Is Contagion in the Eye of the Beholder?

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Abstract

Empirical research on contagion between international stock markets generally focuses on market returns converted to US dollars, as this would be consistent with the perspective of an international investor. This note argues that such a conversion is inappropriate, since only returns denominated in local currencies accurately reflect supply and demand in national stock markets. When these returns are converted to a common currency they are also affected by exchange rate fluctuations, which leads to biased results as is illustrated using an example from the sub-prime crisis.

Keywords: Stock Market Contagion, Exchange Rates, Sub-prime Crisis.
JEL codes: F3, G11, G15.

1 Introduction

As discussed by Rigobon (2002), contagion between stock markets is defined as shock transmission being stronger than expected on the basis of economic fundamentals (*pure contagion*), or as shock transmission having suddenly strengthened at times of financial crises (*shift contagion*). Empirical research on the

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strength of this transmission mechanism generally focuses on the similarity between contemporaneous market returns, for instance using a measure of correlation between them. As a first step in analysing these similarities, the original local currency returns are often converted to a common currency, which is usually chosen to be the US dollar. This note shows that such conversion is inconsistent with economic theory on financial contagion, and can lead to biased empirical findings when for instance analysing the current sub-prime crisis.

2 Why are returns converted to a common currency?

The practice to focus on US dollar returns in analysing stock market contagion is widespread. Some authors do so by means of a robustness test while using local currency returns in their main analysis, see for instance Hamao *et al.* (1990) and Lee and Kim (1993). However, many examples exist of studies focusing on US dollar returns directly, such as King *et al.* (1994), Forbes and Rigobon (2002), Bae *et al.* (2003), Rigobon (2003), Chan-Lau *et al.* (2004), Bekaert *et al.* (2005), Caporale *et al.* (2005), Corsetti *et al.* (2005), Baur and Fry (2007), Flavin and Panopoulou (2007), Rodriguez (2007), Dungey *et al.* (2008), and Baele and Inghelbrecht (2009). Generally, the use of US dollar returns is motivated by stating that these "were most frequently used in past work on contagion" (Forbes and Rigobon 2002, p. 2236) and "represent profits of investors with international portfolios" (Corsetti *et al.* 2005, p. 1189).

Indeed, the practice to adopt the perspective of the US dollar investor originated already some time ago, as it stems from the early literature on international diversification between stock markets. Grubel (1968) chose this perspective when analysing the correlation between US and foreign stock market returns, all converted to US dollars. His aim was “to demonstrate the range of possible gains to *American* investors from international diversification of their portfolios” (p. 1304, italics added), during the period 1959–1966. At the time, exchange rate risk was difficult to hedge so that the potential gains from international diversification were different for an American investor than for, say, a British investor. When converting the payoffs from the international portfolio to their domestic currencies, both investors were exposed to fluctuations in different exchange rates. Therefore, in a similar diversification study using US dollar returns, Levy and Sarnat (1970) note that “the optimal investment proportions set out in this paper are relevant ... for [investors from] the United States, but not for [investors from] the United Kingdom” (p. 669). Hence, since diversifying across international stock markets also implied exposing oneself to national exchange rate fluctuations, analysing the potential gains from such a transaction required adopting a particular investor perspective.

3 Why should returns be expressed in local currencies?

When analysing contagion between stock markets, adopting a particular investor perspective by converting returns to a common currency is all but a trivial issue. For instance, what to do when empirical evidence is found for contagion between market returns converted to US dollars, but not for contagion between returns converted to euros? Arguing that to all international investors only returns in US dollars are relevant, would be equally arbitrary as arguing that only returns in euros are important to them. Alternatively, one could claim that US dollar investors are interested in the outcomes based on US dollars, while euro investors are interested in the outcomes based on returns in euro. This interpretation, however, is inconsistent with economic theory on the channels through which shocks can be transmitted between financial markets.

As discussed by Rigobon (2002), there first exist *fundamental links* between markets, arising from trade, international coordination of macroeconomic policies, or common shocks. Examples are a coordinated monetary contraction or a worldwide oil price shock, which simultaneously lower economic growth prospects across countries so that their stock markets decline. Second, *financial links* can induce transmission of shocks between markets, for instance when a large bank incurs losses in one market and therefore has to sell assets in another to meet the regulatory capital requirements. Third, *investor behaviour* can induce the transmission of shocks between markets, for instance through herding behaviour, where investors sell on the selling behaviour of other investors, or learning behaviour, where investors learn about their own market from developments in other similar markets. Fourth, *liquidity links* caused by margin calls or wealth effects can require international investors to rebalance their portfolios by selling otherwise attractive assets in two markets simultaneously.

These theories of shock transmission clearly show why adopting a particular investor perspective is unnecessary and even inappropriate when analysing contagion between financial markets: it cannot be the case that an oil price shock, investor panic, or a liquidity-constrained hedge fund only exists in the world of a US dollar investor, but not in the world of a euro investor. Of course, euro investors could turn out to be hedged against the consequences of the contagion, for instance if the euro depreciates at the same time so that the negative return on the international investment portfolio translates into a positive return in euros after all. Such diversification gains for euro investors, however, would not refute the fact that also from their perspective contagion has taken place. Contagion is not in the eye of the beholder.

