Central bank balance sheet expansion: Japan's experience

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Abstract

The expansion of central bank balance sheets and the changes in their composition during financial crises have been effective in rectifying market malfunction and stabilising financial markets in Japan and elsewhere. However, the unconventional policy measures are accompanied by costs, as they are likely to lead to misallocation of resources and to the risk of looser fiscal discipline. An additional possibility is the adverse international transmission of monetary expansion through changes in exchange rates and terms of trade, depending on the price setting behaviour of exporting firms. Even more harmful is the effect on emerging economies when there is financial market disruption in the financial centres.

Keywords: Central bank balance sheets; international transmission; financial stability

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I. Introduction

With the onset of the Lehman shock, central banks of advanced economies faced the zero bound of nominal interest rates and embarked on unconventional monetary policy measures. The Bank of England was in the forefront, initiating its large-scale asset purchase program in March 2009. That move was followed by the Federal Reserve, and the Bank of Japan instituted a new fund to purchase a variety of risky assets in the framework of "comprehensive easing policy" in October 2010.

The Bank of Japan had experience with unconventional policy measures prior to the Lehman shock, however. It should be noted that the expansion of central bank balance sheets is only one aspect of unconventional policy measures. In its second round of unconventional policy measures, extending from December 2008 to the present, the BOJ put emphasis on easing credit and bolstering growth, rather than on quantitative easing as in the first round of policy measures.

The recent expansion of central bank balance sheets was accompanied by a depreciation of major currencies, including the US dollar, the euro and the pound sterling, but not the Japanese yen or Swiss franc. The expansion of central bank balance sheets in advanced economies provoked criticism from the governments of emerging economies. Mr. Mantega, the Brazilian Minister of Finance, accused the aggressive expansion of the US Federal Reserve's balance sheet of causing "currency wars", because the dollar depreciation that it entailed a "beggar-thy-neighbor" effect in emerging economies.

Yet Eichengreen and Sachs (1985) had already pointed out that devaluations via monetary base expansion increase global aggregate demand by lowering the global real interest rate. They argued that the beneficial effect was at least as important as the expenditure-switching effect of competitive devaluation.

In the context of "new open-economy macroeconomics" (NOEM), Obstfeld and Rogoff (1995) insisted that not only the home economy, but also foreign economies, benefit from monetary expansion. They pointed out that the impact of terms-of-trade and current-account changes on national welfare is of secondary importance.

However, terms-of-trade improvements cause a welfare-enhancing shift of national budget constraints. Corsetti and Pesenti (2008) graphically showed that terms-of-trade changes can play a critical role in the international transmission of monetary policy. Depending on exporters' price-setting behavior, the international transmission mechanism may be either positive or negative.

This paper attempts to examine how monetary expansion in the form of large-scale purchase programs has affected welfare, both nationally and internationally. We investigate the international transmission of monetary expansion through changes in exchange rate and terms of trade, in light of the Japanese experience.

The emerging economies may benefit from lower global real interest rates and improved terms of trade. However, aside from the added complication of macroeconomic policy management with respect to inflation and asset price bubbles in the domestic economy, adverse effects on manufacturing production due to the erosion of competitiveness cannot be ruled out.

Section II provides an international comparison of quantitative and credit-easing policies, examining those of the advanced economies in comparison with the Japanese experience specifically. Section III reviews the long-term movement of real exchange rates and terms of trade in advanced economies. In Section IV, we turn to the relationship between real exchange rate and terms of trade. Section V focuses on the role of price-setting behavior by exporting firms, which is linked to their choice of invoice currency. Section VI discusses the difference in international transmission of monetary policy arising from the different price-setting behaviors of exporting firms. We offer an evaluation of the recent episodes of

international transmission of monetary policy, on the basis of observations regarding developments in exchange rates and terms of trade.

II. Scope of Quantitative Easing / Credit Easing Policies

Bank of Japan

Japan's unconventional monetary policy began in March 2001, one week after the announcement in the Japanese government's monthly economic report that the nation's economy was in "mild deflation". Before the announcement, neither the government nor the Bank of Japan had recognized mild deflation of about 1% as deflation.

The first unconventional policy period, from March 2001 to March 2006, comprised several measures, including (1) the zero interest rate policy (ZIRP), (2) quantitative easing (balance sheet expansion), (3) policy duration announcements and (4) credit-easing policy (changes in the composition of the balance sheet).

On the quantitative easing (QE) front, the bank reserve target increased from 5 trillion yen to 32–35 trillion yen, with purchase of government bonds amounting to 18 trillion. Thus, the ceiling on government bond holdings was set not to exceed the amount of the BOJ note outstanding at the time when the first round of QE was initiated. The BOJ note rule was introduced under the premise that it would prevent facile monetization of budget deficits (Shiratsuka, 2009). As a result, the unconventional policy measure was executed in conventional fashion, since the BOJ took into account that currency issuance on the liability side is normally backed by long-term assets on the asset side.

The BOJ was evidently more cautious about the consequence of long-term government bond purchasing than were other central banks, as the Ministry of Finance did not indemnify it for the cost of purchasing long-term bonds and other risky assets – a practice that contrasts sharply with TARP in the US or APF in the UK. The BOJ's total assets increased by about 42 trillion yen, and the ratio of the assets to nominal GDP rose from 20% in 2001 to 30% in 2006 (Figure 1). However, it should be noted that prior to the introduction of QE, the BOJ balance sheet had already started to grow – since mid-1997, when the risk of financial crisis intensified both in Japan and in the Asian economies in general.

A commitment regarding the duration of the policy was made as part of the framework of the quantitative easing. The conditions for exit from QE were clarified in October 2003, when it was decided that the policy would be maintained until the core consumer price index showed a stable rate of positive change.[2]

The credit-easing policy included the purchase of ABS (Asset-Backed Securities), ABCP (Asset-Backed Commercial Paper) and equities from financial institutions. It should be noted

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[2] Facing tremendous market stress and disruption, the Bank of Japan embarked on the zero interest rate policy (ZIRP) in February 1999, announcing the duration of the policy in order to affect longer interest rates through the channel of market expectations.

With hindsight we may argue that the termination of the ZIRP in August 2001 was premature, since the Japanese economy entered recession in October 2001. The recession in Japan was caused in part by the bursting of the IT bubble in the United States in April 2001.

Moreover, the conditions for termination of the ZIRP were not transparent enough. Then Governor Hayami noted that the ZIRP would be sustained until fears about deflation subsided. When the ZIRP was terminated, the consumer price index continued to register negative rates of change. Presumably, the deflation of about 1% was not identified as deflation. It seems to us that the "deflationary spiral" that occurred during the Great Depression, which was accompanied by unemployment of 20%–30%, was defined as deflation (Iwata, 2010).

that the purchase of equities was implemented as an instrument of macro-prudential policy, for Japan's major private banks held large amount of equities of customer firms, and the collapse of equity prices endangered the maintenance of their capital base.

What was remarkable was the massive intervention policy implemented by the MOF (Ministry of Finance). From the spring of 2003 to the spring of 2004, the MOF conducted a massive intervention on the foreign exchange market, amounting to about 35 trillion yen, with the implicit target rate ranging from 110 to 120 yen to the dollar.[3] Meanwhile, the bank reserve target was raised by 15 trillion. This may imply that the Ministry of Finance virtually implemented an unsterilized intervention policy to the tune of 15 trillion yen under the zero interest rate policy. The intervention policy, supported by monetary policy easing, seemed to support the downward trend in the value of the yen during the period of quantitative easing.

Moreover, in 2006 and 2007, the yen carry trade maintained the downward trend. Foreign banks could borrow yen-denominated funds at negative interest rates on the short-term money market, due to the advantageous position they enjoyed over Japanese banks on the international financial market. Given the BOJ's sustained zero interest rate policy, foreign banks borrowed yens at comfortably low interest rates, conducting carry trades through interoffice accounts. This helped fund the general increase in the balance sheets of hedge funds and financial intermediaries at financial centers (Hattori and Shin, 2007).

After the bankruptcy of Lehman Brothers, a second round of unconventional monetary policy was implemented, consisting of three pillars: (1) market stabilization, (2) reinforcement of growth and (3) comprehensive monetary easing. For market stabilization, the BOJ instituted a policy measure to support enterprise financing in December 2008, focusing on providing credit to enterprises. It also implemented a measure to enhance the growth base by providing fixed interest-rate funds in June 2010.

In October 2010, the Bank of Japan initiated a "comprehensive easing policy". There was more emphasis on credit easing than there had been in the previous quantitative easing policy. The scope of the assets menu was widened to include private bonds with lower ratings, ETFs and J-REITs. The J-REIT dividend yield in particular reacted sharply, and the J-REIT index bottomed out immediately after the announcement of the BOJ J-REIT purchase (Figure 2).

Within a framework of comprehensive easing, the BOJ established a BOJ asset-purchase fund, thereby abolishing the ceiling on long-term government bond purchasing. The size of fund was expanded three times, rising from 35 trillion to 55 trillion yen by October 2011, and the total purchase of long-term government bonds will increase to 30.6 trillion yen. Yet the losses involved in the asset purchase were not covered by the MOF. It seems desirable to establish an entity separate from the BOJ balance sheet, and to widen the scope to expand the purchase of various assets, including foreign bonds, with collaboration from the MOF. One of the authors proposed establishing a crisis prevention fund of 50 trillion yen for purchasing foreign bonds. The MOF should indemnify this fund from loss at an initial meeting of the state strategy conference in late October 2011.

