FAQ
FOCUSED AND QUICK
ISSUE 10
November 22, 2010

Long Memory in Currency Returns

Supachoke Thawornkaiwong

FOCUSED AND QUICK (FAQ) Issue 10

LONG MEMORY IN CURRENCY RETURNS

SUPACHOKE THAWORNKAIWONG

November 22, 2010

*

Why would speculators want to short the US dollar and long the Thai baht?

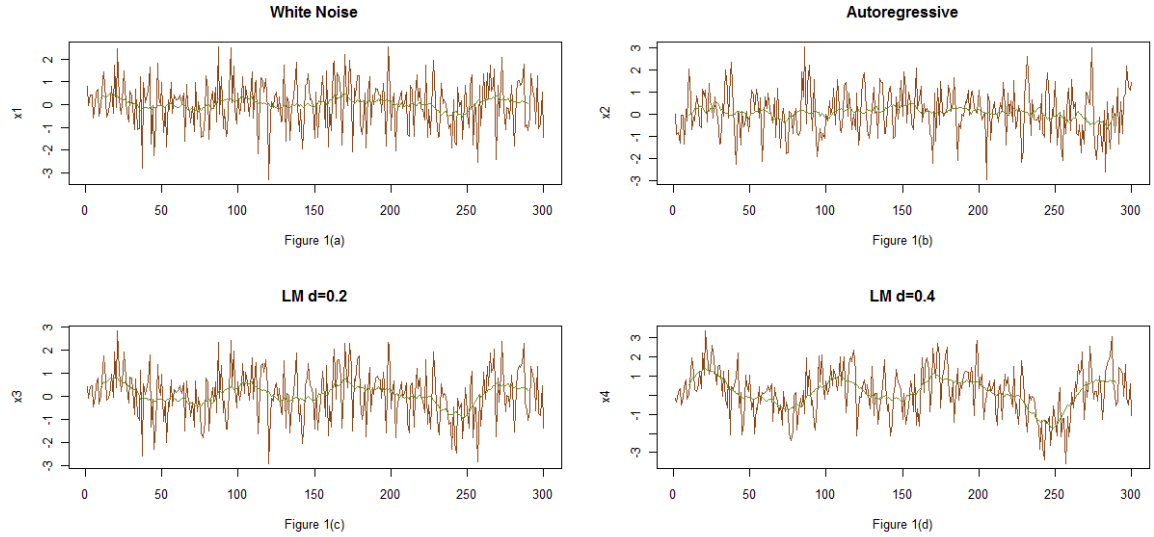
Excerpt

In this short article, I discuss the persistence of the Thai baht appreciation rates against the US dollar. By employing a statistical tool investigated in Robinson (1995), I found that, unlike major and some other regional currencies, the appreciation rates of the baht have long memory, indicating a high degree of persistence and hence long-term predictability. I then discuss some plausible explanations for this observed behaviour of the Thai baht and reasons why policymakers should be worried about it.

Before you start reading this short article, I would like to ask you to close your eyes and imagine yourself as a well-established Thai exporter. If you had not been abducted by an alien or too obsessed with gossip, you should have heard the news about the recent strong appreciation of the Thai baht. Of course, as an exporter you may be grumbling or moaning about the future of your business. You may also be praising yourself and your friends for being clever enough to sell all the US dollar you earned for the Thai baht regardless of the fact that your collective action could have been partly responsible for such appreciation. Now you may be wondering what your next step should be. An econometrician's suggestion would be to short the dollar and buy the baht now for your anticipated dollar receivables in, say, the next three months. You may be thinking this must be a joke given the recent new high of the baht, but I can reassure you that this is not absurd given one striking behaviour of the baht. **The appreciation rates of the baht against the dollar have LONG MEMORY!!!**

* Source: [Thailand Exchange Rate Photo] n.d. [image online] Available at:
< http://newshopper.sulekha.com/thailand-exchange-rates_photo_1491550.htm > [Accessed 20 November 2010]

Figure 1



I hope it is not too painful for you to recall the time when you had to study econometrics. At some point your lecturer mumbled about an Autoregressive Moving Average, ARMA, process and preached that whenever you see a time series that looks more or less stationary, i.e. fluctuating around some value without a tendency to deviate from that value, you should try to fit an ARMA process to that data. Yes, you learnt how to have fun with it using E-views, but are you sure that an ARMA process will give a good fit to the appreciation rates of the baht?

