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Hedging bank market risk with futures and forwards

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ABSTRACT

This paper investigates the effectiveness for futures and forward hedging strategies that can be employed by large US banking firms with exposure to interest rate and foreign exchange risks. By measures of volatility reduction (VR) and value at risk (VaR), we find that while a single direct hedge performs no worse than a composite hedge in alleviating interest rate risk, it outperforms the composite hedge in reducing foreign exchange risk for banks that manage interest rate risk separately from foreign exchange risk. Also, the integrated hedge of both interest rate and foreign exchange risk with a single instrument of interest rate futures effectively outperforms the corresponding hedge with composite instruments in terms of reducing risks. The integrated hedge with currency forwards alone shows the poorest hedging effectiveness.

1. Introduction

With the expansion of international financial relationships and the continued liberalization of cross-border cash flows, banks have become increasingly exposed to the risks associated with foreign exchange operations as well as funding costs both at home and abroad. Market risks faced by banks that engage in both domestic banking activity and foreign exchange operations are most significantly concentrated on interest rate and foreign exchange exposure. Interest rate exposure arises whenever a bank's financial assets and liabilities have a mismatch in maturity or whenever interest rates or assets and liabilities of the same maturity are not perfectly correlated. Exchange rate exposure arises whenever the bank has an unbalanced position in a particular foreign currency subject to an unexpected fluctuation in foreign exchange rates. Such exposures can have a significant impact on the bank's financial performance.

As documented by researchers, interest and foreign exchange rate derivatives contribute to reducing risk for banking firms (see Brewer, Minton, & Moser, 2000; Schuermann & Stiroh, 2006; Adkins, Carter, & Simpson, 2007; Ahmed, Kilic, & Lobo, 2011; Cyree, Huang, & Lindley, 2012). The futures and forward markets have provided large US banks, among others, with a vehicle to hedge against unanticipated changes in interest and foreign exchange rates (see Choi & Elyasiani, 1997; Allayannis & Ofek, 2001; Purnanandam, 2007; English, Van den Heuvel, & Zakrajsek, 2012). A number of studies have examined the issue of hedging interest rate risk using interest rate futures contracts and hedging foreign exchange risk using currency forward contracts in a separate framework (see Koppenhaver, 1985, 1990; Morgan, Shome, & Smith, 1988; Carter & Sinkey, 1998; Sercu & Wu, 2000; Allayannis & Ofek, 2001; Hagelin & Pramborg, 2004; Papaioannou, 2006; Boudreault, 2010; Memmel, 2011; English et al., 2012, among others). The results based on an isolated analysis of only a particular risk of banking activity may not simultaneously hold true because each model is developed under a different, and often mutually exclusive, set of assumptions.

The need for integrated management of foreign exchange and interest rate risks faced by the bank that engages in both domestic and foreign operations is evident by the fact that the domestic interest rate is influenced by the interest rate development of other currencies and the financial markets' expectations on the future foreign exchange rates of the currencies. For example, a movement of interest rates in either of two currencies will affect not only the net interest revenue but also the cost of holding the foreign currency assets and liabilities. Also, a shift in the financial market's expectation on future foreign exchange rates will produce an interest rate change in relevant currencies, affecting bank funding costs and thus the net interest revenue. The interdependence of these macro-variables will make it important for banking firms to implement a coordinated management of interest rate and foreign exchange risks as a portfolio problem. An integrated analysis of multiple risks within the context of portfolio problems is well addressed in Santomero (1997), Schrand and Unal (1998), Mun and Morgan (2003), Allen and Saunders (2004), Rosenberg and Schuemann (2006), Drehmann, Sorensen, and Stringa (2010), and Alessandri and Drehmann (2010). Although dealing with a different

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array of risk sources from this study, they highlight the importance of integrated risk management when multiple risks are bundled together.

The questions that naturally arise are whether the integrated risk management is effective in reducing risks relative to a separate risk management for banking firms with exposure to both interest and foreign exchange rate risks, and what is(are) the useful instrument(s) in hedging the two risks. We address these questions by examining the effectiveness of various futures/forward hedging strategies that can be employed by large US banks[1] and proposing the best hedging instrument(s) in reducing risks when banks manage the two sources of risks in a separate and integrated setting[2]. In a separate setting for risk management, the banks hedge interest rate risk (foreign exchange risk) by employing interest rate futures (currency forwards) alone–the single direct hedge[3]–, or they may use a combination of interest rate futures and currency forwards – the composite hedge – because they face both interest rate and foreign exchange risk for each of which a separate hedge is available. In an integrated strategy, banks use either interest rate futures or currency forwards or both to hedge the two risks simultaneously.