Furthermore, it is reasonable to conduct the purchase of government bonds in a manner consistent with debt management policy. Lengthening the maturity structure from the debt management policy side should be avoided, because it will prevent long-term interest rates from dropping. In QE 1, debt management policy lengthened the maturity structure by issuing new bonds, while the maturity of the government bonds held by the BOJ was shortened (Iwata, 2010).

[3] See Taylor (2008) for details regarding the implicit exchange-rate target range proposed by Mr. Zenbei Mizoguchi, then MOF Vice-Minister.

The comprehensive easing policy also extended the time horizon for the policy. The easing policy will be maintained until an inflation rate of about 1% appears on the forecast horizon. We can interpret this as a sort of "forecast inflation targeting". One of the authors found it appropriate to introduce that practice in October 2003, when the concept of policy duration was clarified.

In the second round of unconventional policy measures, the expansion of the BOJ balance sheet was initially modest. However, the size of the balance sheet as a proportion of nominal GDP increased more rapidly after October 2010. Yet the level of BOJ's total assets remained lower than during the first quantitative easing policy (Figure 1).

As to intervention policy, there were four market interventions – in August 2010 (2.1 trillion yen), in March 2011 (700 billion yen in a "concerted intervention with the G7 countries"), in August 2011 (4.5 trillion yen) and in October/November 2011 (approximately 10 trillion yen). The total amount was modest in comparison with the major intervention policy of 2003–4.

Where the yen differs from the US dollar, euro and UK sterling is that the nominal/real effective value of the yen showed a sustained upward trend from a bottom in 2007, despite the adoption of BOJ's expansionary monetary policy. This may be due to the fact that Japanese financial institutions sustained less damage than their US counterparts during the global financial crisis, and that Japan's monetary expansion was modest in comparison with the US.

The IMF's annual consultation report provided an assessment of QE 2, pointing to a 25–50bp decline in 10-year bond rates, a stock price rise of 5–7% and an increase of 14.3% in the J-REIT index. However, the effect on the yen was found to be ambiguous.

In spite of the implementation of the two unconventional policies, the deflationary trend persists. The CPI, excluding energy and food, registers approximately a 1% decline, while the rate of change of the comprehensive CPI remains close to zero following the change of base year in August 2011.

Based on various empirical studies, the effects of the two rounds of unconventional policy measures in Japan can be summarized as follows:

1. Liquidity and credit premiums narrowed significantly.
2. The private bond spread was reduced, reflecting smaller risk premiums. In the second round of unconventional policy measures, the impact on the J-REIT dividend yield was conspicuous.
3. Longer-maturity interest rates declined, mainly due to the policy duration effect. This was supplemented by quantitative easing policy in the first round of unconventional policy measures. In the second round, the lower long rates were primarily achieved by direct asset purchasing, for the policy duration effect was not employed until the comprehensive easing policy was announced.
4. Equity prices responded positively to the unconventional policy measures, while the impact on bank credit was limited, due to balance sheet adjustments both by banks and non-financial firms in the process of deleveraging during QE 1, and as a result of weak demand for bank loans in a stagnant economy during QE 2.
5. The impact on the exchange rate seems to have been significant in the first QE, as massive intervention was employed in the process of increasing the bank reserve target under the ZIRP (Watanabe and Yabu, 2007). The joint efforts succeeded in bringing down the nominal/real yen exchange rate, which in turn helped to bring about a gradual increase in the rate of change of core consumer prices to slightly above zero in early 2006. In the second round of unconventional policy measures, however, the effect on the exchange rate was muted, because the Federal Reserve

and other central banks implemented asset purchase programs on a far greater scale than the BOJ.

6. The impact on aggregate demand was limited, primarily due to the fact that the expansion of BOJ's asset holdings and the monetary base expansion cannot be permanent, given the commitment to exit from QE. QE was conceived as a temporary measure to employ while the financial intermediary function of financial institutions was restored. This problem is common to other central banks' balance sheet expansion as well. The BOJ has not yet succeeded in reversing the persistent deflationary expectations.[4]

The Federal Reserve

After the policy rate was reduced to its essentially zero lower bound in December 2008, the Federal Reserve introduced the first large-scale asset purchase program (QE 1) amounting to $1.75 trillion in March 2009. This included the massive purchase of MBS ($0.6 trillion), agency bonds and government bonds ($0.3 trillion). The spreads between MBS and Treasuries were significantly reduced.

Before launching QE 1, the Fed introduced the dollar swap line program with the ECB and the SNB, in the face of disruption in the dollar funding market, including the euro/dollar FX swap market**,** in December 2007. At the peak of the program, swaps outstanding totaled more than $580 billon, accounting for over 25% of the Fed's total assets in December 2008 (Flemming and Klagge, 2010).[5] The swap arrangements proved to be effective in stabilizing financial markets. At the same time, they pointed to a need for international coordination to provide sufficient global liquidity when financial shocks originate at centers of international reserve currencies. At the end of November 2011, in the face of global fear regarding the euro's existential crisis, the Federal Reserve slashed the penalty rate on dollar liquidity from 1% to 0.5% in swap arrangements with the ECB, BOE, BOJ, BOC and SNB.

The second large-scale purchase program was initiated in November 2010 and ended in July 2011. The second policy program focused on purchases of government bonds totaling $0.6 trillion, as the Federal Reserve adopted quantitative easing rather than a credit-easing policy.

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[4] Dr. Ryuzo Miyao argued at the conference that the deflationary expectation has been removed since the mid-2000 decade, citing the survey report on inflation expectations in Japan. Yet the break-even rate for index bonds has revealed persistent deflationary expectations, although the index bond market is not well-developed in Japan.

[5] The Fed introduced a system of reciprocal currency arrangements, a dollar swap line program, with the ECB and the SNB in December 2007; its function was similar to the Term Auction Facility, constituting an instrument to stabilize the financial market as a "lender of last resort".

The first phase, from December 2007 to September 2008, aimed to extend the TALF to overseas financial institutions, and the second phase, from September to October 2008, involved the BOE, BOJ, BOC, RBA, SR, NB, DN, RBZW, BCB, BM, BOK and MAS. The Fed expanded the size and scope of the program, and the available amounts rose from $67 billion to $620 billion.

The BOJ joined the arrangement in the third phase, from October 2008 to February 2010. In the case of Korea, the Bank of Korea loans funded by the swap arrangement with the Fed were more effective in stabilizing the financial market than were swaps in which the BOK used its own foreign reserves. This is because of market confidence and the effective additional amount of foreign reserves (Baba and Shim, 2010). The total available amount peaked at $580 billion, representing 25% of the FRB's total asset holdings. In September 2009, the Fed opened foreign currency swap lines with the ECB, the SNB, the BOE and the BOJ, which enabled it to provide liquidity in foreign currencies to US financial institutions. In the face of deepening fiscal crisis in Europe, the dollar swap arrangement entered the fourth phase in May 2011.

One of the differences between the Fed's policy and Japan's quantitative easing policy was its focus on the asset side of the central bank balance sheet, whereas the BOJ set its target on the liability side of the balance sheet, ie the amount of sight deposits outstanding by financial institutions at the BOJ. The policy centering on the asset side aimed to support the financial intermediary function through asset purchases by the central bank, while the liability-side policy provided a buffer against funding liquidity by increasing private banks' excess reserve. The difference between the unconventional policy measures of the Fed and the BOJ reflects in part the difference in financial structure (market-based system versus banking-based system). The emergency liquidity was provided not only to commercial and investment banks but also to the shadow banking system.

A second difference is the inclusion of large-scale purchasing of MBS, putting emphasis on the credit-easing side of unconventional policy measures. A third difference is the speed of expansion of the central bank balance sheet. The Fed took about one year to increase the size of its balance sheet from 20% to 30% (Figure 3), while the BOJ took five years to reach a 10% increase in the ratio.

In August 2011, the Federal Reserve announced the extension of the low interest rate through mid-2013, aiming to produce lower long rates through the channel of market expectations regarding policy duration. Mr. Evans, President of the Chicago Federal Reserve Bank, urges further clarification of the exit conditions. Monetary easing should remain in place as long as the unemployment rate remains above 7.5%, given the dual mandate of the Federal Reserve.

In September 2011, the Fed implemented "Operation Twist" (the asset composition change policy) to the tune of $400 billion. The Maturity Extension Program was designed to change the composition of the balance sheet and lengthen the maturity of the Fed's holdings of government bonds from 75 months to 100 months. Operation Twist is expected to lower the long-term interest rate by 15bp, an effect is similar to that of QE 2 (Alon and Swanson, 2011).

After the announcement of the two policy measures – one to lower interest rates on maturities of one month to two and half years, and the other to reduce rates on maturities longer than three years – the decline of nominal long rates was accompanied by lower real bond yields, which fell below 0%. The sharp reduction in long-term interest rates was in part due to the flow of money from money market funds into the Treasury market that occurred because the money market funds proved to be engaged in lending to European borrowers.

