



Linear and nonlinear exchange rate exposure[☆]

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Abstract

This paper presents a new methodological approach to examine exchange rate exposure which takes account of the role of the market portfolio and macroeconomic variables in exposure regressions, exchange rate regimes based on periods of depreciation and appreciation, and nonlinear exposure. Within each regime we show that the stock market's own exposure to exchange rates should be taken into account before considering industry exposure. In addition, we adjust the exchange rate and the stock market for common economy-wide factors that are unrelated to exchange rates. Within this framework we show that exposure to bilateral exchange rates is statistically and economically important and that industries with extensive international trade are more often exposed than industries with low levels of international trade. The signs of exposure coefficients in each regime are consistent with the extent to which an industry exports. We also show that nonlinear exposure is often statistically and economically significant. Interestingly, there is little evidence that industries are exposed to a currency basket.

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Empirical evidence indicates that there are deviations from purchasing power parity that national economies are becoming increasingly integrated, product and financial markets are

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becoming globalized, and corporate profits are affected by currency movements. In the light of this, it is puzzling that the economic and statistical relationship between exchange rate changes and US stock returns is marginal at best. The majority of empirical studies test for a constant linear relationship between stock returns and exchange rate changes.¹ In contrast, the theoretical literature on the relationship between the value of a firm and the exchange rate generally posits a nonlinear relationship.² Furthermore, there are a number of theoretical models that illustrate how firm behavior will be different when the currency is depreciating relative to it appreciating.³ Therefore, measuring exposure could be further complicated by the fact that exposure may depend on the exchange rate regime. These factors mean that the traditional method of measuring linear exposure may be inappropriate.

Consider Fig. 1 which illustrates both linear and nonlinear exposure for an exporter. The long straight line depicts the case where exposure is estimated as one linear relationship for the whole period and the hyperbola does the same for nonlinear exposure. We also plot two straight lines joined at zero but with different slopes where linear exposure is shown separately for appreciation and depreciation periods.

The figure illustrates the nature of the trade off between estimation methods. Estimating linear exposure for the whole period gives a line with a slope matching the nonlinear curve around zero. This line is useful for finding the effects of small changes in the exchange rate, but as the absolute level of depreciation or appreciation increases, it does a progressively worse job in showing the link between changes in exchange rates and stock returns. Estimating linear exposure separately for appreciation and depreciation periods allows the slope of the posited relationship to change across the two. However, even in this case, if the actual relationship is nonlinear then it would be necessary to use separate nonlinear terms in each regime. A small number of studies examine nonlinear exposure but in economic terms the estimated effects are limited, especially for developed markets, and in particular in the US.⁴

The contribution of our paper lies in assessing linear, nonlinear and regime specific exposure using a methodological innovation relative to the current literature. The central part of our work focuses on the role of the market portfolio in exposure regressions. The market portfolio is typically included in the exposure regression to proxy for omitted factors that may cause spurious correlation between stock returns and exchange rates. However, when it is included the resulting estimate of exposure is that which is in addition to the extent that the market is exposed. Therefore, if a firm's exposure coefficient is estimated to be zero it does not necessarily imply that the firm is not exposed. In light of this, the current methodology of assessing exchange rate exposure is not adequate to answer the question of whether firms are exposed to exchange rates.

Bodnar and Wong (2003) address the issue of the role of the market portfolio in exposure regressions. They focus on the return horizon and the choice of a value versus an equally weighted market portfolio and find that exposure estimates are sensitive to this choice. We

¹ See, for example, Jorion (1990), Bodnar and Gentry (1993), Amihud (1994), Griffin and Stulz (2001) and Doidge et al. (2000).

² Krugman (1987), Feenstra (1989), Marston (1990), Knetter (1991) and Marston (2001) provide theoretical models that consider how firms react to exchange rate changes. Mann (1986), Knetter (1989), Marston (1990) and Knetter (1993) report evidence on firms changing margins and prices when exchange rates change.

³ See, for example, Krugman (1987), Baldwin (1988), Baldwin and Krugman (1989), Dixit (1989), Froot and Klemperer (1989), Knetter (1994), and Kogut and Kulatilaka (1994).

⁴ See Allayannis (1997), Allayannis and Ihrig (2001), Bodnar et al. (2002), Doidge et al. (2000), Griffin and Stulz (2001) and Bartram (2002).

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