On the inherent instability of international financial markets: natural nonlinear interactions between stock and foreign exchange markets

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ABSTRACT

We develop a novel financial market model in which the stock markets of two countries are linked via and with the foreign exchange market. To be precise, there are domestic and foreign speculators in each of the two stock markets which rely either on linear technical or linear fundamental trading strategies to determine their orders. Since foreign stock market speculators require foreign currency to conduct their trades, all three markets are connected. Our setup entails a natural nonlinearity which may cause persistent endogenous price dynamics. Moreover, we analytically show that market interactions can destabilize the model's fundamental steady state.

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1. Introduction

Recurrent dramatic upward and downward movements of international asset prices raise the question whether our global financial system is inherently unstable. Consider, for instance, the course of major stock markets since the mid 1990s. First we saw the emergence of the dot-com bubble and its consequent crash. Afterwards, many stock markets around the world recovered, reaching even previous highs, but only to collapse once again in the second half of 2007. How spectacular such long-term price swings can be is visible in the top panel of Fig. 1, which displays the evolution of the German stock market index, the so-called DAX, between 1996 and 2010. The DAX more than tripled its value twice, and yet it lost about half of its value twice, too. A similar worrying picture emerges with respect to foreign exchange markets. The strong shifting behavior of the USD-EUR exchange rate, depicted in the bottom panel of Fig. 1, is only one of many stunning examples. After a shaper downward movement between 1999 and 2002, the USD-EUR exchange rate almost doubled its value by 2008, only then to lose a substantial part of its value again. Comprehensive historical accounts of such phenomena and their macroeconomic consequences are provided by Kindelberger [27], Minsky [34], Galbraith [20], Shiller [36] and Akerlof and Shiller [1].

Without doubt, a crucial question is thus what kind of mechanisms may cause such dynamics. While no monocausal explanation is to be expected here, our paper points out that integrated international financial markets may be prone to severe price fluctuations. To be precise, we show that stock and foreign exchange markets are – by construction – nonlinearly interwoven and that interactions between them may give rise to endogenous dynamics. Our results are based on a model which has the following structure. We consider two countries, called countries *H*(ome) and *A*(broad). Both countries have a stock market in which the market participants (speculators) use either technical or fundamental analysis rules to predict the future direction of the markets. Hence, there are four types of traders in each stock market: domestic chartists, domestic

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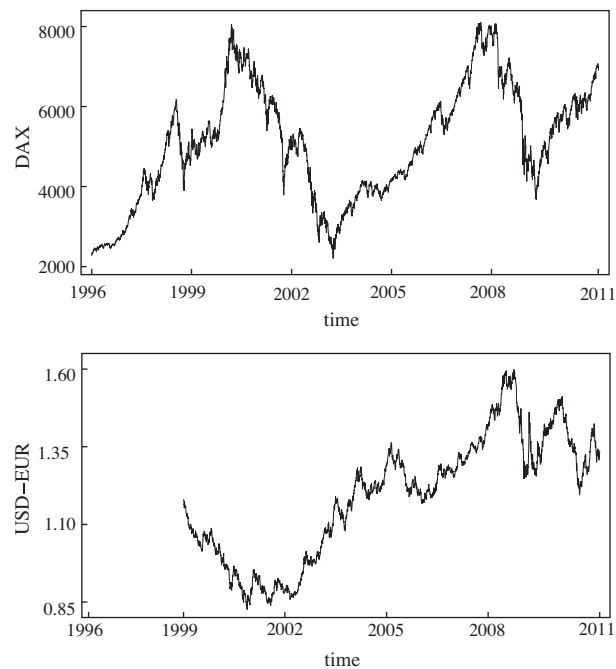
Fig. 1. Long-run swings of international asset prices. The top panel shows the evolution of the DAX (i.e. the leading German stock market index) between 1996 and 2010. The bottom panel presents the course of the USD-EUR exchange rate between 1999 and 2010.

fundamentalists, foreign chartists and foreign fundamentalists. In order to highlight the nonlinear connection between the markets, we design the model as simply as possible. In particular, the relative importance of the four trader types is constant over time and their trading strategies are linear. Moreover, the price adjustments in the stock and foreign exchange markets are proportional to the traders' excess demands.

It is important to note that the stock markets are linked via and with the foreign exchange market. First, technical traders who trade abroad take both the stock price trend and the exchange rate trend into account. Second, fundamental traders who trade abroad condition their orders on both mispricing on the foreign stock market and mispricing on the foreign exchange market. Third, the transactions of foreign traders go through the foreign exchange market. Suppose, for instance, that a trader from country A wants to buy stocks in country H. Then this trader obviously also trades on the foreign exchange market to obtain foreign currency for the stock purchase. The amount of foreign currency required is a nonlinear function of prices: the demand for stocks, which is a function of current and/or past stock prices, is multiplied by the current stock price. This nonlinearity, which has a quite natural foundation, is the only nonlinearity within our model. But, as we will see, its impact on the dynamics is not to be underestimated.

Simulations of our model – a six-dimensional nonlinear dynamic system – reveal that interactions between stock and foreign exchange markets may trigger endogenous dynamics. That is, the stock prices of the two countries and the associated exchange rate oscillate persistently around their fundamental values for a broad range of parameter values. Moreover, we also establish the destabilizing nature of market interactions analytically in the form of a local stability analysis, that is, based on the linearized system around the steady state. Irrespective of whether there are interactions between the markets, our model has a unique steady state in which prices properly reflect their fundamental values. Roughly speaking, we find that if the steady state of the model with isolated stock markets is unstable, then the steady state of the model with market interactions is also unstable. However, if the steady state of the model with isolated stock markets is stable, the steady state of the model with market interactions may be unstable. In this sense, market interactions can be regarded as a destabilizing force for the dynamics of international financial markets. Our results also indicate that regulating financial markets is a complicated issue since causalities acting inside our model may run against basic economic intuition.

Our paper is part of the burgeoning field of agent-based financial market modeling (for recent surveys see [11,25,30,44], among others). Guided by empirical evidence,[1] a number of interesting approaches have been proposed in the last two decades which help us to explain the behavior of financial markets. Let us briefly categorize the main mechanisms discussed so far.

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[1] Empirical evidence showing that financial market participants rely on technical and fundamental trading rules to determine their orders is overwhelming, see [24,32,33,23] among others. These results strengthen the view that agents are boundedly rational [37,26,38].