Imports, Exports, Dollar Exposures, and Stock Returns*

SUPARNA CHAKRABORTY, YI TANG, AND LIUREN WU

Zicklin School of Business, Baruch College

First draft: December 16, 2006; This version: November 11, 2008

ABSTRACT

We measure the dollar risk exposure of US industries by regressing stock portfolio returns on each industry against the returns on a broadly defined dollar index. The exposure estimates vary widely across different industries in both magnitudes and directions. We trace this large cross-sectional variation in dollar exposure to the industry's average import and export activities. We find that the dollar exposure increases with imports but decreases with exports. On average, dollar appreciation helps the stock performance of import-oriented companies but hurts the stock performance of export-oriented companies. Based on this finding, we propose a methodology to combine the information in imports, exports, and stock returns to enhance the identification of the dollar risk exposure for different industries, and we analyze how each industry's expected stock return varies with its dollar exposure. We identify a strongly negative risk premium for bearing positive exposures to the dollar, and we find that the risk premium moves with the business cycle and becomes more negative during recessions.

JEL CLASSIFICATION CODES: G12, E32.

KEY WORDS: Dollar risk exposure, imports, exports, currency risk premium, stock returns.

*The authors are from Zicklin School of Business, Baruch College, One Bernard Baruch Way, Box B10-225, New York, NY 10010. Email correspondences are Suparna_Chakraborty@baruch.cuny.edu, Yi_Tang@baruch.cuny.edu, and Liuren_Wu@baruch.cuny.edu, respectively. We thank Yakov Amihud, David Backus, Turan Bali, Craig Brown, Ozgure Demirtas, Linda Goldberg, Armen Hovakimian, Kenneth Singleton, Chris Telmer, Rui Yao, and seminar participants at Baruch College for comments. We welcome comments, including references to related papers we have inadvertently overlooked.

Imports, Exports, Dollar Exposures, and Stock Returns

With increasing global market integration, a firm's performance depends on not only the domestic market fluctuations but also the international market conditions. Researchers often regard exchange rate fluctuation as a metric for changing international market conditions and believe that its fluctuation has direct impacts on the functioning and profitability of a firm. What are not so clear are the fundamental determinants and asset pricing implications of the relation, as embedded in the following three questions: (1) How does a firm's share value fluctuate with the exchange rate? (2) What are the fundamental drivers of the relation? (3) How do investors price the stocks differently for firms with different exchange rate exposures?

In this paper, we answer the three questions in light of the experience of US industries. First, to quantify the relation between exchange rate fluctuation and the stock performance of different industries, we regress the stock returns for each industry against the returns on a broadly defined dollar index. We say that an industry in the US has positive dollar exposure if its stock return increases with the appreciation of the dollar and that its dollar exposure is negative if the stock return decreases with dollar appreciation. Our estimation results show that the dollar exposure estimates vary widely across different industries in both magnitudes and directions. For example, industries under the title of "boot and shoe cut stocking," 'steel investment foundaries," and "space vehicle equipment" generate highly negative dollar exposure estimates. Stock returns in these industries tend to decline when the dollar appreciates. On the other hand, industries under "household refrigerator and freezer" and "men's and boy's underwear " generate highly positive dollar exposures. Stock returns in these industries tend to rise with dollar appreciation. The dollar exposure estimates also vary greatly within the same broad sector classification. For example, while space vehicle equipment under the defense sector generates highly negative exposure estimates, the "ordnance and necessary accessories" industry under the same defense sector generates highly positive exposures.

The large cross-sectional variation in dollar exposure among US industries leads us to the second question: Can we trace the different dollar exposure of each industry to the roots of its business fundamentals? As in extant literature,[1] we believe that international trade is an important economic fundamental that lies at the heart of exchange rate exposures. A firm with no direct or indirect international trading activities shall have little exposure to exchange rate fluctuation. However, deviating from the literature, we argue

[1] Examples include Jorion (1990), He and Ng (1998), Griffin and Stulz (2001), and Dominguez and Tesar (2001, 2006).

that it is not the aggregate international trade activity that determines the currency risk exposure. It is the imbalance of the trade that generates currency exposure. A firm can undergo large quantities of international trades while maintaining little currency exposure if the firm can balance its imports with its exports. Simply put, import- and export-oriented companies should have quite different currency exposures. When left unhedged, these different exposures can show up in stock returns. To test this hypothesis, we regress cross-sectionally the dollar exposure estimates of each industry against the logarithm of the industry's imports volume and the exports volume, each normalized by the market capitalization of the industry. The regression identifies a significantly positive linkage with imports, but a significantly negative linkage with exports. On average, dollar appreciation helps the stock performance of import-oriented companies, but hurts the stock performance of export-oriented companies.

Our cross-sectional regression results make economic sense. Dollar appreciation makes US exports more expensive and hurts the demand for exports. Reduced demand hurts the sales and thus profitability of the exporting company. On the other hand, dollar appreciation reduces the cost of imports (Campa and Goldberg (2005)) and therefore increases the profitability of an import-oriented company. The different impacts on profitability can show up in stock returns and generate the negative exposure estimates for exporting companies and positive exposure estimates for importing companies.

Understanding the fundamental sources of the currency exposure is important by itself. In this paper, we go one step further and show that the identified linkage can be used to further enhance the estimation accuracy of the dollar exposure for each industry. With the enhanced identification of the dollar risk exposure, we can also sharpen our answer to the third question and obtain a more significant estimate on the market risk premium for the dollar risk exposure. Specifically, we propose to use a weighted average of imports, exports, and the dollar exposure estimates from the stock returns to define an enhanced dollar exposure. We use this enhanced dollar exposure to predict the stock returns based on cross-sectional regressions, while controlling exposures to other commonly identified stock market risk factors. The weighting coefficients for the enhanced dollar exposure are estimated by maximizing the likelihood of the predicting errors. Then, the time series average of the cross-sectional regression slope on the dollar exposure measures the average dollar exposure risk premium. We find that incorporating the information in imports and exports helps us generate a more significant risk premium estimate on the dollar exposure.

The average risk premium on the enhanced dollar exposure is significantly negative. The negative estimate suggests that on average, import-oriented companies generate lower returns than export-oriented companies. When we form stock portfolios ranked by the enhanced dollar exposure, the average return spread between high- and low-dollar exposure portfolios is also significantly negative. Furthermore, when we study the time variation of the dollar risk premium, we find that the dollar risk premium varies with the business cycle and becomes more negative during recessions than during expansions.

Intuitively, our finding on the negative dollar risk premium suggests that dollar appreciation represents an adverse movement for the US economy. Since import-oriented companies benefit from dollar appreciation, these companies act as natural hedges against the dollar risk exposure. As a result, investors are willing to accept a lower expected return on these import-oriented companies. The variation of the risk premium with the business cycle further suggests that either the risk level or the risk aversion against dollar exposure becomes larger during recessions than during expansions.

The rest of the paper is organized as follows. The next section reviews the literature that forms the background of our study. Section II describes the data. Section III estimates the dollar risk exposure. Section IV studies sources of dollar risk exposure. Section V enhances the identification of the dollar exposure using the import and export information, and estimates the risk premium on the enhanced dollar risk exposure. Section VI performs robustness analysis by controlling for additional risk factors in other financial markets. Section VII concludes.

I. Background

Identifying the currency exposure of different firms, industries, or economies has been a perennial topic in the academic literature. For example, Jorion (1990) examines 287 US multinationals during 1981–1987 and finds 15% of the firms to have significant exposures. Bodnar and Gentry (1993) examine industries from the US, Canada, and Japan during 1979-1988 and find that 20% to 35% of the industries have significant currency risk exposures. Amihud (1994) examines 32 large US exporting firms during 1982–1988 but finds no significant currency exposure. Allayannis (1997) analyzes the time variation of the exchange rate exposure of US manufacturing industries from 1978 to 1986. He finds that the level of industry aggregation at which the exposure is examined matters: Significant exposure at the four-digit SIC level is often masked at the more aggregate two-digit level. Allayannis and Ihrig (2001) analyze the exchange rate exposure of US manufacturing industries and find that 4 of 18 industry groups are significant exposed to exchange rate movements. They find that on average, a 1% appreciation of the dollar decreases the return of the average industry by 0.13%. Dominguez and Tesar (2001, 2006) examine a set of non-US industrialized countries over the period 1980–1999 and find large cross-country differences. They find that a large fraction of Japanese firms have exposures to weekly movements in exchange rates, but Chilean firms show very weak exposures.

It is understandable that different firms, industries, or economies have different currency exposures. In the US, we find that the dollar exposure estimates vary greatly across different industries while the average dollar exposure across all industries is close to zero. Interestingly, earlier studies often try to select a more homogeneous sample, e.g., firms with large international business exposures and large exports, in the hope of obtaining more uniform currency exposure estimates. In this paper, we do not shun away from the cross-sectional heterogeneity in currency exposure. Instead, we regard it as a natural outcome of the heterogeneity in business operations and, more importantly, a key information source for identifying the market price of currency risk.

