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CARF-F-373

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August 2015

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Abstract

This paper extends the analysis of Bernanke et al (2004) to show that the official Japanese purchases of foreign exchange in 2003-04 seem to have lowered long-term interest rates not only in the United States, but in a wide range of countries, including Japan. It seems that this decline was triggered by the investment of the intervention proceeds in US bonds and that global portfolio rebalancing spread the resulting decline in US dollar yields to bond markets in other currencies, thus easing global monetary conditions. We also show that the global portfolio balance effect is detectable in the response of yields to large Japanese intervention in data before and after 2003/04, though the effect is weaker. While our findings contribute to a growing body of work that points to common responses across bond markets to official portfolio shifts in the form of large-scale bond purchases ("quantitative easing"), our analysis has the advantage of focusing on a pure portfolio shock.

JEL codes: E5, G12, O24

Key words: Intervention, portfolio balance effect, Japan, bond market

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1. Introduction

Policy developments can require a rethinking of long-held propositions about policy. So it is with the effects of foreign exchange interventions, changes in official reserve management practices and large scale asset purchases.

These require us to rethink the proposition dating back to Joan Robinson's 1937 essay that currency depreciation (or resisting currency appreciation) is a beggar-thy-neighbour policy. This phrase condemns currency depreciation in a world of insufficient effective demand as a case of robbing the foreign Peter to pay the domestic Paul: cheaper exports of the home country increase output and employment at the expense of sales and jobs in competing countries.

However, policy developments mean that this analysis has become incomplete and misleading. Foreign exchange reserve management has shifted its investment focus from gold in the 1930s and Treasury bills in the 1950s to bonds today. We argue in this paper that as a result currency intervention today bears similarities to the large-scale asset (bond) purchases (LSAPs) that have recently become a popular unconventional monetary policy tool.[1]

LSAPs targeted at bonds can ease monetary conditions through either market liquidity effects or portfolio balance effects. In the latter case, if market participants that have sold bonds to the central bank purchase substitutes (or are expected to do so), bond prices broadly go up and yields down (see e.g. Bernanke and Reinhart (2004), Bernanke et al (2004), Sack (2009), Bernanke (2010) and Bernanke (2012)). Lower bond yields resulting from this portfolio rebalancing can stimulate interest-sensitive investment and raise asset prices, inducing wealth effects.[2] Indeed, Neely (2010) documents a drop in international bond yields in response to the Federal Reserves LSAP in 2008-09, suggesting a global portfolio balance effect. Bauer and Neely (2014) can be read to find that portfolio balance effects rather than lower expected policy interest rates are generally responsible for lower yields. Rogers et al (2014) uses high frequency data to measure the bond market spillovers of unconventional monetary policy.

To our knowledge, just one paper examines the impact of interventions on the government bond yields of the target currency. Bernanke et al (2004) establish that US government bond yields declined during the period of Japanese foreign exchange intervention in 2003-04.[3] They argue that this happened because the Japanese Ministry of Finance (MoF) invested the freshly purchased US dollars in US government bonds.

We add to their analysis by carefully considering the series of decisions between MoF intervention and investment in US bonds and then by establishing that the same intervention also caused a decline in long-term interest rates around the world. In particular, ten-year government bond yields in other industrialised countries declined, as did ten-year interest rate swap rates in a variety of currencies. We also identify a decline in bond yield of emerging market economies whose bond markets are more globally integrated. This suggests a broadly based portfolio balance effect driven by close substitutability of similar bonds for the particular bonds purchased. Indeed, even Japanese interest rates seem to have decreased in response to the interventions.[4]

[1] One important difference is that currency intervention amounts are not announced beforehand, whereas the eventual size of LSAP or quantitative easing measures often is announced in advance.

[2] This portfolio balance effect should work also at a policy rate well above the zero lower bound. See the argument over the "bills only" doctrine within the Federal Reserve in the 1950s in Ritter (1980).

[3] Also related to our paper are Warnock and Warnock (2009) in their international perspective. They show that a broad range of US interest rates declines when foreigners purchase US government bonds.

[4] In a working paper version of this paper, we also examine the effect of the Swiss interventions of 2009/10 (Gerlach-Kristen et al, 2011). Since no official intervention data are available for Switzerland, that analysis is more tentative. Nevertheless, we also find an effect of interventions there on global bond yields as well.

Our findings complement those of Bauer and Neely (2014), Rogers et al (2014) and Neely (2015), who find that announcements of large-scale bond purchases by the Federal Reserve pushed down bond yields across a wide swath of bond markets. Our study has the advantage of focusing on a portfolio shock, rather than a joint monetary policy/ portfolio shock.

Going beyond the sample of Bernanke et al (2004), we show that Japanese interventions also had a detectable impact on bond yields in the US and elsewhere in the years before and after the 2003/04 episode. That said, the effect in the 1990s is only significant for large interventions.

Our main conclusion is that a "beggar-thy-neighbour" charge, which concentrates on trade effects, overlooks the monetary easing caused by the investment of the proceeds of intervention that occurs abroad and even at home. In times when policymakers of different countries simultaneously attempt to loosen monetary conditions, this may be a welcome spillover. However, when global growth is uneven and economies are out of synch so that some economies require unchanged or tighter monetary conditions, global diffusion of monetary easing through integrated bond markets may be unwelcome. Corrective domestic action may be called for.

The rest of the paper proceeds as follows. The next section presents a short macroeconomic backdrop to the heavy interventions of 2003-04. We then turn in Section 3 to the regressions that identify the impact of interventions then on US Treasury holdings and on government bonds yields and interest rate swap rates. Section 4 extends the sample back to January 1991 to forward to October 2013. The last section concludes.

2. Macroeconomic background

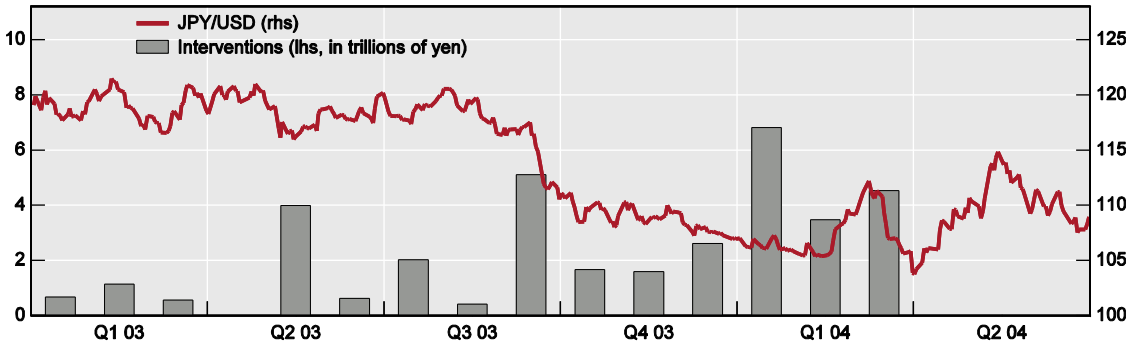
Japanese property prices began collapsing in 1991, and the economy has since been marked by low growth and, until 2013, phases of moderate deflation. The Bank of Japan cut interest rates to close to zero in 1999 and adopted quantitative easing in 2001. In January 2003, the MoF began to intervene in the foreign exchange market to counter an appreciation of the yen against the US dollar that had begun a year before. Its entry into the market was quiet – "stealth interventions" as market participants later dubbed them. Initially, market participants were left to infer the interventions from the monthly disclosure of a Bank of Japan account linked to currency operations (Ito, 2005, p 224). On 8 May 2003, the MoF published daily data for the first calendar quarter that showed the full extent of its dollar-buying.

