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The End of the Japanese Stagnation: An Assessment of the Policy Solutions

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Abstract

After more than a decade of stagnant growth, the Japanese economy is showing signs of full recovery with deflation having come to an end. Since the mid 1990s both supply side and demand side policy solutions have been suggested to counter the Japanese stagnation . Using of a factor vector autoregressive (F-VAR) model, this paper aims to assess whether the real depreciation of the yen and the quantitative easying implemented by the Bank of Japan have contributed to the recovery of the Japanese economy and to the reversal of deflationary dynamics. The results of the paper point to the effectiveness of the above policies, as well as to the role exercised by domestic productivity improvements and the expansion of world economic activity.

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1 Introduction

Surely, one of the most interesting macroeconomic phenomena of the 1990s is the Japanese stagnation. This is on account of both the gravity of the phenomenon, i.e., "a lost decade of growth", and the likelihood that other industrialized countries could also be affected by such a prolonged recession, given the similarity of the transmission mechanisms of shocks in the G7 countries.[1]

When assessing the macroeconomic developments in Japan since the 1980s, two key issues may be singled out related to developments in the financial markets and the management of monetary policy, respectively. In fact, the stagnation of the 1990s followed a period of strong and noninflationary economic growth, coupled by an excessive collateralized credit expansion (even to the risky segments of the market) and rapidly climbing land and stock prices. Once monetary policy turned contractionary to halt financial imbalances, a banking crisis set in.

As pointed out by Hoshi and Kashyap (1999) and Kanaya and Woo (2000), after the collapse of the stock market, due to nonperforming loans and the reduction in the value of collaterals and equity holdings, banks and financial institutions started facing solvency problems. Taking also into account the increase in the margins that followed the downgrading of Japanese banks in 1992, and the adoption of more stringent cash-flow projections based evaluation criteria, the overall effect was the impaired banks' ability to lend and firms' ability to borrow, leading to a reduction in loans, investment, and output.[2]

Moreover, the contraction in potential output, due to the fall in productivity and shrinking labour force, may have contributed to the contraction in investment (Krugman, 1998). Negative effects on the potential output path due to revisions in labour laws (which determined the reduction of the workweek length from 44 hours to 40 hours between 1988 and 1993) and policies that subsidized inefficient firms and declining industries (thus discouraging investment and the introduction of new and more productive technologies), have also been pointed out by Hayashi and Prescott (2002).

Finally, the implemented monetary and fiscal policies were inadequate.[3] Despite the

[1] See, for example, Bagliano and Morana (2006).

[2] Yet, while in the literature there is substantial agreement concerning the reduction of credit availability, particularly from 1997 onwards (Motonishi and Yoshikawa, 1999, and Woo, 1999), there is much less agreement concerning the negative effects that the latter would have exercised on investment. For instance, according to Kuttner and Posen (2001), the contraction in bank lending would have affected small and medium sized enterprises, since large firms were able to finance themselves going directly to capital markets (see Morana, 2004, for additional details).

[3] According to Krugman (1998), despite the setting in of a liquidity trap, monetary policy was mostly carried out in a conventional manner and was overly restrictive. Similarly, Hetzel (1999) has pointed to the strong reduction in money growth as the key determinant of the slowdown in economic activity and the fall in the deflationary trap. Fiscal policy was also inadequate, tending to be contractionary over the 1990s. In addition, significant Ricardian effects have been pointed out by Krugman (1998).

gradual reduction in short-term rates between 1991:3 and 1995 and the zero interest rate policy starting in 1999,[4] coupled with quantitative easing aimed at increasing banks reserves, real output growth stagnated over the period 1992:1-2005:2, growing at an annual rate of 1.2%,[5] and CPI inflation steadily decreased, turning into deflation since 1999.[6] Real stock market prices and bank loans stagnated as well, showing an annual average reduction of 3% and 1%, respectively. Finally, the real effective exchange rate depreciated at an annual average rate of 3%.

Hence, both demand and supply side mechanics transmitted the financial/monetary policy shock to output and prices. That is, the reduction in productivity and the shrinking labour force led to a reduction in potential output that reinforced the effects of the banking crisis and contributed to further depressing investment. Moreover, supply side rigidities possibly magnified these effects, slowing down the endogenous reaction of the macroeconomy to the imbalances. Finally, inadequate economic policies made the stagnation persistent, leading the economy to deflation.

Since recent macroeconomic figures indicate the end of the stagnation and deflation in the Japanese economy, an assessment of the mechanics of its recovery is of great interest. Different economic policies may have contributed to the recovery - for instance, the restructuring of the banking sector, the introduction of the quantitative easing policy by the Bank of Japan, and the real depreciation of the exchange rate. These policies are theoretically well grounded in the literature.

As far as quantitative easing is concerned, the literature has examined three main unorthodox transmission channels. First, quantitative easing could have been carried out through the depreciation of the exchange rate, leading to an expansion of external demand and an increase in inflation and inflationary expectations. The latter effect would have also led to a reduction in the real interest rate, boosting domestic demand (Meltzer, 1999, McCallum, 2000, 2001a, 2001b, and Svensson, 2001).

Second, quantitative easing could have been achieved by the Bank of Japan purchasing long-term government bonds or equities, leading (through portfolio rebalancing) to a fall in long term-interest rates and an increase in asset prices. The latter could have stimulated investment and consumption through Tobin's q and wealth effects, respectively. In addition, investment could have been boosted through the credit channel, since (as a consequence of the increase in asset prices) borrowers' balance sheets, the value of

[4] The overnight rate averaged at 5% in 1992, 3% in 1993, 2% in 1994 and 1% in 1995.

[5] One should not be misled by this plausible figure for the average annual real GDP growth rate. Growth in Japan has been extremely volatile since 1992, with a standard deviation close to 3%. In fact the rate of growth of real GDP has been equal to 0.25% in 1992, -0.3% in 1993, 2% in 1994, 2.5% in 1995, 4% in 1996, 0.3% in 1997, -1.2% in 1998, 0.2% in 1999, 3.2% in 2000, -2% in 2001, 1.2% in 2002, 2% in 2003, and 0.9% in 2004.

[6] The GDP deflator already points to deflation starting in 1995.

collaterals and the net corporate asset values of banks and financial institutions would have improved, thus increasing borrowing and lending abilities (Goodfriend, 2000).

Third, quantitative easing could have been carried out by the underwriting of government bonds in compensation for a tax cut. Then, the transfer of purchasing power to households could have stimulated aggregate demand through an increase in consumption. Yet, the effectiveness of this latter policy would be subject to the expectations concerning the temporary or permanent nature of the tax cut and the Ricardian/debt neutrality conditions of the economy (Goodfriend, 2000).