According to the IMF's assessment of the cumulative effects of QE 1 and 2, the long-term interest rate fell 105bp. Gagnon et al (2010) estimated that the 10-year term premium was reduced by 30–100bp. If the effect of agency bonds and MBS are included, the impact was much larger. The announcement of QE 1 provided the real turning point for the market in CDS and equities in the US and emerging countries, thereby narrowing the spread between MBS interest rates and government bond interest rates.

The IMF study found that QE 1 and 2 pushed the dollar down by 5%. It is interesting to note that, according to IMF estimates, the two programs served to raise the yen 12%. The estimates suggest that US LSAP 1 and 2 dominated the movement of the yen. The yen/dollar ratio rose sharply after 2008, thereby dampening the effect of the BOJ's expansionary policy measures on the yen.

As to effect on aggregate demand and unemployment, the San Francisco Federal Reserve Bank, citing the FRB/US model, argued that LSAP 2 would raise real GDP by 3% and increase the inflation rate by 1%, thereby reducing unemployment 1.5% (Chung, Laforte, Reifschneider and Williams, 2011). The actual outcome was rather disappointing. The limited effect may be in part attributable to the issuance of new government bonds at a faster rate than the Fed's purchase of bonds.

So far, the US seems to have escaped falling into deflation. Although the expected inflation rate rose with QE 2, it fell steeply as commodity prices started to decline. In September 2011, it stood at the same level as it had in the summer of 2010 when QE 2 was announced.

Moreover, US expansionary monetary policy was accompanied by a rise in commodity prices that fed back into the US economy, dampening consumer spending. The US expansion slowed down starting in early 2011, in part due to the oil price hike.[6] Adverse international repercussions from monetary expansion can undermine improvement in the welfare of the domestic economy – an issue that we shall return to in Section VI.

ECB

The liquidity shock of early August 2007 prompted the ECB to provide massive liquidity (a total of €95billon) to the financial market through main refinancing operations, in response to the first signs of the subprime seizure. The majority of the liquidity was sterilized, as the widening of the Euribor-OIS spread slowed down.

In the wake of the Lehman shock, the euro system's balance sheet expanded from €1.5 trillion to €2 trillion by mid-2008. In comparison with other central banks, the expansion of its total assets remained relatively modest until mid-2009.

In October 2008, the ECB decided to change its weekly main refinancing operations to a tender procedure with full allotment at a fixed rate. Mr. Trichet called this "enhanced credit support". The enhanced credit policy worked to lower funding costs for banks of peripheral countries such as Greece, Ireland and Portugal; average cost was estimated to have fallen almost 500bp, according to the IMF spillover study (2011).

However, the balance sheet expansion began again in June 2009. The ECB began to purchase the covered bonds and continued the operation for one year. This asset purchase can be described as an "ambiguous quantitative easing policy" or as "non-standard monetary policy".

Facing the deepening fiscal crisis, the ECB began to purchase bonds issued by the governments of Greece, Ireland and Portugal in May 2010, in an attempt to remedy the malfunctioning of the government bond market (the Securities Markets Program). In July 2011, it purchased Italian and Spanish government bonds. As of end-October, total purchases of government bonds had reached about €183 billion.

The Treaty on European Union (Article 21.1) prohibits the ECB from directly buying bonds from EU governments, based on the premise that the ECB is not allowed to engage in deficit financing of euro member governments. The purchase of government bonds from secondary markets is not prohibited. But the potential loss will erode the ECB's capital base.

It is not the General Council of the ECB, but the European Council, that has the power to make decisions on increasing the ECB's capital. The issue of indemnification will arise immediately if euro member governments want to employ the ECB's securities markets program for the purpose of leveraging the European Financial Stability Facility. As early as late 2010 the ECB attempted to persuade finance ministers to at least double the EFSF rescue fund and indemnify it against possible losses from its purchase of weaker euro member countries' securities.

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[6] Empirical evidence based on event study does not support the notion that the announcement of LSAP 1 and 2 pushed up energy prices (Glick and Ludec, 2011). However, it may be that energy demand rose due to the expansion in emerging economies produced by the US stimulus measures.

While it is uncertain to what extent the ECB will purchase government bonds in the future, the ECB decided to reinstitute the purchase of covered bonds in October 2011. The ratio of its total assets to nominal GDP increased comparably to other central banks' ratios: from 15% in 2007 to 25% in 2011 (Figure 4).

Non-standard monetary policy seems to have exerted a significant effect on bank lending rates, but not on the amount of bank lending. The euro rate was affected by the interest rate differential between the US and the euro area, while the effect of non-standard monetary policy on the euro rate seems to be ambiguous (Takaya, 2011).

Bank of England

In January 2009, the Bank of England created a new fund, the "Asset Purchase Facility", which initially purchased commercial paper funded by the proceeds of sales of short-term Treasury bills by the Debt Management Office. This policy measure can be classified as credit easing akin to fiscal operations. In March 2009 the BOE embarked on its quantitative easing policy, announcing that it would purchase £200 billion of long-term government bonds, or 14% of nominal GDP, exceeding the expected size of the newly issued 2009 bond. In October 2011, the BOE expanded the asset purchase by £75 billion in view of weak domestic demand and an expected inflation rate lower than the medium-term target, despite the current high inflation rate of 4.5% in August.

The BOE asset purchase was conducted by a separate entity, the BOE Asset Purchase Facility Fund, a limited liability company. Both the BOE and the Fund are fully indemnified by the Treasury for any losses arising out of the asset purchase program. Furthermore, an agreement was concluded between the Chancellor of the Exchequer and Governor King to the effect that the debt management policy would not alter the plan for gilt purchases as a result of the temptation to minimize cost (Iwata, 2009).

Another difference from the BOJ's quantitative easing policy is that the BOE focused its asset purchases on the non-bank private sector, such as pension funds; it did not aim to expand bank lending directly. The banking sector was in a process of deleveraging, and faced a risk of capital shortage.

The BOE's total assets had already expanded prior to the launch of the quantitative easing policy. The ratio of the balance sheet to nominal GDP increased from less than 5% at end-2008 to over 15% in mid-2010 (Figure 5).

According to the BOE's empirical evidence based on event studies regarding the effect of QE 1, the long-term interest rate in the 5- to 25-year segment was lowered by 50–120bp, mainly through a portfolio rebalancing effect (Loice et al, 2010). The size of the effect was similar to the effect of US QE I and II. Yet the impact on equity prices was muted, although the negative tail risk diminished considerably with the implied volatility, falling about 40%.The medium-term inflation expectation seems to have remained stable, despite the fact that the inflation rate considerably exceeded the target. Moreover, the effect of QE 2 is expected to be larger than that of the 0.75% interest rate cut.

The impact on the exchange rate was small; the event study suggests that the scale of the immediate response of sterling to the QE announcements would bring about an estimated depreciation of 4%.

During the period of February 2009 to March 2010, sterling actually appreciated 1%. The uncovered interest rate parity suggests an 8% depreciation, if we consider the reduction of ten-year spot yields around the QE announcement events.

The smaller impact on sterling may be attributed to two facts. First, prior to the introduction of the large-scale asset purchase program, the nominal/real sterling rate began to drop sharply in mid-2007. The large-scale asset purchase program was instituted after the depreciation bottomed out.

Secondly, other advanced economies also implemented expansionary monetary policies.

Thirdly, Mr. Broadbent, a member of the BOE Monetary Policy Committee, pointed out that the sustained expected depreciation of the real 5-year forward sterling rate could be attributable to the changes in terms of trade and the relative price of non-traded output to traded output (Broadbent, 2011).

In his view, the market judged that the credit crunch would hit the demand for non-tradables hard, as shown by weak residential investment and the anticipated reduction of public spending due to the vulnerability of public finances. Moreover, the low supply elasticity arising from a low degree of factor mobility added to the expected decline in non-tradable prices.

In other words, a sharp expected decline of expenditure in the non-tradable sector brought about a sizable depreciation in the real sterling rate, judging from the developments of real 5-year forward rates against the dollar and the euro. This insight is illuminating indeed, and we shall return in Section IV to this issue of the relationship between the real exchange rate, the terms of trade and the relative price of non-traded to traded output.

The Swiss National Bank

The ratio of the SNB's balance sheet to nominal GDP increased sharply immediately after the collapse of Lehman Brothers, at the same time as the second phase of international agreement on the US dollar swap arrangement came into play. Furthermore, the SNB engaged in intervention policy starting in the spring of 2009, with the aim of moving out of deflation and avoiding an excessive appreciation of the Swiss franc.

The size of the SNB's balance sheet as a proportion of nominal GDP expanded rapidly, from 25% in September 2008 to over 50% in 2010 (Figure 6). When the ECB introduced its 12-month long-term repo operations in 2009, the SNB was obliged to intervene on the foreign exchange market. Then euro-area banks unable to access Swiss franc funding on the interbank markets to finance loans denominated in Swiss francs used the ECB's liquidity tenders and immediately sold euros on the spot market. The Swiss franc is now a shadow currency such as the German mark prior to the introduction of the euro.

The Swiss economy fell into deflation in early-2009. But thanks to a massive intervention policy, deflation ended in October 2010. The achievement was accompanied by a large capital loss, which invited criticism. Yet in Japan we have accumulated even greater capital losses in the Foreign Exchange Account due to the sharp appreciation in the yen rate after 2008.