Graph 1 shows the intervention data together with the JPY/USD exchange rate. The MoF managed to hold the yen roughly stable mostly in the 117-120 range against the US dollar until August 2003.[5] However, the exchange rate came under increasing upward pressure as international investors again began buying Japanese equities and in the process bid for yen.

[5] There is a large number of papers studying whether the interventions successfully influenced the exchange rate. See Fatum (2010), Fatum and Hutchison (2003, 2005 and 2006), Ito (2003, 2004 and 2005), and Sarno and Taylor (2002) for the Japanese case and Neely (2005) for a general discussion. On the issue of sterilisation, see also Ito (2004), Fatum and Hutchison (2005), Watanabe and Yabu (2011) and Gerlach-Kristen et al (2012).

Graph 1

The Japanese Ministry of Finance's currency interventions, 2003-04: sales of Japanese yen

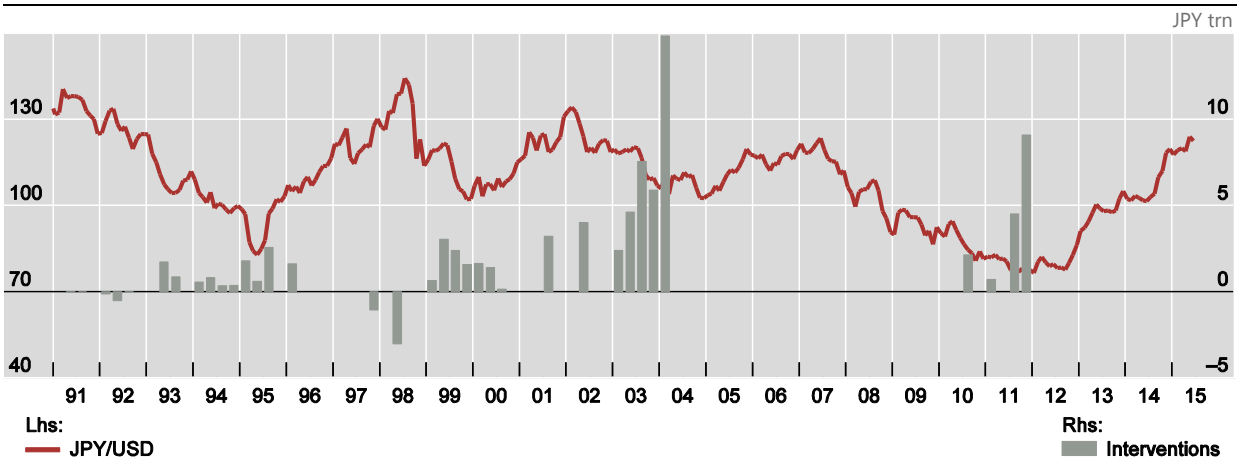


Source: Japanese Ministry of Finance; national data.

Moreover, the G7 called for more exchange-rate flexibility in September 2003, adding to the pressure for the yen to appreciate. On 16 March 2004, at an exchange rate of 106, the MoF quietly stopped intervening. By then, it had acquired JPY 35 trillion (USD 330 billion) over the fifteen months of intervention. This amounted to roughly 7% of Japanese GDP.

Section 3 analyses the impact of these interventions on yields and swap rates for 23 economies and 19 currencies. As a robustness test, in Section 4, we extend the sample period beyond the 2003/04 episodes considered in Bernanke et al (2004) to span January 1991 to October 2013. Graph 2 shows the JPY/USD exchange rate and the intervention amounts for this longer sample. It can be seen that the 2003-04 episode featured theretofore record quarterly amounts. Interventions since that episode have been rare but large, including the record JPY 8 trillion purchase of dollars on 31 October 2011.

The Japanese Ministry of Finance interventions, 1991-2015: sale of Japanese yen — Graph 2



Source: Japanese Ministry of Finance; national data.

Table 1 shows summary statistics of the interventions for the four subsamples 1 January 1991 to 31 July 1995, 1 August 1995 to 14 January 2003, 15 January 2003 to 17 March 2004 and 18 March 2004 to 11 October 2013. It can be seen that interventions were most frequent in the 2003/04 episode, followed by the 1991-1995 period. However, in that earlier period interventions were much smaller than in 2003/04.

Table 1

Japanese Ministry of Finance foreign exchange interventions, 1991-2013

	Number	Frequency (% days)	Minimum, ¥ billion	Maximum, ¥ billion	Mean, ¥ billion	Median, ¥ billion
1/1/1991 - 7/31/1995	162	13.6%	3.2	338.8	47.2	37.1
8/1/1995 - 1/14/2003	50	2.6%	39.0	2620.1	519.5	433.4
1/15/2003 - 3/17/2004	129	42.5%	0.1	1666.4	273.3	172.6
3/18/2004 - 10/11/2013	8	0.4%	202.8	8072.2	2052.7	499.3

Note: Frequency of intervention in last period is 0.3% if the sample period is allowed to run to 30 March 2015. Sources: Japanese Ministry of Finance, authors' calculations.

3. Global monetary easing effects of the foreign exchange intervention

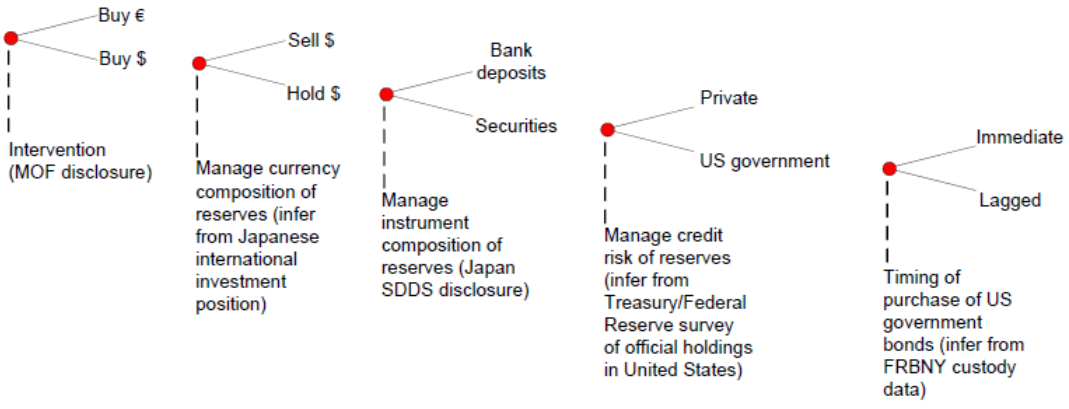
In this section we study the impact of interventions. We first establish that the US dollar purchased by the MoF seem to have been invested fully over time in US bonds. Having studied the quantities, we turn to the price effect and show that US Treasury yields, as well as the yields of close international substitutes, declined after Japanese interventions.