Figures 1(a)-(d) show four time series I simulated. The green curves are filtered series. You can interpret them as trends after removing some noisy components. I personally don't recommend you to take these curves seriously but they could help untrained eyes spot salient features of the time series. While the series in Figure 1(a) is erratic, Figure 1(b) shows data with a higher degree of persistence in the sense that positive values tend to be followed by a number of positive values and vice versa. Note that a white noise process and an autoregressive process (Figures 1(a) and 1(b), respectively) are ARMA processes. Figures 1(c) and 1(d) show even higher levels of persistence. I hope you could see that the series in Figure 1(d) is more persistent. I guess you can take a wave-like behaviour of the green curves as a sign of persistence too. It can actually be proven mathematically that no ARMA process can capture the behaviour in Figures 1(c) and 1(d). **The deficiency of an ARMA process arises from the fact that it cannot generate a high degree of persistence.**

To better understand a basic idea of persistence, let me introduce a new concept. Since a proper definition of long memory time series requires a working knowledge of spectral analysis, to make this literature more accessible, I employ the following intuitive definitions. Let $\gamma(u)=Cov(z_t,z_{t+u})$ be the autocovariance of a time series z_t. We say that a time series has ***short memory*** if $\sum_{u=0}^{\infty}|\gamma(u)|<\infty$. If we regard a time series as a sequence of shocks, this implies that a shock at time t only has a finite impact on the series. On the other hand, we say that a time series has ***long memory*** if $\sum_{u=0}^{\infty}|\gamma(u)|=\infty$, i.e. an impact of a shock is long lasting (infinite). This also implies long-term predictability of the series since the autocovariance function determines how future values of the series are correlated with the current and past values of the series. In order to study long memory time

series, probabilists and statisticians pay close attention to something called a fractional process. A fractional process is a time series model indexed by a number d where d is called the memory parameter. If d is equal to zero then the series has short memory. If d is greater than zero, then the series has long memory. The memory parameter d reflects a degree of persistence of the series, i.e. higher values of d contribute to higher degrees of persistence, as can be seen from Figures 1(c) and 1(d). It can be shown that any ARMA process has short memory, i.e. d=0. This is the reason why an ARMA process cannot capture any data exhibiting a high degree of persistence.

Table 1

Currency	Memory parameter (d)	Foreign exchange market size	Growth of reserve since 2004 (%)
Japanese yen	0	19.0	34
Pound sterling	0	12.9	70
Swiss franc	0	6.4	291
Korean won	0	1.5	66
Brazilian real	0	0.7	456
Malaysian ringgit	0	0.3	78
Thai baht	0.04 *	0.2	265
Philippine peso	0.05 *	0.2	277
Chilean peso	0.06 **	0.2	67
Indonesian rupiah	0.08 **	0.2	149
Israel new shekel	0	0.2	179
Colombian peso	0.05 *	0.1	125

Note: If an estimated memory parameter is not statistically different from zero, it is simply reported as zero indicating short memory. The * and ** signs indicate that the null hypothesis of short memory is rejected at 5% and 1% levels respectively. The FX market size is proxied by the ratio of each currency's average daily turnover to the average daily global FX market turnover in April 2010. Growth of reserve is calculated from September 2004 to September 2010.

Suppose you are a risk-neutral agent and your objective is simply to maximize your expected returns. Suppose further that there are two assets whose returns follow two stationary time series with mean zero and equal variance. If one of them has long memory while the other has short memory and their recent returns have been positive, which asset would you bet your money on? Typically to make a serious forecast, one should construct a Hilbert space and make a fancy projection. Nevertheless, **with long memory time series, forecasting can be qualitatively easy**. Recall the intuitive notion of a time series exhibiting long memory. Yes, it's all about persistence and long-term predictability. If the recent returns have been positive, it is likely that the future returns will be positive for some time. On the other hand, if the returns have short memory and today return is positive, it is possible that future returns may be positive for a short period of time but it is likely that they will turn negative soon. Knowing this, a risk-neutral agent would generally go for the one with long memory.

Now we can view a currency as an asset and consider its returns. As a speculator, it is interesting to see if there is a currency whose returns have long memory. I employed the technique in

Robinson (1995) to estimate and test for long memory in the daily returns of various currencies (see Table 1), including currencies of both advanced and emerging markets. The currencies listed in this table are ordered according to the size of the foreign exchange market, from largest to smallest. One striking observation is that the memory parameters of currency returns seem to establish some kind of relationship with the size or liquidity of the respective FX markets. **Major currencies with high degree of market liquidity appear to have short memory, i.e. there is no return persistence. Meanwhile, currencies with smaller or less liquid markets are by and large found to have long memory in their returns**, though to different degrees. From this, I am tempted to infer that the thinness of the FX market, which makes the price sensitive to reasonably large flows, be it from speculative or trade purposes, could be a culprit for long memory in the currency returns.

From Table 1, there seems to be a weak relationship between FX intervention, reflected from significant reserve accumulation, and long memory in currency returns. However, the interaction of the market size and active intervention gives a more reasonable explanation for such long memory. Further studies should be conducted to investigate if these factors are indeed partly responsible for long memory in currency returns.