In August 2011, Switzerland's central bank announced an upper limit on the euro/franc rate, virtually pegging the Swiss franc to the euro. No appreciation would be tolerated beyond 1.2 francs to the euro, though a lower limit was not set. This implied a policy of unlimited intervention on the foreign exchange market. The ECB reintroduced its 12-month repo operations. This would imply upward pressure on the Swiss franc vis-à-vis the euro, leading the SNB to intervene in the spot market, with a consequent further expansion of the SNB's balance sheet. Critics expressed the view that the unlimited intervention policy would invite danger from a beggar-thy-neighbor effect and provoke protectionist pressures in trading-partner countries. We will return this issue in Section VI.

III. Long-term Developments in Exchange Rates and Terms of Trade

Long-term developments in nominal/real effective exchange rates

In our discussion of the effect of unconventional monetary expansion, we now turn to the long-term evolution of the Japanese nominal/real exchange rate and terms of trade in comparison with other major economies.

The first remarkable fact is a sustained upward trend in the nominal and real effective yen rate since 1970. As to nominal rates, the Japanese yen and the Swiss franc show a strong upward trend (Figures 7.1 and 8). The degree of appreciation in the two cases is quite comparable, the nominal rates rising by a factor of four, the real rates nearly doubling. The difference between the two country's rates reflects two factors: the difference in their inflation rates, and the identities of their other trading-partner countries.

The nominal effective rate of the German mark (or, after 1999, the euro), as in the case of the Japanese and Swiss currencies, followed an upward, though much less pronounced, trend. In contrast, the real effective rate remained remarkably stable, with no appreciation since 1970 (Figure 9). The nominal/effective euro rate moved in parallel with the German rate, but appreciating more steeply than the German currency (Figure 10).

Germany benefited greatly from the introduction of the euro. After the introduction, the mark's real effective rate (employing unit labor cost as a denominator) depreciated by about 18%, while the real rates of the peripheral countries' currencies appreciated on the order of 7%–10% (Table 1). The competitiveness of German firms was substantially strengthened.

On the other hand, the US dollar has depreciated both in nominal and real terms, hitting a new low in 2011. The divergence between the nominal and real effective dollar rates was small in comparison with the sterling spread (Figure 11).

The nominal sterling rate depreciated drastically, by about 100%. But real effective rate depreciation was limited to about 25%, due to the fact that inflation was higher in the UK than in the economies of its trading partners (Figure 12).

As to the Asian economies, the depreciation of the nominal rate for the Korean won, at about 400%, was much greater than the depreciation of sterling, though the real rate depreciation was limited to about 70% (Figure 13). Similar trends can be observed with respect to the Chinese yuan (Figure 14).

The second marked feature is a sharp appreciation in nominal/real effective yen rates after the burst of the bubble, which reached its apotheosis in 1995. As Obstfeld (2011) noted, "In Japan's economic history after the bubble burst, the yen's strong nominal/real appreciation in 1990–95 stands out as a pivotal episode".

It is rare indeed, following the burst of a huge bubble, that a nation's currency should experience such an uninterrupted rise in both nominal and real terms (the "yen appreciation syndrome").The nominal effective yen rate appreciated by 45%, while the real effective rate underwent a revaluation of 38% between the second quarter of 1990 and the second quarter of 1995. In spite of the sharp appreciation of the real effective yen rate, the terms of trade deteriorated 1.9%. If we exclude energy prices from import prices, however, the terms of trade improved by a slight 0.1% (Table 3).

After the Lehman collapse, for instance, the US dollar continued to slide from its 2002 peak, reaching a trough in 2011. The nominal effective dollar rate depreciated 55%, while the real effective rate lost 33% (Table 3). This large depreciation is comparable only to what occurred after the Plaza Accord, when the nominal effective dollar rate fell 53% while the real effective rate dropped 45%. The difference between these two episodes of major dollar depreciation is the magnitude of the deterioration in the United States' terms of trade. This time around, the terms of trade worsened by 12%, whereas the deterioration was only 2.2% in the earlier

event. This has implications for the international repercussions of US expansionary monetary policy, an issue dealt with in Section VI.

It is interesting to note that Reinhardt and Rogoff (2008) identified dollar crashes in 1969, 1971 and 1975 – a currency crash being defined as a sharp exchange-rate decline of more than 15% in a year's time. With the dollar's delinking from the gold standard in August 1971, the depreciation in the nominal effective rate was only 20% between the first quarter of 1970 and the third quarter of 1973 (Table 3).

Finally, even the nominal effective euro rate declined 7.1% from its peak in the third quarter of 2009, though this was a much smaller drop than experienced by other major currencies.

The third salient feature is related to quantitative easing. The trend of both the nominal and real effective yen rates was downward during the period of the first quantitative easing policy from March 2001 to March 2006. Empirical research by Watanabe and Yabu (2009) indicated that the increased bank reserve target combined with the massive intervention policy from the spring of 2003 to the spring of 2004 exerted a significant impact on the nominal/real yen rate, contrasting with conventional sterilized intervention policy.

The fourth way in which the yen rate differed markedly from other major currencies consisted of an extraordinary surge, from a bottom in 2007, despite the ample provision of liquidity and the subsequent implementation of comprehensive easing policy by the BOJ.

In the wake of the Lehman collapse, the yen and Swiss franc have been chosen as safe haven currencies. The nominal effective yen rate appreciated by 34%, while the real effective rate rose 27% between the second quarter of 2007 and the third quarter of 2011. It is important to note that Japan's terms of trade deteriorated a very significant 27.5%. Excluding energy prices from import prices, the deterioration was 6% (Table 2). The Japanese yen appreciated more than the Swiss franc in this period.

Long-term trends in the terms of trade

As to trends in the terms of trade, several features can be identified, as follows:

First, Japan's terms of trade showed a long-term decline from 1970 to 2011, in contrast to movements in the nominal/real effective yen rates (Figure 7.1). One of the primary factors worsening the terms of trade was the rising trend in energy prices. Japan's terms of trade deteriorated markedly in the course of the two oil price hikes of 1973–74 and 1979–80, in addition to the effects of the sharp upward trend from the middle of the 2000 decade to 2008.

Second, both the real effective yen rate and Japan's terms of trade are affected by shocks to the nominal yen rate, moving in the same direction as the latter.

On the other hand, the US terms of trade moved in tandem with the real effective dollar rate, except for the first half of the 1980s, when the real effective dollar rate deviated markedly from the terms of trade. At that time, protectionist pressures mounted, and led to the Plaza Accord in 1985 to avoid excessive overshooting of the dollar rate. However, the overshooting and upward deviation of the real dollar rate were much smaller than occurred with the Japanese currency after 1985 (Figure 11).

It is remarkable that both the UK and German terms of trade remained stable over the long term despite the fluctuation of real effective exchange rates.

Third, Japan's terms of trade continued to worsen during the QE 1 and 2 periods, although they improved slightly with the sharp decline of oil prices in July 2008. The real effective yen rate was on a downward trend during the QE 1 period, while QE 2 was accompanied by a sharp rise in the real effective yen rate and a worsening in the terms of trade. This worked to reduce the profit margin of Japanese firms, as discussed in the next section.

In the case of the UK, nominal sterling depreciation was about 40% between mid-2007 and 2009 (Figure 12). QE 1 was adopted after the sharp decline in the nominal effective rate. The decline in the effective exchange rate was accompanied by higher import prices, which significantly raised consumer prices. The depreciation may enhance international competitiveness by lowering UK export prices on the international market. However, it is notable that the terms of trade have remained virtually stable since 1980. The rise in import prices has been almost completely offset by higher export prices.

MacCoille et al (2010) explained the stability of the UK terms of trade as a result of the pricing strategies adopted by UK exporters and trading partners who export to the UK. According to their research, the equal proportions of UK exporting companies pricing in local currency (LCP) and foreign exporting companies pricing in their own domestic currency (PCP) led to the increase of both export and import sterling prices, broadly corresponding to the exchange-rate depreciation. The asymmetrical pricing behavior of UK and euro-area exporters left terms of trade unchanged in the face of exchange rate changes.

We elaborate in Section V on the question of exchange rate pass-through and choice of invoice currency in relation to changes in the terms of trade. Before discussing the question of invoice currency selection, we turn to Section IV, which examines the relationship between exchange rates and terms of trade.

IV. Relationship between Exchange Rates and Terms of Trade

The nominal exchange rate is responsive to asset market shocks, including changes in monetary policy. On the other hand, terms of trade are affected by exogenous productivity shocks and by changes in international commodity prices, which are determined exogenously to individual countries.

Changes in terms of trade in response to exchange-rate changes depend on a number of factors.

First, changes in the terms of trade in response to exchange-rate changes will initially depend on the currency in which domestic and foreign companies set their prices under the assumption of nominal price rigidity. Firms may also have agreed fixed-price contracts. The menu costs could be non-negligible.

Second, over time firms will be able to change their prices, depending on the timing of the renegotiation of fixed-price contracts. Prices will reflect changes in marginal costs and in price markups over marginal costs in response to exchange-rate changes. The relative responsiveness of demand and supply elasticity and the market structure affect outcome as far as prices are concerned.