Through the uncovering of the key macroeconomic mechanics of the Japanese economy, this paper empirically assesses the above policies with particular reference to the role of a real exchange rate depreciation and a money supply expansion. The empirical analysis is novel from the following points of view. First, in contrast with previous work in the literature, the analysis is performed in the context of a large scale macroeconometric model for the US, Japan, Canada, the UK, and the Euro-12 area economies (hereafter, G7). This framework gives more reliable results, since it can account for the interactions among the G7 countries when assessing the response of the Japanese economy to policy interventions. For instance, when assessing the effects of a real depreciation of the yen on domestic output the model controls for the policy responses in the rest of the G7 countries.

Second, the analysis uses the framework of a factor vector autoregressive model (F-VAR), allowing to distinguish common dynamics in the G7 countries from country specific dynamics. The accurate identification of shocks, in conjunction with the large information dataset, leads to a more reliable picture concerning the effects of policy shocks.

The main findings of the paper are as follows. First, the real depreciation of the yen is likely to have led to a significant expansion in real output. Second, the quantitative easing policy carried out by the Bank of Japan is likely to have counteracted deflationary dynamics. Moreover, there is no evidence of negative effects of deflationary shocks on real output. Finally, both the world economic expansion and domestic supply side restructuring policies are likely to have contributed to the recovery of the Japanese economy.

The rest of the paper is organized as follows. Section 2 describes the econometric methodology. Section 3 discusses the data, and Section 4 reports the empirical results. Finally, Section 5 concludes.

2 Econometric Methodology

Following Stock and Watson (2005), consider the following factor model:

$$X_t = \Lambda F_t + D(L) X_{t-1} + \upsilon_t, \quad (1)$$

$$F_t = \Phi(L) F_{t-1} + \eta_t, \quad (2)$$

where X_t is an n-variate vector of variables of interest, F_t is an r-variate vector of global factors, υ_t is an n-variate vector of idiosyncratic i.i.d. shocks, η_t is an r-variate vector of common or global i.i.d. shocks, $E[\eta_t \upsilon_{is}] = 0$ for all i, t, s, Λ is an $n \times r$ matrix of loadings, and $D(L)$, $\Phi(L)$ are polynomial matrices with elements $\delta(L)$s and $\phi(L)$s, respectively, of order p:

$$D(L) = \begin{bmatrix} \delta_{1,1}(L) & ... & \delta_{1,n}(L) \\ \vdots & \ddots & \vdots \\ \delta_{n,1}(L) & \dots & \delta_{n,n}(L) \end{bmatrix}, \Phi(L) = \begin{bmatrix} \phi_{1,1}(L) & ... & \phi_{1,r}(L) \\ \vdots & \ddots & \vdots \\ \phi_{r,1}(L) & \dots & \phi_{r,r}(L) \end{bmatrix}.$$

By substituting (2) into (1), the vector autoregressive form of the factor model (F-VAR) can be written as

$$\begin{bmatrix} F_t \\ X_t \end{bmatrix} = \begin{bmatrix} \Phi(L) & 0 \\ \Lambda\Phi(L) & D(L) \end{bmatrix} \begin{bmatrix} F_{t-1} \\ X_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{F_t} \\ \varepsilon_{X_t} \end{bmatrix}, \quad (3)$$

where

$$\varepsilon_t = \begin{bmatrix} \varepsilon_{F_t} \\ \varepsilon_{X_t} \end{bmatrix} = \begin{bmatrix} I \\ \Lambda \end{bmatrix} \eta_t + \begin{bmatrix} 0 \\ \upsilon_t \end{bmatrix},$$

with variance covariance matrix

$$E\varepsilon_t\varepsilon_t' = \Sigma_\varepsilon = \begin{bmatrix} \Sigma_\eta{}' & \Sigma_\eta{}'\Lambda' \\ \Lambda\Sigma_\eta{}' & \Lambda\Sigma_\eta{}'\Lambda' + \Sigma_\upsilon \end{bmatrix},$$

where $\Sigma_\eta = E\eta_t\eta_t'$, and $\Sigma_\upsilon = E\upsilon_t\upsilon_t'$.

The inversion of the F-VAR form yields the vector moving average form (VMA) for the X_t process

$$X_t = B(L)\eta_t + u_t,$$

where $B(L) = [I - D(L)L]^{-1} \Lambda [I - \Phi(L)L]^{-1}$, and $u_t = [I - D(L)L]^{-1} \upsilon_t$.

2.1 Estimation

The estimation problem may be written as follows:

$$\min_{F_1,\dots,F_T,\Lambda,D(L)} T^{-1} \sum_{t=1}^{T} [(I - D(L)L) X_t - \Lambda F_t]' [(I - D(L)L) X_t - \Lambda F_t],$$

and solved following an iterative procedure. Since a priori information concerning the economic interpretation of the factors, i.e., global GDP rate, global inflation rate, global short- and long-term interest rates, global money growth, and global stock prices growth, is available, the estimation of the F_t factors can be carried out considering the relevant subset of variables.

Therefore, given a preliminary estimate of $D(L)$, the r static factors F_t can be estimated as the first principal component of each of the r-subset of variables $(I_i - D_i(L)L)\, X_{i,t}$ $i = 1, ..., r$; then, conditional on the estimated static factors, an estimate of Λ and $D(L)$ can be obtained by OLS estimation of the block of equations corresponding to X_t in (1). The procedure is then iterated until convergence. Once the final estimate of F_t is available, the $\Phi(L)$ matrix in (3) can be obtained by OLS estimation of the block of equations corresponding to F_t. Then, by also employing the final estimate of the Λ and $D(L)$ matrices, the restricted VAR coefficients in (3) can be computed.

The F-VAR model employed in this paper can be considered as a special case of the F-VAR approach of Stock and Watson (2005), arising when the number of static and dynamic factors are equal. Given the a priori information available on the global factors, the latter are estimated using the relevant subset of variables, rather than the entire data set. Compared with the original Stock and Watson approach, the proposed approach has the advantage of allowing a more clear-cut interpretation of the global shocks, as well as the identification of all the idiosyncratic shocks.

