For example, the correlation between the MajorInd and BroadInd ranges from 0.53 to 0.93 at the two-digit level and 0.40 to 0.97 at the three-digit level. When only U.S. imports are used to create the weights assigned to each country's currency, the range of correlations between the major and broad currency indexes (MajorIndM and BroadIndM) increases. When

[21]For example, Campa and Goldberg (2004) and Gil-Pareja (2003) use GDP while Olivei (2002) uses industrial

the choice of using exports plus imports or imports only is the primary difference, such as MajorInd and MajorIndM, correlations between the indexes continue to be high.

Holding the number of currencies fixed in the index, the choice of aggregate or industry-specific weights also may make a difference. As shown in the bottom third of Table 3, correlations between the aggregate and industry-specific indexes range from 0.67 to 0.997 at the two-digit level and 0.41 to 0.996 at the three-digit level, with correlations between the import only indexes generally lowest.

These correlations indicate that we should expect pass-through estimates to be most similar between indexes that differ only in whether exports plus imports are used for weighting each country's currency versus only imports. We expect the greatest differences to occur when comparing results for a major currency industry level index to a broad currency industry level index (MajorInd compared to BroadInd and MajorIndM compared to BroadIndM).

Pass-through Estimates

Our focus is on the estimate of β_2, the pass-through coefficient in equation (5). Regardless of the exchange rate index, the estimate of β_2 is statistically significant for nearly all the industries, as shown in Table 4. At the two-digit level, the pass-through relationship was statistically significant for all nine industries, except when the MajorM, BroadInd and BroadIndM exchange rates were used. When using any of these three indexes, pass-through for industry 35 (chemicals and chemical, petroleum, coal, rubber and plastic products) was not statistically significant. In addition, when the BroadIndM exchange rate index was used, pass-through for industry 31 (food, beverages and tobacco) was not statistically significant.

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production.

[22] Based on a concordance from Statistics Canada.

At the three-digit industry level, regardless of the exchange rate index, pass-through was never statistically significant for industries 341 (paper and paper products), 351 (industrial chemicals) and 384 (transport equipment). The pass-through coefficient typically hovered around zero in the first two industries. This result indicates that firms in these two industries typically adjust markup to offset the effect of changes in the exchange rate on their export prices, leaving U.S. import prices unchanged. In contrast, the pass-through estimates for the transport equipment industry (384) range from 24 to 39 percent but are not statistically significant. The model does not appear to provide a good framework for analyzing changes in import prices in this industry as the $\overline{R}^2$ was negative (appendix tables 1-8). When industry-level exchange rates with import-only weights were used (MajorIndM and BroadIndM), pass-through for industry 331 (wood products excluding furniture) was also not statistically significant. The only other case in which the pass-through relationship was not statistically significant occurred for industry 322 (wearing apparel except footwear) using the BroadIndM index.

The coefficients on the other variables in equation (5) were statistically significant less frequently but generally had the expected signs, as detailed in the appendix tables.[23] The proxy for foreign input costs (*w*) was statistically significant for most 2-digit industries, particularly when the major currencies were used. At the three-digit industry level this variable was statistically significant in slightly less than half the industries. The coefficient on the proxy for the U.S price of domestic substitute goods (p^y) was statistically significant less often, particularly at the two-digit level. Changes in U.S. consumer expenditures (I^{US}) typically had a positive effect on import prices, but the estimated coefficients were generally close to zero and were

[23] The quarterly dummy variables are not included in the appendix tables, but the results are available from the authors.

significant for only a few industries.[24] Finally, with the exception of the first quarter dummy using the broad indexes, the quarterly dummy variables were statistically significant for only a few industries, indicating a general lack of seasonality.

We find, as expected, that a depreciation of the dollar increases the price of U.S. imports, whereas an appreciation of the dollar lowers the price of U.S. imports (see Table 4). There are two industries for which the pass-through coefficient sometimes has the opposite sign — industry 341 (paper and paper products) using the Broad and BroadM indexes and industry 351 (industrial chemicals) using the BroadM and BroadInd indexes. In all cases, the estimates are not statistically significant and are close to zero in measure.

Likewise pass-through is almost always less than complete, $\beta_2 < 1$. There are four industries for which the hypothesis that $\beta_2 = 1$ could not be rejected for most of the exchange rate indexes. Complete pass-through could not be rejected for industry 353 (refined petroleum products) using any of the eight exchange rate indexes, nor for industries 382 (non-electrical machinery) and 390 (other manufactured goods) using all except the MajorIndM index. For industry 383 (electrical machinery) full pass-through could only be rejected when using the two major currency industry level exchange rate indexes (MajorInd and MajorIndM). There are two additional industries for which full pass-through could not be rejected for at least one exchange rate index. Complete pass-through in industry 372 (non-ferrous metals) could not be rejected when using the two major currency industry-level exchange rate indexes or the Broad index, while complete pass-through in industry 385 (professional and scientific equipment) could not be rejected when using either broad currency aggregate index (Broad and BroadM).

Average pass-through at the three-digit level always was greater than at the two-digit level with the differences most pronounced for the aggregate indexes, as shown in Table 4.

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[24] This result is similar to previous studies. Gil-Pareja (2003) tested a variety of proxies for consumer expenditures

Average pass-through estimates, at the two-digit level ranged from 26 percent (Major and MajorM) to 33 percent (BroadInd). At the three-digit level average pass-through ranged from 33 percent (BroadIndM) to 46 percent (Broad). The three-digit level estimates are all slightly higher than the 30 percent average pass-through found by Olivei and the 32 percent average pass-through found by Yang.

Examining the four industry-level exchange rate indexes, average pass-through declined slightly when moving from an index based on exports and imports to one based solely on imports (MajorInd to MajorIndM and BroadInd to BroadIndM), but varied little when moving from a major to broad currency index (MajorInd to BroadInd and MajorIndM to BroadIndM). Despite being highly correlated, the most pronounced differences in average pass-through were between the major and the broad aggregate indexes (Major to Broad and MajorM to BroadM). In these indexes, adding additional currencies raised average pass-through by 5 to 8 percentage points. These latter results are similar to those of Feinberg (1991) who found that a 101-currency index produced larger estimates of pass-through than did a10-currency index.

We also find that the pass-through estimates vary more across industries than across exchange rate indexes, as shown in Table 5. At the two-digit industry level the standard deviation of the pass-through estimates varied from 0.02 to 0.13 when holding the industry fixed but varying the exchange rate indexes. In contrast the standard deviation of the pass-through estimates varied from 0.12 to 0.18 when holding the index fixed but varying the industry. Similarly, at the three-digit level the standard deviation across indexes, holding the industry fixed, varied from 0.03 to 0.28. The standard deviation holding the index fixed and varying the industry ranged from 0.23 to 0.34. These results support the findings of Knetter (1993) that export firms within an industry behave similarly and that industry rather than source country

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and found similar results.

appears to matter more for pass-through behavior. Although Knetter's study was limited to four industrial countries (Germany, Japan, United Kingdom and United States) our results indicate this behavior applies more generally.[25]

Despite the narrow range of average pass-through rates, there were some clear differences in the point-estimates of pass-through at the industry level among the eight indexes, particularly at the three-digit level. Most notable were industries 353 (refined petroleum) where pass-through varied from 58 percent using the BroadIndM index to 136 percent using the Broad index and industry 383 (electrical machinery) where pass-through varied from 43 percent using the MajorIndM to 102 percent using the Broad index.