Third, it is conventional wisdom that depreciation in the nominal/real exchange rate is accompanied by worsening terms of trade as import prices rise. However, this may not always be the case. Under conditions of flexible prices with non-tradable goods, absence of home bias with respect to tradable goods in trading nations will make the movement of terms of trade entirely independent of changes in real exchange rates.

Okada and Hamada (2010) have pointed out that the real exchange rate can diverge from the terms of trade as a result of two factors, namely:

1. the degree of home bias with respect to tradable goods produced by the home country; and
2. the international “difference in differences” of non-tradable/tradable price relationships from one country to another.

To demonstrate these two points, we follow the procedure employed by Okada and Hamada (2010) and by Obstfeld (2011).

The overall price index is defined as the weighted sum of tradable goods (P_T) – composed of goods 1 (export goods) and goods 2 (import goods) – and non-tradable goods (P_N). The price index of tradables is the weighted average of the two tradable goods (P_1, P_2), as follows:

$$P = P_T^{\theta_T} \times P_N^{\theta_N}, \quad P^* = P_T^{*\theta_T^*} \times P_N^{*\theta_N^*};$$

$$P_T = P_1^{\delta_1} \times P_2^{\delta_2}, \quad P_T^* = P_1^{*\delta_1^*} \times P_2^{*\delta_2^*}.$$

Then the real exchange rate = $E P^*/P$

$$= E \times \left(P_1^{*\delta_1^*} \times P_2^{*\delta_2^*}\right)^{\theta_T^*} \left(P_N^*\right)^{\theta_N^*} \Big/ P_1^{\delta_1} \times P_2^{\delta_2} \left(P_N\right)^{\theta_N}$$

$$= E \times \left[P_1^*/P_1\right] \times \left(P_1/P_2\right)^{\delta_2 \theta_T} \Big/ \left(P_1^*/P_2^*\right)^{\delta_2^* \theta_T^*} \times \left(P_N^*/P_1^*\right)^{\theta_N^*} \Big/ \left(P_N/P_1\right)^{\theta_N}$$

$$= E \times \left[P_1^*/P_1\right] \times \left(P_1/P_2\right)^{\delta_2} \Big/ \left(P_1^*/P_2^*\right)^{\delta_2^*} \times \left(P_N^*/P_1^*\right)^{\theta_N^*} \Big/ \left(P_N/P_1\right)^{\theta_N}$$

If we express the real exchange rate logarithmically (in small letters), then:

Real exchange rate = $(e + p_1^* - p_1) + [\delta_2 \theta_T (p_1 - p_2) - \delta_2^* \theta_T^* (p_1^* - p_2^*)] + [\theta_N^* (p_N^* - p_1^*) - \theta_N (p_N - p_1)]$

As already pointed out by Mr. Broadbent, the real exchange rate is affected by terms of trade changes and by the relative price of non-traded output to tradables. The first term describes the "head-to-head competition" effect among exporting firms; the second term represents the "overall terms of trade" effect; and the third indicates the modified "Harrod-Balassa-Samuelson" effect (we employ the word "modified" because the third term includes the price of non-tradables relative to the price of tradable goods 1 only, rather than the price of both categories of tradables.

Based on the above equation, Obstfeld argues that "a rise of import price pushes up Japan's tradables price level and causes the real appreciation of the yen" (smaller value). This may not necessarily be true. The assumed opposite movements of the terms of trade and the real effective exchange rate are contrary to Japan's experience, except for 2007 and 2008. Our conjecture is somewhat different from his, as explained below.

Let us assume that prices are flexible, ie the "law of one price" holds with respect to the two tradable goods categories, so that

$P_1 = E \bullet P_1^*$, $P_2 = E \bullet P_2^*$.

Then the real exchange rate can be greatly simplified, as follows:

$$EP^* / P = \left(P_1/P_2\right)^{\left(\delta_2 - \delta_2^*\right)} \left(P_N^*/P_T^*\right)^{\theta_N^*} \Big/ \left(P_N/P_T\right)^{\theta_N}.$$

In logarithmic form:

Real exchange rate = $(\delta_2 - \delta_2^*)\,(p_1 - p_2) - [\theta_N\,(p_N - p_T) - \theta_N^*\,(p_N^* - p_T^*)]$.

This result was obtained by Okada and Hamada (2010). The first term represents the terms of trade multiplied by the difference in weights attached to tradable goods 2 in home and

foreign country. If there is a home bias with respect to the tradable goods produced by the foreign country, then it implies that $\delta_2 < \delta_2^*$.

As a result, real exchange-rate appreciation will be positively correlated with change in the terms of trade. However, the change in the terms of trade will be much larger than the real exchange-rate changes, as the home bias is less than one by definition. In reality, the terms of trade are more stable than the real exchange rate in the countries under observation (the US and UK; see Figure 7.3).

In addition, the positive association may be mitigated by the difference between the non-tradable/tradable price relation in one country and the non-tradable/tradable price relation in the other. If the non-tradable/tradable price differential is higher in the home country than in the foreign country, the positive association will diminish.

Furthermore, if purchasing power parity holds, with the home bias remaining in tradable goods, then the real exchange rate remains constant at one, for the purchasing power parity can be defined as:

$PPP=P/P^*$

and the terms of trade are determined entirely by the difference between one country's non-tradable/tradable price relationship and the other's.

Terms of trade = $(p_1 - p_2) = [\theta_N (p_N - p_T) - \theta_N^* (p_N^* - p_T^*)] / (\delta_2 - \delta_2^*)$.

Domestic productivity in tradable goods higher than non-tradable productivity pushes up the ratio of non-tradable to tradable goods prices. In addition, it tends to worsen the terms of trade. In reality, the trend of worsening terms of trade in Japan is often attributed to the differential between tradable-sector productivity and productivity in the non-tradable sector. On the other hand, a positive productivity shock to the tradable sector abroad works to improve the terms of trade in the domestic economy.

Harrod-Balassa-Samuelson effect

If there is no home bias, ie the consumers in the two country have identical preferences, $\delta_2 = \delta_2^*$, then the real exchange rate is completely independent from movement in the terms of trade. In this case, the real exchange rate is determined solely by the difference between the non-tradable/tradable price ratios of the two countries.

Given that the price differential between tradable goods and non-tradable goods may reflect a difference in labor productivity between the two sectors, a larger labor productivity differential in the home country implies the appreciation of its real exchange rate.[7]

Japan's labor productivity in the tradable sector is much more rapid than it is in the non-tradable sector. As a result, the productivity differential between the tradable and non-tradable sectors is larger in Japan than in the US. Thus, there is a tendency for Japan's real exchange rate with the dollar to appreciate (Harrod-Balassa-Samuelson effect). The terms of trade tend to worsen if the purchasing power parity holds.

To his surprise, Obstfeld (2011) could not detect any empirical evidence of short-run correlation between relative productivity changes and the yen real rate vis-à-vis the US dollar. In reality, real exchange rates show much more volatility than do relative productivity changes in the two economies. Obstfeld pointed out that only in the 1995–2004

[7] On a more rigorous derivation based on production function, see Obstfeld (2011), pp.72–77.

period, when Japan's relative productivity growth rate became smaller than that of the US, did the Harrod-Balassa-Samuelson model point in the right direction.[8]

The role of oil price changes

In Japan, the divergence between the real exchange rate and the terms of trade is conspicuously larger than it is in other countries like the UK and Germany.

In addition, the secular decline in terms of trade is notable. This may be due to heavy dependence on oil imports for the energy supply. Rising oil import prices may lower the relative price of non-tradable goods, and thus induce real depreciation, as the energy input share may be larger in the tradable sector. The secular deterioration of terms of trade during the period from 1970 to 2010 can be attributed at least partially to the rise in oil and food prices. Dollar-denominated oil and commodity prices are determined on the international market.

Moreover, the real price of oil and the real effective yen rate display a high negative correlation. Rising oil prices affect not only the terms of trade, but also, simultaneously, the real effective exchange rate. Japanese import prices have been strongly correlated with movement in oil prices.

Obstfeld (2011) found that Japan's terms of trade declined by more than 54% between 1988 and 2007, while the decline in the ex-energy terms of trade was much more moderate, at only about 18%. The ex-energy terms of trade have shown more stability than the overall terms of trade (Figures 7.2, 7.3).

It is true that the energy price rise contributed significantly to the deterioration in Japan's terms of trade. But given the existence of home bias with respect to tradable goods, it remains a puzzle why the terms of trade have worsened despite the strong rising trend of Japan's real effective exchange rate over the long run.

It is characteristic that Japan's export price did not respond to the rise in the oil price. Moreover, the export prices show a great deal of stability, despite the strong rising trend of nominal and real effective exchange rates. This suggests that Japanese firms resisted the appreciation by squeezing profits and cutting the ratio of markup to marginal costs. This suggests that Japanese exporters adopted the strategy of "pricing-to-market" or "non-pass-through" of exchange-rate changes to export prices.

Mark-ups and deflation

If the real effective exchange rate appreciates sharply and deviates from the fundamental rate, it will compress markups under conditions of monopolistic competition, and erode the international competitiveness of exporting firms.

If we can represent production costs by average costs, then international competitiveness can be described as:

$\phi = (P/Wc)/(P^*/Wc^*) = (P/P^*)/ (Wc^*/Wc)$.