The observations mentioned in the previous paragraph can be illustrated with a comparison of the ringgit and the baht. You may be surprised to know that **the ringgit and the baht have different behaviours despite your belief that Thailand and Malaysia share similar economic fundamentals**. The latest (up to October 2010) 300-day returns of the ringgit and the baht are plotted in Figures 2(a) and 2(b). I hope you can see, with a guide of the green curves, that Figure 2(b) shows more persistence while Figure 2(a) shows more volatility. Note that the scale of Figure 2(b) is far less than that of Figure 2(a). This implies that the daily fluctuation of the appreciation rates of the ringgit is much higher than that of the baht. What could be the cause of the discrepancy in the behaviour of the two currencies? The slightly larger size of the Malaysian FX market may not be enough to explain the difference. Rather, it is more **plausible that the larger daily fluctuations in the ringgit returns are due to more balanced capital flows in Malaysia**, thanks to larger Malaysian resident capital outflows that help create offsetting downward pressure on the ringgit.

I guess some of you may protest quietly that my analysis is too simple since I haven't taken into account contribution from other variables you think determine the behaviour of the baht. Yes, you are right. I took a time series analyst's humble approach to think that we probably don't know much about complex reality. We

Figure 2

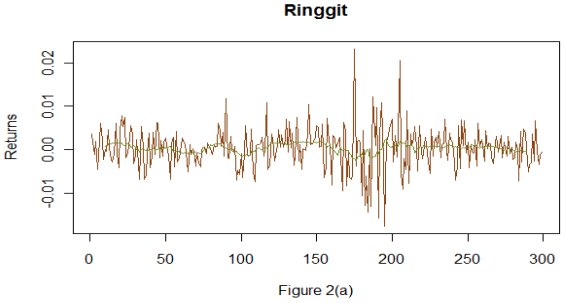


Figure 2(a)

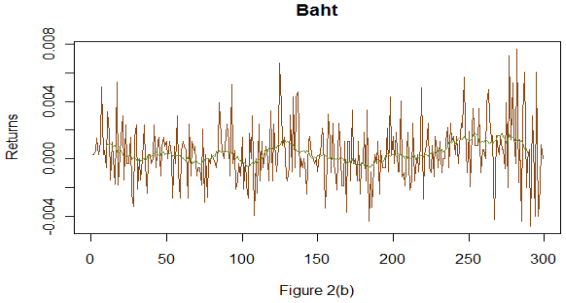


Figure 2(b)

simply regard any observed time series as an equilibrium path determined by some very complicated structure and interaction between players in the foreign exchange market. Our aim is to detect salient features of the observed path which may shed light on some structure hidden under the mask of randomness. And here we found that the returns of the baht have long memory.

Now welcome back to reality! It may be fun to imagine yourself as an exporter or a speculator and think about an opportunity to make a substantial gain. However, as a central banker, I think you should be concerned about long memory in the appreciation rates of the baht. **First, returns on any currency shouldn't be so predictable.** Recall that economists love associating market efficiency with a random walk. The main reason is that if an asset's prices follow a random walk, then its returns follow a white noise process, i.e. given a whole history of prices, the best linear forecast is simply that the expected return is exactly zero. In this case there won't be any upward or downward pressure from speculation on the returns. I found that for those currencies whose returns don't have long memory, their returns are also quite unpredictable in the sense that they are quite close to a white noise process. In this case, they are relatively safe from such speculation. It should be noted that long-memory time series is not a new subject. A standard mathematical textbook on time series analysis such as Brockwell and Davis (1987) has a section on this issue. Those investment banks and hedge funds with an army of employees trained to do mathematics, statistics and econometrics should be well aware of this literature. **If they find any asset whose returns have long memory, it is likely that they will think it is going to be an easy bet.**

Second, it is important to find out whether the BOT, as a main player in the foreign exchange market, unintentionally plays a role in creating the persistence in the returns of the baht. **Is it possible that the BOT's signal and intervention in the foreign exchange market, as can be seen from the fast growing foreign reserve, affect other players' belief in such a way that it becomes self-fulfilling, creating long memory in the Thai baht returns?** Moreover, does slow market liberalization, both in terms of foreign participation in the local foreign exchange market and flexibility for Thai investors to invest abroad, make the matter even worse? Policymakers must give these issues a serious thought for well-meaning actions could backfire and produce counterproductive results.

Acknowledgement

I am grateful to Roong Mallikamas and Nasha Ananchotikul for numerous comments and suggestions which have improved the presentation of this short article substantially. I also would like to thank everyone at the Economic Research Department and many individuals at the Monetary Policy Group for helping me start my first step on empirical work.

References

Brockwell, P.J., Davis, R.A., 1987. Time Series: Theory and Methods. Springer-Verlag, New York.

Robinson, P.M., 1995. Gaussian semiparametric estimation of long range dependence. Annals of Statistics 23, 1630 - 1661.

Contact author:

Mr. Supachoke Thawornkaiwong
Researcher
Economic Research Department
Monetary Policy Group
supachot@bot.or.th