Stock and Watson (2005) have provided details about the asymptotic properties, i.e., consistency and asymptotic normality, of the estimation procedure for the case of I(0) variables. The two-step iterated procedure is equivalent to Maximum Likelihood estimation of the model and therefore is fully efficient. Moreover, the use of the principal components estimator for the estimation of persistent processes has been justified by the recent theoretical developments of Bai (2003, 2004) and Bai and Ng (2004), allowing therefore for an accurate estimation of the factors in the current framework.[7]

[7] In particular, Bai (2003) has considered the generalization of principal components analysis (PCA) in the case of weakly dependent processes, establishing consistency and asymptotic normality when both the unobserved factors and idiosyncratic components show limited serial correlation, also allowing for heteroscedasticity in both the time and cross section dimensions of the idiosyncratic components. In Bai (2004) consistency and asymptotic normality have been derived for the case of I(1) unobserved factors and I(0) idiosyncratic components, also in the presence of heteroscedasticity in both the time and cross section dimensions of the idiosyncratic components. Moreover, Bai and Ng (2004) have established consistency for the case of I(1) idiosyncratic components. As pointed out by Bai and Ng (2004), consistent estimation is also achieved by PCA in the intermediate case of long memory processes, and Monte Carlo results in Morana (2007) support this conclusion.

2.2 Identification of Structural Shocks

The identification of the structural shocks in the F-VAR model can be carried out as follows. By denoting ξ_t the r structural global shocks, the relation between reduced form and structural form global shocks can be written as $\xi_t = H\eta_t$, where H is square and invertible. The identification of the structural shocks amounts then to the estimation of the elements of the H matrix. It is assumed that $E\left[\xi_t \xi_t'\right] = I_r$, and hence $H\Sigma_\eta H' = I_r$.

Moreover, by denoting ψ_t the n structural idiosyncratic shocks, the relation between reduced form and structural form idiosyncratic shocks can be written as $\psi_t = \Theta v_t$, where Θ is square and invertible. The identification of the structural idiosyncratic shocks amounts then to the estimation of the elements of the Θ matrix. It is assumed that $E\left[\psi_t' \psi_t\right] = I_n$, and hence $\Theta\Sigma_v'\Theta = I_n$.

The VMA representation of the factor model in structural form can then be written as

$$X_t = B^*(L)\xi_t + C^*(L)\psi_t,$$

where

$$B^*(L) = B(L)H^{-1} = \left[I - D(L)L\right]^{-1} \Lambda \left[I - \Phi(L)L\right]^{-1} H^{-1},$$

$$u_t = C^*(L)\psi_t, C^*(L) = C(L)\Theta^{-1}, C(L) = \left[I - D(L)L\right]^{-1},$$

and $E\left[\psi_{i,t}\xi_{j,t}'\right] = 0$ for any i, j.

Given r factors, $r(r-1)/2$ restrictions need to be imposed in order to exactly identify the structural global shocks. Moreover, exact identification of the n structural idiosyncratic shocks requires the additional imposition of $n(n-1)/2$ zero restrictions. Instead of employing the double Choleski strategy proposed by Bagliano and Morana (2006), this paper implements the generalized impulse response analysis (Pesaran and Shin, 1998) in the context of the thick modelling estimation approach of Granger and Jeon (2004).[8] The proposed approach should allows to draw robust conclusions not only for the ordering of the variables, but also for the potential misspecification of the econometric model.

3 The Data

The dataset involves quarterly seasonally adjusted time series variables over the 1980:1-2005:2 period for five countries/regions - the US, Japan, the euro-12 area, the UK, and Canada - and considers eight variables for each country/region: the real GDP growth (g), the CPI inflation rate (π), the nominal short- and long-term interest rates (s and l,

[8] See Stock and Watson (2005) for details on alternative identification strategies.

respectively),[9] the nominal money balances growth,[10] the effective exchange rate return (e), the real stock returns (f), and the real oil price growth (o). Note that these variables are free of unit of measurement heterogeneity.[11]

The time series properties of the data are assessed by means of unit roots tests. In addition to the standard ADF tests (Said and Dickey, 1984), the KPSS test (Kwiatkowski, Phillips, Schmidt and Shin, 1992) is also employed. In contrast to the ADF test, which assumes difference stationarity, I(1), under the null, the KPPS test assumes stationarity, I(0), around either a constant term or a constant plus a linear deterministic trend process.

In order to account for an adaptive nonlinear trend, the Enders and Lee (2004) ADF test and a modified version of the KPSS test are employed. Similarly to the Enders and Lee (2004) test, the modified KPSS test accounts for a deterministic adaptive nonlinear trend, using the Gallant (1984) flexible functional form (to be specified below). The critical values of the tests have been tabulated by means of Monte Carlo simulation with 10,000 replications.

The results of the unit root tests are reported in Table 1. As is shown in the table, real and nominal variables point to slightly different results. As far as the real variables are concerned, the ADF and KPSS tests yield consistent results, pointing to the rejection of the I(1) hypothesis and the nonrejection of the I(0) hypothesis at the 5% level in all but one cases. The only exception is real output growth in Japan, where the tests reject both the I(1) and I(0) null hypotheses. The rejection of the null of stationarity detected by the KPSS test in Japan may be explained on the basis of the slowdown of economic growth in the beginning of the 1990s; once a nonlinear trend is included in the KPSS auxiliary equation, the null of stationarity is no longer rejected. Moreover, the findings for the euro area and the UK output growth series point against the inclusion of a nonlinear trend in the auxiliary equation, in line with previous results for structural stability in the euro area series (see Morana, 2006).

On the other hand, the outcome of the tests for the nominal variables is less clear-cut. As far as the nominal interest rate series are concerned, the findings are inconclusive. In general, while the ADF tests do not reject the null of nonstationarity, the KPSS tests do not reject the null of stationarity.[12] Furthermore, for nominal money growth and inflation, the null of nonstationarity is always rejected when the tests include the nonlinear trend,

[9] The short-term rate is the three-month government bill rate, and the long-term rate is the ten-year government bond yield.

[10] Nominal money balances refer to the respective measures of broad money in the countries investigated: M2 for the US, M2+CD for Japan, M3 for the euro area and Canada, and M4 for the UK.

[11] Thus, they overcome the different units of account shortcoming. For instance, one would not be able to extract a global factor, say from the GDP series in levels, unless all the series were expressed in the same unit of account, say US$.

[12] Note that the ADF test rejects the unit root hypothesis for the US long-term interest rates; the evidence for Canada is rather mixed.

with the exception of money growth in Japan. Yet, while the null of stationarity is never rejected for money growth at the 1% level, it is rejected for inflation in the US, Japan and the euro area.