3.1. Quantity effects of the interventions

When the MoF buys US dollars against yen, it is generally thought to invest the dollar proceeds in US Treasuries. Ceteris paribus, sizeable purchases of Treasury bonds can drive down yields. Bernanke et al (2004) simply regress the yields on the intervention.

On further consideration, at least five decisions stand between the intervention to hold down the yen and the purchase of US Treasury bonds. The following Figure considers each in turn.

From MOF intervention to purchase of US government bonds: a stylised decision tree



Source: authors

First, is the choice of the currency in which to intervene. Unlike most currencies, the yen trades actively against both the US dollar and the euro. In fact, according to the MoF disclosure, in the 2003-04 period, only ¥83 billion out of ¥35 trillion in intervention was executed by selling yen against euro—that is, less than 1%.

Second, is the management of the MoF's reserves by currency. While the MoF was buying dollars in the market almost exclusively, standard diversification would suggest that the MoF would subsequently sell some proportion of these dollars for other currencies. Here we draw on the Bank of Japan's article on Japan's international investment position, which indicates the exchange rate valuation effects for Japan's foreign exchange reserves for calendar years 2003 and 2004. On the hypothesis that Japan's reserves are invested in dollars or euro, the valuation effect, combined with the movements of the yen versus the dollar and the euro, can be used to infer the weights on the dollar and the euro (Table 2). Under this hypothesis, the Japanese reserves were invested 90-95% in dollars.

Table 2

The dollar share of Japanese foreign exchange reserves, 2003-04

	Foreign exchange reserves			Exchange rates				Implied $ weight
	Level, end-year (¥ trillion)	Valuation change (¥ trillion)	Valuation change as % of average reserves	¥/$, end-year	¥/€, end-year	¥/$, % change	¥/€, % change	
2002	56.063			119.37	125.72			
2003	72.083	–6.119	–9.6	106.97	134.91	-10.39%	7.31%	95.3%
2004	87.720	–1.717	–2.1	103.78	140.96	-2.98%	4.48%	88.8%

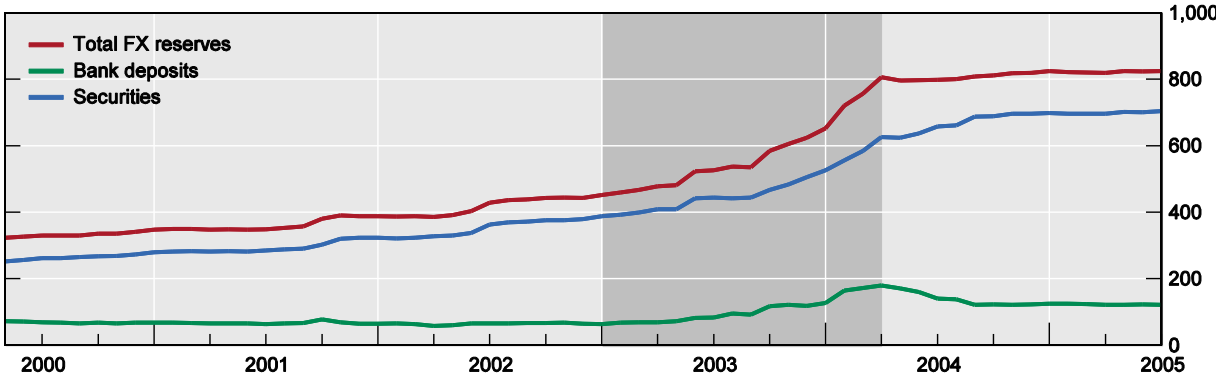
Note: Inferred on the hypothesis that reserves are held in US dollars and euro only. Average reserves taken to be the sum of current and previous end-year reserves divided by two. Sources: Bank of Japan (2004, 2005), authors' calculations.

Third, is the choice of investing in securities or bank deposits. Drawing on the Japanese data reported according to the IMF's special data dissemination standards (SDDS), McCauley (2005) shows that the bulk, over 80%, of Japan's 2003-04 intervention proceeds were invested in securities, with some temporary build-up of bank deposits in the wake of heavy intervention (Graph 3).[6]

Graph 3

Japanese foreign exchange reserves by instrument

In billions of US dollars



Source: Japanese Ministry of Finance.

[6] The SDDS data do not provide a currency decomposition, so they do not reveal the instrument composition of dollar reserves in particular.

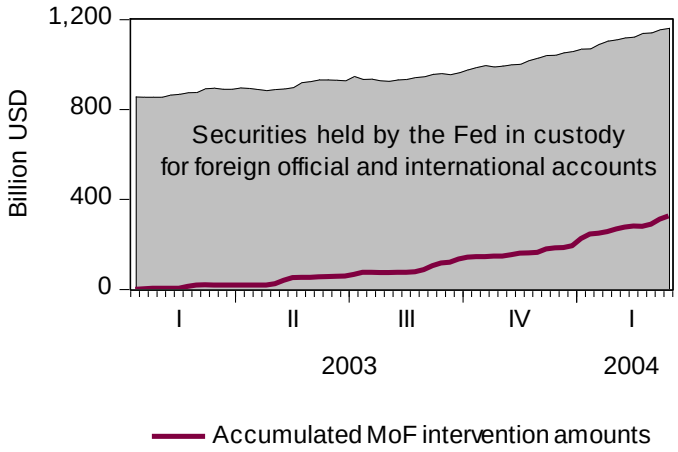
Fourth is the choice of which securities to buy. In 2003-04, the most conservative reserve managers might invest dollars only in US Treasury or agency securities; somewhat less conservative ones might in addition buy supranational and other countries' agency dollar bonds, and those with most risk appetite might buy US corporate bonds. According to McCauley (2005), US Treasury data showed that official holdings of securities in the United States in June 2004 included $1,172 billion in Treasury securities, $216 billion of agency securities and only $47 billion of corporate bonds. In other words, US Treasury data suggest that something like 97% of reserves invested in fixed-income securities in the United States were in invested in public securities, ie Treasury or agency securities.

If the overwhelming majority of Japanese purchases of dollars remained invested in the dollar, and the bulk was invested in US government bonds, the fifth and final choice, a crucial one for our analysis, is how fast these investments were made. If they were practically instantaneous, we would expect to find an immediate impact on US yields as well. If they were very protracted, or if market participants were not aware of the MoF's investment strategy, we would expect the response of yields to the investment to be spread over time.