The crucial thing to note from the above discussion is that contagion is about similarities in the driving forces underlying the market returns. The returns are thus not of particular interest in themselves, but are merely used as indicators of the (unobserved) changes in supply and demand in national stock markets. These changes are most accurately reflected by the returns in local currencies, since only these returns fully come about in national stock markets themselves. This property does not apply to returns converted to a common currency, since these are not only driven by supply and demand in national stock markets, but also by supply and demand in the market for foreign exchange. Apparently, this seemingly trivial insight has been overlooked by most previous research, even though it was already touched upon in a diversification study by Longin and Solnik (1995), who "use returns in local currency to focus on the correlation across markets rather than across currencies" (p. 21).[1]

4 Does it matter empirically?

To analyse whether converting local currency returns to US dollars can bias empirical analyses of stock market contagion, I examine the similarity between daily stock market returns for the Netherlands, the United Kingdom and the United States during the current sub-prime crisis. In particular, for the three distinct country pairs, I calculate one-month moving averages of correlation between returns expressed in US dollars and between returns expressed in local currencies.[2] Figure 1 shows the difference between the obtained correlation

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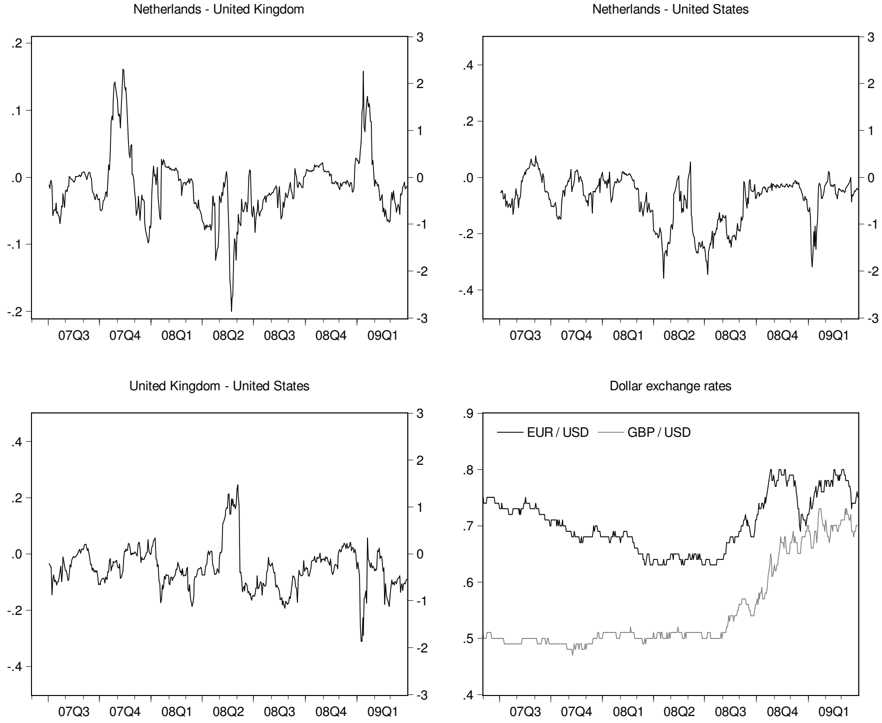
[1] The authors argue that financial instruments have become available to hedge currency risk, so that all investors can copy the payoffs from the local currency portfolio. While in the context of their diversification analysis this is an important insight, it would not have played a role when contagion between markets had been the object of analysis.

[2] Since Forbes and Rigobon (2002) it is well-known that correlation inadequately measures contagion. The above exercise therefore does not claim to analyse contagion itself, but only aims to illustrate the bias that can arise when such analyses are performed with US dollar returns. Moreover, using some alternative measures proposed in the literature, such as constant and dynamic conditional correlations or the synchronicity measure recently introduced by Mink and Mierau (2009), did not affect the conclusions. Results are available upon request.

Figure 1: One-month moving average of the difference between US dollar return correlations and local currency return correlations; dollar exchange rates



Netherlands - United Kingdom

Netherlands - United States

United Kingdom - United States

Dollar exchange rates

For the first three graphs, the left axis indicates the size of the difference while the right axis indicates the difference divided by the standard deviation of the underlying local currency correlations. The stock market indices used are the AEX Index (Netherlands), the FTSE 100 (United Kingdom), and the S&P 500 (United States).

patterns. A value of 0.15 on the left axis indicates that during that particular month the correlation between US dollar returns was 15 points higher than the correlation between local currency returns. On the right axis, this difference is divided by the standard deviation of the country pair's local currency correlations. The bottom right graph presents the dollar exchange rates.

The figure shows that the difference between the correlation of US dollar returns and of local currency returns can be large, and can suddenly change in magnitude or even sign. In absolute size, the bias turns out to be the largest for the United Kingdom - United States country pair, fluctuating between -0.31 and 0.24. In relative terms, the bias is the largest for the Netherlands - United Kingdom country pair, as its size fluctuates between -2.9 and 2.3 standard deviations of the underlying local currency correlation. Furthermore, the standard deviation of this bias turns out to equal 71 percent of the standard deviation of the local currency correlations, while for the other two country pairs this is about 50 percent. These findings illustrate that focusing on returns in US dollars can lead to substantial over- or underestimation of (changes in) the similarity of contemporaneous stock market returns.

5 Conclusion

Inspired by the early literature on diversification between international stock markets, empirical reseach on stock market contagion often focuses on market returns converted to US dollars. This note argues that for a contagion analysis such a conversion is inappropriate, since only returns denominated in local currencies accurately reflect supply and demand in national stock markets. For the current sub-prime crisis, the bias that results from converting returns to US dollars turns out to be large due to the volatility of the dollar exchange rate.

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