Results Using Other Specifications

Equation (5) assumes that firms react to exchange rate changes only in the quarter in which they occur. The presence of existing contracts, the delay between ordering and receiving goods, and the costs of changing prices may mean that import prices respond with a lag to exchange rate changes. To test for this possibility, we adjusted equation (5) to include up to four lags of the exchange rate change. Import prices may also respond with a lag to changes in the cost of production, w, and/or to changes in the price of competing goods in the U.S. market, p^y. To allow for this possibility, we re-estimated equation (5) adding a one-quarter lag of the dependent variable as an explanatory variable.

The results are similar to our original specification both in terms of the number of industries in which pass-through is statistically significant and the size of the pass-through. None of the lag specifications increases the number of statistically significant pass-through estimates; for the broad industry indexes adding exchange rate lags produces a noticeable drop,

[25] Campa and Goldberg (2004) also find that the industry composition of a country's imports is a primary

particularly at the three-digit level. For example, when four lags are used, pass-through is statistically significant in only 12 of the 19 three-digit industries using the BroadInd index and 9 industries using the BroadIndM index.

Average pass-through estimates are shown in Table 6. The estimates using 4 lags can be seen as proxies for long-run pass-through. Regardless of the index, these estimates do not approach full pass-through. Adding lags also reduces the differences in average pass-through between the two and three-digit industries. For the major currency indexes, long-run average pass-through estimates are about 50 percent at the two-digit industry level and around 40 to 50 percent at the three-digit level. For the broad currency indexes, long-run average pass-through ranges from 38 percent (BroadIndM) to 51 percent (BroadM) at the two-digit industry level and from 35 percent (BroadIndM) to near 60 percent (BroadM).   In general, our long-run estimates are around the 50 percent average pass-through found in studies cited by Goldberg and Knetter (1997).

Our results support the findings of Feenstra (1989) and Campa and Goldberg (2004) that import prices adjust quickly to exchange rate changes. About three-quarters of the long-run pass-through occurs in the initial quarter in the 2-digit industries and in the 3-digit industries. Between 80 and 100 percent of the long-run rate of pass-through occurs within two lags.

The lagged import price regression was most similar to the original specification both in terms of the number of industries for which pass-through was statistically significant and their size of the pass-through estimates. Long run pass-through estimates when a lagged import price is included are slightly higher at the two-digit level than pass-through in the no-lag specification and nearly identical at the three digit level.[26]

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determinant of the extent of pass-through into aggregated import prices.

[26] Long run pass-through is calculated as $\beta_2 /(1-\rho)$ where ρ is the coefficient on the lagged import price.

A common assumption in the pass-through literature is that foreign firms respond symmetrically to changes in their input costs, *w*, and the exchange rate, *e*. As a result the estimated pass-through coefficients should be the same regardless of whether *w* and *e* are estimated separately, as in this paper and Blonigen and Haynes (2002), or jointly, as in Feenstra (1989) and Gron and Swenson (1996). Blonigen and Haynes fail to reject the symmetry restriction, as does Feenstra in most industries. Gross and Schmitt (2000), in contrast, find "no clear evidence that the data would support the restriction of symmetric pass-through" and hence separately estimate the foreign cost and exchange rate coefficients. Using a Wald test we find support for the symmetry restriction in most industries. Nevertheless, regardless of the exchange rate index or the lag structure, symmetry does not hold for all industries.[27] For example, the Wald test always rejects the symmetry hypothesis (at the 5 percent significance level) for industry 352 (other chemicals). These results support our specification.

5. Choosing an Index

A priori we would expect the BroadIndM index to be the best choice. A broad currency index seems preferable to a major currency index as the former incorporates more trading partners of the United States. However, if firms appear to behave similarly across countries, as argued by Knetter and supported by our estimates, then a major currency index would provide sufficient information if currency fluctuations are similar. An import weight index might better track the behavior of import prices, as argued by Woo (1984) and used recently by Marazzi et.al. (2005). Finally, we expect an industry-based index should be preferable to an aggregate index, as the currency weights better reflect actual trading patterns. As long as there are differences

[27] These results are available from the authors.

across industries in trading partners and differences in bilateral exchange rate changes, an industry-specific index should provide a better measure of pass-through than an aggregate index.

To determine if a specific index is preferable to the others, we use the J test procedure developed by Davidson and MacKinnon (1981). The J test compares the following two hypotheses:

$$\mathrm{H}_0: \quad \Delta \ln p_{i,t}^{US} = \beta_{1,i} + \beta_{2,i}\Delta \ln e_{i,t}^{b} + \beta_{3,i}\Delta \ln p_{i,t}^{y} + \beta_{4,i}\Delta \ln w_{i,t}^{b} + \beta_{5,i}\Delta \ln I_{i,t}^{US} + \text{dummies} + u_{i,t}$$
$$\mathrm{H}_1: \quad \Delta \ln p_{i,t}^{US} = \beta_{1,i} + \beta_{2,i}\Delta \ln e_{i,t}^{-b} + \beta_{3,i}\Delta \ln p_{i,t}^{y} + \beta_{4,i}\Delta \ln w_{i,t}^{-b} + \beta_{5,i}\Delta \ln I_{i,t}^{US} + \text{dummies} + v_{i,t}$$

where b refers to any one of the eight possible exchange rate indexes, and $-b$ is any one of the remaining indexes. The J test for H_0 consists of first estimating the equation associated with H_1 and then estimating the equation associated with H_0 but incorporating the fitted values from the estimated equation for H_1 as an additional explanatory variable. If the fitted values from model in H_1 are shown to have explanatory power in the model in H_0, then H_0 is rejected. Reversing the process will determine if H_1 can be rejected.

The finite sample distribution of the J test may deviate from its standard normal asymptotic distribution causing the test to over-reject. As a result we used a bootstrapped J test as suggested by Davidson and MacKinnon (2002). The bootstrap test for H_0 consists of estimating the equation associated with H_0 and then resampling the rescaled residuals to form 9999 bootstrap samples.[28] The bootstrap test statistic is calculated in the same way as the J test statistic.