When examining the fundamental sources of currency exposures, many studies direct their attention to the "openness" of a firm, an industry, or an economy. Jorion (1990) uses the share of foreign sales in total sales as a measure for openness and find that the currency exposure is significantly positively related to the share of foreign sales. Griffin and Stulz (2001) examine the hypothesis that industry competitiveness across countries is an important explanation for exchange rate exposure, but they do not find supporting evidence among US industries. Dominguez and Tesar (2006) use the aggregate bilateral trade flows with the US as a measure of openness for the non-US industrialized countries. They find only a weak link between the openness measure and the exchange rate exposure. He and Ng (1998) find that high exchange rate exposure is related to high exports for Japanese multinationals.

In this paper, we argue that it is not the aggregate openness that matters for currency risk exposure. It is the direction or *imbalance* of openness that generates currency exposure. A firm can be very open in terms of international trade, but can still show minimal currency exposure by balancing its imports with its exports. Furthermore, an import-driven firm and an export-driven firm may both have strong currency exposures, but their exposures are unlikely to be in the same direction. Our empirical findings confirm our conjecture and show that import-oriented US firms tend to react positively to dollar appreciation whereas export-oriented companies tend to react negatively. In related works, Allayannis (1997) finds that the time variation of the dollar exposure in an industry is related positively to the variation of the industry's share of imports but negatively to the variation of the industry's exports share. Campa and Goldberg (1999) show that investment responsiveness to exchange rates varies positively with respect to sectorial reliance on exports and negatively with respect to sectorial reliance on imports.

We do not stop at finding the dollar risk exposure and relating the cross-sectional variation in the exposure to the industry's differences in the average imports and exports activities. Instead, we make use of this finding to further enhance the identification of the dollar risk exposure. Since both imports and exports contain information about the dollar exposure, we propose to exploit the information to reduce the noise in the dollar exposure estimates. With the enhanced identification, we estimate how industries with different dollar exposures differ in expected excess returns, and find that the market charges a significantly negative risk premium on positive dollar risk exposures.

Early international asset pricing models, e.g., Solnik (1974), Sercu (1980), Stulz (1981), and Adler and Dumas (1983), all provide explicit roles for exchange rate risk. A large stream of empirical studies have also tried to identify the market pricing of the exchange rate risk, but often with confusing results. For example, Jorion (1991) uses a sample of US firms to show that currency risk exposures vary systematically across different industries, but he does not find any significant pricing for the currency risk exposure. Dumas and Solnik (1995) and De Santis and Gerard (1998) study the currency pricing in the framework of an international asset pricing model, where country portfolio returns are related to the return on a world portfolio and returns on several foreign currencies. In a similar framework, Carrieri, Errunza, and Majerbi (2004) study whether currency risks in emerging market are priced and whether they have spillover effects on the developed markets. A key feature of these studies is their reliance on the *intertemporal* variation in the expected returns of the country portfolios and the conditional covariances between these portfolio returns and the risk factors. In this paper, we argue that the currency exposures vary much more *cross-sectionally* than intertemporally. Different types of industries have different business operations that lead to different risk exposures. By contract, as the industry classification largely stays the same over time, the risk exposure of an industry cannot vary too much over time. Therefore, it is much more efficient to identify the market pricing of risk factors based on cross-sectional variations instead of intertemporal variations.

By linking currency exposures to economic fundamentals and analyzing the currency risk premium, our research is also related to classic theoretical and empirical studies on the fundamental determination of exchange rates, e.g., Aizenman and Riera-Crichton (2007), Dumas (1992), Engel, Mark, and West (2007), Engel and West (2005), Evans and Lyons (2002), Lothian and Taylor (1996), Mark (1995), and Sercu and Uppal (2000).

II. Data

Our analysis involves four broad data types. To study the dollar risk exposure of US firms, we build an aggregate dollar index, and we relate the dollar index return to returns on US stocks. To explore the sources of the exposure, we obtain imports and exports data on different industries. We also control our risk exposure analysis by incorporating standard market risk factors.

A. The dollar index

We relate stock returns in the US to the strength of the dollar, which we measure through a broadly defined dollar index. The index is a weighted average of foreign exchange values of the US dollar against the currencies of a large group of major US trading partners. The index weights vary over time and are derived from US export shares and from US and foreign import shares. Monthly data for the dollar index are available from the Federal Reserve Bank of Atlanta Statistical Release.[2] The sample period for our analysis is from January 1973 to December 2001.

Each exchange rate reveals the relative strength of two currencies. By forming a broad dollar index, we focus on the strength of dollar against a basket of other currencies. Figure 1 plots the time series of the dollar index in the left panel and the monthly returns on the index in the right panel. During our sample period, the dollar has shown a steady appreciating trend, except the decline in the late 1980s. The right panel shows that the log returns on the index can be very volatile, with a monthly range from -4.175% to 4.243%.

[Figure 1 about here.]

Table I reports the summary statistics of the monthly returns on the dollar index under R^{fx}. The log returns have an annualized mean estimate of 4.566%, and an annualized standard deviation estimate of 4.456%. The monthly return series show a first-order autocorrelation of 0.347. The skewness and kurtosis

[2] The dollar index has been used to study international stock returns in, for example, Ferson and Harvey (1993, 1994) and Harvey (1995a,b).

estimates are both small. In the column under ER^{fx}, we also report the summary statistics of the log excess return on the dollar index over the Treasury bill rate. The excess return has an annualized mean of -1.995% and an annualized standard deviation of 4.4%.

To accommodate the different trade activities and hence different currency exposures in different industries, Goldberg (2004) proposes and constructs industry-specific dollar indices. By aligning the weighting of the index for each industry with the industry's trading activities, Goldberg often finds stronger exposure estimates with the industry-specific dollar indices than with an aggregate dollar index that we use here. Nevertheless, in this paper, our objective is not to identify strong and uniform currency exposures for all industry, in which case using the industry-specific dollar index would be more appreciate. Instead, our objective is to identify and compare the cross-sectional variations of the exposure of different industries to one common exchange rate factor, and link the cross-sectional differences in currency exposures to cross-sectional differences in imports, exports, and expected stock returns. For the cross-sectional comparison to make economic sense, it is imperative for us to use one common factor rather than using a different factor for each industry.

B. Stock market risk factors

When we measure the dollar risk exposure of US stocks, we control for systematic risk factors identified from the stock market, including the excess return on the market portfolio over the Treasury bill rate (ER^{mkt}), and the size (SMB) and book to market (HML) risk factors identified by Fama and French (1993). Time series on these risk factors and the Treasury bill rates are made available on Kenneth French's online data library.

The market portfolio return is constructed as the value-weighted return on all NYSE, Amex, and Nasdaq stocks. To construct the size and book-to-market factors, Fama and French (1993) first construct six portfolios according to the rankings on market capitalizations (ME) and book-to-market equity ratios. In June of each year, they rank all NYSE stocks from the Center for Research in Security Prices (CRSP) at the University of Chicago based on the market capitalization. Then, they use the median NYSE size to split NYSE, Amex, and Nasdaq stocks into two groups, small and big. They also break NYSE, Amex, and Nasdaq stocks into three book-to-market groups based on the breakpoints for bottom 30%, middle 40%, and top 30% of the ranked values of BM for NYSE stocks. They construct the SMB factor as the difference between the return on the portfolio of small size stocks and the return on the portfolio of large size stocks, and the *HML* factor as the difference between the return on the portfolio of high book-to-market stocks and the return on the portfolio of low book-to-market stocks.

Table I reports the summary statistics of the three risk factors and the riskfree rate. Over our sample period, the market portfolio has an annualized excess return of 5.886% over the Treasury rate. The size and book-to-market portfolios both generate positive mean excess returns at 2.235% and 5.587%, respectively. The Treasury rate has a sample average of 6.562% during our sample period. The excess return on the market portfolio has an annualized standard deviation of 16.327%, close to four times larger than that on the dollar index excess return. The standard deviation estimates on *SML* and *HML* are smaller at 11.812% and 11.229%, respectively. The autocorrelation estimates for returns on the stock market risk factors are all much smaller than the estimate on the dollar index returns.

C. Imports and exports

We obtain the annual US import and export data by four-digit SIC coded industries. The data from 1972 to 1988 are compiled by Robert Feenstra and are made publicly available at the Center for International Data at University of California, Davis. The data from 1989 to 2001 are updated and maintained by Peter Schott and are made publicly available at Yale University.

The import and export data cover manufacturing industries with the four-digit SIC code starting with either 2 or 3. There are 488 unique SIC codes in the original data set. To be included in the study, each industry must have at least three observations on the import and export measures and at least 24 monthly industry portfolio returns. We lose 86 industries because of the restrictions. The import is defined as the total of merchandize that has physically cleared through Customs either entering consumption channels immediately or entering after withdrawal for consumption from bonded warehouses under Customs custody or from Foreign Trade Zones. The export is defined as the selling price, or cost if not sold, including inland freight, insurance, and other charges to the US port of export, but excluding unconditional discounts and commissions. See Feenstra (1996, 1997) and Feenstra, Romalis, and Schott (2002) for a detailed documentation of the data.

Table II reports the summary statistics of the imports (IM) and exports (EX), both in millions of dollars. Since the observation is on a panel of 402 industries over 30 years, we summarize the behavior of the data in three different ways. In panel A, we first take the time-series average on each series and then report the cross-sectional statistics of the time-series averages. Thus, the statistics in panel A measure the cross-sectional variation of the average trade quantities across different industries. In panel B, we average the trade quantities cross-sectionally at each year, and then report the time-series statistics on the average trade quantities. The statistics reflect the time-series variation of the average trade quantities in US industries. In the panel C, we first measure the time-series statistics of each series and then report the cross-sectional average of these time-series statistics. Thus, the numbers reflect the time-series statistics of a typical industry.

