Does Asian foreign exchange intervention really hurt Europe?

Lessons from a three-asset portfolio model

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Abstract

In the current policy debate, it is often argued that foreign exchange interventions by Asian central banks lead to an excessive appreciation of the euro against the dollar. This paper shows that in a three asset portfolio model the opposite holds: Interventions by Japan's central bank strenghten the dollar against the euro.

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1 Introduction

Since the G7 meeting in Dubai in September 2003, the debate about the Asian countries' interventions in the foreign exchange markets has heated up. Not only has the US administration repeatedly criticised China for hurting US industries and thus employment by keeping its currency pegged at an supposedly undervalued level. Popular press has also argued that the Asian central banks' purchase of dollars not only keeps the dollar artificially cheap vis-à-vis the Asian currencies, but also increases the burden Europe has to carry. The Euro, so it was argued, is appreciating further and faster against the dollar as it would the case would Asian central banks stop their purchases of US dollars.[1]

This paper shows that this notion is not necessarily true. Instead, in a simple three asset (euro, dollar and yen assets) portfolio model, it can be shown that

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[1]See for example the *Economist*'s special survey section on the world economy from September 20, 2003.

in the short run the Asian central banks' purchases of dollar assets do not lead to a depreciation of the dollar vis-à-vis the euro, but rather keep the dollar stronger than it would otherwise be the case. It is the Asian currencies which depreciate against the euro when the Asian central banks' intervene and buy dollar assets against their own currency. The dollar, on the other hand, would depreciate further against the euro should the Asian central banks stop their foreign exchange interventions.

This paper is organised as follows: Section 2 sets up the basic model and deduces multipliers for changes in the supply of the three assets types on the exchange rates vis-à-vis the euro. Section 3 then examines how the US current account deficit and the Asian central banks' purchase of dollars influences the exchange rates. Section 4 concludes.

2 The Model: Basic Setup

The model used in this paper is based on a portfolio model following Branson (1979) and Branson and Henderson (1985).[2] Instead of Branson's formulation of bonds, money and foreign assets as three possible asset classes, this paper's model includes three kind of interest-bearing assets, each denominated in a different currency: assets in US-dollars, assets in euro and assets in yen. Official foreign exchange interventions affect exchange rates via the *portfolio channel*, one of the standard channels in the theory of FX interventions.[3] In this paper, only short run consequences of the foreign exchange interventions are covered in order to keep the argument concise. Long run consequences as the change in foreign trade or real output in the economies concerned are neglected.

The model is structured as follows: S^{US} denotes the supply of US assets, S^{Y} the supply of Yen-denominated assets, and S^{EU} the supply of assets denominated in euro. A^{x} denotes the portfolio demand of each asset class. Demand for each asset is a positive function of that asset's yield i^{x} and a negative function of the other assets' yields. Moreover, demand for each asset is positively sloped in aggregate wealth W. It is further assumed that the supply of assets in all three currencies is positive.

Equations (1) to (3) represent the equilibria in the three asset markets with W denoting total wealth of the private sector measured in euro. Wealth is the sum of the euro value of assets in all three currencies (4). e^{US} denotes the euro/dollar exchange rate (measured as euro per dollar), e^{Y} the euro/yen exchange rate (measured as euro per yen). Thus a fall in e^{US} represents a depreciation of the dollar towards the euro, a fall in e^{Y} a depreciation of the yen towards the euro. For simplicity, yields on all three assets are assumed to be constant and determined by factors exogenous to the model such as national monetary policies and capital

[2] For a straightforward exposition, see Gärtner (1997, p. 145ff) or Gandolfo (2002).