The preferred exchange rate index is determined through a three-step procedure illustrated in Figure 1. In the first step each of the four major currency indexes is tested against its broad currency index partner (row one, Figure 1), where H_0 uses the major currency index and H_1 uses the broad currency index. In every pairing, the J-test was performed for each of the 9 two-digit industries and 20 three-digit industries. As shown in Figure 1, the broad currency index was rejected far more than the major currency index. Indeed, the major currency index was rejected, at most, one time at the two-digit level, and one-time at the three-digit level. In contrast, the broad currency index was rejected in over half the industries at the two-digit level and close to half the industries at the three-digit level. Thus, contrary to our priors, a major currency index is preferable to a broad currency index.

Having rejected the broad currency index we next focus on the four major currency indexes. We use a bootstrap J test to determine if the major currency indexes weighted by exports plus imports are preferred to the major currency indexes weighted by imports alone (Major compared with MajorM and MajorInd compared with MajorIndM, as shown in row two, Figure 1). The results are not as clear-cut as in the first step. Nevertheless, the bootstrapped J test results weakly favor the use of indexes based on both exports and imports.

The final step determines whether the most preferred index is based on aggregate or industry level weights -- the Major or the MajorInd index (row three, Figure 1). Using the bootstrap J test the Major index was rejected in 4 of the two-digit industries and 9 of the three-digit industries, while the MajorInd index was rejected in 2 of the two-digit industries and 4 of the three-digit industries.[29] These results indicate that the MajorInd index is the preferred index among the eight, especially at the three-digit industry level. Overall our results support our *a priori* belief that an industry-level index would perform better than an aggregate index. There is little evidence that trade weights based on imports only is preferable. Moreover, there is clear evidence for preferring a major currency over a broad currency index.

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[28] The rescaled residuals are calculated by multiplying the estimated residuals, $\hat{u}$, by $[(n/(n-k)]^{1/2}$ where n is the number of observations and k is the number of variables in the regression equation.

[29] Similar results are found through a comparison of MajorM and MajorIndM.

We further investigated the result that a major currency index was always preferable to a broad currency index, as this result appears to be counterintuitive. The share of the major currencies was 63 percent in the Broad index and 67 percent in the BroadM index, averaged over the sample period. For the industry level indexes the median share of the major currencies across all industries (and averaged over the sample period) was 69 percent in the BroadInd index and 70 percent in the BroadIndM index. There was however, a substantial variation across industries. In the BroadInd index the share of major currencies, averaged over all years, ranged from 15 percent for industry 322 (wearing apparel) to 83 percent for industry 384 (transport equipment). In the BroadIndM index the share of major currencies ranged from 12 percent for industry 322 to 93 percent for industry 341 (paper and paper products). Consequently, it is clear that for some industries the behavior of the major currencies is likely to be the primary factor determining pass-through but for other industries this is not obvious.

Next we make use of the fact that each broad currency index is a weighted average of its corresponding major currency index and a set of non-major currencies. We can thus rewrite equation (5) for the broad indexes as follows:

$$\begin{aligned} \Delta \ln p_{i,t}^{US} &= \beta_1 + \beta_{2M,i} \Delta \ln e_{i,t}^{M} + \beta_{2N,i} \Delta \ln e_{i,t}^{N} + \beta_{3,i} \Delta \ln p_{i,t}^{y} \\ &+ \beta_{4M,i} \Delta \ln w_{i,t}^{M} + \beta_{4N,i} \Delta \ln w_{i,t}^{N} + \beta_{5,i} \Delta \ln I_{i,t}^{US} + dummies \end{aligned} \tag{6}$$

where M refers to the major currency index and N refers to the index of non-major currencies. This specification allows us to determine if pass-through from the major currencies to U.S. import prices differs from pass-through from the non-major currencies to U.S. import prices, and likewise for pass-through from the costs of production.

Regardless of the broad index used, our estimate of β_{2N} was rarely significant and small in magnitude. At the two-digit level pass-through from changes in the non-major currencies was never significant for the Broad, BroadM and BroadInd indexes. When using the BroadIndM index, the estimate of β_{2N} was only statistically significant for industry 39 (miscellaneous manufacturing), and in this industry the pass-through of changes in the non-major currencies was less than half the estimate of pass-through for the major currencies. At the three-digit level pass-through was never significant for the Broad index. When using the BroadIndM index, the estimate of β_{2N} was statistically significant only for industry 382 (non-electrical machinery). When using either the BroadM or the BroadInd indexes, the estimate of β_{2N} was statistically significant in two industries: 351 (industrial chemicals) and 371 (iron and steel) for the former index; 311 (food products) and 355 (rubber products) for the latter index.[30]

Foreign costs for the non-major currency countries are more often statistically significant than is exchange rate pass-through. Nevertheless, the cost variables for the non-major currency countries in the broad indexes are less often significant than the cost variables for the major currency countries. The results from estimating equation (6) provide further evidence that the non-major currencies can be ignored when examining exchange rate pass-through at the industry level.

Lastly, we created a new exchange rate index (and foreign input cost index) that added China and Mexico to the currencies in the major indexes. This new index incorporates the two most important U.S. trading partners that are excluded from the major indexes. Using bootstrapped J tests we compared the regression using the new indexes with those using the major currency indexes. The results confirm the preference for the major currency index.

6. Conclusion

This paper examined the choice of the exchange rate index in industry-level pass-through estimates. In the process we contribute to the small literature that has generated estimates of

[30] The full results are available from the authors.

pass-through for numerous industries. In addition, we provide a systematic analysis of the importance of the choice of an exchange rate index for pass-through results. In light of the cumbersome data requirement to construct industry-specific exchange rates, our results are valuable in providing guidance concerning how much data are necessary for industry-specific pass-through studies.

We find, regardless of the exchange rate index, pass-through in both the long and short run is generally incomplete but varies across industries and across indexes. Average pass-through was highest when using a broad aggregate index and this result was robust to the lag specification. Using industry-level indexes the number of currencies did not have a noticeable effect on short-run average pass-through. Long-run average pass-through, however, was higher when using a major currency industry-level index than when using the broad currency counterparts. Our long-run estimates of mean pass-through are around the 50 percent average cited in Goldberg and Knetter's (1997) literature review.

We used bootstrapped J tests to determine which if any of the eight indexes provided the best fit. Our results showed a clear dominance of the major currency indexes over the broad currency indexes. Separating the effects of changes in the major and non-major currencies on import prices showed that the non-major currencies rarely provide any explanatory power for changes in the price of U.S. imports. Given the large data requirements for construction of these broad indexes, our finding is good news for empirical researchers. Within the group of major currency indexes the industry-level index was preferable to the aggregate index. There was weak support for using exports and imports for the trade weights rather than imports only. In sum, our results indicate that the MajorInd index is the preferred index.

Based on this index, average pass-through at the two-digit ISIC level was 30 percent in the short-run and 52 percent in the long-run. Average pass-through at the three-digit level was

38 percent in the short-run and 46 percent in the long-run. There were, however, sharp variations across industries with pass-through ranging from near zero to over 100 percent. Further research is needed to explore the causes of these industry-level differences.