Fukao and Dekle (2011) focused on estimating average costs for high-productivity manufacturing, low-productivity manufacturing and the service sector in the US and Japan

[8] Yet he also added that the real yen rate against Germany is more consistent with the HBS theory. Moreover, Lane (2011) confirmed the possibility that the real exchange rate might appear to be co-integrated with the relative productivity variables. Dekle and Fukao (2011) find more evidence than does Obstfeld (2011), by adding the low productivity manufacturing sector to the model in Japan and the US.

during the period from 1980 to 2005. After the Plaza Accord, the ratio of average US costs to average Japanese costs declined sharply.

The above-mentioned authors derived the long-run equilibrium dollar-yen rate (benchmark PPP) from estimated average costs. The actual exchange rate widely overshot their putative equilibrium values in the 1985 to1995 period.

An attempt to arrest the erosion of the international competitiveness of Japanese firms by cutting wages and increasing the proportion of non-regular workers was one of the major factors which brought the Japanese economy into persisting deflation and depressed the level of investment, including software investment. It is symbolic that the trend of nominal wages began to register a negative rate of change in 1997.

We conjecture that Japan entered the era of deflationary equilibrium after 1995; the GDP deflator showed a negative rate of change in late 1994. CPI deflation started after the reappreciation in mid-1998, when the Asian crisis required appreciation of the yen through joint US-Japan intervention.

According to the estimates of the Dekle-Fukao model, the real exchange rate returned to the equilibrium level in 2003 when the nominal yen-dollar exchange rate was around 120 yen/dollar. This was exactly the rate at which the Ministry of Finance initiated the "Great Intervention Policy" in the spring of 2003. Thanks to the intervention policy, with implicit agreement between the Japanese and US authorities, the nominal yen/dollar rate remained around the 110–120 range. However, the findings of Dekle and Fukao diverge significantly from those of Jorgenson and Nomura (2007), who have provided empirical evidence, based on the PPP in terms of GDP, that the overvaluation reached levels of 78%, 41% and 24% in 1995, 2000 and 2004, respectively.

International competitiveness

If consumer prices can be taken to represent the movements of wage costs, and the law of one price holds, then international competitiveness can be measured by the difference between the terms of trade and the real exchange rate.

$\phi = (P_1/P)/(P_2^*/P^*) = (P_1/P_2)(EP^*/P)$

Hence, we can see that international competitiveness will be eroded if the appreciation of the real exchange rate exceeds the improvement in the terms of trade. In other words, if the real effective appreciation is not accompanied by improved terms of trade, it will lead to more difficult competitive conditions for Japanese industries. On the other hand, if the real effective exchange rate remains at one, then international competitiveness can be measured by changes in the terms of trade.

In fact, the US real effective exchange-rate appreciation exceeded the terms of trade improvement in the first half of the 1980s (Figure 11). The excessive dollar appreciation led to the Plaza Accord in 1985, although the appreciation of the real effective dollar rate was comparatively small (about 20%) in comparison with the appreciation of real effective yen rate in the mid-1990s (about 100%).

The international competitiveness of Japanese firms has been eroded by the steady rise of the yen, with a peak in 1995. Japan's share of the world export market declined from 10% in 1993 to 5% in 2010, although its GDP continued to represent about 9% of the global economy (Figure 15).

It is debatable whether the current appreciation of the nominal/real effective exchange rate since 2007 is excessive or not. The current real effective exchange rate is close to its 2003 level, which is lower than the 1995 level. However, Jorgenson and Nomura (2007) estimate the equilibrium yen rate at 134 in 2004. It should be noted in addition that the terms of trade

have continued worsening in recent years, diverging significantly from the real effective exchange rate.

Figure 16 shows the current real yen/dollar rate, with the Japan-US wage cost differential by industry as a denominator. Real appreciation has been greater in the case of major industries such as electrical equipment and transportation machinery than it was in 1995. Figure 17 presents Balassa's findings on comparative advantage by industry. The comparative advantage of general machinery and electrical machinery tends to decline after 1995. The comparative advantage of transportation equipment followed an upward trend up to 2008, but finally turned downward in 2009.

In addition, import penetration rose sharply in 2009, showing a pattern similar to the increase in 1995–1996 (Figure 18). Furthermore, the ratio of output price to input price in manufacturing, ie the terms of trade at the enterprise level, showed a declining trend starting in the mid-1990s, with the exception of precision machinery. A sharp drop in the terms of trade implied a heavy reduction in markups, notably in iron and steel, and in electrical machinery – industries that are exposed to fierce competition from Korean and Chinese exporters. Real effective exchange rates in Korea and China continued on a substantial downward trend that had begun in the 1970s or 1980s (Figure 13, 14).

In contrast, Germany maintained its share of the world export market at its early-1990s level by maintaining a stable real exchange rate thanks to the lower nominal euro rate, reflecting the international competitiveness of German exporters within the euro area.[9] German export industries have been well protected by the introduction of the euro.

V. Choice of invoice currency

Three options

There are three options for monopolistic exporters facing exchange-rate uncertainty in invoicing their transactions. The currency used for trade contracts is referred to as the invoice currency.

Given wide and rapid exchange-rate fluctuations under a floating exchange-rate system, it can be very costly for exporting firms to re-optimize offer prices at the time when the exchange rate changes. It seems reasonable to assume that exporters have to set prices before the exchange rate is known. Demand is then a function of the price that importers face after the exchange-rate uncertainty is removed. The choice of invoice currency would not have a different effect on the profit functions if exporters were to set prices after the exchange rate is known.[10]

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[9] The productivity differential between traded and non-traded sectors is larger in accession economies than in euro-member economies. The price of non-traded goods in relation to traded goods is higher in the accession countries. Thus, overall inflation will be higher at a given exchange rate. This leads to appreciation of the real effective exchange once a country joins the euro system.

[10] Friberg (1998) noted that under the pre-set pricing framework, the invoice currency functions as a store of value, after the price is set in some currency which functions as the accounting unit. The medium-of-exchange function of money is fulfilled by the currency used for payment – which is normally the same as the one used for the invoice.

Baccheta and Wincoop (2002) argued that within the partial equilibrium framework, the choice between PCP and LCP depends on the shape of the profit function, ie whether it is convex or concave in price (exchange-rate) changes. A monopolistic firm chooses PCP when the profit function is convex and the product differentiation is high. It chooses LCP when the profit function is concave and the product differentiation is low.

Producer currency pricing

The first option for exporters is to set their export prices in their home currency. The export price is P_1, irrespective of exchange-rate changes. In the literature this is termed "producer's currency pricing" (PCP).

In the case of PCP, the pass-through is 100%. This means wide fluctuations in import prices. In reality, import prices change much less than the exchange rate.

Under PCP, both the law of one price and purchasing power parity hold. Furthermore, the terms of trade immediately worsen as the exchange rate depreciates, for the terms of trade under PCP can be expressed as follows:

Terms of trade = $(P_1/P_2) = (P_1/EP_2^*)$.

Depreciation of the home country currency implies a greater E, thus worsening the terms of trade of the home country.

Assuming that exporters do not hedge their demand risk by buying forward contracts in their own currency, their offer price is higher due to risk aversion.[11] The optimal price is set independently from the shape of the utility function or the stochastic properties of the exchange rate ("separation theorem"), except for the specific demand function.

Local currency pricing

The second choice is to set the price in the currency of the destination country (local currency pricing, or LCP). By definition, the exchange rate pass-through is zero. The implicit assumption made here is perfect price discrimination by exporting firms, or market segmentation across the border. As a result, neither the law of one price nor purchasing power parity holds in the presence of nominal price rigidities.

In addition, by using the forward market and setting their prices in the importing country currency, exporters can fully avoids risk and achieve the same profit as under conditions of certainty. If the forward markets are efficient, exporters will hedge fully. In the case of LCP with hedging in the forward market, exporters' offer price does not depend on the shape of utility function or the stochastic properties of the exchange rates ("separation theorem").

Under LCP, exchange-rate depreciation is immediately accompanied by improved terms of trade for the home economy, because the export price is set in local currency, as denoted by P_1^F.

Under LCP, the terms of trade can be expressed as follows:

Terms of trade = $(P_1/P_2) = (EP_1^F/P_2^*)$.

Depreciation of the domestic currency (ie greater E) leads to an improvement in the terms of trade for the home country, while worsening the terms of trade for the foreign country. This is exactly opposite to that of the PCP case. It must be noted that the law of one price does not hold, because P_1 is different from EP_1^F. The terms of trade changes to depreciation/appreciation can be summarized as shown in Table 6. It may be noted that asymmetric use of PCP and LCP results in no change in the terms of trade, as pointed out by MacCoille et al (2010).

[11] Friberg (1998) noted that exporters usually do not hedge against demand risk by buying forward contracts in their own country. Yet it is not to be assumed that multi-national firms such as trading companies do not hedge against demand risk in the forward market.

On the other hand, uncovered interest rate parity can still hold, if we assume the international bond trading. The differentiated response of terms of trade to exchange-rate changes has important implications for the international transmission of monetary policy and its impact on national welfare, as discussed in Section VI.

Pricing to market and LCP

The choice of invoice currency is often discussed in relation to the practice of exchange rate pass-through or "pricing-to-market" (PTM) employed by exporting firms.

