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Direct versus indirect regression estimates of foreign exchange cash flow exposure

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ABSTRACT

To estimate foreign exchange (FX) cash flow exposure, one may choose between direct and indirect regression approaches, where the direct approach uses accounting-based cash flow data and the indirect approach uses equity returns as a cash flow proxy. The indirect approach typically includes one or more additional independent variables to control for the impact of FX changes on the required rate of return. Frequently, the control variable is an equity index. We propose that using a bond return control variable instead of equity returns addresses several theoretical problems inherent in the indirect estimation approach. In our empirical analysis we find that using the bond-based control variable results in FX cash flow exposure estimates that are more highly correlated with direct measures than using an equity index as a control variable.

1. Introduction

Unexpected changes in foreign exchange (FX) rates can substantially affect a firm's cash flows, leaving financial managers with important risk management decisions. To effectively manage FX risk, managers need to estimate FX cash flow exposure, the sensitivity of cash flows to unexpected FX rate changes. Estimating FX cash flow exposure using popular regression approaches requires a cash flow measure. Typically this involves a choice between (a) a direct approach, using cash flow data or accounting-based cash flow proxies, and (b) an indirect approach, using stock returns.

Measuring FX cash flow exposure is important for financial managers. From a theoretical perspective, reducing cash flow volatility can benefit the firm (e.g., Froot, Scharfstein, & Stein, 1993; Smith & Stulz, 1985; Stulz, 1984), thus requiring financial managers to quantify FX cash flow exposure. Survey data corroborates that financial managers' primary goal of hedging is the reduction of cash flow volatility rather than the volatility of firm value (Bodnar, Hayt, & Marston, 1996, 1998; Bodnar, Hayt, Marston, & Smithson, 1995). Indeed findings by Bartram and Bodnar (2012) and Giaccotto and Krapl (2014) show that FX equity exposures are, at the firm level, primarily determined by a cash flow effect.

Direct estimates of FX cash flow exposure have been found for single companies, for example, by Garner and Shapiro (1984), Oxelheim and Wihlborg (1995), and Bartram (2008). But noise problems with cash flow data, especially near-zero and negative observations, often make direct estimation of FX cash flow exposure difficult or impossible. To our knowledge, the only studies using larger samples of direct estimates are Bartram (2007), for US nonfinancial firms, and Martin and Mauer (2003) for US financial firms.

Because direct estimates of FX cash flow exposure are often problematic, the indirect approach, called the capital market approach (Martin & Mauer, 2005), is often used, especially in research. The advantage of equity returns is the absence of the noise problem inherent in cash flow data and accounting-based cash flow proxies. When using the capital market approach, many researchers have included various macroeconomic variables to control for spurious correlation between FX rates and factors that affect stock returns. Following Jorion (1990), many have used an equity market index control variable. But other variables have been used instead of, or in addition to an equity index; examples include the specifications suggested by Chow, Lee, and Solt (1997b) and Doukas, Hall, and Lang (2003).

As Bodnar and Wong (2003) show, including an equity index control variable to estimate FX cash flow exposure with the capital market approach may be problematic. This is so because the equity index itself is likely to have a non-zero aggregate FX cash flow exposure; this results in FX cash flow exposure estimates that are net measures relative to the

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index rather than total FX cash flow exposures. In contrast to equity, a Treasury bond has no FX cash flow exposure (e.g., Chow, Lee, & Solt, 1997a), but the return would be affected by impact of FX changes on the risk-free rate and thus on required rates of return in general. It follows that the Treasury bond return could be a better control variable than an equity index in terms of yielding a better indirect estimate of FX cash flow exposure.

Since true FX cash flow exposures are unobservable, we believe that a first step in this analysis is to empirically compare a sample of direct estimates with the corresponding indirect estimates using each of the control variables. It is likely that the best control variable to use in indirect estimation of FX cash flow exposure yields average estimates that are empirically closer to average direct estimates based on large samples. Moreover, we hypothesize that FX exposure estimates using the Treasury bond return control variable will be more highly correlated with direct estimates of FX cash flow exposure than are estimates using an equity index control variable.

We estimate direct estimates of FX cash flow exposure for a sample of 3659 US companies, following the only two techniques found in the literature, (Bartram, 2007) and (Martin and Mauer, 2005). Although the two techniques yield different direct estimates, we observe that the estimates of *both* techniques are significantly more correlated with the indirect estimates when controlling with a bond return than with an equity index. Moreover, using the bond return control variable provides indirect estimates that are more highly correlated with the direct estimates than alternative control variable specifications such as the three Fama–French factors and size-matched equity portfolios.

This paper proceeds as follows. Section 2 summarizes the capital market-based and cash flow-based FX cash flow exposure measures and presents theoretical support for the use of an interest rate (bond) control variable. In Section 3 we discuss the methodology and describe the data used in our analysis. Section 4 presents the primary empirical results and corresponding discussions, whereas in Section 5 we address issues of robustness and provide results of additional tests. Section 6 concludes the study.