Panel A shows that the average imports and exports vary greatly from one industry to another. The imports vary from 82 thousand dollars to 51.78 million dollars, and the exports vary from 168 thousand dollars to 14.99 million dollars. The cross-sectional distributions of imports and exports show large skewness and kurtosis. To obtain better distributional behaviors, we also report the statistics on the natural logarithms of the imports (ln(IM)) and exports (ln(EX)). The time-series averages of the log imports vary from -3.073 to 10.683, with a cross-sectional standard deviation of 1.869. The time-series averages of the log exports vary from -1.845 to 9.592, with a cross-sectional standard deviation of 1.853. The cross-sectional distributions of the log imports and log exports are much closer to be normally distributed, with small skewness and kurtosis estimates.

In contrast to the large cross-sectional variation, panel B shows that the time-series variations of the average imports and exports are much smaller. The time-series standard deviation estimates for the cross-sectional averages of log imports and log exports are at 0.877 and 0.892, respectively, less than half of the corresponding time-series standard deviation estimates. When we look at the average time-series statistics for each industry in panel C, we find that the average standard deviations estimates are even smaller at 0.381 for log imports and 0.276 for log exports.

To control for the size differences for different industries, we also compute the aggregate market capitalization (ME) for each industry. The market capitalization for each firm is computed as the shares outstanding multiplied by the share price, both of which are available from CRSP. We aggregate the market capitalization of all firms within each industry, and we normalize the imports and exports of an industry in year t by the industry's aggregate market capitalization in December of year $t-1$. Table II reports the summary statistics on the logarithm of the market-capitalization normalized imports and exports under the two columns titled "ln(IM/ME)" and "ln(EX/ME))," respectively. With the normalization, the cross-sectional standard deviations become even larger at 2.237 for imports and 1.878 for exports; yet, the time-series standard deviation estimates for the cross-sectional averages in panel B become much smaller at 0.119 for imports and 0.11 for exports. The cross-sectional variation estimates are 20 times larger than the time-series variation estimates. The cross-sectional averages of the time-series standard deviation estimates in panel C are at 0.342 for normalized imports and 0.307 for normalized exports. Both numbers are comparable to the estimates on the log imports and exports without normalization, but are much smaller than the corresponding cross-sectional standard deviation estimates.

Regardless of how we measure and scale the imports and exports quantities, we find much larger cross-sectional variation across different industries than time-series variation over different time periods. The different magnitudes of variation along the two dimensions suggest that different industries can differ dramatically from one to another in their respective international trading activities, but that the international trading activities for a fixed industry and for the US economy as a whole are relatively stable over time.

D. Stock returns on industry portfolios

Corresponding to imports and exports for each industry defined by the four-digit SIC code, we also compute the monthly stock returns for each industry. Stock returns data are available from CRSP. We assign each stock to a four-digit SIC industry. At each year t, we use the four-digit Compustat SIC code of the stock for the fiscal year ending in calendar year $t-1$. Whenever the Compustat SIC code is not available, we use the CRSP SIC code for June of year t. Then, we construct equal-weighted industry portfolios at the beginning of July of year t and rebalance the portfolios on an annual basis. To be included in an industry portfolio in year t, a stock must have return data for July of year t and market capitalization for December of year $t-1$. Once we have formed the industry portfolio, we compute the monthly excess return on each portfolio, defined as the portfolio return minus the Treasury bill rate of the corresponding month.

The last column in Table II reports the summary statistics of the industry portfolio excess returns (ER). Different from the trade data, the industry portfolio excess returns show large cross-sectional variation but even larger time-series variation. The standard deviation estimate in panel A at 5.245 reflects the standard deviation of the mean excess return or average risk premium on each industry portfolio. By contract, the standard deviation estimate in panel B at 18.802 reflects the large intertemporal variation of the market excess return over the average risk premium. The standard deviation estimate in panel C at 33.994 shows that the excess return realizations for a typical industry can differ dramatically from its mean value. Taken together, the much larger intertemporal standard deviation on the portfolio returns suggest that the large randomness in return realization can overwhelm the cross-sectional differences in risk premiums. This feature makes it inherently difficult to estimate risk premiums on different risk exposures accurately.

III. Measuring the Dollar Exposure of US Industries

To gauge how stock returns from different industries vary with the dollar index, we perform the following time-series regression on each industry portfolio i,

$$ER_t^i = \beta_{i0} + \beta_i^{fx} ER_t^{fx} + \beta_i^{mkt} ER_t^{mkt} + \beta_i^{smb} SMB_t + \beta_i^{hml} HML_t + e_t^i, \tag{1}$$

where ER_t^i denotes the time-t monthly log excess return on the i-th industry portfolio, ER_t^{fx} denotes the time-t monthly log excess return on the dollar index, ER_t^{mkt} denotes the time-t log excess return on the market portfolio, and SMB_t and HML_t denote the monthly return series on the size and book-to-market portfolios, respectively. Thus, the slope coefficient β_i^{fx} measures the dollar risk exposure of the i-th industry portfolio while controlling for variations in the three stock market risk factors.

We repeat this estimation for each of the 402 industries over the whole sample period from February 1973 to December 2001. Table III reports the cross-sectional statistics of the full-sample estimates and t-statistics on the slope coefficients in panel A. The last column reports the statistics on the R-squares of the regressions. The most interesting estimate to us is the estimate on β^{fx}, which measures the dollar exposure of different industry portfolio returns while controlling for variations in the three stock market risk factors. The cross-sectional average of the estimates on β^{fx} is very small, so is the average t-statistics. The small average estimate is consistent with the often insignificant findings in the literature when one regress the market aggregate returns on the dollar index returns. Nevertheless, the dollar exposure estimates show large cross-sectional variation, ranging from -2.417 to 1.799. The t-statistics range from -2.692 to 3.134. The cross-sectional standard deviation of the dollar exposure estimates is 0.629. Figure 2 plots the histogram of dollar exposure estimates and the t-statistics. Out of the 402 industries, 182 of them have negative dollar exposure estimates with 16 of them significant at at least the 10% level, and 220 of them have positive dollar exposure estimates, with 33 significant at at least the 10% level.

[Figure 2 about here.]

When we look into the descriptions of the different industries and their dollar exposure estimates, we find that industries under the title of “boot and shoe cut stocking,” “steel investment foundaries,” and “space vehicle equipment” generate highly negative dollar exposure estimates, but industries under “household refrigerator and freezer” and “men’s and boy’s underwear ” generate highly positive dollar exposure estimates. The dollar exposure estimates can vary greatly even within the same broad sector classification. For example, while space vehicle equipment under the defense sector generates highly negative exposure estimates, the “ordnance and necessary accessories” industry under the same defense sector generates highly positive exposure estimates.

For the controlling risk factors, the market beta estimates (β^{mkt}) average around one as expected. The cross-sectional standard deviation of the estimates is small at 0.28. The average exposure estimates on the SMB and HML risk factors are also positive and significant, but with larger cross-sectional standard deviations at 0.546 for SMB and 0.484 for HML.

To account for potentially time-varying risk exposures, we also perform rolling window estimation on equation (1). For each industry, we repeat the estimation each year in July of each year with a rolling window of ten years. The choice of a relatively long rolling window is to cover at least a full business cycle for each rolling regression (Hoberg and Phillips (2006)). We require that that within each ten-year rolling window, each industry have at least three annual observations on imports and exports and 24 monthly observations on industry portfolio returns. This requirement reduces the number of industries from 402 to 375. Panel B of Table III reports the cross-sectional statistics on the time-series averages of the slope estimates. The statistics are very much similar to those on the full-sample estimates in Panel A, showing that the rolling-window estimation generates sensible results.

Panel C of Table III reports the time-series statistics of the cross-sectional averages of the slope estimates across the different industries. The time-series standard deviation of the average dollar exposure is about ten times smaller than the cross-sectional standard deviation of the full-sample estimates or time-series averages of the rolling-window estimates. The much smaller time-series variation is partly due to the smoothing effect of the rolling window, but it also reflects the intertemporal stability of the dollar exposure for the average economy. When we calculate the cross-sectional averages of the time-series statistics in panel D, the average time-series standard deviation for each industry is less than half of the cross-sectional standard deviation, showing that the dollar exposure of each industry is also relatively stable over time.

IV. Tracing Dollar Exposure to Import and Export Activities

When we regress industry portfolio returns on dollar index returns, we find that the average dollar exposure is small, but that the exposure estimates show large cross-sectional variations. These cross-sectional variations can come either from sample variation (e.g., standard errors in the coefficient estimates), or from fundamental differences in the business operations. The intertemporal stability of the rolling-window estimates suggests that the cross-sectional variation cannot come all from estimation error. The important question is then: Where does the dollar exposure difference come from?