[3] See e.g. Dominguez and Frankel (1993) or Sarno and Taylor (2001).

productivity, while the expectation of exchange rate changes is independent from the actual exchange rate. As the paper is about the short term impact of currency market intervention, only the partial equilibrium in the asset market is regarded:

$$
\begin{aligned}
A^{US}\left(\underset{+}{i^{US}}, \underset{-}{i^{Y}}, \underset{-}{i^{EU}}, \underset{+}{W}\right) &= e^{US}S^{US} && (1)\\
A^{Y}\left(\underset{-}{i^{US}}, \underset{+}{i^{Y}}, \underset{-}{i^{EU}}, \underset{+}{W}\right) &= e^{Y}S^{Y} && (2)\\
A^{EU}\left(\underset{-}{i^{US}}, \underset{-}{i^{Y}}, \underset{+}{i^{EU}}, \underset{+}{W}\right) &= S^{EU} && (3)\\
W &= e^{US}S^{US} + e^{Y}S^{Y} + S^{EU} && (4)
\end{aligned}
$$

Substituting (4) into (1) to (3) and totally differentiating yields:

$$A^{US}_{W}\left(e^{US}dS^{US} + e^{Y}dS^{Y} + dS^{EU} + S^{US}d^{US} + S^{Y}de^{Y}\right) - e^{US}dS^{US} - S^{US}de^{US} = 0 \quad (5)$$

$$A^{Y}_{W}\left(e^{US}dS^{US} + e^{Y}dS^{Y} + dS^{EU} + S^{US}d^{US} + S^{Y}de^{Y}\right) - e^{Y}dS^{Y} - S^{Y}de^{Y} = 0 \quad (6)$$

$$A^{EU}_{W}\left(e^{US}dS^{US} + e^{Y}dS^{Y} + dS^{EU} + S^{US}d^{US} + S^{Y}de^{Y}\right) - dS^{EU} = 0 \quad (7)$$

with subscripts denoting partial derivatives. Writing as a matrix and using Cramer's rule[4] yields the reaction of e^{US} and e^{Y} when the supply of assets in any of the three currencies change:

$$
\begin{aligned}
de^{US} &= -\frac{e^{US}}{S^{US}}dS^{US} + \frac{A^{US}_{W}}{A^{EU}_{W}S^{US}}dS^{EU} && (8)\\
de^{Y} &= -\frac{e^{Y}}{S^{Y}}dS^{Y} + \frac{A^{Y}_{W}}{A^{EU}_{W}S^{Y}}dS^{EU} && (9)
\end{aligned}
$$

For changes in the exchange rates as a result of an increase of the supply of dollars, we get:

$$
\begin{aligned}
\left.\frac{de^{US}}{dS^{US}}\right|_{dS^{EU}=dS^{Y}=0} &= -\tfrac{e^{US}}{S^{US}} < 0 && (10)\\
\left.\frac{de^{Y}}{dS^{US}}\right|_{dS^{EU}=dS^{Y}=0} &= 0 && (11)
\end{aligned}
$$

[4]For computational details, see the appendix.

$$\left.\frac{de^{US}}{dS^{Y}}\right|_{dS^{EU}=dS^{US}=0} = 0 \tag{12}$$

$$\left.\frac{de^{Y}}{dS^{Y}}\right|_{dS^{EU}=dS^{US}=0} = -\frac{e^Y}{S^Y} < 0 \tag{13}$$

$$\left.\frac{de^{US}}{dS^{EU}}\right|_{dS^{US}=dS^{Y}=0} = \frac{A_W^{US}}{A_W^{EU} S^{US}} > 0 \tag{14}$$

$$\left.\frac{de^{Y}}{dS^{EU}}\right|_{dS^{US}=dS^{Y}=0} = \frac{A_W^{Y}}{A_W^{EU} S^{Y}} > 0 \tag{15}$$

As can easily be seen, $\frac{de^{US}}{dS^{US}}$ and $\frac{de^{Y}}{dS^{Y}}$ are negative. An increase of the supply of US-dollars thus leads to a depreciation of the dollar towards the euro, an increase in yen assets to a depreciation of the yen towards the euro. Interestingly, an increase in dollar assets leaves the yen/euro exchange rate unchanged, while an increase in yen assets leaves the dollar/euro exchange rate unaltered.