Graph 4 shows the amounts of Treasury and federal agency securities that the Federal Reserve holds in custody for foreign official and international accounts. We presume that MoF investments in such securities would be held in custody at the Federal Reserve Bank of New York and would thus be recorded in this statistic.[7] It is striking how the custody holdings increase over the time of the intervention period almost exactly by the accumulated intervention amount. It is thus possible that the investment took place rather fast.

Graph 4

Cumulative interventions of the Japanese Ministry of Finance and Federal Reserve custody holdings



Source: Federal Reserve, Japanese Ministry of Finance.

Regression analysis confirms that overall custody holdings rose with cumulative Japanese intervention in this period. In estimating this relationship, keeping track of the timing is important. The Federal Reserve publishes weekly official holdings in custody data as of Wednesday close of business. Given the two-day settlement lag of FX transactions, these data cannot contain any MoF Treasury purchases funded with any interventions on Wednesday or indeed on Tuesday. At the latest, MoF intervention through Monday could be invested by Wednesday, and could show up in this week's holdings release. Interventions that took place in the four previous business days, i.e. Tuesday the previous week through Friday the previous week, also could fund increases in this week's official securities holdings.

[7] The fact that measured Chinese holdings of Treasury securities tend to be increased with the annual surveys from the levels implied by the monthly Treasury International Capital flow data (Setser and Pandy (2009)) suggests that US government securities held in Chinese reserves, which were also increasing in this period, are not generally held in custody at the Federal Reserve.

To allow for the lagged investment of MoF dollars in US securities, we estimate the relationship using an error-correction setup. This allows the data to speak on how much of the cumulated intervention ends up in the custody holdings, and how fast. We regress this week's change in the custody holdings on the cumulated interventions that took place during the seven to two business days before the custody release, on the lagged level of custody holdings and on the level of cumulated interventions seven business days before the release.[8] Thus, using weekly data, we fit

$$\Delta holdings_t = c_0 + c_{\Delta acc}\Delta acc\ interventions_t^{previous\ week} + c_{EC}\left(holdings_{t-1} - c_{acc}\Delta acm\ interventions_{t-1}^{previous\ week}\right) + e_t \quad (1)$$

The sample is 15 January 2003 to 16 March 2004. Given the weekly release of the custody data, we estimate at that frequency. Custody holdings and interventions are measured in billions of US dollars.

Table 3 reports the results in the first column. About a third of intervention between last Tuesday and this Monday ends up this Wednesday's close of business custody holdings. Moreover, the results, if taken literally, suggest that all of the accumulated intervention eventually ended up in the custody holdings. That is, we find that the level of custody holdings and the accumulated reserves seem to increase one-for-one in the longer term. If we impose $c_{acc} = 1$, this restrictions is not rejected in a Wald test (p-value of 0.412) and we obtain the estimates reported in the second column. Here, the estimated coefficient on this week's intervention of 0.334 and the estimated adjustment coefficient of -0.168 imply together that about 45% of Tuesday through Monday intervention will be invested by the Wednesday of the following week.

Table 3

Impact of Japanese Ministry of Finance interventions on Federal Reserve custody holdings

	Unrestricted	Restricted
c_0	174.643*** (65.750)	148.584*** (54.888)
$c_{\Delta acc}$	0.351*** (0.116)	0.334*** (0.113)
c_{EC}	-0.198** (0.075)	-0.168** (0.063)
c_{acc}	0.967*** (0.041)	1
Adjusted R^2	0.189	0.195

Note: OLS estimates of equation (1), $holdings_t = c_0 + c_{\Delta acc}\Delta acc\ interventions_t^{previous\ week} + c_{EC}\left(holdings_{t-1} - c_{acc}\Delta acc\ interventions_{t-1}^{previous\ week}\right) + e_t$, using weekly data spanning 15 January 2003 to 16 March 2004. Stars */**/*** indicate significance at the ten/five/one percent level. Sources: Federal Reserve and Japanese Ministry of Finance.

Taken together, the estimation suggests that the MoF invested about a third of the intervention proceeds almost immediately in US Treasuries and agency bonds that the Federal Reserve Bank of New York holds in custody for its official counterparts. Within weeks, most of the proceeds seem to have been invested in US bonds.

[8] If we include lagged changes in custody holdings or lagged intervention increases, these variables are insignificant.

3.2. Price effects of the interventions

Having established the size and speed of the quantity effects, we now turn to prices. Like Bernanke et al (2004), we expect to find a direct effect of the Japanese interventions on US bond yields. If investors rebalanced their portfolios, or if market makers anticipated their doing so, we would also expect bond yields in other currencies, including the Japanese yen, to decline. However, this effect should only be found for economies whose bonds serve as close substitutes for US bonds.

We follow Bernanke et al (2004) and regress the daily change in the ten-year US government bond yield on the intervention amount of the MoF, which can take the value of zero. To account for the time that passes between the striking of the foreign exchange deal and its actual settlement and possible investment, we consider the change in yield from the day before the deal until two days after.[9] We thus fit

$$i_{t+2} - i_{t-1} = c + a * intervention_t + b * (vix_{t+2} - vix_{t-1}) + e_t \quad (2)$$

where we measure the foreign exchange interventions in trillion yen. These equations allow for changes in global risk aversion, as measured by the Chicago Board Options Exchange market volatility indicator VIX, to affect bond yields.[10]

To test for a global portfolio balance effect, we also consider potential substitute bonds from other advanced economies. As such, we use ten-year government bonds from France, Germany, Greece, Ireland, Italy, Portugal, Spain, the United Kingdom, Switzerland and Japan.

Moreover, we estimate all equations using as well ten-year interest rate swap rates, which are yields from generic private-sector derivative contracts that are close substitutes for government bonds. With them, we can assess whether the rebalancing of portfolios is limited to government bonds or instead exerts broader effects on private yields.

Finally, we consider the effect on emerging market government bond yields. We start out from the prior that these vary in their integration with global bond markets and thus in the degree to which they serve as substitutes for US Treasuries. We therefore expect to find varied effects. To account for the fact that emerging market bond markets are not as developed as those in advanced economies, we concentrate on the most commonly traded segment. We use 10-year yields for China, India, Malaysia, Mexico, Singapore, Taiwan and Thailand, the 7-year yield for Indonesia, the 5-year yield for Hong Kong, 3-year yields for Korea and the Philippines and 1-2 year yields for Brazil.

There are two alternative sample specifications for the estimation of equation (2). Table 4 reports the estimation results using the entire period 15 January 2003 to 16 March 2004. Table 5 reports the output using intervention days only, which decreases the sample from 306 to 129 observations.

Concentrating first on the advanced economies bond yields in the top panel, we find the strongest response in the United States. We estimate that one trillion yen of intervention lowered the US bond yield by 9.6 basis points. This translates to an impact of roughly one basis point for a USD 1 billion intervention.[11]

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[9] We also ran regressions using $i_{t+1} - i_{t-1}$. The impact of the intervention is significant in this setup, too.