Economic explanations for the presence of a nonlinear deterministic trend in the nominal variables of the US and the euro area have been suggested by Bierens (2000) and Morana (2006). They argue that successful long-run monetary policy management is responsible for shaping the trend behavior of the nominal variables, and that policy decisions cannot be understood in terms of a stochastic process, but rather in terms of a deterministic one. For instance, the use of the interest rate as a policy instrument by the central bank renders it a stepwise deterministic process, creating nonlinear deterministic trends both in the short- and long-term interest rate series.

Moreover, the presence of long-memory in the nominal variables, in addition to structural breaks, has been widely documented in the literature (see Morana, 2006, for the euro area, and Bagliano and Morana, 2007, for the US). This feature may actually explain why the KPSS test tends to reject the null of stationarity, in particular, for the inflation rate. As found by Morana (2006), deviations of nominal interest rates from the nonlinear trend may be very persistent, and determined not only by long-memory dynamics but also by short-memory (ARMA) dynamics.

Since it is possible to rely on the autoregressive representation of a fractional autoregressive moving average process (ARFIMA) for estimation, the determination of the order of fractional integration of the series is beyond the scope of this study.[13]

However, structural change should be taken into account. Therefore, the stationary representation of the F-VAR model has been augmented by an adaptive specification for the deterministic component, expressed in terms of sine and cosine expansions, following the Gallant (1984) flexible functional form. Hence, the deterministic component in the F-VAR, to be included in the ith equation of (1), is specified as $\mu_{i,t} = \mu_{i,0} + \mu_{i,1}t + \mu_{i,2}\sin(2\pi t/T) + \mu_{i,3}\cos(2\pi t/T)$, where T is the sample size.

[13] Also note that the estimation of the persistence parameter would benefit from the use of a larger sample and a higher frequency than the ones used, and from the use of semiparametric estimators.

Table 1: Unit-root tests

	ADF_m	ADF_t	ADF_{nlt}	$KPSS_m$	$KPSS_t$	$KPSS_{nlt}$
g_{US}	-3.82**	-3.53**	-6.86**	0.12	0.08	0.07*
g_{JA}	-8.15**	-8.90**	-10.04**	0.87**	0.16*	0.04
g_{EA}	-8.02**	-8.18**	-8.01**	0.20	0.18	0.09**
g_{UK}	-6.49**	-6.49**	-6.48**	0.20	0.10	0.09**
g_{CA}	-5.96**	-5.93**	-5.46**	0.09	0.05	0.05
π_{US}	-8.07**	-8.60**	-7.68**	1.31**	0.17	0.08**
π_{JA}	-2.86	-3.52*	-8.79**	0.49*	0.14	0.12**
π_{EA}	-3.37*	-2.84	-7.55**	0.26	0.09	0.10**
π_{UK}	-3.45**	-3.37	-5.01**	0.86**	0.08	0.05
π_{CA}	-6.93**	-7.95**	-6.98**	0.44	0.10	0.04
s_{US}	-1.52	-2.92	-3.89	0.39	0.05	0.02
s_{JA}	-1.53	-2.37	-3.57	0.35	0.01	0.01
s_{EA}	-1.17	-2.36	-2.81	0.35	0.03	0.02
s_{UK}	-1.13	-2.04	-2.80	0.24	0.04	0.04
s_{CA}	-1.66	-4.27**	-2.90	0.19	0.03	0.03
l_{US}	-2.20	-4.26**	-5.80**	0.27	0.07	0.02
l_{JA}	-1.73	-2.06	-2.14	0.33	0.03	0.03
l_{EA}	-1.56	-3.16	-3.57	0.37	0.02	0.02
l_{UK}	-1.17	-2.79	-3.66	0.24	0.03	0.03
l_{CA}	-2.08	-4.88**	-4.91*	0.20	0.05	0.03
m_{US}	-5.39**	-5.45**	-7.72**	0.41	0.25**	0.07*
m_{JA}	-1.95	-3.02	-4.16	0.28	0.10	0.06
m_{EA}	-2.39	-2.15	-7.48**	0.35	0.13	0.04
m_{UK}	-2.35	-1.90	-6.06**	0.40	0.05	0.03
m_{CA}	-3.10*	-3.08	-8.07**	0.20	0.13	0.06
e_{US}	-8.30**	-8.26**	-8.88**	0.17	0.15	0.03
e_{JA}	-7.51**	-7.77**	-7.87**	0.21	0.03	0.03
e_{EA}	-6.98**	-6.93**	-7.50**	0.12	0.07	0.02
e_{UK}	-7.81**	-7.86**	-7.96**	0.05	0.04	0.03
e_{CA}	-6.95**	-6.97**	-7.51**	0.15	0.15*	0.04
f_{US}	-9.28**	-9.36**	-9.59**	0.10	0.08	0.04
f_{JA}	-11.49**	-11.67**	-12.54**	0.25	0.08	0.05
f_{EA}	-6.35**	-6.46**	-6.55**	0.08	0.05	0.05
f_{UK}	-10.61**	-10.83**	-11.26**	0.18	0.04	0.04
f_{CA}	-8.93**	-8.88**	-8.96**	0.06	0.03	0.03
o_{US}	-7.89**	-7.96**	-8.79**	0.32	0.03	0.02
o_{JA}	-7.48**	-7.84**	-8.41**	0.30	0.04	0.03
o_{EA}	-7.38**	-7.96**	-8.54**	0.22	0.05	0.03
o_{UK}	-7.96**	-7.43**	-8.74**	0.23	0.04	0.03
o_{CA}	-8.13**	-8.14**	-9.04**	0.31	0.03	0.02

Notes: The first (last) three numeric columns report the ADF (KPSS) tests for three specifications of the deterministic trend: a constant (ADF_m and $KPSS_m$), a constant plus a linear trend (ADF_t and $KPSS_t$), and a constant plus a nonlinear trend (ADF_{nlt} and $KPSS_{nlt}$).
For the ADF tests, the critical values are -2.89 (-3.50), -3.46 (-4.06), and -4.35 (-4.95), for the 5% (1%) significance level. The corresponding values for the KPSS tests are 0.46 (0.73), 0.15 (0.22), and 0.06 (0.08).
* and ** denote significance at the 5% and 1% level, respectively.
Definitions of the series are given in the text.