From the perspective of maximizing profits under exchange-rate uncertainty, exporters can stabilize demands in the foreign market by choosing LCP and engaging in less than full exchange rate pass-through. In fact, the choice of invoice currency is a function of the same factors (related to demand and cost functions) that determine the exchange rate pass-through[12].

Knetter (1993) provided empirical evidence that, for Japanese exports, destination-specific export price adjustment offsets 48% of the impact that exchange-rate changes have on price in the buyer's currency. For Germany and the UK, the number is 36%, while for the US, it is zero.

It is understandable that the US terms of trade have moved in tandem with the exchange rate. Both exports and imports are invoiced in dollars (this is true for 90% of exports and close to 100% of imports).

Conversely, Japanese exporters' exchange rate pass-through to export prices is 52%, which is much lower than the numbers for US, UK and German exporters. The difference may reflect the degree of product differentiation and shape of profit functions of the exporters of different countries.

It may also be due to the increasing share of intra-firm transactions and to market share considerations among Japanese exporters, the role of yen as an international currency aside.

Empirical evidence shows "mark-to-market" practices or low exchange rate pass-through to be positively associated with the choice of local currency (LCP) as the invoice currency. In other words, under LPC, exporting firms tends to choose the local currency as their invoice currency.

On the other hand, a study by the Cabinet Office estimated the exchange-rate change pass-through to be about 30%–40% between 1983 and 1990. But the share of the pass-through dropped to about 20% in the 1990s, before recovering to about 40%–60% in the latter half of the 2000 decade. The proportion to which the yen was used as an invoice currency for Japanese exports gradually increased during the period under observation. Thus, the magnitude of the pass-through was apparently affected not only by the choice of invoice currency but also by other prevalent economic conditions in the world economy.

The third-currency pricing option

The third option is for exporters is to use a third country's currency for invoicing. Many Asian countries use the US dollar. Goldberg and Tille (2005) found the use of dollar as an invoice

[12] Friberg (1998) demonstrated that the sufficient conditions for choosing the local currency as an invoice currency are the same as the conditions requiring the exchange rate pass-through of export prices to be less than one.

currency in trade with non-US counterparts to be closely correlated with the extent to which a country's exports or imports featured organized-exchange transactions in items like commodities, precious metals and reference-priced goods such as chemical products.

An organized-exchange good is one that has an overt market, while a reference good is a uniform good without an official market but with reference prices that are published in trade magazines. In these markets, the firm is a price taker, and exchange-rate uncertainty easily translates into commodity price uncertainty.

We also observe that exports of differentiated goods tend to be invoiced in the exporting country currency, whereas organized-exchange goods and reference-priced goods are predominantly invoiced in the US dollar.

The role of the vehicle currency

The choice of a vehicle currency as a medium of exchange in order to facilitate international transactions in the foreign exchange market is influenced by network externality and low transaction costs coupled with the presence of inertia (Krugman, 1980). Low transaction costs are closely associated with a high degree of liquidity in the foreign exchange markets and domestic financial markets.

When a vehicle currency is used, stochastic changes in the third country's exchange rate affect demand. Exporters will prefer LCP, as they can fully insulate themselves from risks by using the forward currency market. But if the vehicle currency has less variance than the domestic currency, an exporter will prefer pricing in the vehicle currency to pricing in the home currency.

Actual use of invoice currency

It is interesting to note that the proportion of Japan's dollar-invoiced exports was 47.4% in 2009, while the dollar-invoiced proportion of US exports was 95% in 2003. In the case of Germany the 2002 figure was 32.3% (Table 5).

On the other hand, the yen-invoiced share of Japan's exports increased gradually from 36.1% in 2000 to 42.2% in 2009.[13] For Japanese imports, the dollar is the dominant invoice currency, reflecting in part the fact that commodity prices are denominated in dollars. Dollar-invoiced imports represent 72.1% of total imports, while yen-invoiced imports hover around 20–24% of the total (Table 4).

It is important to note that price setting behavior affects the terms of trade and the international transmission of monetary policy. Both the exchange rate pass-through and the choice of invoice currency suggest that not only PCP, but also LCP, plays an important role in firms' price setting throughout the global economy, except for the US. Even the mixed use of PCP and LCP may be one source of deviation from the law of one price and purchasing power parity.

[13] Grassman (1973) found that the producer's currency tends to be the chosen currency in trade of Sweden and Denmark ("Grassman's Law").

VI. Difference in international transmission of monetary policy

New open-economy macroeconomics has provided new insight into the international transmission of monetary policy. Under conditions of nominal price rigidities, the transmission mechanism is influenced by differences in price setting behavior, which is linked to the choice of invoice currency.

It is also important to discern the effect of production and employment on a nation's welfare. Although the effects of monetary expansion on employment and production are the main focus in the political debate, it is crucial to watch the effects of monetary expansion on terms of trade for different countries, as well as the world real interest rate, in assessing impact on economic welfare.

As regards the effect of international transmission of monetary expansion on welfare, the main findings in the literature on the new open-economy macroeconomic model can be summarized as follows (Obstfeld and Rogoff, 1995; Corsetti and Pesenti, 2008; Betts and Devereux, 2000).

1. If all domestic and foreign exporting firms adopt PCP, then exchange rate changes affect export price in the foreign economy via a 100-percent pass-through effect. The 100% pass-through raises the home-currency price of imports, while it leaves export prices unchanged; thus it worsens the terms of trade for the home economy. Higher import prices expand domestic production, thereby reducing foreign production. At the same time, the domestic economy's current balance improves, while the foreign country's worsens.

   The deterioration of the home country's terms of trade will not necessarily affect the domestic labor supply, for the income and substitution effects tend to offset each other, and the domestic labor supply is completely shielded from changes in the terms of trade in the case of the Cobb-Douglas utility function.

   Foreign consumers can enjoy a higher level of consumption for an unchanged level of labor effort; the terms of trade improvements more than offset the reduction in production (Obstfeld and Rogoff, 1995; Corsetti et al, 2000). Thus, it is unlikely that domestic monetary expansion will cause a "beggar-thy-neighbor" effect. The expenditure-switching effect (which shifts world demand from foreign goods to home goods) works to dampen the volatility of the exchange rate by reinforcing the reallocation of resources. Monetary policy that is optimal for world welfare can be conducted without international policy coordination.

2. If all domestic and foreign exporting firms adopt LCP as their price setting behavior, then changes in the exchange rate do not affect export prices as denominated in foreign country currency. The terms of trade change with exchange-rate changes; depreciation raises the home currency price of exports, but leaves import prices unchanged. This results in terms of trade improvements for the home economy, contradicting the observation that depreciation is usually accompanied by a worsening of terms of trade.

   Changes in exchange rate involve no expenditure-switching effect. The trade balance is left unchanged in the absence of an expenditure-switching effect. Depreciation of the home currency, however, raises the markup over marginal costs in terms of the domestic currency, and reduces the markup of foreign firms; it shifts world income distribution toward the home economy. Home consumption increases relative to foreign consumption. As a result, domestic monetary expansion always improves domestic welfare by improving the terms of trade and increasing domestic income and production, while the welfare of the foreign country is eroded by the poorer terms of trade, although foreign production increases due to the lower real world interest rate and the expansion of world consumption. The terms of trade

deterioration offsets the increase in foreign production, leaving the foreign income unchanged. Instead of an expenditure-switching effect, the switch of the labor burden produces a "beggar-thy-neighbor" effect. Workers in the foreign country need to work more to sustain the same level of consumption. The adoption of LCP increases the cross-country correlations for production, but reduces the consumption correlations.

Moreover, given the absence of expenditure-switching effects, the adoption of LCP will result in an exchange rate that is more volatile in response to unanticipated monetary and fiscal shocks; each central bank attempts to stabilize changes in marginal costs in the home economy. Facing high volatility of exchange rates, foreign producers raise the markup rate on export prices. Stabilizing the exchange rate is helpful to stabilize marginal costs in the two countries. This points to advantages associated with choosing a fixed exchange-rate regime under LCP, rather than a flexible exchange-rate regime (Devereux and Engel, 2003).

The optimal monetary policy for maximizing welfare in the domestic economy depends on the foreign monetary policy's being optimal. Assuming a symmetric objective function for the two central banks, there is no need for international policy coordination. International policy coordination is, however, needed in the case of asymmetric and mixed use of PCP and LCP in the two countries (Corsetti and Pesenti, 2008).

3. The story becomes more complicated if, in addition to the mixed use of PCP and LCP, one country adopts PCP while another adopts LCP.

   By incorporating the asymmetry and mixture cases into the Obstfeld-Rogoff model, Otani (2002) argues that whether the beggar-thy-neighbor effect is generated or not depends on the share of LCP, the value of elasticity of substitution and the size of the country.[14]

   Table 7 summarizes the above results. Caution is in order, in that the spillover effect of domestic monetary expansion can actually be accompanied by worsening welfare in foreign countries. It should be noted that the IMF spillover study focuses on the effect of monetary policy on production in foreign countries, rather than on welfare. Moreover, if LCP dominates the world economy, it is sensible to have a more stable exchange-rate regime. Let us turn now from the results of the model to evaluating the spillover effect of monetary expansion in Japan in comparison with other countries.