[10] The results are also robust to using only the change in the VIX between *t*-1 and *t*.

[11] Bernanke et al report an effect of 0.73 basis points. If we focus on the impact of interventions on bond yields the next day, we find a smaller effect that is only border-line significant. Thus, perceived intervention, as distinct from the subsequent investment of the proceeds, does not seem to be the whole story. Compare Gagnon et al (2010), who find a 38-82 basis-point effect from $1.7 trillion of bond purchases under the LSAP programme.

Table 4

Impact of interventions on government bond yields and swap rates (in %): All trading days

Advanced economies: Ten-year bond yields											
	United States	Australia	Canada	France	Germany	Italy	Nether-lands	Spain	Switzer-land	United Kingdom	Japan
Intervention amount (trillion JPY)	-0.096***	-0.050*	-0.063***	-0.052***	-0.053***	-0.052***	-0.055***	-0.053***	-0.061***	-0.065***	-0.035*
VIX	-0.009**	-0.003	-0.009***	-0.005	-0.005	-0.005	-0.005*	-0.004	-0.000	-0.003	-0.003
Adjusted R^2	0.048	0.006	0.044	0.023	0.024	0.022	0.025	0.021	0.025	0.029	0.007
Advanced economies: Ten-year swap rates											
	USD	AUD	CAD	EUR					CHF	GBP	JPY
Intervention amount (trillion JPY)	-0.102***	-0.060**	-0.068***	-0.044**					-0.053***	-0.049**	-0.051***
VIX	-0.008*	-0.008*	-0.007**	-0.004					-0.001	-0.002	0.001
Adjusted R2	0.039	0.022	0.040	0.013					0.021	0.013	0.020
Emerging markets: Bond yields											
	China	India	Malaysia	Mexico	Singapore	Taiwan	Thailand	Indonesia	Hong Kong	Korea	Philippines	Brazil
Maturity	10 years	10 years	10 years	10 years	10 years	10 years	10 years	7 years	5 years	3 years	3 years	1-2 years
Intervention amount (trillion JPY)	-0.143***	0.007	-0.031***	-0.021	-0.084**	-0.057**	0.021	0.005	-0.137***	-0.051*	-0.116***	-0.229***
VIX	-0.007	0.009*	0.001	0.012**	-0.014***	0.005	-0.001	-0.011	-0.005	0.000	0.019	0.130***
Adjusted R2	0.074	0.012	0.005	0.011	0.048	0.004	-0.006	0.001	0.071	0.003	0.015	0.164

Note: OLS estimates of equation (2), $i_{t+2} - i_{t-1} = c + a * intervention_t + b * \left(vix_{t+2} - vix_{t-1}\right) + e_t$, for different countries and currencies, sample 15 January 2003 to 17 March 2004. Constant included but not reported. Stars */**/*** indicate significance at the ten/five/one percent level based on White heteroskedasticity consistent standard errors. Sources: Bank for International Settlements and Japanese Ministry of Finance; authors' calculations.

But we also find reactions in the yields of bonds that may be considered close substitutes for US bonds. The second strongest impact is detected for UK government bonds, the yields on which decrease by an estimated 6.5 basis points, followed by Canadian bonds, the yields on which declined by 6.3 basis points. MoF interventions seem to have lowered yields in Switzerland as well, with a drop of 6.1 basis points per trillion yen, and yields in the euro area countries respond similarly, with drops between 5.2 and 5.5 basis points. In Japan itself, the ten-year government bond yield is estimated to drop by about 3.5 basis points, though this response is significant at the ten percent level.[12]

In interpreting these findings it is fair to recognise the base line of correlation of national bond yields with US Treasury yields, as a reviewer has pointed out to us. Appendix Table A1 reports the correlations, which typically lie between 0.6 and 0.9. Yet the correlation can arise from a correlation of monetary policy (Hofmann and Bogdanova (2012); Bauer and Neely (2014)), or common drivers of term premia, including portfolio shocks. By focusing on portfolio shifts arising as a by-product of currency intervention, we are able to interpret the betas in Table 4 as arising from portfolio rebalancing.

The second panel in Table 4 reports results for interest rate swap rates, which are representative private yields. Here, we estimate response coefficients between 4.4 and 10.2 basis points. Again, the effect is largest in the US, where the MoF funds were largely invested. These estimates lie in the range obtained for government bond yields and thus suggest a wide portfolio balance effect that reaches private sector yields and thereby affects the cost of debt for firms and households.

The third panel of Table 4 shows responses of emerging market yields. For China, India, Malaysia, Mexico, Singapore, Taiwan and Thailand, we use ten-year yields, and the estimated impact of a trillion yen intervention ranges, where significant, between 3.1 basis points for Malaysian bonds to 14.3 basis points for Chinese bonds. Other than the somewhat anomalous size of the Chinese bond reaction, these estimates lie in the range identified for the advanced economies. Table A2 in the Appendix reports statistics on the bond market integration in Asia. It appears that we identify the strongest impact of the Japanese interventions for those economies that have a bond market which is closely integrated with that of the United States. For the shorter-term bonds used for Indonesia (7 years), Hong Kong (5 years), Korea and the Philippines (both 3 years) and Brazil (1 to 2 years), the estimated response tends to be comparatively large.[13]

The results in Table 5, which are obtained using only intervention days, paint a similar picture. The effect of interventions is strongest in the US bond yields, and somewhat smaller and highly significant in Europe and Canada. For Australia and Japan, we only detect a significant impact for the swap rates. The lowest panel reports the results for the emerging market economies, which also differ little from the findings in Table 4.

[12] Given that the cumulated intervention reached ¥35 trillion, this estimated impact suggests that the Japanese intervention lowered Japanese bond yields by some 1.2%, which would imply a negative 10-year bond yield. Of course, the yield stayed positive. One explanation for this is that the intervention effect wore off over time.

[13] This may reflect the fact that MoF investment in Treasuries favoured Treasuries of 1-5 year maturities, as do reserve managers in general (McCauley and Rigaudy (2011, p 36)), so that the impact was larger at such medium-term maturities.

Our findings are of a piece with a considerable body of research that has been published since our initial report. The first two columns in Table 6 collect our results from Table 4, standardising them to show the number of basis point move in the given market associated with a 100 basis-point move in the US market. The next three columns present the findings of event studies of the Federal Reserve announcements of its first round of large-scale bond purchases, with Neely (2015) and Bauer and Neely (2014) based on daily data, and the Rogers et al (2014) result based on high-frequency data. The last column reports the results of the cointegration analysis of the bond markets of Obstfeld (2015)—which to our eyes may even overstate the integration of bond markets. Our research design differs substantially from that of the event studies, so the resemblance of results is remarkable.

