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# How do exchange rates co-move? A study on the currencies of five inflation-targeting countries

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ABSTRACT

This paper does three things. First, it explores the type of asymmetry in exchange rate correlation for five inflation-targeting countries. We show their currencies co-move more closely with the currencies of some influential foreign countries during joint appreciations than joint depreciations against a world currency. Second, it establishes empirically the linkage between interest rate differentials and exchange rate correlation. We find evidence that both widening and narrowing interest rate differentials will reduce the correlation. Third, it proposes a new version of the asymmetric dynamic conditional correlation model. The model proves to be capable of providing great insight into the two issues investigated.

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## 1. Introduction

Over recent years, interest in exchange rate co-movements has been growing rapidly out of that in univariate exchange rate movements. An often cited reason is the crucial importance of information on exchange rate co-movements in financial and economic applications. Examples of financial applications include pricing multivariate currency options (Salmon and Schleicher, 2007) and optimizing currency portfolios (Beine, 2004). Concerning economic applications, how exchange rates co-move matters for the real economy and inflation, hence for central banks to achieve desired appreciation/depreciation of the domestic currency against several foreign currencies (Benediktsdottir and Scotti, 2009).

In gauging short-run exchange rate co-movements, researchers have used two popular measures: tail dependence and correlation. The former allows for multivariate non-normal distributions and focuses on the probability of joint *extreme* appreciation or depreciation. This is useful for capturing tail risk in a portfolio. The latter stays on the multivariate normality assumption and looks at how two currencies move together *on average* across the marginal distributions. This is relevant to investors seeking portfolios with a global minimum variance. Adopting a conditional copula approach, Patton (2006) examines tail dependence, while Benediktsdottir and Scotti (2009) investigate tail dependence and correlation, between exchange rates. This paper employs the concept of correlation to study how the currencies of five inflation-targeting countries co-move with some influential foreign currencies in terms of their exchange rates against a common world currency. We contribute to the intervention literature, the inflation-targeting literature, and the literature on modeling dynamic conditional correlation (DCC) or time-varying correlation among financial asset returns.

In the intervention literature, the effects of central bank interventions (CBIs) on exchange rate dynamics have attracted tremendous attention of researchers. Early investigations mainly probed into the level and/or volatility of a given exchange rate to explore the effectiveness of CBIs. This literature is vast and has yielded mixed evidence (see Nikkinen and Vahamaa, 2009, and the references therein). More relevant to our study, however, are several recent papers that turn to exchange rate co-movements under CBIs. Beine (2004) applies a multivariate GARCH model to look at whether coordinated CBIs affect the variances and covariance between the yen-dollar and euro-dollar exchange rates. He documents that increases in the covariance (correlation) tend to be associated with concerted interventions. Nikkinen and Vahamaa (2009) take a different approach and examine implied correlation among the yen-dollar, euro-dollar and pound-dollar rates. They argue that, unlike *ex post* exchange rate correlation used in Beine

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(2004), *ex ante* exchange rate correlation implied by the prices of currency options incorporate all the information underlying market expectations about future exchange rate dynamics. Their results suggest that CBIs significantly affect the market expectations about future exchange rate co-movements through increasing *ex ante* correlations among major exchange rates.

A common feature of the intervention studies is that they look at the effects of an *event* (i.e., an official intervention) on exchange rate movements and co-movements. Unlike them, we ask whether a particular monetary policy *regime*, namely inflation targeting (IT), would result in asymmetric dynamics in exchange rate correlation and, if so, what type of asymmetry it might be. Surprisingly, the literature on inflation targeting and exchange rates has so far neglected this issue.[1] Because inflation targeting is a regime, not an event, approaches of an event-study nature are not relevant. Also, a regime is not quantifiable, and an inflation target does not change frequently enough to be an informative variable. Thus, in examining exchange rate co-movements under inflation targeting, our strategy is to test the conjecture that the currency of an IT country should demonstrate positive-type asymmetry (to be defined below) in the dynamics of its correlation with an influential foreign currency vis-à-vis a common world currency. To illuminate this conjecture, let us carry out simple economic reasoning as follows.[2]