4 Empirical Results

The specification of the F-VAR model follows Bagliano and Morana (2006), where four common factors were found among the 35 endogenous variables of interest. Using principal components analysis, the factors were extracted from four groups of variables, namely the real GDP growth series, the real stock prices returns, the real oil price growth rate, and all the nominal series (i.e., the inflation rate, the nominal short- and long-term interest rates, and the nominal money growth series). Hence, the estimated factors have a clear-cut macroeconomic interpretation, being associated with global real output growth, global stock market dynamics, real oil price growth and global nominal/monetary developments, respectively.[14]

On the basis of misspecification tests, the lag length of the F-VAR is set to one lag. In total, the econometric model comprises 39 equations. The first 35 equations refer to the 35 endogenous variables, i.e., real output growth, inflation, nominal short- and long-term rates, nominal money growth, real exchange rate returns, and real stock returns for the five countries in the system. Each of these contains 43 parameters, of which, 35 are associated with the lagged endogenous variables, 4 with the lagged endogenous factors, i.e., the oil price growth factor, the output growth factor, the nominal factor and the stock market return factor, and 4 parameters are associated with the deterministic components. The remaining four equations describe the global factors and contain 26 parameters each, of which, 4 parameters are associated with the lagged endogenous factors and 4 with the deterministic components. The estimation period is 1980:1-2005:2, and the F-VAR model is estimated following the iterative procedure described in Section 2.

4.1 Impulse Response Functions

Figures 1-5 plot the generalized impulse response functions (IRFs) to unit global and idiosyncratic shocks. With the exception of interest rates, the figures picture the cumulated IRFs. In addition to the median response, the figures also plot the 95% confidence intervals, obtained by Monte Carlo simulations.

4.1.1 Global Shocks

As shown in Figure 1, a positive global output shock has a permanent positive impact on the output level and money balances. While the impact on the price level is negative

[14] The proportion of total variance explained by the first principal component is equal to 0.57 for real stock market returns, 0.40 for real output growth, 0.95 for real oil price growth and 0.65 for the nominal variables. In all cases the first principal component bears the interpretation of a global factor, since all the corresponding variables react as expected. On the other hand, the remaining principal components tend to capture idiosyncratic dynamics.

and significant in the short-run, i.e., for one year, the impact on real stock prices is not significant at any forecast horizon. A temporary increase in both the short- and long-term interest rates should also be noted, possibly pointing to a contractionary monetary policy reaction that leads to an increase in the short-term rate and transmits along the term structure to the long-term rate. Finally, following the global economic expansion, the yen tends to appreciate permanently in real terms. Given the positive correlation between output and interest rates and the lack of correlation between output and the price level in the long-run, the global output shock could be interpreted as a global demand shock.

Since the nonlinear deterministic trend included in the F-VAR specification is, in general, found to be relevant for explaining trend dynamics in the nominal variables, the interpretation of the shock associated with global monetary developments is less clear-cut. According to the work of Bierens (2000) and Morana (2006), the global monetary factor can be associated with the common nonlinear deterministic component, capturing the medium- and long-term monetary policy management. Therefore, the shock to the residual component obtained by detrending the nominal factor cannot be associated with global monetary developments.

Yet, in the light of recent results by Gordon (2005), pointing to a strong contribution of productivity growth to the determination of US inflation, a tentative interpretation of the second global shock as a global productivity shock can be provided. In fact, as shown in Figure 1, a negative global productivity shock has a negative and permanent impact on real output, leading to an increase in the price level and in nominal money balances, and triggering a temporary contractionary monetary policy response. On the other hand, no significant effects can be found for both the real exchange rate and real stock prices.

Moreover, a negative supply side shock, i.e., an increase in the real oil price, leads to a short-term contraction in real output and to a permanent increase in the price level and money balances. While, no significant effects can be found for the real stock prices and the exchange rate, a contractionary monetary policy response should be noted, with interest rates temporarily increasing over benchmark values.

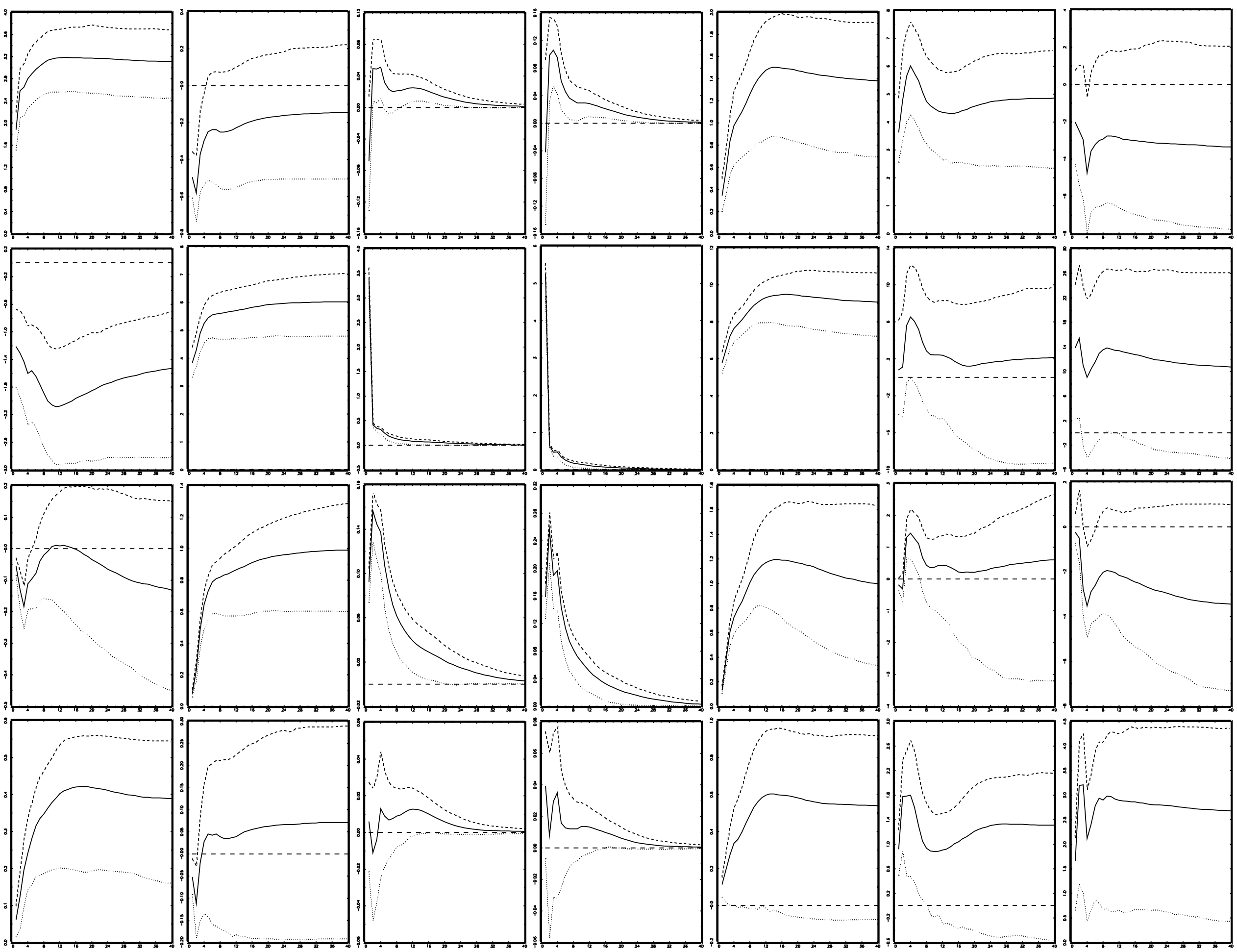
Finally, a positive global stock market expansion leads to a permanent and significant expansion in the Japanese stock market and in real output, pointing to significant wealth/Tobins'q effects. The shock also leads to a real appreciation of the yen in the short-run, while no significant effects can be found for the rest of the variables.