Estimates of spillovers of US bond yields to mature bond markets

Basis points per 100 basis points on the US Treasury bond — Table 6

Bond market	Japanese intervention, 2003-04		Neely (2015): LSAP1 events	Bauer & Neely (2014): LSAP1 events	Rogers, Scotti and Wright (2014) intra-day data	Obstfeld (2015): long-term levels, monthly data 1989-2014):
	Government	Swap				
AU	53	60	67	37		74
CA	63	68	53	54		129
CH	61	53				88
DE	53	44	41	44	36	115
ES	53	44				111
FR	52	44				118
IT	52	44			16	158
JP	35	51	19	12	20	69
UK	65	49	46		48	137

AU = Australi; CA = Canada; CH = Switzerland; DE = Germany; ES = Spain; FR = France; IT = Italy; JP = Japan; UK = United Kingdom.

Note: LSAP1 = first Federal Reserve large scale asset (ie bond) purchase.

Sources: Authors' calculations based on cited work.

In sum, we find broad evidence for a global portfolio balance effect extending beyond the US Treasury market. Bond yields in advanced economies and in emerging market economies whose bond markets were integrated into the global bond market dropped after MoF interventions. If interventions take place at a time when monetary loosening is called for in these economies as well as in Japan, this effect should be welcome. In other instances, monetary policy might have to be tightened to undo the effect of the global portfolio rebalancing.

Table 5

Impact of interventions on government bond yields and swap rates (in %): Intervention days only

Advanced economies: Ten-year bond yields											
	United States	Australia	Canada	France	Germany	Italy	Nether-lands	Spain	Switzer-land	United Kingdom	Japan
Intervention amount (trillion JPY)	-0.100***	-0.050	-0.079***	-0.063***	-0.061***	-0.061***	-0.062***	-0.062***	-0.050***	-0.069***	-0.013
VIX	-0.009	-0.002	-0.008	-0.006	-0.005	-0.006	-0.006	-0.007	-0.003	-0.004	-0.009*
Adjusted R^2	0.067	0.003	0.068	0.048	0.046	0.049	0.048	0.048	0.039	0.048	0.019
Advanced economies: Ten-year swap rates											
	USD	AUD	CAD	EUR					CHF	GBP	JPY
Intervention amount (trillion JPY)	-0.117***	-0.066**	-0.082***	-0.056***					-0.047***	-0.056**	-0.049***
VIX	-0.010	-0.008	-0.008	-0.006					-0.003	-0.003	-0.011**
Adjusted R2	0.079	0.035	0.074	0.033					0.027	0.028	0.076
Emerging markets: Bond yields											
	China	India	Malaysia	Mexico	Singapore	Taiwan	Thailand	Indonesia	Hong Kong	Korea	Philippines	Brazil
Maturity	10 years	10 years	10 years	10 years	10 years	10 years	10 years	7 years	5 years	3 years	3 years	1-2 years
Intervention amount (trillion JPY)	-0.117***	-0.016	-0.025	-0.082**	-0.078**	-0.056***	0.063*	0.064**	-0.133***	-0.054	-0.118**	-0.346***
VIX	-0.007	0.015**	-0.006*	0.003	-0.015**	0.003	-0.010	-0.011	-0.004	-0.005	-0.002	0.111**
Adjusted R2	0.112	0.062	0.033	0.013	0.050	0.019	0.023	0.016	0.113	0.012	0.011	0.181

Note: OLS estimates of equation (2), $i_{t+2} - i_{t-1} = c + a * intervention_t + b * \left(vix_{t+2} - vix_{t-1}\right) + e_t$, for different countries and currencies, sample 15 January 2003 to 17 March 2004. Constant included but not reported. Stars */**/*** indicate significance at the ten/five/one percent level based on White heteroskedasticity consistent standard errors. Sources: Bank for International Settlements and Japanese Ministry of Finance; authors' calculations.

4. The global portfolio balance effect before and after 2003/04

We now extend our estimation sample beyond the episode of 2003/04 to span January 19991 to October 2013. Table 6 presents in the lines labelled “All interventions” the output for the same regression as in Table 4. Thus, we examine how inventions impact on government bonds yields over a three day window, while controlling for the impact of the VIX.

Table 7 shows the output for three additional subsamples: the first spans 1 January 1991 to 31 July 1995; the second 1 August 1995 to 14 January 2003; the third 18 March 2004 to 11 October 2013. We concentrate on advanced economies only because of the lack of development of emerging market local currency bond markets in the earlier years of this longer sample.

It can be seen that we find no significant impact of interventions on yields in the data before 2003. After 2004, there is a clear significant effect for all countries but France, Italy and Japan, though compared with the results in Table 4, the estimated coefficients are about half as small.

Broadly, it is a puzzle that the results of Bernanke et al (2004) and our international extension do not generalise to the earlier period and do so only partially for the subsequent period. Three factors might be at work. First, there might be a size threshold for the portfolio effect. Second, frequency may matter to raise the salience to market participants of imminent demand for US Treasuries on the part of the Japanese authorities. Finally, communication by the Japanese authorities, which increased over time, might play a role.

Taking up size first, rather than deciding ourselves how many of the small interventions to ignore, we let the data speak. We estimate equation (2) for each country and currency, first dropping the smallest 1% of interventions, then the smallest 2% and so on. For each round, we record the sum of squared residuals for all countries and currencies. Proceeding this way, we find the small sum of squared residuals, and thus the best fit of the model, if we drop the smallest 91% of the interventions.

Selection by size shrinks the subsamples asymmetrically. None of the largest 9% of interventions took place in the 1991-1995 sample. Of the interventions between 1996 and 2003, 24% fall among the largest and are thus retained; for 2003-04, only 11% do, while in the 2004-2011 sample, 50% do.

In Table 6, the lines labelled “only largest interventions” point to the conclusion that the differences across sub-samples do not arise solely from the scale of daily interventions. For one thing, the top 11% of interventions by size in our key sample period of 2003-04 exert much the same, or at most a bit stronger, effect on global bond or swap yields as all interventions in that period. Results for 1995-03 generally exhibit the expected sign and rise in significance (excepting Italy and Switzerland), bur remain weak by comparison to 2003-04. Effects for the most recent period weaken with the restricted sample, but are based on so very few observations that not much can be said.

A possible interpretation is that it was the combination of large size and high frequency that made for a larger effect in 2003-04 than in the earlier period. This combination gets closer to the character of a large-scale bond purchase programme.

Another, perhaps complementary, interpretation is that greater disclosure by the authorities of intervention sets apart the 1995-2003 period and our key sample period of 2003-04. At some stage the Bank of Japan's monthly disclosure of transactions with the government started to provide enough detail on the central bank's underwriting of government bills to allow market participants to draw inferences about the scale of intervention (Ito (2004, p 182); Ito (2005, p 224)).[14] Then in August 2000, the Ministry of Finance began disclosing daily intervention data quarterly, and, according to Ito (2004, p 182), monthly aggregates in June 2003. While only in the last period were daily amounts known within hours, it would have been evident to market participants in the early months of 2003 that very large-scale intervention was taking place, and by June 2003, the high frequency was also known.