One common conjecture in the literature is that currency exposure is linked to the openness of the economy (or firm). For example, Dominguez and Tesar (2006) use bilateral trade to proxy for the openness of an economy. We agree that the degree of openness is important for currency exposure. A totally closed economy should be little affected by exchange rate movements. However, we argue that the direction or asymmetry of the international trade is the more relevant source for exchange rate exposure. A firm that balances imports with exports can have little currency exposure regardless of the aggregate quantity of the international trade. The direction of the currency exposure depends on whether the firm is more export or import oriented.

To test our hypothesis, we regress cross-sectionally the full-sample dollar exposure estimates (β^{fx}) on the time-series averages of the imports and exports of the corresponding industry. We scale imports and exports by the market capitalization of the corresponding industry to control for the size effect, and we take natural logarithms on the scaled quantity to obtain better distributional behaviors. The cross-sectional regression is over 402 industries. For comparison with the literature, we also regress the dollar exposure estimates against the logarithm of the total trades scaled by the market capitalization.

The regression estimates, t-statistics, and the (adjusted and unadjusted) R-squares are reported in Table IV. When regressing the dollar exposure on total trades, we obtain a slope coefficient estimate that is not significantly different from zero and an adjusted R-square that is no greater than zero. The regression results suggests that the total trades do not explain anything about the dollar exposure. By contract, when regressing the dollar exposure on the imports and the exports separately, we obtain significantly positive slope coefficient estimate on imports and significantly negative slope coefficient estimate on exports. The adjusted R-square of the regression remains low at 1.34%, indicating that a large proportion of the dollar exposures cannot be explained by the average imports and exports activities. Nevertheless, the slope estimates are statistically significant on both imports and exports. In particular, the estimates suggest that import-oriented companies are more likely to have positive exposures to the dollar index variation whereas export-oriented companies are more likely to have negative exposures to the dollar index variation. Putting it differently, stocks of import-oriented companies tend to react positively to dollar appreciation, but stocks of export-oriented companies tend to react negatively to dollar appreciation.

We have experimented with different transformations and scaling of the imports and exports volume. For example, we have used imports and exports without taking logarithms, and without the market capitalization scaling. These variations do not alter the qualitative results regarding the direction of the impacts of imports and exports on the dollar risk exposure, showing the robustness of the finding.

Our results make economic sense. For export-oriented companies, dollar appreciation makes their exports more costly for foreign consumers and hence reduces their sales. As traditional wisdom goes, domestic currency appreciation hurts exports. On the other hand, for import-oriented companies, dollar appreciation makes their imports less expensive and hence increases their profit margins. Our regression results reflect the different impacts of imports and exports on the currency exposure. The results support our argument that it is not the degree of openness in terms of total imports and exports that determines currency exposure; instead, it is the imbalance of international trade that generates the exposure.

When the sensitivities of dollar exposures to imports and exports are similar in absolute magnitudes, we can use the logarithm of imports-to-exports ratio, ln(IM/EX), to measure the imbalance of the international trade and directly regress the dollar exposure on the imbalance. The last two rows of Table IV report the results from such a univariate regression. The slope coefficient estimate is significantly positive, showing the informativeness of the trade imbalance measure about currency exposure. Nevertheless, the adjusted R-square of this univariate regression is lower than that from the bivariate regression. Therefore, it is beneficial to allow for different sensitivities of the dollar exposure to imports and to exports.

To analyze the time-variation of the relation between dollar exposure and import/export activities, we also perform rolling-window estimation. At each year, we regress the ten-year rolling-window estimates of the dollar exposure on the ten-year rolling averages of imports and exports. We estimate three different specifications as we have done in Table IV. Specification I regresses the dollar exposure on the logarithm of the total imports and exports normalized by market capitalization. Specification II regresses the exposure on the logarithm of the market-capitalization normalized imports and exports separately. Specification III regresses the exposure on the logarithm of the ratio of imports and exports. Table V reports the regression coefficients for all three specifications at each year from 1983 to 2002. The last two rows of the table report the sample averages of the coefficient estimates and their Newey and West (1987) t-statistics. The average results are largely consistent with our unconditional cross-sectional regression in Table IV. In particular, the average slope coefficient on imports is significantly positive and the average slope coefficient on exports is significantly negative.

V. Linking Dollar Exposure to Expected Stock Returns

Import- and export-oriented companies have systematically different dollar risk exposures, but does the difference in dollar exposures lead to different expected excess returns on their stocks?

We estimate the risk premiums on different types of risk exposures following a procedure popularized by Fama and MacBeth (1973). At each month t, we regress cross-sectionally the next month's excess stock portfolio returns on the time-t rolling-window estimates of the risk exposures,

$$ER^i_{t+1} = \eta^0_t + \eta^{fx}_t \beta^{fx}_{it} + \eta^{mkt}_t \beta^{mkt}_{it} + \eta^{smb}_t \beta^{smb}_{it} + \eta^{hml}_t \beta^{hml}_{it} + e^i_t, \tag{2}$$

where η^0_t denotes the intercept of time-t cross-sectional regression and η^k_t denotes the risk premium estimate for each unit of risk exposure on the k-th risk factor, with $k = fx, mkt, smb, hml$ denoting the dollar risk, stock market portfolio, SMB, and HML risk factors, respectively. All risk exposures are estimated based on a ten-year rolling window and updated annually in July of each year. As a concrete example, monthly excess returns from July 1995 to June 1996 are all regressed on risk exposure estimates based on a ten-year window from July 1986 to June 1995.

The time-series averages of the slope estimates capture the average risk premiums charged by the stock market on each unit of risk exposure in the four risk sources. Table VI reports the time-series averages of the regression estimates and the Newey and West (1987) t-statistics under "I. Without IM/EX." The average slope estimates are negative on the dollar risk exposure and positive on the other three risk exposures. Nevertheless, none of the slope averages are statistically significant. In this estimation, all risk exposures (β^k_{it}) are estimated by regressing the industry portfolio excess returns on the four risk factors with a ten-year rolling window. One potential reason for the low statistical significance is that the rolling-window estimation generates noisy risk exposure estimates.

To reduce the noise in the dollar risk exposure estimates and to enhance the identification of the dollar risk premium, we resort to our findings in the previous section that the dollar risk exposures are related to the imports and exports of the corresponding industries. The analysis is meant to identify the fundamental economic sources of the dollar risk exposure, but the linkage also suggests that the import and export quantities in an industry contain useful information that we can exploit to sharpen the estimation of the dollar risk exposure.

To incorporate the information in imports and exports, we propose an alternative estimation method based on the following specification,

$$ER^i_{t+1} = \eta^0_t + \eta^{fx}_t \left(\beta^{fx}_{it} + \lambda_{IM} \ln\left(\frac{IM}{ME}\right)_{it} + \lambda_{EX} \ln\left(\frac{EX}{ME}\right)_{it} \right) + \eta^{mkt}_t \beta^{mkt}_{it} + \eta^{smb}_t \beta^{smb}_{it} + \eta^{hml}_t \beta^{hml}_{it} + e^i_t, \quad (3)$$

where we regard the dollar exposure as an average of information from three sources: the original rolling window regression estimates based on stock returns β^{fx}_{it}, the imports, and the exports. As we have done earlier, we scale the imports and exports by the market capitalization of each industry and then take natural logarithms on the scaled quantities. In line with the rolling-window risk-exposure estimates, we also employ a ten-year rolling window in estimating the averages of the logarithm of the scaled imports and exports to be used in the regression. The imports and exports data are available annually. Corresponding to the risk exposure estimates with a rolling window from July 1986 to June 1995, for example, we use the averages of the log scaled imports and exports from year 1985 and 1994. The half year lag in timing is to make sure that the imports and exports data are available in June of 1995. Furthermore, for pure identification reasons, we normalize the weighting on β^{fx}_{it} to unity, and hold the weighting coefficients on imports and exports (λ_{IM} and λ_{EX}) to be constant over time. We estimate the system of equations based on an iterative procedure. First, given initial guess on the two coefficients, we perform cross-sectional regressions each month to obtain the risk premiums η^k_t. Then, we estimate the two coefficients by maximizing the likelihood of the forecasting errors from the regression, assuming that the regression errors are identical, independent, and normally distributed. The likelihood estimates on the two coefficients are 1.163 for λ_{IM} and -1.032 for λ_{EX}. The t-statistics for the two estimates are 11.2 and -10.64, respectively.

Both the sign and the high statistical significance confirm our earlier findings that imports relate positively to the dollar exposure and exports relate negatively to the dollar exposure.

Table VI reports the average risk premiums estimated from this approach under "II. with IM/EX." With the enhanced identification using information from imports and exports, the time-series average of the dollar risk premium η_t^{fx} now becomes negative and statistically significant at the 10% confidence level, with a t-statistic of -1.68. Thus, through equation (3), we have not only linked the dollar exposure to fundamental international trading quantities such as imports and exports, but also exploited this linkage in sharpening the identification of the dollar risk exposure and dollar risk premium.

The negative risk premium estimate suggests that in aggregate, market participants view dollar appreciation as an adverse shock to the economy. Thus, companies with positive dollar exposures generate higher stock returns during adverse economic conditions. Investors are willing to receive a lower expected excess return to gain positive exposures to dollar appreciation so that they can hedge against adverse movements in the economy.