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Table 1

Manufacturing Industries in Pass-through Regressions

ISIC rev. 2	Description
31	Manufacture of food, beverages and tobacco
32	Textiles, wearing apparel and leather industries
33	Wood and wood products, including furniture
34	Paper and paper products, printing and publishing
35	Chemicals, chemical, petroleum, coal, rubber and plastic products
36	Non-metallic mineral products, except coal and petroleum
37	Basic metals
38	Fabricated metal products, machinery and equipment
39	Other manufactured goods
311	Food products
321	Textiles
322	Wearing apparel except footwear
323	Leather products
331	Wood products except furniture
341	Paper and paper products
351	Industrial chemicals
352	Other chemicals
353	Refined petroleum products
354	Misc. petroleum and coal products
355	Rubber products
356	Plastic products
371	Iron and steel
372	Non-ferrous metals
381	Fabricated metal products
382	Machinery except electrical
383	Electrical machinery
384	Transport equipment
385	Professional and scientific equipment
390	Other manufactured goods

Table 2 **Exchange Rate Indexes -- Construction Features**				
Index	Countries/ Currencies*	Multilateral vs. Bilateral	Exports & Imports vs. Imports Only	Aggregate vs. Industry
Major	17/7	Multilateral	Exports & Imports	Aggregate
Broad	36/26	Multilateral	Exports & Imports	Aggregate
MajorM	17/7	Bilateral	Imports Only	Aggregate
BroadM	36/26	Bilateral	Imports Only	Aggregate
MajorInd	17/7	Bilateral	Exports & Imports	Industry
BroadInd	36/26	Bilateral	Exports & Imports	Industry
MajorIndM	17/7	Bilateral	Imports Only	Industry
BroadIndM	36/26	Bilateral	Imports Only	Industry

* The 17 countries in the Major index are: Australia, *Austria, Belgium* , Canada, *Finland, France, Germany Ireland, Italy* , Japan, *Luxembourg, Netherlands, Portugal, Spain* , Sweden, Switzerland, and the United Kingdom The 11 countries in italics adopted the euro in January 1999. The 36 countries in the Broad index include those in the Major index plus the following: Argentina, Brazil, Chile, China, Colombia, Hong Kong, India, Indonesia, Israel, Korea, Malaysia, Mexico, Philippines, Russia, Saudi Arabia, Singapore, Taiwan, Thailand and Venezuela.

Table 3 **Correlations of Log First Differences of Exchange Rate Indexes**			
Type	Indexes Compared	ISIC	Correlation Coefficient or Range
Aggregate Indexes	Major and Broad		0.900
	MajorM and BroadM		0.906
	Major and MajorM		0.996
	Broad and BroadM		0.992
Industry Indexes	MajorInd and BroadInd	2-digit	0.534 to 0.932
	MajorIndM and BroadIndM	2-digit	0.461 to 0.954
	MajorInd and MajorIndM	2-digit	0.945 to 0.999
	BroadInd and BroadIndM	2-digit	0.905 to 0.995
	MajorInd and BroadInd	3-digit	0.397 to 0.967
	MajorIndM and BroadIndM	3-digit	0.266 to 0.983
	MajorInd and MajorIndM	3-digit	0.863 to 0.999
	BroadInd and BroadIndM	3-digit	0.892 to 0.995
Aggregate vs. Industry	Major and MajorInd	2-digit	0.854 to 0.997
	Broad and BroadInd	2-digit	0.812 to 0.983
	MajorM and MajorIndM	2-digit	0.667 to 0.992
	BroadM and BroadIndM	2-digit	0.711 to 0.974
	Major and MajorInd	3-digit	0.812 to 0.996
	Broad and BroadInd	3-digit	0.571 to 0.982
	MajorM and MajorIndM	3-digit	0.450 to 0.994
	BroadM and BroadIndM	3-digit	0.406 to 0.982

