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Non-linear exchange rate relationships: An automated model selection approach with indicator saturation

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ABSTRACT

This paper examines whether the explanatory power of exchange rate models can be improved by allowing for cross-country asymmetries and non-linear effects of fundamentals. Both appear to be crucial. The samples include the USD versus pound and yen from 1982:10 to 2013:10, and automated model selection is conducted with indicator saturation. Several non-linear effects are significant at 1%. Further, many of the indicators present in the linear models are eliminated once allowing for non-linearities; suggesting some of the structural breaks found in previous work were an artifact of the misspecified linear functional form. These conclusions are robust to estimation using principal components.

1. Introduction

The volume of trading in the foreign exchange market has increased dramatically in recent years from $3.3 trillion daily in April 2007 to $5.5 trillion in April 2013 (Bank of International Settlements, 2013). Clearly understanding the driving forces behind exchange rate movements is more important now than ever given our increasingly globalized financial system and world economy. Despite this, connecting exchange rate movements to movements in fundamentals remains a daunting and contentious issue. Monetary models of the exchange rate have struggled to account for movements in the

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exchange rate even ex post (Rogoff, 2001). This implies that the fundamentals which are supposed to drive the exchange rate in theory (namely relative money supplies, income, inflation, interest rates, trade, etc.) have little explanatory power in reality. Certain sample periods have appeared well fitted (Mark, 1995), but there has been little consistency as the samples have been extended (Cheung, Chinn, & Pascual, 2005). Some optimism has emerged regarding the longer-run ability of monetary models (Engel, Mark, & West, 2008; MacDonald, 1999), but the vast majority of short term and even longer term movements in exchange rates remain anomalous.

An important and promising strand of the literature has attempted to address this deficiency by allowing for non-linear effects of fundamentals on the exchange rate. Some of the empirical studies have allowed for recurrent shifts between two regimes in Markov switching models (De Grauwe & Vansteenkiste, 2007; Engel & Hamilton, 1990; Frömmel, MacDonald, & Menkhoff, 2005), or smooth transition threshold models (Kilian & Taylor, 2003; Sarantis, 1999; Taylor & Peel, 2000). While these approaches have offered an improvement over linear models in many cases, few would argue that there is not much left to uncover. Others have allowed for stark and unpredictable changes in the relationship based on tests for parameter instability, though with linear relationships within regimes, and have offered notable improvement via these piece-wise linear models (Beckmann, Belke, & Kühl, 2011; Goldberg & Frydman, 1996a, 2001). Questionnaire evidence from actual traders supports the notion that the effects of fundamentals change over time, but also indicates that they differ across countries (Cheung, Chinn, & Marsh, 2004).

This study investigates how much improvement can be garnered by allowing for cross country asymmetries and non-linear dynamic effects of the fundamentals; for example, allowing the effect of a change in the interest rate to depend on the country and magnitude of the change. Two exchange rates are examined at the often perplexing monthly frequency, the US dollar per Japanese yen (USD/JY) and US dollar per British pound (USD/BP), from October 1982 to October 2013. These currencies constitute three of the most heavily traded in the world (Bank of International Settlements, 2013). The information set also includes data on money supplies, production, consumer prices, three-month T-bill rates, 10-year bond rates, current accounts, and unemployment, as well as squared, cubic, and exponential terms for each regressor. This provides a very general functional form capable of approximating myriad elaborate non-linearities including smooth transition functions with asymmetries (Castle & Hendry, 2009).[1]

The model selection for both the linear and non-linear models is conducted using the Autometrics algorithm (Doornik, 2009a) with a model selection bias correction applied to the estimates which overcomes the usual detractions of step-wise regression (Hendry & Krolzig, 2005). Autometrics allows for estimation even when the number of regressors exceeds the number of observations by conducting block searches with feasible subsets. This obviates the need to estimate models with fewer variables, for example assuming linearity and symmetric effects across countries as is commonly done, in order to conserve degrees of freedom.

Of course, there are still many potential omitted variables in this (or any) analysis. In this context, such omissions may include microstructure effects, impacts from technical trading, autonomous expectations related to imperfect knowledge, currency interventions, non-economic news, and other policy or institutional changes. Structural change external to the model is captured through the use of impulse and step indicator saturation procedures (Hendry et al., 2008; Castle et al., 2015b). This provides a form of robust estimation, and the indicators prove significant and necessary to achieve the well behaved residuals required for valid inference.

The linear models account for less than 20% of the variation in the monthly exchange rate changes. The non-linear models with asymmetries meanwhile can account for more than twice the variation in the USD/JY sample and more than three times for the USD/BP sample. The non-linear model with asymmetries is preferred according to several model selection criteria, including an index test for non-linearity (Castle & Hendry, 2010), and both the asymmetries and non-linear effects appear to be

[1] A panel approach as in Belke, Beckmann, and Dobnik (2012) allows focus on shocks which are common or unique to different exchange rates (i.e. national versus international trends). The non-linear automated model has not yet been extended to a panel framework however.