Consider an IT country H (as the home country with currency $C_H$) and an influential foreign country F (with currency $C_F$), and denote their exchange rates against a world currency ($C_W$) as $S_{W/H}$ (the world currency price of $C_H$) and $S_{W/F}$ (the world currency price of $C_F$). Suppose $S_{W/F}$ rises (appreciates) due to some economic shocks. Given other economic variables, this would make F's goods/services relatively dearer than H's if measured by $C_w$, causing H's exports hence aggregate demand to rise over time and thus pushing up H's expected inflation. H's central bank is likely to pursue a beggar-thy-neighbor policy through currency appreciation (a rise in $S_{W/H}$), as this would help prevent inflation from rising above the target in H. Now suppose $S_{W/F}$ falls. Unlike the case of $S_{W/F}$ rising, this would not exert an upward pressure on expected and actual inflation but may reduce domestic output in H. However, as the monetary policy strategies of H's central bank are geared at price stability, not output stabilization, the central bank is less likely to pursue currency depreciation (a fall in $S_{W/H}$) for stimulating exports hence output. Thus, under the IT regime, the responses of H's central bank to rises/falls in $S_{W/F}$ may be asymmetric in the way described above. Further, such asymmetric responses tend to lead to stronger correlation between $S_{W/H}$ and $S_{W/F}$ during their joint appreciations than joint depreciations. We term this asymmetry "positive-type asymmetry". However, there also exists the possibility of "negative-type asymmetry" – exchange rates are more strongly correlated during joint depreciations than joint appreciations. Negative-type asymmetry is likely due to portfolio rebalancing (Patton, 2006). For instance, when $C_W$ appreciates so that both $S_{W/H}$ and $S_{W/F}$ fall, there may be a shift of funds from both $C_H$ and $C_F$ to $C_W$, leading to high exchange rate correlation during joint depreciation of $S_{W/H}$ and $S_{W/F}$. When $C_W$ weakens so that both $S_{W/H}$ and $S_{W/F}$ rise, if market participants consider $C_H$ to be more (less) desirable than $C_F$, there will be a shift of funds from $C_W$ to $C_H$ ($C_F$) rather than to $C_F$ ($C_H$). As a result, $S_{W/H}$ ($S_{W/F}$) is more likely to rise than $S_{W/F}$ ($S_{W/H}$) or, equivalently, $S_{W/H}$ and $S_{W/F}$ will have low correlation when they are appreciating together.

We hypothesize that the price stability preference of an IT central bank is strong enough to outweigh the portfolio-rebalancing effect, so positive-type asymmetry will prevail in the exchange rate correlation between $S_{W/H}$ and $S_{W/F}$. Our main research task is to empirically test this hypothesis. By uncovering the type of asymmetry in exchange rate correlation and by linking the asymmetry to price stability featuring inflation targeting, one can learn how effective the IT regime is. If positive-type asymmetry is present, we consider the regime to be effective in tying the central bank to achieving price stability. This distinguishes our study from the recent intervention studies on exchange rate correlation: While they look at the effectiveness of CBI events by examining whether the magnitude of exchange rate correlation (*ex post* or *ex ante*) changes following CBIs, we look at the effectiveness of the IT regime by examining whether positive-type asymmetry characterizes the dynamics in exchange rate correlation. We find overwhelming evidence of positive-type asymmetry for the foreign exchange (FX) market correlations of IT currencies, as opposed to the overwhelming evidence of negative-type asymmetry for stock market correlations found in the literature (see Baele, 2005; Dennis et al., 2006; Ang and Chen, 2002, among others).

In addition to uncovering a common pattern of asymmetric exchange rate correlation for IT countries, we further investigate the possible effects of interest rate differentials (IRDs) on the correlation. Such effects, if present, are not unique to IT countries. For instance, Benediktsdottir and Scotti (2009) find certain evidence that currencies (including non-IT currencies) with a higher interest rate differential with the US dollar tend to have their exchange rates against the dollar co-move less closely, in terms of both tail dependence and correlation. However, while Benediktsdottir and Scotti (2009) take the copula approach, we base empirical investigation on the DCC model; and more importantly, while they use absolute IRDs in the current period, we use absolute changes in IRDs in the previous period. Our results are therefore different: *both* widening and narrowing IRDs tend to lower exchange rate correlation, which is consistent with the prediction of the uncovered interest parity (UIP) condition (to be discussed in more detail in Section 4.3).

Our third contribution lies in methodological innovations conceived to accomplish the proposed research tasks. The innovations contribute to the literature on the DCC analysis of co-movements among financial asset returns or economic variables.[3] Specifically, we extend the standard DCC model of Engle (2002) to a *new* asymmetric one and add to it exogenous variables. In fact, Sheppard (2002) already extends the model to include asymmetric effects, but the asymmetric effects are characterized by differing slopes across joint negative and joint positive values of past shocks. Our proposed asymmetric DCC (ADCC) model is different: It captures asymmetry by appealing to "eccentricity", i.e., by re-centering the news impact surface away from zero as in the spirit of the asymmetric GARCH (AGARCH) model (Engle and Ng, 1993). In addition, Sheppard (2002) does not consider incorporating exogenous variables in his ADCC model. The importance of incorporating exogenous variables is suggested by Cappiello et al. (2006), as this helps identify and assess potential determinants of time-varying correlation. As will become clear later on, our proposed model proves to be more capable, than Sheppard's (2002) asymmetric model, of providing insight into the asymmetry pattern of exchange rate correlation for the

[1] Some studies focus on the pass-through from exchange rates to inflation (e.g., Allsopp et al., 2006), some examine whether monetary policy should also react to the exchange rate in addition to the output gap and inflation deviations from the target (e.g., Taylor, 2001), and some probe into the connection between inflation targeting and floating exchange rates (e.g., Edwards, 2007).

[2] To the best of our knowledge, no formal theoretical models are readily available for predicting asymmetric dynamics in exchange rate correlation under the IT regime. Thus, we base the economic reasoning on some macroeconomic commonsense as, e.g., Patton (2006) does, to motivate the investigation and offer possible explanations for the empirical findings about positive-type asymmetry.

[3] The DCC model and the concept of time-varying correlation have become increasingly popular in studying financial issues, macroeconomic problems, or their mixture. An incomplete list of recent studies include Chulia et al. (2010), You and Daigler (2010), Yang et al. (2009), Cai et al. (2009), Lee (2006), Crespo Cuaresma and Wojcik, 2006, and Fang et al. (2006).

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