Table 4

Passthrough Estimates

ISIC	Major		MajorM		MajorInd		MajorIndM		Broad		BroadM		BroadInd		BroadindM	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
31	0.227 **	0.077	0.236 **	0.080	0.246 **	0.079	0.286 **	0.094	0.260 **	0.100	0.287 **	0.101	0.208 *	0.091	0.104	0.073
32	0.132 **	0.030	0.134 **	0.032	0.112 **	0.026	0.095 **	0.023	0.139 **	0.038	0.139 **	0.039	0.120 **	0.040	0.102 **	0.037
33	0.260 **	0.072	0.276 **	0.075	0.488 **	0.119	0.516 **	0.140	0.339 **	0.100	0.370 **	0.100	0.592 **	0.141	0.540 **	0.151
34	0.115 *	0.056	0.117 *	0.058	0.172 *	0.082	0.218 *	0.093	0.133 *	0.077	0.136 *	0.077	0.172 *	0.096	0.183 *	0.099
35	0.169 *	0.093	0.156	0.098	0.219 *	0.096	0.219 *	0.098	0.225 *	0.126	0.227 *	0.127	0.182	0.130	0.155	0.128
36	0.359 **	0.059	0.374 **	0.062	0.410 **	0.065	0.351 **	0.056	0.448 **	0.082	0.475 **	0.082	0.514 **	0.088	0.462 **	0.078
37	0.203 **	0.080	0.227 **	0.083	0.259 **	0.091	0.240 **	0.089	0.321 **	0.101	0.326 **	0.103	0.270 **	0.098	0.212 **	0.088
38	0.358 **	0.032	0.378 **	0.034	0.384 **	0.034	0.337 **	0.030	0.421 **	0.047	0.427 **	0.049	0.439 **	0.048	0.406 **	0.038
39	0.486 **	0.108	0.469 **	0.116	0.426 **	0.092	0.424 **	0.068	0.469 **	0.148	0.461 **	0.153	0.472 **	0.122	0.468 **	0.114
311	0.233 **	0.074	0.244 **	0.077	0.250 **	0.080	0.301 **	0.107	0.322 **	0.094	0.323 **	0.095	0.281 **	0.078	0.130 *	0.056
321	0.249 **	0.036	0.261 **	0.039	0.223 **	0.034	0.194 **	0.030	0.298 **	0.046	0.311 **	0.047	0.302 **	0.055	0.287 **	0.054
322	0.242 **	0.063	0.244 **	0.066	0.262 **	0.054	0.264 **	0.050	0.307 **	0.086	0.298 **	0.088	0.198 *	0.106	0.172	0.103
323	0.279 **	0.052	0.276 **	0.056	0.264 **	0.043	0.226 **	0.038	0.310 **	0.066	0.304 **	0.070	0.121 *	0.052	0.088 *	0.046
331	0.228 **	0.072	0.238 **	0.075	0.334 **	0.128	0.219	0.153	0.240 **	0.098	0.240 **	0.100	0.282 *	0.142	0.124	0.148
341	0.014	0.067	0.012	0.070	0.061	0.102	0.178	0.120	-0.015	0.088	-0.004	0.089	0.075	0.114	0.194	0.119
351	0.055	0.220	0.067	0.229	0.038	0.234	0.034	0.242	0.039	0.293	-0.009	0.293	-0.028	0.295	0.002	0.270
352	0.406 **	0.129	0.433 **	0.134	0.335 **	0.120	0.305 **	0.109	0.617 **	0.175	0.577 **	0.177	0.457 **	0.146	0.390 **	0.127
353	1.093 **	0.325	1.094 **	0.335	1.112 **	0.397	0.989 *	0.421	1.358 **	0.455	1.353 **	0.463	0.673 *	0.350	0.582 *	0.296
354	0.278 *	0.124	0.286 *	0.129	0.341 *	0.153	0.311 *	0.146	0.371 *	0.163	0.382 *	0.164	0.388 **	0.159	0.298 *	0.132
355	0.144 **	0.041	0.147 **	0.044	0.176 **	0.046	0.151 **	0.040	0.196 **	0.056	0.203 **	0.056	0.215 **	0.060	0.173 **	0.046
356	0.239 **	0.061	0.254 **	0.064	0.265 **	0.069	0.250 **	0.063	0.315 **	0.083	0.315 **	0.084	0.286 **	0.093	0.209 **	0.080
371	0.118 *	0.056	0.126 *	0.059	0.125 *	0.055	0.111 *	0.051	0.193 **	0.073	0.202 **	0.074	0.133 *	0.059	0.111 *	0.051
372	0.626 **	0.156	0.663 **	0.160	0.784 **	0.191	0.803 **	0.202	0.698 **	0.189	0.650 **	0.194	0.483 **	0.191	0.304 *	0.167
381	0.358 **	0.039	0.374 **	0.041	0.410 **	0.042	0.357 **	0.037	0.430 **	0.056	0.442 **	0.055	0.505 **	0.061	0.458 **	0.052
382	0.639 **	0.254	0.654 **	0.274	0.586 *	0.267	0.503 *	0.231	0.641 *	0.338	0.616 *	0.343	0.613 *	0.333	0.575 *	0.277
383	0.861 **	0.278	0.690 *	0.297	0.532 *	0.249	0.432 *	0.215	1.017 **	0.349	0.957 **	0.361	0.917 **	0.364	0.765 **	0.320
384	0.244	0.275	0.289	0.288	0.390	0.327	0.348	0.287	0.235	0.361	0.271	0.367	0.368	0.372	0.349	0.312
385	0.678 **	0.126	0.705 **	0.131	0.572 **	0.107	0.534 **	0.093	0.801 **	0.169	0.770 **	0.174	0.711 **	0.137	0.658 **	0.117
390	0.645 *	0.343	0.655 *	0.358	0.569 *	0.291	0.493 *	0.261	0.820 *	0.440	0.870 *	0.453	0.810 *	0.372	0.761 *	0.362
Mean 2-digit	0.256		0.263		0.302		0.299		0.306		0.317		0.330		0.293	
Mean 3-digit	0.381		0.386		0.381		0.350		0.460		0.454		0.389		0.331	

* denotes significance at the 5 percent level based on a one-tailed test.

** denotes significance at the 1 percent level based on a one-tailed test.

Table 5

Standard Deviation Across Indexes and Industries

Across Indexes		**Across Industries -- 2 digit ISIC**	
ISIC	**Std. Dev.**	**Index**	**Std. Dev.**
31	0.059	Major	0.123
32	0.017	MajorM	0.122
33	0.127	MajorInd	0.129
34	0.036	MajorIndM	0.125
35	0.032	Broad	0.126
36	0.060	BroadM	0.130
37	0.047	BroadInd	0.175
38	0.036	BroadindM	0.174
39	0.022		
311	0.063	**3- digit ISIC**	
321	0.042	Major	0.284
322	0.046	MajorM	0.273
323	0.084	MajorInd	0.257
331	0.059	MajorIndM	0.230
341	0.081	Broad	0.343
351	0.033	BroadM	0.337
352	0.109	BroadInd	0.255
353	0.282	BroadindM	0.230
354	0.045		
355	0.027		
356	0.037		
371	0.036		
372	0.164		
381	0.052		
382	0.049		
383	0.208		
384	0.059		
385	0.091		
390	0.133		

Table 6

Average Pass-through in alternative specifications

2-Digit Industries

	Original	Lags of exchange rate				Lagged Import Price
Index	β_2	$s_{i,1}$	$s_{i,2}$	$s_{i,3}$	$s_{i,4}$	$\beta_2/(1-\rho)$
Major	0.26	0.34	0.40	0.43	0.48	0.29
MajorM	0.26	0.35	0.41	0.44	0.47	0.30
MajorInd	0.30	0.39	0.46	0.48	0.52	0.34
MajorIndM	0.30	0.39	0.46	0.47	0.52	0.33
Broad	0.31	0.38	0.44	0.45	0.48	0.35
BroadM	0.32	0.40	0.47	0.50	0.51	0.35
BroadInd	0.33	0.40	0.45	0.46	0.45	0.37
BroadIndM	0.29	0.35	0.39	0.39	0.38	0.32