Whether these interpretations satisfy or not, the consistent finding is that much of any movement of US yields that was associated with Japanese official dollar purchases communicated itself to bond markets denominated in other currencies. While we may not have a good story for the variation of apparent effects across sub-periods, we can still conclude that, conditional on the compression of US dollar bond yields, yields on bonds denominated in other currencies were likewise compressed.

[14] See (in English) for the period since May 2004: http://www.boj.or.jp/en/statistics/boj/other/tseifu/index.htm/

Table 7

Impact of interventions (trillion JPY) on government bond yields and swap rates (in %)

Ten-year bond yields												
		United States	Australia	Canada	France	Germany	Italy	Nether-lands	Spain	Switzer-land	United Kingdom	Japan
1/1/1991 to 7/31/1995	All interventions	0.048	0.113	-0.047	-0.093	0.048	-0.212	-0.127	-0.131	-0.008	-0.007	-0.499***
	Only largest interventions	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
8/1/1995 to 1/14/2003	All interventions	0.002	0.010	0.022	0.010	0.005	-0.022	-0.002	-0.003	-0.004	0.012	-0.000
	Only largest interventions	-0.004*	-0.006**	-0.005**	-0.005***	-0.004**	-0.020	-0.004**	-0.011***	-0.002	-0.006***	-0.003**
1/15/2003 to 3/17/2004	All interventions	-0.096***	-0.050*	-0.063***	-0.052***	-0.053***	-0.052***	-0.055***	-0.053***	-0.061***	-0.065***	-0.035*
	Only largest interventions	-0.115***	-0.093***	-0.077***	-0.070***	-0.070***	-0.069***	-0.071***	-0.071***	-0.058***	-0.076***	-0.036***
3/18/2004 to 10/11/2013	All interventions	-0.037***	-0.026**	-0.026***	-0.008	-0.035***	-0.018	-0.033***	-0.053***	-0.014**	-0.033***	-0.003
	Only largest interventions	-0.003	-0.002	-0.003*	-0.002	-0.003*	-0.021*	-0.003*	0.002	-0.003**	-0.003*	-0.001
Ten-year swap rates												
		USD	AUD	CAD	EUR					CHF	GBP	JPY
1/1/1991 to 7/31/1995	All interventions	0.132	0.114	-0.132	-0.051					-0.119	0.029	-0.221**
	Only largest interventions	NA	NA	NA	NA					NA	NA	NA
8/1/1995 to 1/14/2003	All interventions	-0.000	0.017	0.022	-0.001					0.001	0.004	-0.018
	Only largest interventions	-0.003	-0.006**	-0.006**	-0.004**					-0.003**	-0.005***	-0.003**
1/15/2003 to 3/17/2004	All interventions	-0.102***	-0.060**	-0.068***	-0.044**					-0.053***	-0.049**	-0.051***
	Only largest interventions	-0.121***	-0.092***	-0.081***	-0.062***					-0.049***	-0.067***	-0.052***
3/18/2004 to 10/11/2013	All interventions	-0.033***	-0.027***	-0.034***	-0.021***					-0.015**	-0.019**	-0.003
	Only largest interventions	-0.003	-0.002	-0.002	-0.003**					-0.002*	-0.004**	-0.001

Note: OLS estimates of equation (2), $i_{t+2} - i_{t-1} = c + a * intervention_t + b * \left(vix_{t+2} - vix_{t-1}\right) + e_t$, for different countries and currencies, sample 15 January 2003 to 17 March 2004. "Only largest interventions" uses only the largest 9% of all interventions over the period 1991 to 2013. The decision to drop the remaining 91% smaller interventions is based on repeated estimations of equation (2), where we successively dropped the smallest 1%, 2% etc of all observations and recorded the sum of squared residuals. This sum is smallest if the smallest 91% of interventions are dropped. For the first subsample, this implies dropping all interventions. Constant included but not reported. Stars */**/*** indicate significance at the ten/five/one percent level based on White heteroskedasticity consistent standard errors. Sources: Bank for International Settlements and Japanese Ministry of Finance; authors' calculations.

5. Conclusions

This paper shows that the Japanese foreign exchange interventions in 2003/04 seem to have increased MoF holdings of US Treasuries and lowered long-term interest rates in the US. We find that simultaneously, government bond yields and interest rate swap rates decreased in a range of advanced countries, including Japan, as well as in emerging market economies whose bond markets are integrated into global bond markets. These findings point to a global portfolio balance effect that reflects the global integration of many bond markets.

These findings afford a new perspective on what has been called the currency wars. If the proceeds of large-scale currency interventions are invested in major bond markets, these incidental large-scale bond purchases can ease monetary conditions abroad in economies with internationally integrated bond markets. Given the state of the US economy in 2003, the US authorities might well have welcomed lower bond yields that were a side-effect of Japanese intervention then, even if they did not welcome the intervention itself. Chinese intervention and its investment in US bonds in 2005-2006 would have been less welcome in its timing since it may have contributed to the so-called conundrum of rising policy rates and broadly stable bond yields.

In general, when cycles are not in synchronicity, as in early 2011 when emerging market economies were tightening monetary policy as leading economies sought to ease monetary conditions, large bond purchases, whether as unconventional monetary policy or as an incidental consequence of currency intervention, would be welcome in some places and problematic in others. Thus, the broad global monetary effect of currency intervention, arising from the investment habitats of central bank reserve managers, amounts to a global policy externality that deserves to be systematically taken into account by policymakers (Caruana (2012a, b)).

Appendix

Correlation of bond yields

Table A1 shows the correlation between the different national ten-year bond yields used in the analysis and the ten-year treasury yield. While correlations in the advanced economies and in many of the emerging markets are about 0.6, we record a correlation above 0.9 only for five of the 47 entries in Table A1.

Table A1

Correlation of national ten-year bond yields with US treasury yields

Advanced economies										
	Australia	Canada	France	Germany	Italy	Nether-lands	Spain	Switzerland	United Kingdom	Japan
1/1/1991-7/31/1995	0.94	0.95	0.79	0.83	0.48	0.82	0.47	0.66	0.84	0.70
8/1/1995-1/14/2003	0.76	0.75	0.69	0.77	0.60	0.76	0.60	0.67	0.76	0.75
1/15/2003-3/17/2004	0.85	0.40	0.88	0.89	0.89	0.88	0.90	0.79	0.77	0.75
3/18/2004-10/11/2013	0.86	0.97	0.80	0.91	-0.53	0.84	-0.67	0.86	0.95	0.92

Emerging market economies							
	China	India	Malaysia	Mexico	Singapore	Taiwan	Thailand
1/15/2003-3/17/2004	0.84	-0.53	0.59	-0.20	0.84	0.80	0.45

Integration of emerging market bonds markets with the US treasury market

Table A2 reports statistics on the integration of Asian bond markets with the US treasury market. We take the information on bond market integration from McCauley and Jiang (2004), who estimate the pass-through of changes in the US Treasury yield to local bond yields in the period January 2001 through March 2004. They find that, Hong Kong, with its currency peg to the dollar, showed greatest bond market integration, with Singapore and Taiwan at moderate levels of integration. If we use a threshold of 0.3 pass-through of US Treasury yield changes to local bond yield changes, Korea, Malaysia and the Philippines also had somewhat integrated local bond markets, while China, India, Indonesia and Thailand did not. These priors sort the Asian emerging bond markets well in relation to the estimations results in Table 4. Exceptions are the Chinese and Korean bond markets.