Interestingly, in line with Bagliano and Morana (2006), the generalized impulse responses are very similar in the rest of the G7 countries, pointing to similar transmission mechanisms in these economies.[15] Finally, the positive response of output to the global demand and productivity shocks suggests that, in addition to the improved domestic eco-

[15] The results are availble upon request from the author.

nomic policies, the recovery of the Japanese economy might have also benefited from the recent phase of the world economic expansion.

Figure 1



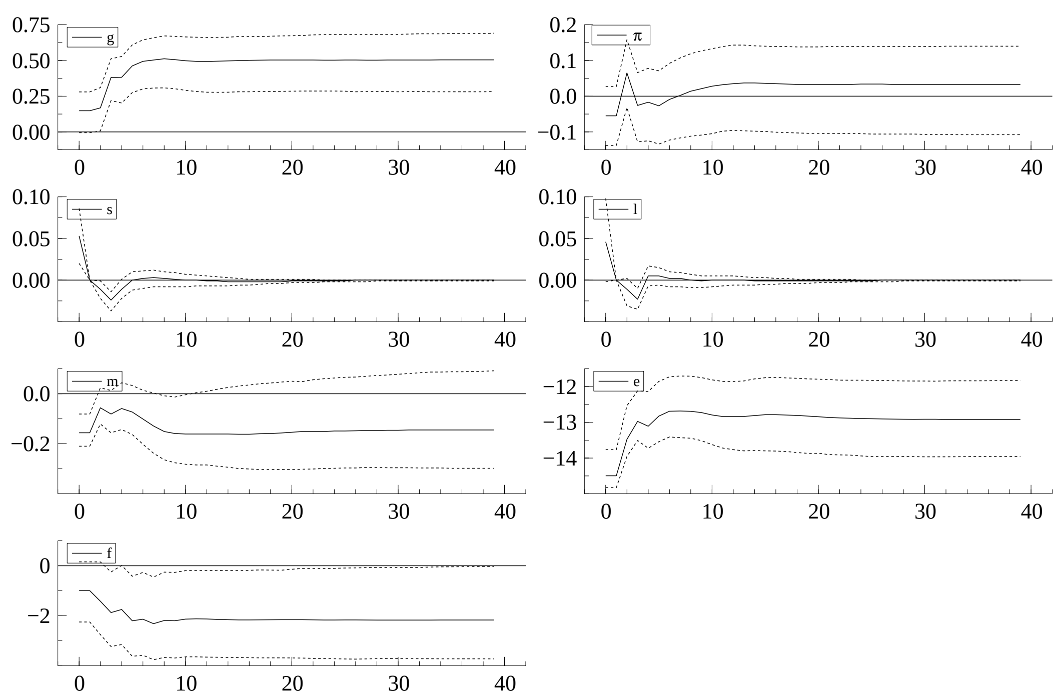
Notes: Rows 1-4 are associated with unit global demand, productivity, oil price, and stock market shocks, respectively.
Columns 1-7 plot the generalised IRFs of real output growth, inflation, short- and long-term interest rates, nominal money growth, real effective exchange rate return, and real stock returns to the above shocks, respectively.
For instance, plot (1,1) pictures the cumulated responses of output growth to a unit global demand shock, while plot (2,3) gives the responses of the short-term rate to unit global productivity shock.

4.1.2 Idiosyncratic Domestic Shocks

Having controlled for the effects of global shocks, the analysis allows for an accurate assessment of the response of the Japanese economy to domestic policy shocks. In particular, the assessment concerns whether (i) nominal money growth shocks have inflationary effects, (ii) a real depreciation of the yen leads to an expansion in real output, (iii) a moderate deflation, as the one experienced by Japan, contributes to the economic depression, and (iv) a domestic productivity increase contributes to the recovery of the economy. As shown in Figures 2-5, the findings allow for a clear-cut evaluation of the above issues.

As shown in Figure 2, a real depreciation of the exchange rate leads to a permanent expansion in the output level, without affecting significantly none of the other variables, apart from nominal money balances and the short-term rate in the short-run. In fact, a real depreciation of 14% of the yen is associated with a permanent increase of about 0.5% in real GDP.