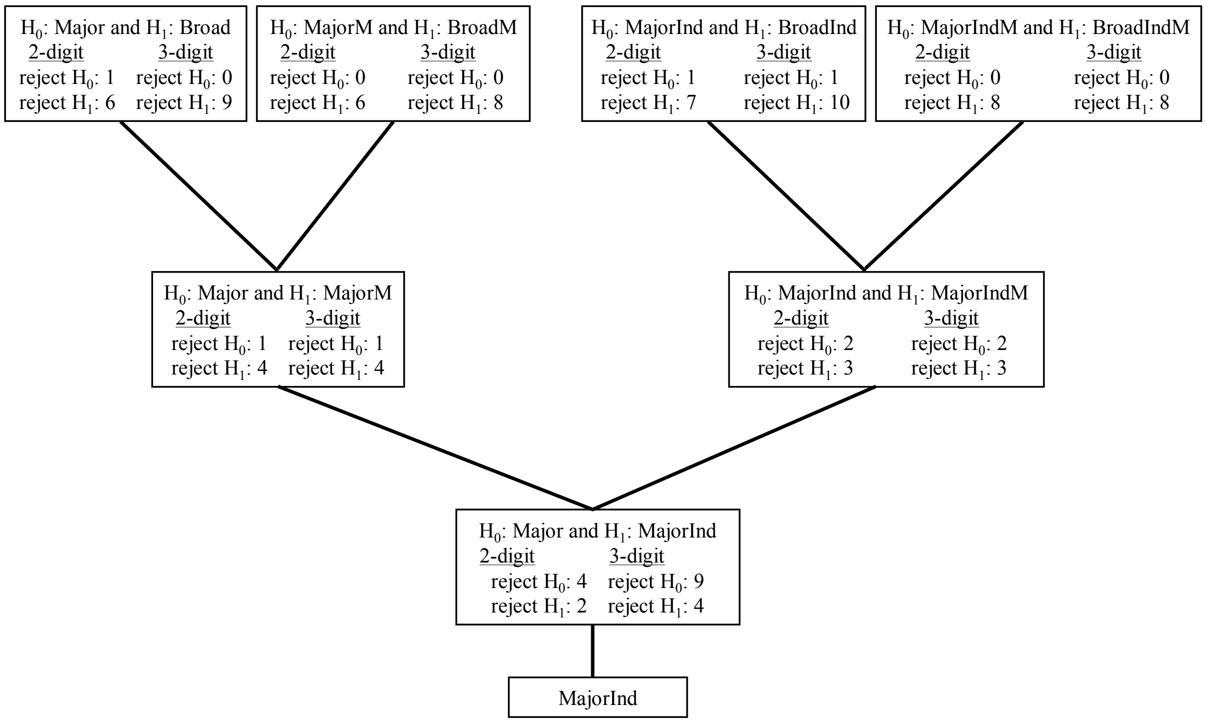
3-Digit Industries

	Original	Lags of exchange rate				Lagged Import Price
Index	β_2	$s_{i,1}$	$s_{i,2}$	$s_{i,3}$	$s_{i,4}$	$\beta_2/(1-\rho)$
Major	0.38	0.39	0.48	0.43	0.51	0.38
MajorM	0.39	0.38	0.47	0.46	0.52	0.39
MajorInd	0.38	0.36	0.44	0.42	0.46	0.39
MajorIndM	0.35	0.33	0.40	0.39	0.43	0.37
Broad	0.46	0.43	0.53	0.47	0.54	0.46
BroadM	0.45	0.43	0.54	0.54	0.59	0.46
BroadInd	0.39	0.34	0.39	0.40	0.42	0.39
BroadIndM	0.33	0.28	0.33	0.33	0.35	0.32

Notes: $s_{i,m} = \sum_{k=0}^{m} \Delta \ln e_{i,t-k}$

ρ is the coefficient on lagged import prices.

Figure 1-- J-test Pairs



The numbers in the boxes indicate how many times each index was rejected in the bootstrapped J tests.

Appendix Table 1

Regression Coefficients – Major

ISIC	e	p^y	w	I^{US}	$\bar{R}^2$
31	0.227 **	0.084	0.602	-0.033	0.09
32	0.132 **	0.474 **	0.327 *	0.016	0.50
33	0.260 **	0.069	0.790 **	0.041	0.45
34	0.115 *	1.079 **	0.572 **	0.142	0.68
35	0.169 *	-0.168	0.558 **	0.404 ++	0.39
36	0.359 **	-0.287	0.777 **	-0.075	0.43
37	0.203 **	0.619 **	0.399	0.171 +	0.49
38	0.358 **	0.081	0.657 **	-0.027	0.63
39	0.486 **	-0.106	2.156 **	0.051	0.36
311	0.233 **	0.063	0.406	-0.159	0.20
321	0.249 **	0.403 *	0.368 *	0.047	0.54
322	0.242 **	0.696	0.050	-0.010	0.13
323	0.279 **	0.052	0.599 **	-0.045	0.45
331	0.228 **	0.290 *	0.512 **	0.055	0.45
341	0.014	0.230	0.513 **	0.099	0.49
351	0.055	0.803 *	-0.208	0.248	0.04
352	0.406 **	0.294	-0.909 *	-0.172	0.18
353	1.093 **	-0.248	1.889 **	0.362	0.54
354	0.278 *	0.012	0.124	0.146 +	0.22
355	0.144 **	0.002	0.378 **	0.057	0.33
356	0.239 **	0.021	-0.019	0.004	0.19
371	0.118 *	0.826 **	0.166	-0.033	0.46
372	0.626 **	-0.217	0.878 **	0.248 +	0.48
381	0.358 **	0.211	0.347	-0.020	0.54
382	0.639 **	0.877	5.460 **	0.207	0.22
383	0.861 **	2.114	3.078	0.156	0.22
384	0.244	0.243	-0.247	0.170	-0.05
385	0.678 **	-0.507	0.127	0.158	0.24
390	0.645 *	-0.085	1.925	-0.142	0.01

* denotes significance at the 5 percent level based on a one-tailed test.
** denotes significance at the 1 percent level based on a one-tailed test.
\+ denotes significance at the 5 percent level based on a two-tailed test.
\+\+ denotes significance at the 1 percent level based on a two-tailed test.

Appendix Table 2

Regression Coefficients – MajorM

ISIC	e	p^y	w	I^{US}	$\bar{R}^2$
31	0.236 **	0.082	0.591	-0.037	0.09
32	0.134 **	0.491 **	0.308 *	0.015	0.49
33	0.276 **	0.036	0.734 **	0.034	0.45
34	0.117 *	1.084 **	0.544 **	0.140	0.68
35	0.156	-0.142	0.501 **	0.429 ++	0.38
36	0.374 **	-0.187	0.652 **	-0.075	0.42
37	0.227 **	0.588 *	0.432 *	0.165 +	0.50
38	0.378 **	0.142	0.498 **	-0.031	0.62
39	0.469 **	0.216	1.559 **	0.053	0.32
311	0.244 **	0.048	0.460	-0.166	0.20
321	0.261 **	0.380 *	0.412 *	0.040	0.53
322	0.244 **	0.749	-0.063	-0.010	0.12
323	0.276 **	0.062	0.513 *	-0.041	0.42
331	0.238 **	0.271 *	0.464 **	0.052	0.45
341	0.012	0.208	0.518 **	0.101	0.50
351	0.067	0.853 *	-0.301	0.248	0.04
352	0.433 **	0.285	-0.896 *	-0.172	0.18
353	1.094 **	-0.215	1.795 **	0.381	0.54
354	0.286 *	0.026	0.083	0.158 +	0.22
355	0.147 **	0.005	0.349 **	0.056	0.32
356	0.254 **	0.012	-0.007	0.002	0.19
371	0.126 *	0.834 **	0.147	-0.033	0.46
372	0.663 **	-0.254	0.893 **	0.244 +	0.49
381	0.374 **	0.234	0.316	-0.021	0.54
382	0.654 **	1.539 *	3.285 *	0.188	0.17
383	0.690 *	4.127 **	-0.683	0.416	0.20
384	0.289	0.248	-0.232	0.171	-0.05
385	0.705 **	-0.372	-0.356	0.174	0.25
390	0.655 *	-0.124	2.070	-0.149	0.01

* denotes significance at the 5 percent level based on a one-tailed test.
** denotes significance at the 1 percent level based on a one-tailed test.
\+ denotes significance at the 5 percent level based on a two-tailed test.
\+\+ denotes significance at the 1 percent level based on a two-tailed test.