3 Policy Consequences

So what does this mean for the consequences of the huge US current account deficit or the Asian central banks' intervention in the foreign exchange market?

3.1 The US current account deficit

Any current account deficit has to be financed by a change in the net wealth position of the country which runs the deficit. This can be modeled as the emission of securities in international asset markets. Thus, in this paper's model, a US current account deficit leads to an increase in supply of assets denominated in US dollars in the world financial markets. The deficit in the current account is financed via the sale of US bonds to investors outside the United States. Thus,

$$dS^{US} = CA \tag{16}$$

with CA denoting the US current account deficit.

As we know from (8) and (9), this increase in dollar assets leads to a depreciation of the dollar against both the euro and the yen. Thus, a current account deficit in this model yields a weaker dollar, just as is common sense in textbook economic models.

3.2 Asian central bank purchase of dollar assets

If Asian central banks try to limit the dollar's depreciation against their currencies, they will buy dollar assets against their own currency. Thus, the supply of dollar assets decreases, while the supply of yen assets increases. As the value of dollar purchases needs to be paid in yen, for interventions

$$dS^{US} = -\frac{e^Y}{e^{US}} dS^Y \tag{17}$$

must hold. The effects of an intervention of the Asian central bank in order to weaken its own currency against the dollars are thus given by substituting (17) into (8). The change of the euro/dollar exchange rate for an incremental sale of yen assets by the Asian central banks against dollar assets is consequently:

$$de^{US} = -\frac{e^{US}}{S^{US}} \left(-\frac{e^Y}{e^{US}} dS^Y \right) \tag{18}$$

$$\Leftrightarrow \frac{de^{US}}{dS^Y} = \frac{e^Y}{S^{US}} > 0 \tag{19}$$

The change in the euro/yen exchange rate is given by (13). Thus, the intervention *strengthens* the dollar not only against the yen, but also against the euro. The rationale behind this result running contrary to public perception is that the intervention *decreases* the supply of dollars in global financial markets. Which is less surprising is the fact that the intervention also weakens the yen against the euro, as the global supply of yen assets is increased.

4 Conclusion

This paper has shown that the public perception of Asian central bank purchases leading to an excessive depreciation of the dollar against the euro might be misguided. Instead, the Asian central banks' action might even have prevented a deeper depreciation of the US dollar so far. An end to the Asian central banks' intervention policy thus might mean a further depreciation of the dollar against the European currency.

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A Mathematical appendix

To get de^{US} and de^{Y}, we need to solve the system (5) to (7). As we only have two endogenous variables, and Walras' law tells us that the third market will be in equilibrium when two of the three asset markets are in equilibrium[5], we can drop equation (7). Rearranging (5) and (6) and writing as in a matrix form $Ax = d$ gives us:

$$\begin{pmatrix} \left(A_W^{US}-1\right)S^{US} & A_W^{US}S^{Y} \\ A_W^{Y}S^{US} & \left(A_W^{Y}-1\right)S^{Y} \end{pmatrix} \begin{pmatrix} de^{US} \\ de^{Y} \end{pmatrix} = \begin{pmatrix} \left(1-A_W^{US}\right)e^{US}dS^{US} - A_W^{US}e^{Y}dS^{Y} - A_W^{US}dS^{EU} \\ -A_W^{Y}e^{US}dS^{US} + \left(1-A_W^{Y}\right)e^{Y}dS^{Y} - A_W^{Y}dS^{EU} \end{pmatrix} \tag{20}$$