This paper contributes to the literature in two important ways. First, we develop a unified framework for bank futures/forward hedging behavior by integrating two strands of the literature on hedging: studies on bank hedging behavior under interest rate uncertainty with interest rate futures contracts (Koppenhaver, 1985, 1990; Morgan et al., 1988; Brodt, 1988; Purnanandam, 2007; Boudreault, 2010; English et al., 2012, among others) and studies on hedging behavior under exchange rate uncertainty with currency forward contracts (Benet, 1990; Kerkvliet & Moffett, 1991; Allayannis & Ofek, 2001; Brown, 2001; Hagelin & Pramborg, 2004; Papaioannou, 2006; Clark & Mefteh, 2011, among others). Second, our results can provide an important perspective on hedging policy for banks. By accounting for both composite and single direct hedges, we are able to aid bank managers in setting up a hedging policy involving the choice of hedging instrument(s) for separate and integrated risk management practices.

To parsimoniously accomplish our objective, we derive optimal bank holdings of interest rate futures and/or currency forward contracts for alternative hedging strategies within a mean-variance framework, assuming that banking firms accept short-term variable rate deposits, hold foreign exchange positions, and make long-term fixed rate loans. Optimal hedge ratios are estimated using Engle's (2002) DCC multivariate GARCH model with error terms following a skewed-*t* distribution to accommodate the non-normal behavior of the spot and futures/forward returns. Hedging effectiveness is measured by volatility reduction (VR) and value at risk (VaR) metrics calculated by bootstrapping across different hedging strategies.

Our results indicate that a single direct hedge performs no worse than a composite hedge in terms of alleviating interest rate risk when interest rate and foreign exchange risks are separately managed. In addition, the single direct hedge noticeably outperforms the composite hedge in reducing foreign exchange risk because it maintains a near perfect hedge owing to a near-perfect return correlation between the currency open position and the currency forward transactions. This suggests that an additional hedging instrument can have a detrimental effect on the hedging performance if a near-perfect hedge is already in place by an existing instrument. We also find that the integrated hedge with a single instrument of interest rate futures performs better than the corresponding hedge with composite instruments in terms of reducing risks. This can be attributed to (i) the enhanced efficiency in risk reduction driven by internal diversification that attenuates the risk that futures/forwards might otherwise eliminate, (ii) the added crystallization of basis risk by composite hedge, and (iii) the overhedging problems with composite hedge that adds exposure to derivatives and brings about ineffective or overly expensive risk management. The integrated hedge with currency forwards alone shows the poorest hedging effectiveness among all the alternative hedging strategies due in large part to a relatively high degree of currency derivative exposure and a low degree of cross-hedging capability of currency forwards in reducing the interest rate risk.

The paper is organized as follows: Section 2 develops a two-period model that generates the stochastic terminal profit function of a bank facing both interest rate and foreign exchange risks. Section 3 derives optimal holdings of futures/forward position for each of the hedging approaches. In Section 4, the empirical analysis on hedge ratios and hedging effectiveness for different hedging strategies is presented. Finally, conclusions are given in Section 5.

2. Model framework

We take a two-period perspective for banks that engage in both domestic banking activity and foreign exchange operations. At the current time period, the bank receives short-term deposits with known interest rates, makes longer-term fixed rate loans, and enters a net asset (or liability) position in foreign currency with known foreign exchange rates. Also, bank managers anticipate that the bank will not only borrow short-term funds (e.g., negotiable certificate of deposits) at an unknown random rate but also liquidate the net open position in foreign currency at an unknown exchange rate at a later time period. This situation creates both interest rate and foreign exchange risk for banking firms. Facing interest rate and foreign exchange risks, bank managers make decisions with regard to positions in interest rate futures/currency forward contracts to hedge these risks.

Bank profits are derived from the interest revenue on loans plus a return from holding the net asset position in foreign currency less the costs of deposits. The return from bank foreign exchange operations can be expressed by the interest rate for the net foreign currency assets and period considered plus any exchange rate variation (see Grammatikos, Saunders, & Swary, 1986; Mun & Morgan, 2003). It follows that the profit function for the bank, Π, can be written as

$$\prod = LR_L - DR_D + \sum_{i=1}^{n} C_i \left[\left(1+R_i^*\right) \left(S_{i,T} - S_i\right) \right] \quad (1)$$

where L = the fixed dollar amount of long-term loans demanded at the start of the current period; R_L = the long-term fixed loan rate; D = the level of US dollar denominated deposits received by the bank; R_D = the (geometric) average of deposit rates prevailing at the current and terminal period; C_i = the net open position in currency i (expressed in units of foreign currency) at the start of the current period; R_i^* = the (geometric) average of interest rates in currency i prevailing at the current and terminal period; S_i, $S_{i,T}$ = the spot exchange rate of currency i (expressed in units of U.S. dollar per one unit of foreign currency) at the start of the current period and at the end of the terminal period, respectively.

A balance sheet constraint is set to be $L + \sum_{i=1}^{n} C_i S_i = D$ at the start of the current period so that normal bank operations such as loan extensions and foreign exchange operations are funded by

[1] Derivatives activity in U.S. commercial banks continues to be concentrated in large banks, and we employ aggregate data for the large US banking system in our empirical analysis since individual bank data are not available with sufficient detail. We use the term "bank" throughout for ease of exposition.

[2] Large banks may run a separate risk management as part of their overall risk management program (see Comptroller's Handbook, 2012).

[3] A direct hedge in this paper refers to the hedge for which the hedging instrument is a derivative based on the spot position being hedged.