Appendix Table 3

Regression Coefficients – MajorInd

ISIC	e	p^y	w	I^{US}	$\bar{R}^2$
31	0.246 **	0.109	0.560	-0.043	0.10
32	0.112 **	0.733 **	-0.032	0.018	0.50
33	0.488 **	-0.045	0.518 **	0.045	0.45
34	0.172 *	0.996 **	0.494 **	0.163	0.73
35	0.219 *	-0.210	0.629 **	0.360 ++	0.42
36	0.410 **	-0.049	0.512 *	-0.065	0.41
37	0.259 **	0.653 **	0.333 *	0.154	0.50
38	0.384 **	0.142	0.532 **	-0.034	0.63
39	0.426 **	0.181	1.469 **	0.046	0.35
311	0.250 **	0.140	0.117	-0.131	0.20
321	0.223 **	0.696 **	-0.063	0.059	0.55
322	0.262 **	0.814 *	0.030	-0.015	0.21
323	0.264 **	0.055	0.420 **	-0.047	0.49
331	0.334 **	0.193	0.324 **	0.054	0.42
341	0.061	-0.097	0.635 **	0.043	0.57
351	0.038	0.697	-0.015	0.246	0.04
352	0.335 **	0.259	-0.772 *	-0.172	0.16
353	1.112 **	-0.272	1.449 **	0.435	0.50
354	0.341 *	0.028	0.052	0.164 +	0.22
355	0.176 **	-0.001	0.355 **	0.062	0.37
356	0.265 **	0.035	-0.007	0.005	0.19
371	0.125 *	0.864 **	0.092	-0.036	0.47
372	0.784 **	-0.258	0.777 **	0.215	0.50
381	0.410 **	0.279 *	0.243	-0.024	0.56
382	0.586 *	2.481 **	-0.474	0.214	0.15
383	0.532 *	4.173 **	-0.994	0.472	0.20
384	0.390	0.155	0.065	0.167	-0.05
385	0.572 **	-0.299	-1.235 *	0.205	0.27
390	0.569 *	0.536	0.669	-0.133	0.02

* denotes significance at the 5 percent level based on a one-tailed test.
** denotes significance at the 1 percent level based on a one-tailed test.
+ denotes significance at the 5 percent level based on a two-tailed test.
++ denotes significance at the 1 percent level based on a two-tailed test.

Appendix Table 4

Regression Coefficients – MajorIndM

ISIC	e	p^y	w	I^{US}	$\bar{R}^2$
31	0.286 **	0.061	0.640 *	-0.050	0.10
32	0.095 **	0.861 **	-0.169 *	0.020	0.53
33	0.516 **	-0.043	0.388 **	0.050	0.38
34	0.218 *	1.067 **	0.405 **	0.163	0.73
35	0.219 *	-0.182	0.588 **	0.379 ++	0.41
36	0.351 **	-0.130	0.622 **	-0.058	0.42
37	0.240 **	0.748 **	0.222	0.167 +	0.49
38	0.337 **	0.149	0.520 **	-0.040	0.63
39	0.424 **	-0.244	1.814 **	0.033	0.57
311	0.301 **	0.134	-0.043	-0.122	0.19
321	0.194 **	0.713 **	-0.096	0.062	0.55
322	0.264 **	0.796 *	0.032	-0.017	0.24
323	0.226 **	0.091 **	0.278 *	-0.043	0.48
331	0.219	0.228	0.193 *	0.050	0.36
341	0.178	-0.091	0.599 **	-0.020	0.58
351	0.034	0.619	0.124	0.244	0.04
352	0.305 **	0.300	-0.858 *	-0.160	0.17
353	0.989 *	-0.195	1.166 **	0.514 +	0.47
354	0.311 *	0.028	0.048	0.169 ++	0.22
355	0.151 **	-0.002	0.356 **	0.065	0.38
356	0.250 **	0.046	-0.011	0.010	0.19
371	0.111 *	0.878 **	0.066	-0.036	0.46
372	0.803 **	-0.303	0.783 **	0.204	0.51
381	0.357 **	0.271 *	0.292 *	-0.016	0.55
382	0.503 *	2.284 **	0.515	0.204	0.15
383	0.432 *	3.728 **	0.037	0.339	0.17
384	0.348	0.046	0.334	0.158	-0.05
385	0.534 **	-0.282	-0.712	0.139	0.28
390	0.493 *	0.840	0.108	-0.124	0.01

* denotes significance at the 5 percent level based on a one-tailed test.
** denotes significance at the 1 percent level based on a one-tailed test.
+ denotes significance at the 5 percent level based on a two-tailed test.
++ denotes significance at the 1 percent level based on a two-tailed test.

Appendix Table 5

Regression Coefficients – Broad

ISIC	e	p^y	w	I^{US}	$\bar{R}^2$
31	0.260 **	0.107	0.595	-0.043	0.09
32	0.139 **	0.681 **	-0.001	0.016	0.47
33	0.339 **	0.192	0.710 **	0.072	0.39
34	0.133 *	1.265 **	0.477 **	0.115	0.66
35	0.225 *	-0.164	0.580 **	0.428 ++	0.37
36	0.448 **	-0.205	0.583 *	-0.085	0.38
37	0.321 **	0.651 **	0.400 *	0.192 +	0.52
38	0.421 **	0.118	0.302 *	-0.034	0.53
39	0.469 **	0.433	1.008 *	0.046	0.28
311	0.322 **	0.121	0.160	-0.139	0.22
321	0.298 **	0.489 **	0.206	0.056	0.52
322	0.307 **	0.820 *	-0.221	-0.013	0.11
323	0.310 **	0.097 **	0.468 *	-0.041	0.42
331	0.240 **	0.364 **	0.504 **	0.065	0.41
341	-0.015	0.387 *	0.454 *	0.104	0.47
351	0.039	0.822 *	-0.293	0.246	0.04
352	0.617 **	0.036	-0.633	-0.241	0.18
353	1.358 **	-0.125	2.129 **	0.334	0.51
354	0.371 *	0.026	0.091	0.152 +	0.22
355	0.196 **	0.024	0.295 **	0.056	0.29
356	0.315 **	-0.008	-0.063	0.012	0.18
371	0.193 **	0.821 **	0.198	-0.021	0.48
372	0.698 **	0.135	0.579 *	0.292 ++	0.47
381	0.430 **	0.218	0.185	-0.009	0.45
382	0.641 *	1.340 *	3.940 **	0.090	0.21
383	1.017 **	3.278 **	1.099	0.180	0.21
384	0.235	0.150	-0.181	0.168	-0.06
385	0.801 **	-0.593	-0.005	0.145	0.19
390	0.820 *	-0.012	1.661	-0.176	0.02

* denotes significance at the 5 percent level based on a one-tailed test.
** denotes significance at the 1 percent level based on a one-tailed test.
+ denotes significance at the 5 percent level based on a two-tailed test.
++ denotes significance at the 1 percent level based on a two-tailed test.