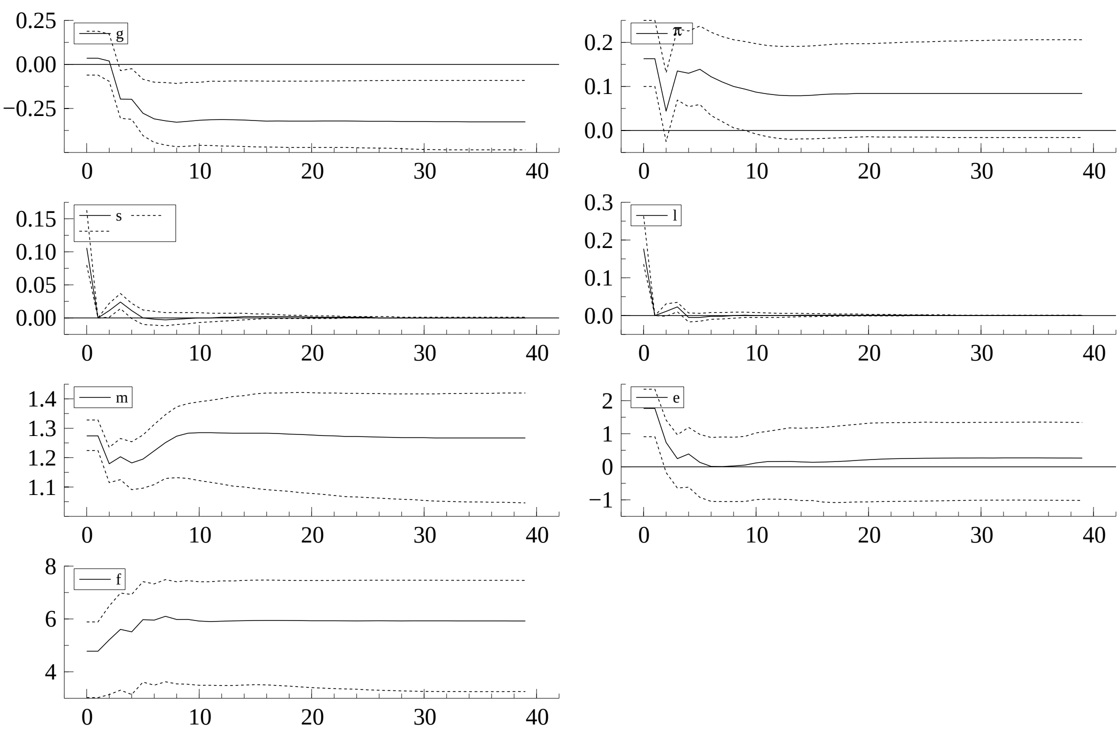
Figure 2



Notes: Generalized responses of real output growth (g), inflation (π), short-term interest rate (s), long-term interest rate (l), nominal money growth (m), real effective exchange rate return (e), and real stock prices return (f) to a real exchange rate (depreciation) shock. The responses are cumulated for g, π, m, e, and f.

This finding is of particular interest since it shows that the Bank of Japan could depreciate the yen, through open market operations aimed at purchasing foreign currencies or bonds, and restore growth through external demand. Note that a depreciation of the yen may fail to exert its expected effects in the case of protectionist measures and depreciation of the currencies of Japan's trading partners. However, since the modelling framework employed in this study controls for the policy responses in the rest of the G7 countries, the above findings are not subject to this latter criticism. It can, therefore, be concluded that the real depreciation of the yen may have played an important role in the recovery of the Japanese economy by stimulating mainly external demand.

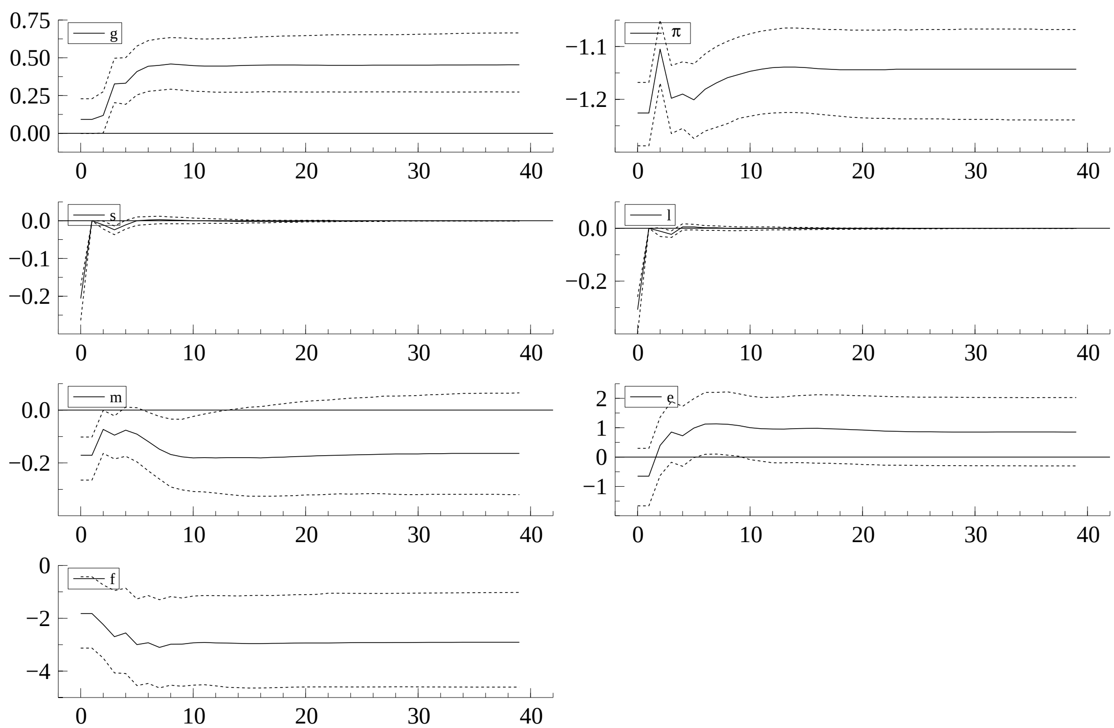
Figure 3



Notes: Generalized responses of real output growth (g), inflation (π), short-term interest rate (s), long-term interest rate (l), nominal money growth (m), real effective exchange rate return (e), and real stock prices return (f) to a positive nominal money balances shock. The responses are cumulated for g, π, m, e, and f.

As shown in Figure 3, an expansion in the money supply leads to a significant increase in the price level in the medium-run, i.e., the three-year horizon. Yet, the impact on the price level is much smaller in size than the one on nominal money balances, since a permanent increase of 3% in the money supply is accompanied by a permanent increase of 0.1% in the price level. This suggests that, although nominal money balances have an inflationary impact, the increase in nominal money balances should be substantial in order to counteract deflationary dynamics.

Figure 4



Notes: Generalized responses of real output growth (g), inflation (π), short-term interest rate (s), long-term interest rate (l), nominal money growth (m), real effective exchange rate return (e), and real stock prices return (f) to a deflation shock. The responses are cumulated for g, π, m, e, and f.

The shock also has positive effects on real stock prices, pointing to a rebalancing of investors' portfolios (given the increased liquidity), as well as short-run effects on interest rates and the exchange rate. Finally, real output is negatively affected by the shock in the medium- and long-run, possibly as a consequence of the real appreciation of the exchange rate and the increase in the short- and long-term rates.

As shown in Figure 4, a deflationary shock does not affect negatively real output at any forecast horizon. In fact, following a negative inflation shock, real output tends to increase. Both interest rates and the money supply are negatively affected, albeit in the short-term only, while the stock market is affected in the long-term as well.