Japan's unconventional policy measures

In the period of the BOJ's first round of unconventional policy measures, the nominal/real yen rate depreciated as a trend. But the nominal/real depreciation was accompanied by worsening terms of trade, which implies better terms of trade for trading-partner countries.

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[14] If all Japanese exporters adopt LCP and all US foreign firms employ PCP, the US monetary expansion exerts a greater influence on US domestic consumption. But Japanese monetary easing will have little influence on US consumption.

Under the assumption that 100 percent of US exporters adopt PCP, while less than half of Japanese exporters do, Japan's monetary expansion can exert a welfare-reducing effect on the US economy if the value of elasticity of substitution exceeds 8.37. But the international transmission effect of Japanese monetary policy on US welfare is negligible, as compared with the effect of US monetary policy. On the other hand, both Japanese and US monetary expansion have beggar-thy-neighbor effects in the case of 50% adoption of LCP by Japanese exporters (Otani, 2003).

In the second round of unconventional policy, the nominal/real yen rate appreciated sizably, reflecting a relatively small adverse effect from financial market disruptions, relatively modest monetary expansion, and the yen's role as a safe haven currency. Despite the nominal/real appreciation of the yen, Japan's terms of trade again deteriorated. It is unlikely that Japan's monetary expansion caused a beggar-thy-neighbor effect, but it could be that Japanese industries are suffering as the result of another excessive spurt in the yen rate due to the combination of real yen-rate appreciation and worsening terms of trade.

The recent US monetary expansion

US monetary authorities seem to regard US monetary expansion as beneficial to all trading-partner countries, implicitly assuming that PCP is employed not only by US firms but also by all the firms of its trading-partner countries.

However, commodity prices reacted to the extraordinary monetary expansion of the US. The commodities market – notably the oil market – was financialized through the participation of various funds, including hedge funds, commodity index funds and pension funds (Iwata, forthcoming). Fund managers aimed to enhance investment in commodities as an alternative investment to traditional equities and bonds starting in the middle of the first 2000 decade. The commodities turned out to be liquid assets whose prices are determined on the forward market.

A rise in oil prices accelerates the worsening of terms of trade triggered by domestic monetary expansion. In April 2011, US gasoline prices rose to nearly four dollars a gallon, the threshold price for dampening consumer spending.

In May, the Chicago Mercantile Market twice raised the margins on forward market transactions, to prevent a speculative, forward-market-led acceleration of oil prices. Moreover, the emergency release of oil stock by the IEA member countries in June and July slowed down the pace of the oil price increase. These two measures suggest the usefulness of additional policy weapons to ward off adverse international repercussions.

These measures mitigated the adverse effects of the worsening US terms of trade. Certainly, the commodity-producing countries enjoyed an improvement in their terms of trade. If the US terms of trade turned down more sharply due to the sharp oil price increase, which dampens consumer spending, a strong monetary expansion could bring about a "beggar-thyself" effect through international repercussions.[15] However, moderate dollar depreciation brings great comfort to the US, since it strengthens the international competitiveness of US firms and has the effect of revaluing US residents' holdings of foreign-currency-denominated assets.

International repercussions for oil prices from US monetary expansion appeared as early as 2007–2008. The US economy entered recession in December 2007, before the Lehman bankruptcy. Hamilton (2009) argued that the recession from the fourth quarter of 2007 to the third quarter of 2008 was triggered by higher oil prices. In other words, more modest monetary expansion could have prevented the recession. In fact, the Federal Reserve temporarily stopped cutting the policy rate in the period from June 2008 to September 2008. On the other hand, the ECB raised its policy rate in July when the oil price peaked. However, the ECB faced the immediate risk of an autumn recession, and cut the policy rate in October.

[15] Corsetti and Pesenti (2001) has already pointed out the possibility that domestic monetary expansion can reduce the domestic welfare if the openness is high and the elasticity of input substitution is not so small under the PCP.

The depreciation of the real sterling rate and the appreciation of the real yen rate

As already pointed out by Broadbent (2011), it is possible that the sharp depreciation of the sterling in 2007–8 was not caused by monetary expansion. But we should note that there was a sharp cut in the policy rate by the BOE, from 5% in late 2008 to 0.5% in early 2009. Therefore, expansionary monetary policy in the form of a lower policy interest rate contributed in part to the depreciation of the nominal exchange rate.

Broadbent pointed to a sharp expected decline of expenditure on non-tradable output, which supposedly brought about a sharp depreciation in the real five-year forward sterling rate.

In the framework of the new open-economy macroeconomic model, exchange-rate changes are determined by uncovered interest rate parity. As a result, the real exchange rate is determined by the difference between the two countries' money-to-consumption ratios. A sharp reduction in domestic consumption (an erosion of the domestic currency's purchasing power) leads to the depreciation of real sterling.[16]

In sharp contrast, Japan experienced an "ever-rising real yen rate" after the bubble burst. In 1990, in a dialogue on US-Japan structural impediments, the Japanese government made a commitment to expand its cumulative public investment to 430 trillion yen over the next ten years, in response to the US request regarding domestic demand expansion to reduce the bilateral current account balance. The ratio of public investment to nominal GDP increased sharply from 1990, reaching a peak in 1995.

After the asset price bubble burst in 1990, Japan's real GDP never fell below the peak of the asset price bubble period, in contrast to the recent experience of other major economies. Presumably, the market expected the boost in demand for non-tradable output due to the increase in public investment. Coupled with this was a stable increase in consumer spending. Both could contribute to an ever-rising real yen rate.

Yen depreciation in the latter half of the 1990s

Based on a three-country, 100% pass-through (PCP) model, taking an approach similar to that of Corsetti et al (2000), Shioji (2001) examined the impact of yen depreciation during the latter half of the 1990s on the welfare of Asian countries.

The insight provided by the model makes it easy to see that yen depreciation via Japanese monetary expansion improves the welfare of Asian countries, although the expansion may exert adverse effects on production in Asian economies. However, the outcome would differ if the assumption regarding the price setting behavior of Asian exporting firms were changed; these firms are likely to adopt LCP rather than PCP.

In addition, it is doubtful whether the yen depreciation in 1995–98 was really caused by monetary expansion in Japan. The BOJ maintained the policy rate at a low level close to zero after December 1995. The ratio of the size of the BOJ balance sheet to nominal GDP evolved stably, while the terms of trade worsened slightly during that period.

We conjecture that the yen rate depreciation was triggered by a notable turnaround of US exchange rate policy, with motion from a weak dollar to a strong dollar in the midst of the Mexican crisis in 1994–5. The joint US-Japanese intervention to strengthen the US dollar caused a marked shift to expected depreciation of the yen/dollar rate. The yen depreciation trend can best be described as a movement toward the equilibrium point of the yen rate, following its overshooting in the preceding post-Plaza Accord period.

[16] In the conversation with Ippei Fujiwara, he made this point more explicit.

On the other hand, if the yen depreciation were caused by a negative productivity shock to the tradables sector, or by financial market shock in Japan, it is obvious that the Asian economies would be more seriously affected.[17]

VII. Conclusion

The expansion of central bank balance sheets and the changes in their composition were designed to mitigate the effects of adverse financial shocks. The unconventional policy measures were effective in rectifying market malfunction and stabilizing the financial market. Central banks acted as a lender of last resort as well as last market-maker. However, the unconventional policy measures adopted by the BOJ have not succeeded in reversing the persistent deflationary tendency, and there has been limited effect on aggregate demand.

The benefit of unconventional policy measures is accompanied by costs: the market distortions created by central banks' massive purchasing of assets are likely to lead to misallocation of resources, not to mention the risk of looser fiscal discipline with the easy monetization of the budget deficit.

This paper explores the possibility of adverse international transmission of monetary expansion through changes in exchange rate and terms of trade; terms of trade changes are one of the most important channels by which domestic monetary expansion is transmitted to foreign countries.

Under the assumption of pre-set pricing, the price setting behavior of exporting firms plays a critical role in determining terms-of-trade changes in response to exchange-rate changes. The terms-of-trade deterioration in the US, with no change in UK or the euro area, may imply that monetary expansion in the advanced economies will have a limited effect on the welfare of emerging economies. In the case of Japan, sharp real yen appreciation has been accompanied by worsening terms of trade, creating benefits for the welfare of trading-partner countries.

More recently, capital flows to advanced economies from emerging economies reversed, reflecting risk-off behavior by global investors in response to the fiscal crisis in the euro area. Now some emerging economies face the risk of sudden capital outflow and downward pressure on the exchange rate of their domestic currencies. More harmful is the effect on emerging economies when there is disruption of financial markets in financial centers. It seems desirable to strengthen international coordination of dollar liquidity provision, with the IMF preventing excessive volatility of exchange rates among major economies[18].

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[17] The simulation outcome may be changed if Japanese and Asian firms adopt LCM in their exports and pass-through is less than one. But it seems problematic to assume that Japanese firms prefer LCP to PCP, given the limited room for hedging on the Asian forward market, with the exception of Korea.

[18] In preparations for the G20 Summit Meeting, the Korean government insisted on the idea of creating a global financial safety network to prevent global financial crisis. As pointed out by Ms. Lagarde, the IMF's "one year forward commitment capacity" amounts to only 246 billion SDRs ($38 billion or €280 billion). This is equivalent to 15% of Italian government debt outstanding.

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