Appendix Table 6

Regression Coefficients – BroadM

ISIC	e	p^y	w	I^{US}	$\bar{R}^2$
31	0.287 **	0.107	0.431	-0.032	0.08
32	0.139 **	0.716 **	-0.040	0.017	0.47
33	0.370 **	0.157	0.638 **	0.063	0.39
34	0.136 *	1.257 **	0.446 **	0.123	0.66
35	0.227 *	-0.171	0.551 **	0.442 ++	0.38
36	0.475 **	-0.239	0.606 *	-0.088 +	0.39
37	0.326 **	0.718 **	0.290	0.194 +	0.51
38	0.427 **	0.150	0.236	-0.031	0.51
39	0.461 **	0.338	1.147 *	0.051	0.27
311	0.323 **	0.139	0.042	-0.129	0.22
321	0.311 **	0.482 **	0.224	0.050	0.52
322	0.298 **	0.858 *	-0.303	-0.011	0.11
323	0.304 **	0.109 **	0.296	-0.035	0.39
331	0.240 **	0.358 **	0.382 *	0.062	0.40
341	-0.004	0.342	0.461 **	0.120	0.48
351	-0.009	0.904 *	-0.426	0.245	0.05
352	0.577 **	0.049	-0.560	-0.216	0.16
353	1.353 **	-0.135	1.914 **	0.422	0.50
354	0.382 *	0.033	0.063	0.159 +	0.22
355	0.203 **	0.012	0.329 **	0.058	0.31
356	0.315 **	0.009	-0.086	0.008	0.19
371	0.202 **	0.830 **	0.161	-0.024	0.48
372	0.650 **	0.261	0.381	0.303 ++	0.45
381	0.442 **	0.239	0.167	-0.008	0.46
382	0.616 *	1.157	4.307 **	0.045	0.19
383	0.957 **	3.320 **	1.004	0.200	0.20
384	0.271	0.174	-0.200	0.170	-0.06
385	0.770 **	-0.545	-0.090	0.163	0.17
390	0.870 *	-0.169	1.881	-0.173	0.02

* denotes significance at the 5 percent level based on a one-tailed test.
** denotes significance at the 1 percent level based on a one-tailed test.
+ denotes significance at the 5 percent level based on a two-tailed test.
++ denotes significance at the 1 percent level based on a two-tailed test.

Appendix Table 7

Regression Coefficients – BroadInd

ISIC	e	p^y	w	I^{US}	$\bar{R}^2$
31	0.208 *	0.142	0.192	0.001	0.05
32	0.120 **	0.724 **	-0.069	0.015	0.45
33	0.592 **	0.011	0.593 **	0.047	0.42
34	0.172 *	1.078 **	0.493 **	0.165	0.71
35	0.182	-0.095	0.454 **	0.452 ++	0.35
36	0.514 **	-0.096	0.437 *	-0.078	0.38
37	0.270 **	0.831 **	0.101	0.193 +	0.49
38	0.439 **	0.190 *	0.170	-0.027	0.54
39	0.472 **	0.167	1.323 **	0.033	0.32
311	0.281 **	0.114	0.213	-0.086	0.24
321	0.302 **	0.583 **	-0.000	0.058	0.47
322	0.198 *	0.574	-0.135	-0.004	0.02
323	0.121 *	0.153 **	0.116	-0.020	0.31
331	0.282 *	0.225	0.349 **	0.055	0.40
341	0.075	-0.083	0.709 **	0.053	0.57
351	-0.028	0.717 *	-0.048	0.246	0.04
352	0.457 **	0.065	-0.518	-0.210	0.16
353	0.673 *	0.376	0.538	0.421	0.42
354	0.388 **	0.043	0.008	0.169 ++	0.23
355	0.215 **	0.040	0.171 *	0.048	0.27
356	0.286 **	-0.033	-0.055	0.036	0.14
371	0.133 *	0.868 **	0.046	-0.037	0.47
372	0.483 **	0.374 *	0.177	0.327 ++	0.43
381	0.505 **	0.280 *	0.118	-0.002	0.48
382	0.613 *	2.295 **	0.037	0.203	0.13
383	0.917 **	3.682 **	0.179	0.298	0.19
384	0.368	0.178	-0.169	0.171	-0.05
385	0.711 **	-0.438	-0.608	0.197	0.23
390	0.810 *	0.158	1.217	-0.174	0.02

* denotes significance at the 5 percent level based on a one-tailed test.
** denotes significance at the 1 percent level based on a one-tailed test.
+ denotes significance at the 5 percent level based on a two-tailed test.
++ denotes significance at the 1 percent level based on a two-tailed test.

Appendix Table 8

Regression Coefficients – BroadIndM

ISIC	e	p^y	w	I^{US}	$\bar{R}^2$
31	0.104	0.125	0.214	0.020	0.03
32	0.102 **	0.749 **	-0.077	0.016	0.45
33	0.540 **	0.044	0.457 **	0.039	0.36
34	0.183 *	1.119 **	0.395 **	0.166	0.71
35	0.155	-0.053	0.367 *	0.486 ++	0.33
36	0.462 **	-0.140	0.359	-0.074	0.38
37	0.212 **	0.909 **	-0.002	0.199 +	0.48
38	0.406 **	0.188 *	0.270 *	-0.035	0.60
39	0.468 **	-0.020	1.423 **	0.013	0.37
311	0.130 *	0.100	0.110	-0.082	0.17
321	0.287 **	0.541 **	0.111	0.063	0.46
322	0.172	0.547	-0.123	-0.002	0.01
323	0.088 *	0.161 **	0.063	-0.018	0.29
331	0.124	0.315 *	0.166	0.053	0.34
341	0.194	-0.045	0.592 **	-0.013	0.57
351	0.002	0.691	-0.005	0.246	0.04
352	0.390 **	0.186	-0.744 *	-0.188	0.17
353	0.582 *	0.376	0.471	0.462	0.42
354	0.298 *	0.040	0.011	0.176 ++	0.22
355	0.173 **	-0.002	0.353 **	0.062	0.38
356	0.209 **	-0.027	-0.063	0.039	0.12
371	0.111 *	0.869 **	0.041	-0.037	0.46
372	0.304 *	0.341	0.227	0.317 ++	0.41
381	0.458 **	0.251 *	0.193	-0.008	0.50
382	0.575 *	2.194 **	0.699	0.186	0.15
383	0.765 **	3.449 **	0.692	0.242	0.19
384	0.349	0.056	0.252	0.161	-0.05
385	0.658 **	-0.354	-0.599	0.155	0.27
390	0.761 *	0.345	0.847	-0.178	0.02

* denotes significance at the 5 percent level based on a one-tailed test.
** denotes significance at the 1 percent level based on a one-tailed test.
+ denotes significance at the 5 percent level based on a two-tailed test.
++ denotes significance at the 1 percent level based on a two-tailed test.