To understand whether the dollar risk premium shows any systematic variation over time, we apply exponential smoothing on the monthly estimates of η_t^{fx} from equation (3),

$$\overline{\eta}_t^{fx} = \phi \overline{\eta}_{t-1}^{fx} + (1-\phi)\eta_t^{fx}, \tag{4}$$

where we set the smoothing coefficient $\phi = 0.97$, corresponding to a half life of about two years. Figure 3 plots the time series of the smoothed dollar risk premium estimates. Over the 20-year period, the dollar risk premium has become increasingly negative, showing a possibly combined effects of increasing aggregate currency exposure (Campa and Goldberg (1997)) and increasingly investor awareness of the risk inherent in currency exposure. Furthermore, we observe that the dollar risk premium becomes more negative during the two recessions of our sample period, one in the early 90s and the other in the early 2000. Investors become more concerned about the dollar risk exposure during recessions than during expansion periods.

[Figure 3 about here.]

Fama and French (1992) has popularized a simpler and more intuitive approach in quantifying risk premiums in terms of risk portfolios. Applying the approach to our case for the dollar risk premium, we form stock portfolios based on the rankings of the dollar risk exposure estimates. Starting from July 1983, we first estimate dollar risk exposure using a ten-year rolling window according to the two methods (with and without import/export information) delineated above. Then, we sort the industries by their dollar risk exposure estimates into five groups based on the quintile breakpoints of the dollar risk exposures. We compute the equal-weighted returns on quintile portfolios. The quintile portfolios of dollar risk exposures are rebalanced annually in July of each year.

Table VII reports the time-series averages of the percentage excess returns for the quintile portfolios. The row under "High-Low" reports the average return spreads between the top quintile (High) portfolio and the bottom quintile (Low) portfolio. The row under "FF-3 alpha" represents the intercept term from a regression of the High-Low return spread on the three Fama-French stock market factors, i.e., market, size, and book to market. This intercept term captures the portion of the dollar risk premium that cannot be explained by three stock market risk factors.

Consistent with the results in Table VI, the average dollar exposure return spreads are negative, more so when we rank the portfolios based on the enhanced dollar risk exposure estimates incorporating the information in imports and exports. Controlling for the three market risk factors does not alter the results much. The FF-3 alpha is estimated at -0.2587% without information from imports and exports, and at -0.3621% with the information from imports and exports. These estimates imply an annualized risk premium of 3-4%, an economically significant quantity.

VI. Robustness Analysis

In estimating the dollar risk exposure and risk premium from stock returns, we control for three systematic risk factors that have been identified from the stock market, i.e., the market portfolio, the size, and the book-to-market factors. One remaining question is to what extent common risk factors identified from other markets affect the dollar risk exposure and dollar risk premium estimates. Answering this question is important as it helps us to understand to what extent the identified risk premium on the dollar risk exposure is a proxy for compensation on other correlated risk factors.

As a robustness check, we examine whether the identified dollar risk exposure and risk premium can be explained by common risk factors identified from other markets. The additional risk factors that we examine include:

1. *The default spread* (DFL), defined as the difference between BAA- and AAA-rated corporate bond yields. The corporate bond yield data are obtained from the Federal Reserve Statistical Release.
2. *The term spread* (TRM), defined as the difference between ten-year Treasury bond yield and the three-month Treasury bill rate, both of which are available from CRSP.
3. *Log dividend-price ratio* (DPR), defined as log difference between the last 12-month's aggregate dividends and the current level of the S&P 500 index. Monthly data on the dividend price ratio are available on Robert Shiller's website.
4. *The three-month Treasury bill rate* (R_f), which we obtain from CRSP

These variables have been widely used in the literature to control for systematic variations in market conditions. The default spread measures the risk premium difference between the two rating groups charged by the corporate bond investors. The term spread represents a risk premium difference between Treasury bonds of different maturities. The log dividend-price ratio is widely received as a stock market condition indicator. Finally, the short-term Treasury bill rate often reflects fundamental economic conditions.

We repeat our analysis by controlling for the variations in these additional risk factors. Specifically, in estimating the dollar risk exposure, we expand the regression in equation (1) to include changes in the four additional variables; and in estimating the dollar risk premium in equations (2) and (3), we also include the risk exposure estimates on the four additional risk factors. Table VIII summarizes the main results from this repeated exercise. Panel A shows the results that trace dollar risk exposure estimates to imports and exports. Again, the regression of the dollar exposure on the total value of imports and exports generates a virtually zero R-square. By contract, regressing the dollar exposure on imports and exports separately generates significantly positive slope coefficient on imports and significantly negative slope coefficient on exports. Directly regressing the dollar exposure on the log import-export imbalance generates a significantly positive slope estimate, but the adjusted R-squares of the univariate regression is lower than that for the regression with imports and exports entered separately. We have also performed the rolling-window regressions as in Table V. The results are largely the same and are available upon request.

Panel B reports the results on the risk premium estimates. When we use the dollar risk exposure estimates from the stock market alone, the dollar risk premium is negative but not statistically significant. When we also incorporate the information in imports and exports to enhance the identification of the dollar risk exposure, the risk premium becomes significantly negative. All these results are largely consistent with what we have obtained without controlling for the additional variables. Therefore, we conclude that the negative risk premium on the dollar risk exposure is not a proxy for risk premiums on credit, term, dividend, or interest rate risk.

VII. Conclusion

Economic theory suggests that the magnitude and direction of a company's currency risk exposure depends crucially on its fundamental involvement in international trade. For US industries, we find that the stock performance of import-oriented companies moves positively with the performance of the dollar, but the stock performance of export-oriented companies tends to move against the dollar. Based on this finding, we use the imports and exports information to enhance the identification of the dollar risk exposure for different industries, and analyze how each industry's expected stock return varies with its dollar risk exposure. We identify a strongly negative risk premium for bearing positive exposures to the dollar. On average, import-oriented companies generate lower stock returns. We also find that the risk premium becomes more negative during recessions than during expansions.

In contrast to traditional focus on time-series variation, our research highlights the importance of exploiting the cross-sectional variation across different firms in identifying their different currency risk exposures and the fundamental sources of the exposures. This paper relies on the cross-sectional variation of industries classified based on four-digit SIC codes, the lowest level of aggregation at which the data are available to us. One line for future research is to construct the imports and exports data and the associated characteristics at the firm level and update the data to the most recent time period. The much larger cross section at the firm level can enhance the identification of the linkage between the currency exposures and the imports and exports activities and also the identification of the currency risk premium. Furthermore, with the firm level data, one can investigate how the exposure and its relation with imports and exports vary with different currency hedging practices in the firm. A firm can presumably remove its currency exposure, even in the presence of imbalanced imports and exports activities, by hedging using currency derivatives such as currency swaps. One can analyze how different degrees of hedging practice across different firms affect their exposures whiling controlling for imports and exports activities. One can also analyze whether increased hedging over time has significantly altered the cross-sectional characteristics of the currency exposures. Another important line for future research is to build structural economic models that link exchange rate exposures to international trade imbalances and explain when and why positive dollar exposure generates negative risk premiums.

References

Adler, Michael, and Bernard Dumas, 1983, International portfolio selection and corporate finance: A synthesis, *Journal of Finance* 38, 925–984.

Aizenman, Joshua, and Daniel Riera-Crichton, 2007, Real exchange rate and international reserves in an era of growing financial and trade integration, *Review of Economics and Statistics* forthcoming.

Allayannis, George, 1997, The time-variation of the exchange rate exposure: An industry analysis, Working paper, University of Virginia.

Allayannis, George, and Jane Ihrig, 2001, Exposure and markups, *Review of Financial Studies* 14, 805–835.

Amihud, Yokov, 1994, Exchange rates and valuation of equity shares, in Yakov Amihud, and Richard Levich, eds.: *Exchange Rates and Corporate Performance* (Irwin, New York).

Bodnar, Gordon M., and William M. Gentry, 1993, Exchange rate exposure and industry characteristics: evidence from canada, japan, and the usa, *Journal of International Money and Finance* 12, 29–45.

Campa, Jose, and Linda S. Goldberg, 1997, The evolving external orientation of manufacturing: a profile of four countries, in *Economic Policy Review* (Federal Reserve Bank of New York, New York).

Campa, Jose, and Linda S. Goldberg, 1999, Investment, pass-through, and exchange rates: a cross-country comparison, *International Economic Review* 40, 287–314.

Campa, Jose, and Linda S. Goldberg, 2005, Exchange rate pass through into import prices, *Review of Economics and Statistics* 87, 679–690.

Carrieri, Francesca, Vihang Errunza, and Basma Majerbi, 2004, Does emerging market exchange risk affect global equity prices?, *Journal of Financial and Quantitative Analysis* forthcoming.

De Santis, Giorgio, and Bruno Gerard, 1998, How big is the premium for currency risk?, *Journal of Financial Economics* 49, 375–412.

Dominguez, Kathryn M. E., and Linda L. Tesar, 2001, A re-examination of exchange rate exposure, *American Economic Review: Papers and Proceedings* 91, 396–399.

Dominguez, Kathryn M. E., and Linda L. Tesar, 2006, Exchange rate exposure, *Journal of International Economics* 68, 188–218.

Dumas, Bernard, 1992, Dynamic equilibrium and the real exchange rate in a spatially separated world, *Review of Financial Studies* 5, 153–180.

Dumas, Bernard, and Bruno Solnik, 1995, The world price of foreign exchage risk, *Journal of Finance* 50, 445–479.