Interestingly, the inflationary effects of an increase in nominal money balances and the lack of negative effects on output of a moderate deflation, as the one experienced by Japan, are consistent with the findings obtained by Morana (2005) using a small scale macroeconometric model for Japan. These results, therefore, point to the significant contribution of the quantitative easing policy carried out by the Bank of Japan to halt deflationary dynamics.

The lack of a negative impact of a deflationary shock on real activity could be associated with the theoretical argument of Friedman (1969) about the optimal rate of deflation necessary to achieve an efficient allocation of resources.[16] In this case, a deflationary shock will not affect negatively real economic activity. However, it is also possible that deflation in Japan has not been deep enough to generate the expected negative effects on real activity.

As shown in Figure 5, an idiosyncratic productivity shock affects real output and the stock market price index positively, and the price level and the real effective exchange rate negatively at any forecast horizon. On the other hand, neither interest rates nor money balances are significantly affected by the shock.

Hence, policies stimulating technical progress contribute significantly to the recovery of the Japanese economy. The positive contribution of domestic productivity advances to the recovery is in accordance with the supply side interpretation of the Japanese slowdown. Hayashi and Prescott (2002) point to the wrong policies which subsidized inefficient firms and declining industries, and Yamaguchi (1999) argues that the firms' inability to adapt to changes and globalization contributed to the stagnation. In particular, laws, regulations and the tax structure did not allow firms to benefit fully of the information and communication technology (ICT) revolution, while the rigid labour market prevented the necessary flow of labour from declining to ascendant industries and from inefficient to efficient firms.

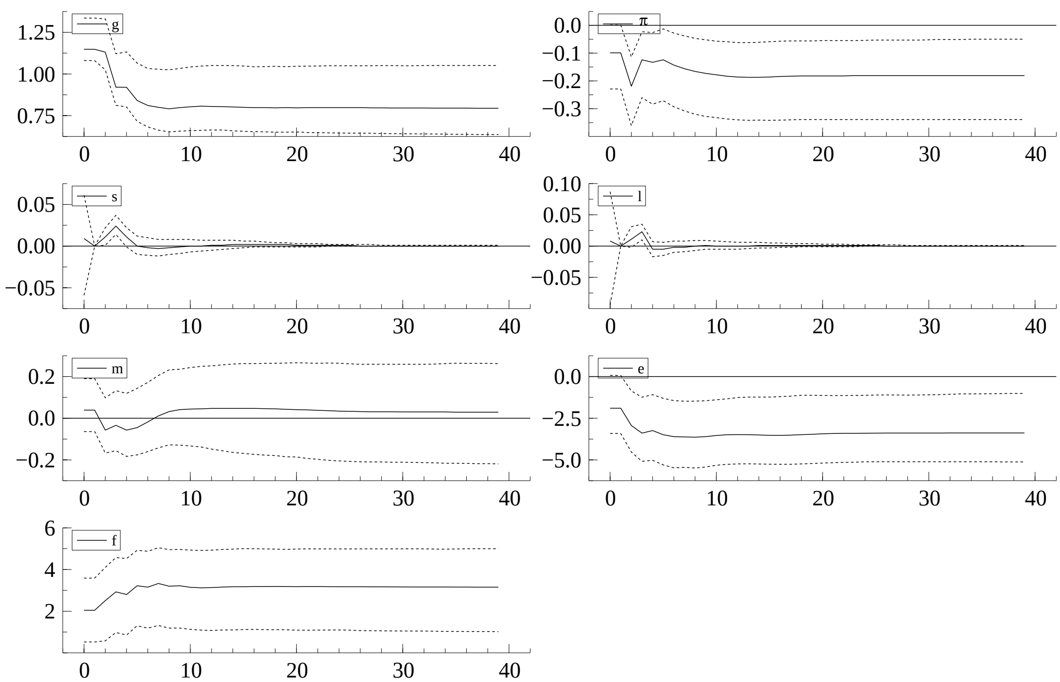
Acknowledging that the inefficient allocation of resources was one of the key causing factors of the Japanese stagnation, the Koizumi cabinet proposed and implemented various supply side measures, concerning competition, deregulation and privatization, complementing existing restructuring policies for the banking system.[17] Therefore, in the

[16] According to Friedman (1969), zero nominal interest rates are necessary for efficient resource allocation, implying an optimal rate of deflation equal to (minus) the real interest rate. Friedman's argument derives from setting the marginal cost of printing money equal to the opportunity cost of holding money (see also Cole and Kocherlakota, 1998).

[17] The reforms aimed to incresase efficiency and productivity by enhancing the role of the market

light of the supply side reforms carried out in Japan over the last decade, it is likely that the domestic productivity channel contributed positively to the recovery.

Figure 5



Notes: Generalized responses of real output growth (g), inflation (π), short-term interest rate (s), long-term interest rate (l), nominal money growth (m), real effective exchange rate return (e), and real stock prices return (f) to a positive productivity shock. The responses are cumulated for g, π, m, e, and f.

Finally, the results regarding stock market, and short- and long-term interest rate shocks can be summarized as follows.[18] It is found that an idiosyncratic positive stock market shock has positive effects on nominal money balances, output, and inflation in the short-run. The effects of short-term and long-term rate shocks are very similar. The interest rate shocks have a negative impact on output in the medium- and long-run, lead to a depreciation of the real exchange rate, increase the money supply and the price level, and have no signficant effects on real stock prices.

mechanism for the allocation of resources, industrial competitiveness, and technological advances, as well as to create a more favourable business environment by revising corporate and taxation laws and promoting foreign investments.

[18] The graphs for the IRFs of these shocks are not reported to conserve space. They are available upon request from the author.

5 Conclusions

In the context of a F-VAR framework, this paper uses a large scale macroeconometric model for the economies of the US, Japan, the euro-12 area, the UK, and Canada to assess the response of the Japanese economy to some key policy shocks (such as exchange rate and nominal money balances shocks) by means of generalized impulse response analysis. Controlling for the interactions among the above economies, it was found that the real depreciation of the yen is likely to have led to a significant expansion in real output since the mid 1990s, while the increase in the money supply, associated with the quantitative easing policy, is likely to have partially counteracted deflationary dynamics. Moreover, there was no evidence of negative effects of a deflationary shock on real output, suggesting that a deflation has to be deeper than what experienced by the Japanese economy in order to generate the expected negative effects on real activity. Finally, productivity increases associated with domestic supply side structural reforms, as well as world economic expansion dynamics, are likely to have further contributed to the recovery of the Japanese economy.

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