2. Direct and indirect approaches to estimating FX cash flow exposure

2.1. Indirect (capital market) approach

Adler and Dumas (1984) introduced the idea of estimating a firm's FX exposure as a regression coefficient. The coefficient in a simple regression of a firm's equity returns on unexpected FX rate changes, with no control variable, is usually referred to as an estimate of a stock's *total* FX exposure. Jorion (1990) added an equity index control variable to avoid the econometric problem of cross-correlated error terms when estimating second-stage, cross-sectional regressions using FX equity exposure estimates as the dependent variable.[1] Subsequent researchers followed Jorion's use of an equity index control variable. See, for example, Bodnar and Gentry (1993), Choi and Prasad (1995), He and Ng (1998), Aabo (2001), Allayannis and Ofek (2001), Griffin and Stulz (2001), Pantzalis, Simkins, and Laux (2001), Doidge, Griffin, and Williamson (2006), Dominguez and Tesar (2006), and Chaieb and Mazzotta (2013).

When indirectly estimating FX cash flow exposure with equity returns, a control variable should control for the impact of FX shocks on the expected/required return (Bodnar & Wong, 2003; Chow et al., 1997a, 1997b). From the perspective of a discounted cash flow model, the idea is to control for the impact of FX shocks on the "denominator", i.e. the discount rate. In terms of a traditional asset pricing model, this idea means controlling for the impact of unexpected FX changes on the risk-free rate, the systematic risk factors, and the risk premia. That way, if the "denominator" effects of FX shocks are controlled, the partial regression coefficient on the FX rate variable represents an indirect estimate of the FX exposure of the "numerator" in discounted cash flow valuation, i.e. the future net cash flow stream to equity holders.

The discounted cash flow perspective reveals a drawback, noted by Bodnar and Wong (2003), of an equity index control variable. Since an equity index is an aggregate of individual firm equities, the equity index itself reflects the aggregate of the FX net cash flow exposures of the firms in the index. So in addition to controlling for "denominator" effects, an equity index also controls (undesirably) for the aggregate FX net cash flow exposure. That is, the FX exposure coefficient is an indirect estimate of only the *difference* between the firm's FX net cash flow exposure and the aggregate FX net cash flow exposure of the firms in the equity index. In principle the only special case in which the FX exposure coefficient would provide a valid indirect estimate of a firm's FX net cash flow exposure is if the equity index has zero aggregate FX net cash flow exposure. This condition could occur only if the index contains firms with positive and negative FX net cash flow exposures that exactly offset each other.

To address the issue of the control variable's FX cash flow exposure, some studies use an equity index that is orthogonalized against the FX rate return. But using a control variable that is uncorrelated with FX rate changes defeats the purpose of controlling for "denominator effects". Moreover, as we know from Giliberto (1985), an orthogonal control variable yields a partial FX equity exposure estimate that is equal to the total FX equity exposure estimate. Orthogonalization advocates believe the approach improves the estimation precision, but Sercu and Vandebroek (2006) show this notion is fallacious.

Alternatively, Pritamani, Shome, and Singal (2004) suggest using a customized equity index that is comprised of *purely domestic* firms as the control variable. The researchers assert that a domestic-firm equity index should be void of aggregate FX net cash flow exposure, and so an FX exposure coefficient with the domestic-firm equity index as the control variable should be a valid indirect estimate of a firm's FX net cash flow exposure. However, a potential issue with the Pritamani et al. method is that the domestic-firm equity index actually might have some FX cash flow exposure; International finance textbooks typically provide examples of domestic firms that indirectly have FX cash flow exposure. Empirically, Choi and Jiang (2009) find that US multinational firms have lower FX equity exposure estimates than a matched sample of non-multinational firms with negligible foreign sales ratios, suggesting that US domestic firms do have FX exposure. Similarly, Aggarwal and Harper (2010) find FX exposure estimates of domestic US firms that are substantial and not statistically different from the FX exposure estimates of US multinationals. Although neither of the two studies explicitly separates the impact of FX changes on the discount rate and on cash flows, the empirical results suggest the existence of potential difficulties with creating a domestic-firm index that has zero aggregate FX cash flow exposure.

Although direct estimates of FX cash flow exposure are likely to be closer to the true FX cash flow exposures, the capital market approach remains more popular among researchers. Reasons include that stock return data, like FX rate changes, are available with daily, weekly, and monthly frequencies. This allows researchers to use shorter estimation windows without compromising statistical accuracy yet capturing time-variation in FX exposures. Moreover, as we mentioned before, the issue of noise in the data is worse for accounting-based variables compared to equity returns. Finally, as Brown (2001) argues, FX exposure at the firm level is complex and researchers are more likely to successfully detect it by analyzing equity returns instead of cash flows. A similar argument is put forth by Griffin and Stulz (2001) who argue that FX exposure is more likely to be detected at the bottom line (stock return level).

2.2. Direct (cash flow) approach

Early, mostly theoretical work in international finance defines FX exposure as the sensitivity of corporate cash flows to unexpected changes

[1] This problem arises when total FX exposure coefficients are estimated with data from the same sample period, as discussed by Thompson (1985).