To apply Cramer's rule, we first need to compute the determinant of the matrix A:

$$|A| = \left(A_W^{US}-1\right)S^{US}\left(A_W^{Y}-1\right)S^{Y} - A_W^{Y}S^{US}A_W^{US}S^{Y} \tag{21}$$

$$= \left(1-A_W^{US}-A_W^{Y}\right)S^{US}S^{Y} \tag{22}$$

As all wealth has to be invested, we get from (4):

$$A_W^{US} + A_W^{EU} + A_W^{Y} = 1 \tag{23}$$

Using (23), we get from (22):

$$|A| = A_W^{EU}S^{US}S^{Y} \tag{24}$$

Applying Cramer's rule to the system yields for de^{US}:

$$\begin{aligned} de^{US} &= \tfrac{1}{|A|}\left[A_W^{Y}S^{Y} - A_W^{Y}A_W^{US}S^{Y} - S^{Y} + A_W^{US}S^{Y} + A_W^{US}A_W^{Y}S^{Y}\right]e^{US}dS^{US} \\ &\quad + \tfrac{1}{|A|}\left[-A_W^{Y}A_W^{US}S^{Y} + A_W^{US}S^{Y} - A_W^{US}S^{Y} + A_W^{US}A_W^{Y}S^{Y}\right]e^{Y}dS^{Y} \\ &\quad + \tfrac{1}{|A|}\left[-A_W^{Y}A_W^{US}S^{Y} + A_W^{US}S^{Y} + A_W^{Y}A_W^{US}S^{Y}\right]dS^{EU} \end{aligned} \tag{25}$$

$$\begin{aligned} &= \tfrac{1}{|A|}\left(A_W^{Y} + A_W^{US} - 1\right)S^{Y}e^{US}dS^{US} \\ &\quad + \tfrac{1}{|A|}\left(S^{Y}A_W^{US}\right)dS^{EU} \end{aligned} \tag{26}$$

With $A_W^{Y} + A_W^{US} + A_W^{EU} = 1$, (26) becomes:

$$de^{US} = \tfrac{1}{|A|}\left[-A_W^{EU}S^{Y}e^{US}dS^{US} + A_W^{US}S^{Y}dS^{EU}\right] \tag{27}$$

$$= -\tfrac{e^{US}}{S^{US}}dS^{US} + \tfrac{A_W^{US}}{A_W^{EU}S^{US}}dS^{EU} \tag{28}$$

[5]See Gärtner (1997, pp. 157ff).

Analogously, we get for de^Y:

$$
\begin{aligned}
de^Y &= \tfrac{1}{|A|}\left[A_W^{US}S^{US} - A_W^{US}A_W^{Y}S^{US} - S^{US} + A_W^{Y}S^{US} + A_W^{Y}A_W^{US}S^{US}\right]e^Y dS^Y \\
&+\tfrac{1}{|A|}\left[-A_W^{US}A_W^{Y}S^{US} + A_W^{Y}S^{US} - A_W^{Y}S^{US} + A_W^{Y}A_W^{US}S^{US}\right]e^{US}dS^{US} \\
&+\tfrac{1}{|A|}\left[-A_W^{US}A_W^{Y}S^{US} + A_W^{Y}S^{US} + A_W^{US}A_W^{Y}S^{US}\right]dS^{EU} \qquad (29) \\
&= \tfrac{1}{|A|}\left(A_W^{US} + A_W^{Y} - 1\right)S^{US}e^Y dS^Y \\
&+\tfrac{1}{|A|}\left(S^{US}A_W^{Y}\right)dS^{EU} \qquad (30)
\end{aligned}
$$

With $A_W^Y + A_W^{US} + A_W^{EU} = 1$, (30) becomes:

$$
\begin{aligned}
de^Y &= \tfrac{1}{|A|}\left[-A_W^{EU}S^{US}e^Y dS^Y + A_W^{Y}S^{US}dS^{EU}\right] \qquad (31) \\
&= -\tfrac{e^Y}{S^Y}dS^Y + \tfrac{A_W^Y}{A_W^{EU}S^Y}dS^{EU} \qquad (32)
\end{aligned}
$$

From (28) and (32), we can easily deduce (10) to (15).