Engel, Charles, Nelson C. Mark, and Kenneth D. West, 2007, Exchange rate models are not as bad as you think, Working paper, University of Wisconsin, University of Notre Dame, and University of Wisconsin.

Engel, Charles, and Kenneth West, 2005, Exchange rates and fundamentals, *Journal of Political Economy* 113, 485–517.

Evans, Martin D. D., and Richard K. Lyons, 2002, Order flow and exchange rate dynamics, *Journal of Political Economy* 110, 170–180.

Fama, Eugene F., and Kenneth R. French, 1992, The cross-section of expected stock returns, *Journal of Finance* 47, 427–465.

Fama, Eugene F., and Kenneth R. French, 1993, Common risk factors in the returns on stocks and bonds, *Journal of Financial Economics* 33, 3–56.

Fama, Eugene F., and James D. MacBeth, 1973, Risk return, and equilibrium: Empirical tests, *Journal of Political Economy* 81, 607–636.

Feenstra, Robert C., 1996, U.S. imports, 1972-1994: Data and concordances, NBER Working Paper 5515 UC Davis.

Feenstra, Robert C., 1997, U.S. exports, 1972-1994, with state exports and other U.S. data, NBER Working Paper 5990 UC Davis.

Feenstra, Robert C., John Romalis, and Peter K. Schott, 2002, U.S. imports, exports and tariff data: 1989–2001, NBER Working Paper 9387 UC Davis, University of Chicago, and Yale University.

Ferson, Wayne E., and Campbell R. Harvey, 1993, The risk and predictability of international equity returns, *Review of Financial Studies* 6, 527–566.

Ferson, Wayne E., and Campbell R. Harvey, 1994, Sources of risk and expected returns in global equity markets, *Journal of Banking and Fiance* 18, 755–803.

Goldberg, Linda, 2004, Industry-specific exchange rates for the united states, *Federal Reserve Bank of New York Economic Policy Review* 10, 1–16.

Griffin, John M., and René M. Stulz, 2001, International competition and exchange rate shocks: A cross-country industry analysis, *Review of Financial Studies* 14, 215–241.

Harvey, Campbell R., 1995a, Global risk exposure to a trade-weighted currency index, Working paper, Duke University.

Harvey, Campbell R., 1995b, Predictable risk and returns in emerging markets, *Review of Financial Studies* 8, 773–816.

He, Jia, and Lilian K. Ng, 1998, The foreign exchange exposure of japanese multinational corporations, *Journal of Finance* 53, 733–753.

Hoberg, Gerard, and Gordon Phillips, 2006, Real and financial industry booms and busts, Working paper, University of Maryland.

Jorion, Philippe, 1990, The exchange rate exposure of u.s. multinationals, *Journal of Business* 63, 331–345.

Jorion, Philippe, 1991, The pricing of exchange rate risk in the stock market, *Journal of Financial and Quantitative Analysis* 26, 363–373.

Lothian, James R., and Mark P. Taylor, 1996, Real exchange rate behavior: The recent float from the perspective of the past two centuries, *Journal of Political Economy* 104, 488–509.

Mark, Nelson, 1995, Exchange rates and fundamentals: Evidence on long-horizon predictability, *American Economic Review* 85, 201–218.

Newey, Whitney K, and Kenneth D. West, 1987, A simple positive-definite heteroskedasticity and autocorrelation consistent covariance matrix, *Econometrica* 55, 703–708.

Sercu, Piet, 1980, A generalization of the international asset pricing model, *Revue de l'Association Française de Finance* 1, 91–135.

Sercu, Piet, and Raman Uppal, 2000, *Exchange Rate Volatility, Trade, and Capital Flows under Alternative Exchange Rate Regimes*. (Cambridge University Press Cambridge, UK).

Solnik, Bruno H., 1974, An equilibrium model of the international capital market, *Journal of Economic Theory* 8, 500–524.

Stulz, René, 1981, A model of international asset pricing, *Journal of Financial Economics* 9, 383–406.

Table I
Summary statistics of monthly returns on the dollar index and market risk factors

Entries report the summary statistics of monthly returns on the dollar index (R^{fx}), excess monthly returns over Treasury bill rate on the dollar index (ER^{fx}), excess monthly returns on the market portfolio (R^{mkt}), returns on the size (SML) and book-to-market (HML) risk portfolios, and the Treasury bill rate (R_f). Data are monthly from February 1973 to December 2001. The mean and standard deviations (Std) are in annualized percentages, the minimum and maximum are in monthly percentages. We also report the skewness, excess kurtosis, and monthly autocorrelation for each time series.

	R^{fx}	ER^{fx}	ER^{mkt}	SML	HML	R_f
Mean	4.566	-1.995	5.886	2.235	5.587	6.562
Std	4.456	4.400	16.327	11.812	11.229	0.764
Minimum	-4.175	-4.585	-23.130	-16.700	-12.800	0.150
Maximum	4.243	3.367	16.050	22.180	13.800	1.350
Skewness	-0.081	-0.166	-0.518	0.641	0.035	1.195
Kurtosis	0.607	0.679	2.215	6.919	2.238	1.657
Autocorrelation	0.347	0.333	0.039	0.014	0.114	0.928

Table II
Summary statistics on the imports, exports, and stock returns

Entries report the summary statistics on the natural logarithm of imports (IM), exports (EX) and the ratio of imports and exports to the market capitalization of the corresponding industry (IM/ME, EX/ME). The last column reports the summary statistics of the monthly excess log returns on industry portfolios (ER). In the first panel, we take time-series averages on the quantities and report the cross-sectional summary statistics of the time-series averages. In the second panel, we take cross-sectional averages and report the time-series statistics of the cross-sectional averages. The trade quantities and the market capitalization are both in millions. For the industry portfolio excess returns, the mean, median and standard deviation (Std) are in annualized percentages, the maximum and minimum are in monthly percentages. The cross-sectional statistics are over 402 industry observations. The time-series statistics are over 30 annual observations for the trade data and 360 monthly observations for the industry portfolio excess returns.

	IM	EX	ln(IM)	ln(EX)	ln(IM/ME)	ln(EX/ME)	ER
A. Cross-sectional statistics of time-series averages							
Mean	884.991	688.685	4.953	4.767	-0.714	-0.912	6.831
Median	177.197	121.356	5.021	4.703	-0.648	-0.937	8.709
Std	3268.866	1782.610	1.869	1.853	2.237	1.878	5.245
Minimum	0.082	0.168	-3.073	-1.845	-7.592	-6.783	-14.466
Maximum	51708.752	14992.312	10.683	9.592	4.331	4.530	5.158
Skewness	11.265	5.263	-0.282	0.034	-0.307	-0.039	-3.849
Kurtosis	160.865	32.199	0.987	0.067	0.155	0.323	34.441
B. Time-series statistics of cross-sectional averages							
Mean	1950.052	1427.413	5.895	5.748	-0.942	-1.087	8.044
Median	1975.805	1385.499	6.249	6.024	-0.920	-1.037	11.407
Std	1231.271	919.761	0.877	0.892	0.119	0.110	18.802
Minimum	329.303	312.689	4.299	4.329	-1.205	-1.271	-28.957
Maximum	4280.166	3089.771	6.981	6.916	-0.775	-0.924	19.404
Skewness	0.229	0.346	-0.678	-0.391	-0.778	-0.331	-0.705
Kurtosis	-0.965	-1.151	-1.024	-1.407	-0.157	-1.361	4.061
C. Cross-sectional averages of time-series statistics							
Mean	884.991	688.685	4.953	4.767	-0.714	-0.912	6.831
Median	836.546	631.468	4.971	4.756	-0.697	-0.915	0.655
Std	374.742	261.144	0.381	0.276	0.342	0.307	33.994
Minimum	411.694	391.299	4.394	4.383	-1.201	-1.332	-29.192
Maximum	1557.425	1149.775	5.464	5.151	-0.281	-0.507	34.227
Skewness	0.373	0.104	-0.037	-0.169	-0.108	-0.132	0.235
Kurtosis	-0.755	-0.437	-0.962	-0.512	-0.434	-0.614	3.390

Table III
Summary statistics on the risk exposure estimates

Entries report the summary statistics on the slope estimates and their statistics of the following time-series regression on each industry portfolio,

$$ER_t^i = \beta_{i0} + \beta_i^{fx} ER_t^{fx} + \beta_i^{mkt} ER_t^{mkt} + \beta_i^{smb} SMB_t + \beta_i^{hml} HML_t + e_t,$$

where ER^i, ER^{fx}, ER^{mkt} denote the monthly excess returns on the ith industry portfolio, the dollar index, and the market portfolio, respectively, and SMB and HML are the size and book-to-market risk factors. All regressions are performed on monthly returns over the sample period from February 1973 to December 2001. The summary statistics are over 402 industries for the full-sample estimates and 375 for the rolling-window estimates. The last column reports the statistics on the R-squares of the regressions.