Table A2

Effect of Japanese Ministry of Finance intervention and Asian local bond market integration

Pass-through of US Treasury yield changes	Effect of intervention		Total
	Significant	Not significant	
More than 0.3	HK, MY, PH, TW, SG	KR	6
Less than 0.3	CN	ID, IN, TH	3
Total	6	3	9

Note: Bond markets classified according to estimated effect of Japanese Ministry of Finance intervention (columns) and estimated pass-through of 1% change in US Treasury yield in the period January 2001-March 2004. X^2 test of the independence of pass-through and significance of measured effect is 3.403, which is significant at the 0.065 level. Fisher's exact test for independence is significant only at the 0.191 level. Sources: Table 4 and McCauley and Jiang (2004, p 54).

References

Bank of Japan (2004, 2005): *Japan's International Investment Position at Year-End 20043/2004*.

Bauer, M D, and C J Neely (2014): "International channels of the Fed's unconventional monetary policy", *Journal of International Money and Finance*, vol 44, June, pp 24-46.

Bernanke, B (2010): *Semiannual Monetary Policy Report to the Congress*, 24 February.

Bernanke, B (2012): "Monetary policy since the onset of the crisis", speech to the Federal Reserve Bank of Kansas City Economic Symposium, Jackson Hole, 31 August 2012.

Bernanke, B, V Reinhart (2004): "Conducting monetary policy at very low short-term interest rates", *American Economic Review*, vol 94, no 2, pp 85-90.

_____, and B Sack (2004): "Monetary policy alternatives at the zero bound: An empirical assessment", *Brookings Papers on Economic Activity*, 2004-2: 1-100.

Caruana, J (2012a): "Policymaking in an interconnected world", speech to the Federal Reserve Bank of Kansas City Economic Symposium, Jackson Hole, 31 August.

_____ (2012b): International monetary policy interactions: challenges and prospects", speech to the CEMLA-SEACEN conference on "The role of central banks in macroeconomic and financial stability: the challenges in an uncertain and volatile world", Punta del Este, Uruguay, 16 November.

Fatum, R (2010): "Foreign exchange intervention when interest rates are zero: Does the portfolio balance channel matter after all?" Federal Reserve Bank of Dallas, Globalization and Monetary Policy Institute Working Paper No. 57, July.

Fatum, R and M Hutchison (2003): "Is sterilized foreign exchange intervention effective after all? An event study approach", *The Economic Journal,* vol 113 (487), pp 390-411.

_____ (2005): "Foreign exchange intervention and monetary policy in Japan, 2003–04", *International economics and economic policy*, vol 2, pp 250–9.

_____ (2006): "Effectiveness of official daily foreign exchange market intervention operations in Japan", *Journal of International Money and Finance*, vol 25, pp 199–219.

Gagnon, J, M Raskin, J Remaché and B Sack (2010): "Large-scale asset purchases by the Federal Reserve: Did they work?" *Federal Reserve Bank of New York Staff Reports*, no 441, March.

Gerlach-Kristen, P, R McCauley and K Ueda (2011): "Currency intervention and the global portfolio balance effect: Japanese and Swiss lessons, 2003-2004 and 2009-2010", CIRJE Discussion Papers, December.

Gerlach-Kristen, P, R McCauley and K Ueda (2012): "Did the Bank of Japan sterilise the Ministry of Finance currency intervention in 2003-2004?" Mimeo.

Hofmann, B and B Bogdanova (2012): "Taylor rules and monetary policy: a global 'Great Deviation'?" *BIS Quarterly Review*, September, pp 37-49.

Ito, T (2003): "Is foreign exchange intervention effective? The Japanese experiences in the 1990s" in P Mizen, ed, *Monetary history exchange rates and financial markets, essays in honour of Charles Goodhart, vol. 2*, Edward Elgar, Cheltenham, UK, pp 126–153.

_____ (2004): "The yen and the Japanese economy, 2004", in CF Bergsten and J Williamson, eds., *Dollar adjustment: How far? Against what?* (Washington: Institute for International Economics, 2004), pp 171–96.

_____ (2005): "Interventions and Japanese economic recovery", *International economics and economic policy*, vol 2 (2005), pp 219–39.

Jeanneau, S and C Tovar (2006): “Domestic bond markets in Latin America: Achievements and challenges”, *BIS Quarterly Review*, June, pp 51-64.

McCauley, R (2005): ”Distinguishing global dollar reserves from official holdings in the United States”, *BIS Quarterly Review*, September, pp 57-72.

McCauley, R and G Jiang (2004): “Diversifying with Asian local currency bonds”, BIS Quarterly Review, September, pp 51-66.

Neely, C J (2005): “An analysis of recent studies of the effect of foreign exchange intervention”, *Federal Reserve Bank of St. Louis Reserve Review*, vol 87, pp 685-717.

_____ (2015): “The Large-Scale Asset Purchases had large international effects”, *Journal of Banking & Finance, v*ol 52, March, pp 101–111.

Obstfeld, M (2015): “Trilemmas and tradeoffs: living with financial globalization”, *BIS Working Paper* no 480, January.

Ritter, L, ed (1980): *The Selected Papers of Allan Sproul*, Federal Reserve Bank of New York, New York.

Robinson, J (1947): *Essays in the theory of employment*, Oxford: Basil Blackwell.

Rogers, J H, C Scotti and J H Wright (2014). “Evaluating asset-market effects of unconventional monetary policy: a cross-country comparison”, *Economic Policy*, vol 29, issue 80, October, pp. 749–799.

Sack, B (2009): “Managing the Federal Reserve's balance sheet”, remarks at 2010 CFA Institute Fixed Income Management Conference, Newport Beach, California, 4 October.

Sarno, L and M P Taylor (2002): *The economics of exchange rates*, Cambridge, Cambridge University Press.

Setser, B and A Pandey (2009): “China’s $1.7 trillion bet: China’s external portfolio and dollar reserves”, Council of Foreign Relations Geonomics Center working paper, January.

Warnock, Francis E, and Veronica Cacdac Warnock (2009): “International capital flows and US interest rates”, *Journal of International Money and Finance*, vol 28, pp 903-919.

Watanabe, T and T Yabu (2010): “The great intervention and massive money injection: The Japanese experience, 2003–2004”, Columbia University Center for Japanese Economy and Business Working Paper Series no 294, March 2011.