	β^{fx}		β^{mkt}		β^{smb}		β^{hml}		R^2
	Estimates	t-statistics	Estimates	t-statistics	Estimates	t-statistics	Estimates	t-statistics	
A. Cross-sectional statistics of full-sample estimates									
Mean	0.048	0.125	0.968	8.079	0.979	5.040	0.332	1.801	0.397
Median	0.043	0.098	0.977	7.498	0.955	4.576	0.360	1.748	0.394
Std	0.629	1.009	0.280	4.555	0.546	3.342	0.484	2.317	0.161
Minimum	-2.417	-2.692	-0.348	-0.752	-0.365	-2.838	-1.776	-4.239	0.048
Maximum	1.799	3.134	2.057	23.391	3.311	18.795	2.516	9.668	0.878
Skewness	-0.236	0.165	-0.444	0.716	0.482	0.995	-0.370	0.476	0.187
Kurtosis	2.321	-0.305	3.374	0.366	0.870	1.784	3.032	0.743	-0.249
B. Cross-sectional statistics of time-series averages of rolling-window estimates									
Mean	0.111	0.167	0.932	5.888	1.000	3.669	0.232	0.908	0.407
Median	0.047	0.097	0.940	5.712	0.997	3.426	0.246	0.947	0.412
Std	0.614	0.896	0.264	2.856	0.543	2.175	0.437	1.266	0.160
Minimum	-2.188	-1.834	-0.697	-0.872	-0.304	-1.700	-2.877	-2.770	0.035
Maximum	2.994	3.306	1.980	16.930	3.496	13.575	2.215	4.519	0.884
Skewness	0.569	0.243	-0.604	0.598	0.574	0.733	-1.345	-0.136	0.224
Kurtosis	2.946	-0.110	4.473	0.724	1.803	1.767	10.524	0.068	-0.235
C. Time-series statistics of cross-sectional averages of rolling-window estimates									
Mean	0.058	0.096	0.948	6.408	0.983	4.079	0.234	0.942	0.424
Median	0.054	0.083	0.949	6.550	1.023	4.065	0.229	0.958	0.429
Std	0.061	0.107	0.027	0.787	0.120	0.294	0.128	0.563	0.055
Minimum	-0.060	-0.071	0.895	4.951	0.706	3.597	0.056	0.141	0.327
Maximum	0.164	0.302	1.009	7.621	1.163	4.617	0.577	2.287	0.501
Skewness	0.149	0.200	-0.078	-0.282	-0.759	0.069	0.823	0.649	-0.421
Kurtosis	-0.521	-0.783	0.885	-0.695	0.260	-0.677	1.299	0.124	-0.947
D. Cross-sectional averages of time-series statistics of rolling-window estimates									
Mean	0.111	0.167	0.932	5.888	1.000	3.669	0.232	0.908	0.407
Median	0.110	0.169	0.929	5.863	0.998	3.612	0.210	0.813	0.402
Std	0.296	0.496	0.142	1.111	0.246	0.927	0.259	0.912	0.074
Minimum	-0.295	-0.535	0.740	4.322	0.660	2.403	-0.091	-0.243	0.308
Maximum	0.529	0.875	1.126	7.450	1.330	5.042	0.606	2.257	0.512
Skewness	0.029	0.009	-0.012	-0.025	0.021	0.109	0.171	0.152	0.194
Kurtosis	0.004	-0.204	-0.480	-0.357	-0.140	-0.072	-0.433	-0.479	-0.349

Table IV
Tracing dollar exposures to imports and exports

Entries report the estimates, *t*-statistics (in parentheses), and adjusted R-squares of various cross-sectional regressions that link the dollar exposure β^{fx} to various combinations of exports and exports. The dollar exposure for each industry is estimated by regressing the industry portfolio returns on the dollar index returns and other stock risk factors over the whole sample period from February 1973 to December 2001. The regressors are time-series averages of the imports and export variables. Each cross-sectional regression is over 402 industries.

	Intercept	ln((IM+EX)/ME)	ln(IM/ME)	ln(EX/ME)	ln(IM/EX)	R^2	Adj. R^2
I.	-0.0295	0.0129				0.23%	-0.01%
	(-0.92)	(0.75)					
II.	0.0394		0.0583	-0.0536		1.84%	1.34%
	(0.92)		(2.68)	(-1.93)			
III.	0.0352				0.0466	0.99%	0.74%
	(1.10)				(2.00)		

Table V

Time variation in the relation between dollar exposures and imports and exports

Entries report annual regression estimates when we regress the 10-year rolling-window dollar exposure estimate each year on different formulations of the ten-year rolling-window averages of imports and exports. The last two rows report the time-series averages and their Newey-West *t*-statistics of the estimates.

	I		II			III	
Year	Intercept	ln((IM+EX)/ME)	Intercept	ln(IM/ME)	ln(EX/ME)	Intercept	ln(IM/EX)
1983	0.1146	0.0306	0.1334	0.0708	-0.0519	0.1147	0.0646
1984	0.1337	0.0238	0.1510	0.0382	-0.0205	0.1347	0.0327
1985	0.1614	0.0118	0.1671	0.0196	-0.0126	0.1607	0.0184
1986	0.0583	-0.0045	0.0458	0.0075	-0.0184	0.0568	0.0080
1987	0.0823	0.0144	0.0735	0.0367	-0.0347	0.0713	0.0361
1988	0.0792	0.0123	0.0662	0.0412	-0.0405	0.0661	0.0391
1989	0.1431	0.0624	0.1479	0.0809	-0.0459	0.1071	0.0716
1990	0.0566	0.0231	0.0498	0.0276	-0.0250	0.0461	0.0279
1991	0.0132	0.0150	-0.0320	0.0662	-0.0886	-0.0046	0.0606
1992	-0.0599	0.0023	-0.0888	0.0291	-0.0510	-0.0649	0.0230
1993	0.0035	0.0444	-0.0045	0.0823	-0.0727	-0.0122	0.0739
1994	0.0700	0.0653	0.0958	0.0634	-0.0247	0.0573	0.0536
1995	0.0561	0.0565	0.0758	0.0626	-0.0304	0.0437	0.0553
1996	0.0521	0.0427	0.0652	0.0430	-0.0218	0.0437	0.0382
1997	0.1597	0.0602	0.1931	0.0540	-0.0122	0.1523	0.0487
1998	0.0585	0.0138	0.0571	0.0325	-0.0316	0.0562	0.0305
1999	-0.0059	-0.0009	-0.0205	0.0600	-0.0741	-0.0055	0.0601
2000	-0.0110	-0.0006	-0.0233	0.0452	-0.0560	-0.0109	0.0460
2001	0.0245	0.0180	0.0280	0.0166	-0.0083	0.0183	0.0137
2002	-0.0028	-0.0163	-0.0089	-0.0171	0.0065	0.0045	-0.0167
Mean	0.0594	0.0237	0.0586	0.0430	-0.0357	0.0518	0.0393
t-value	3.2727	3.4938	2.7356	7.3054	-6.0525	2.8023	7.8183

Table VI
Identifying dollar risk exposures and risk premiums

Entries report time-series averages and Newey and West (1987) t-statistics (in parentheses) of the coefficient estimates from the following cross-sectional regression performed at each month t,

$$ER^i_{t+1} = \eta^0_t + \eta^{fx}_t \beta^{fx}_{it} + \eta^{mkt}_t \beta^{mkt}_{it} + \eta^{smb}_t \beta^{smb}_{it} + \eta^{hml}_t \beta^{hml}_{it} + e^i_t,$$

where ER^i_{t+1} denotes next month's excess return on the i-th industry portfolio, β^k_t denotes the ten-year rolling-window risk exposure estimates, η^k_t denotes the slope coefficient on each risk exposure, with $k = fx, mkt, smb, hml$ denoting the four sources of systematic risks in the stock market, and η^0_t denotes the intercept of the regression. We consider two methods in estimating the dollar risk exposure β^{fx}_t,

I. Without IM/EX: We regress excess returns on each industry portfolio to excess returns on the dollar index, the market portfolio, the size portfolio, and the book-to-market portfolio using a ten-year rolling window. The slope coefficients estimates represent the risk exposure estimates on the four risk sources, β^{fx}_t, β^{mkt}_t, β^{smb}_t, and β^{hml}_t.

II. With IM/EX: We estimate the following system of equations,

$$ER^i_{t+1} = \eta^0_t + \eta^{fx}_t \left(\beta^{fx}_{it} + \lambda_{IM} \ln(IM/ME)_{it} + \lambda_{EX} \ln(EX/ME)_{it}\right) + \eta^{mkt}_t \beta^{mkt}_{it} + \eta^{smb}_t \beta^{smb}_{it} + \eta^{hml}_t \beta^{hml}_{it} + e^i_t,$$

where the coefficients (λ_{IM} and λ_{EX}) are hold constant over time. Given the two coefficients, the risk premiums are estimated using cross-sectional regression. The two coefficients are estimated by maximizing the likelihood of the observations, assuming that the regression errors are identically and independently normally distributed.

Method	η^0	η^{fx}	η^{mkt}	η^{smb}	η^{hml}
I. Without IM/EX	0.4713	-0.0287	0.1605	0.0416	-0.0119
	(1.14)	(-0.29)	(0.43)	(0.17)	(-0.04)
II. With IM/EX	0.4777	-0.0655	0.124	0.0771	0.0181
	(1.14)	(-1.68)	(0.34)	(0.30)	(0.07)

Table VII
Average return spreads between high and low dollar risk exposure portfolios

Entries report time-series averages of percentage monthly excess returns on quintile portfolios formed based on the rankings of dollar risk exposures. The dollar risk exposure is estimated in two alternative ways. The first approach (I. Without IM/EX) estimates the exposure by regressing the excess stock returns on the dollar index returns and other market risk factors, without incorporating information from imports and exports. The second approach (II. With IM/EX) incorporates the information in imports and exports in estimating the dollar risk exposures. The row under "High-Low" reports return spreads between top and bottom quintile portfolios. The row under "FF-3 Alpha" is obtained from regressing the return spread on market, size, and book-to-market risk factors. We also report the Newey and West (1987) t-statistics for each estimate in parentheses.

	I. Without IM/EX		II. With IM/EX	
Low	0.6438	(1.63)	0.7275	(1.99)
2	0.6870	(2.00)	0.7452	(1.98)
3	0.8175	(2.18)	0.8140	(2.05)
4	0.7441	(1.86)	0.6236	(1.67)
High	0.4510	(1.22)	0.4545	(1.17)
High-Low	-0.1927	(-1.09)	-0.2730	(-1.29)
FF-3 Alpha	-0.2587	(-1.32)	-0.3621	(-1.61)

Table VIII
Robustness analysis

Panel A reports the estimates, *t*-statistics (in parentheses), and adjusted R-squares of various cross-sectional regressions that link the dollar exposure estimates β^{fx} to various combinations of exports and exports. The dollar exposure for each industry is estimated by regressing industry portfolio returns on the dollar index returns, and seven additional market risk factors including the stock market portfolio (mkt), the size factor (smb), the book-to-market equity risk factor (hml), and changes in default spread (dfl), term spread (trm), log dividend-price ratio (dpr), and the short-term Treasury bill rate (Rf). The regression is over the whole sample period from February 1973 to December 2001. The regressors are time-series averages of the imports and export variables. Each cross-sectional regression is over 402 industries. Panel B reports the time-series averages and Newey and West (1987) *t*-statistics (in parentheses) of monthly cross-sectional regressions that regress next month's stock returns on various risk exposure estimates. In the panel, method I uses the dollar risk exposure estimates without incorporating imports and exports information, method II incorporates the information in imports and exports in enhancing the dollar risk exposure estimates via a maximum likelihood method.

A: Tracing dollar risk exposure to imports and exports

	Intercept	ln((IM+EX)/ME)	ln(IM/ME)	ln(EX/ME)	ln(IM/EX)	R^2	Adj. R^2
I.	-0.0167	0.0023				0.00%	-0.25%
	(-0.49)	(0.13)					
II.	-0.0395		0.0612	-0.0714		1.96%	1.46%
	(-1.05)		(2.65)	(-2.62)			
III.	-0.0301				0.0498	0.97%	0.72%
	(-0.87)				(1.98)		

B: Estimating risk premiums on risk exposures

Method	η^0	η^{fx}	η^{mkt}	η^{smb}	η^{hml}	η^{dfl}	η^{trm}	η^{dpr}	η^{rf}
I. Without IM/EX	0.4348	-0.0294	0.1952	0.0231	-0.0201	0.0144	0.0280	-0.0671	-0.0619
	(1.08)	(-0.31)	(0.51)	(0.09)	(-0.08)	(1.57)	(1.15)	(-0.60)	(-1.90)
II. With IM/EX	0.4387	-0.0294	0.1413	0.0699	0.0046	0.0144	0.0352	-0.0587	-0.0670
	(1.06)	(-1.94)	(0.37)	(0.27)	(0.02)	(1.55)	(1.42)	(-0.53)	(-1.99)

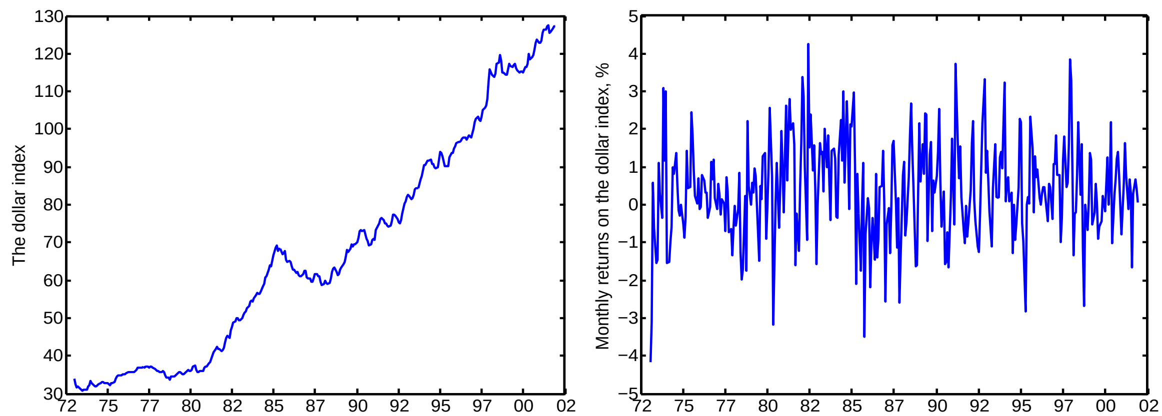

Figure 1. The time series of the dollar index and monthly returns on the index.
The left panel plots the time series of the weighted average dollar index. The right panel plots the monthly returns on the dollar index.

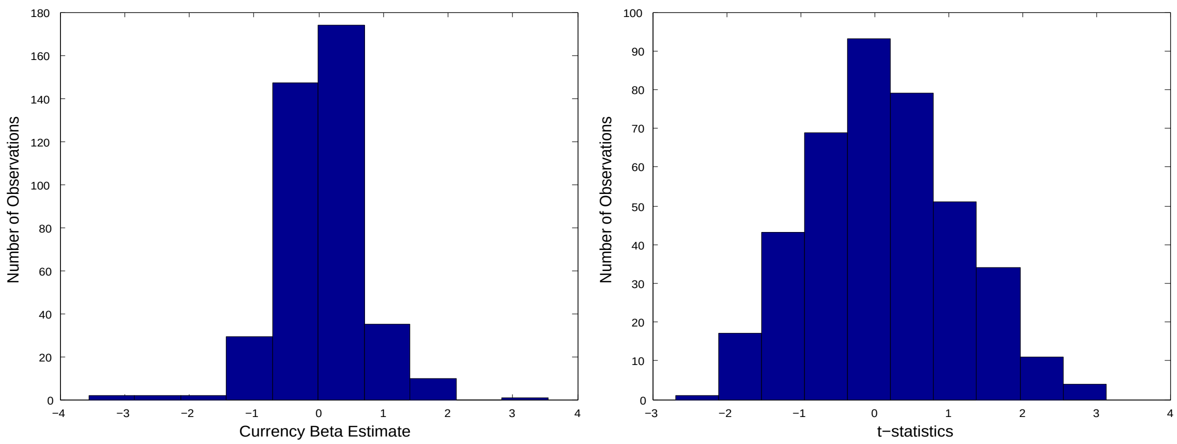

Figure 2. Histogram of slope coefficient estimates and *t*-statistics on dollar exposures. The left panel plots the histogram of industry dollar risk exposures. The left panel plots the histograms of the corresponding *t*-statistics

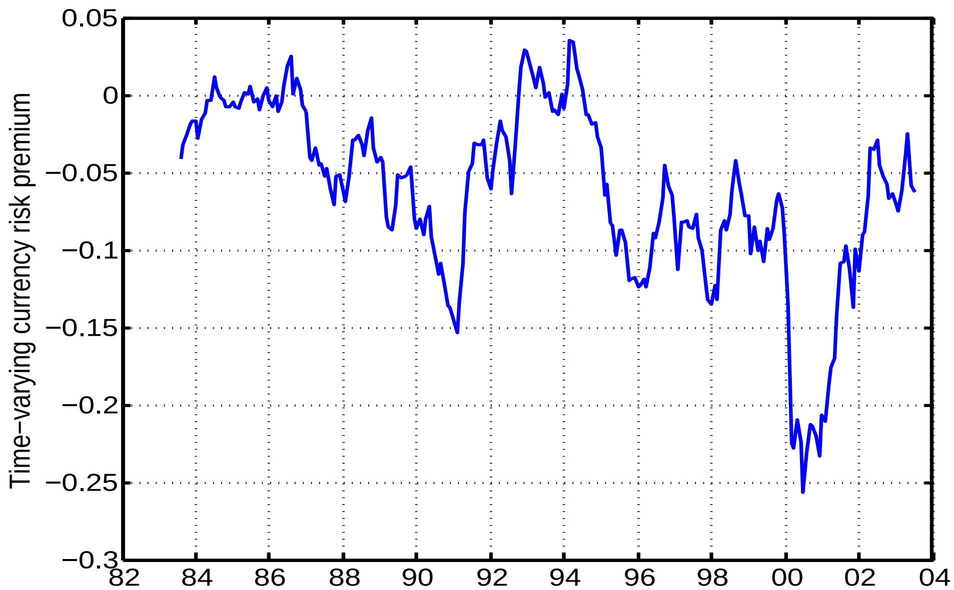

Figure 3. Time-varying dollar risk exposure.

The line plots the time series of the smoothed dollar risk premium estimates. We first obtain monthly dollar risk premium estimates from cross-sectional regressions, and then apply exponential smoothing on the estimates to generate the line plot.