E C O N O M I C S B U L L E T I N

Application of the IS−MP−IA model to the German economy and policy implications

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Abstract

Extending the IS−MP−IA model developed by Romer (2000) and applying the GARCH (Engle, 1982, 2001) methodology, the author finds that equilibrium GDP in Germany is positively affected by stock market performance and real exchange rate appreciation, and negatively influenced by the expected inflation rate, the government deficit/GDP ratio, and the U.S. federal funds rate. The relatively low deficit/GDP ratio of 1.83% in 2003 indicates that its fiscal condition was healthy. However, some other EU members may need to exercise fiscal discipline. Because real appreciation has a positive impact on output, a stronger euro may not be a concern for Germany but may be worried by those EU member nations which depend upon exports to stimulate their economies.

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1. Introduction

Scholars have continued to study German macroeconomic activities and policies because Germany plays a significant role in the EU and is the fifth largest economy in the world. During 1991-2003, the average annual growth rate of real GDP was 1.26%. The growth rate was below 1.00% during 2001-2003 and -0.10% in 2003 partly due to the worldwide economic slowdown. In recent years, the inflation rate in Germany has trended down from 5.08% in 1992 to 1.05% in 2003. The call money rate, which is the equivalent of the U.S. federal funds rate, followed the world trend to decline from 4.37% in 2001 to 2.32% in 2003 in order to stimulate the German economy. Since 1997, the government had maintained a budget deficit/GDP ratio within the 3% level except for the 3.47% in 2003 in order to provide expected government services and strengthen the economy. Deficit spending and borrowing resulted in a debt/GDP ratio of 73.3% in 2003. The Maastricht Treaty of 1992 and the Stability and Growth Pact of 1997 require member nations to maintain a budget deficit/GDP ratio within 3% and the debt/GDP ratio within 60%. After reaching to a high of 100 in year 2000, the financial share price index declined 54.48% to 45.52 in 2003, suggesting that household consumption and business investment would be affected negatively. The unemployment rate has trended up slowly from 9.8% in 1993 to 11.68% in 2003. There are several possible reasons for the relatively high unemployment rate. The lending rate was relatively high exceeding 9.0% since 1989 except for the year of 1999. Some of the large number of immigrants may not have needed skills. The reunification in 1990 raised the unemployment rate. The mark/dollar exchange rate changed from a high of 3.15 in 1984 to 1.67 in 1998, and the euro/dollar exchange rate changed from 1.0 in 1999 to 0.79 in 2003.The relatively strong German mark and the euro made German-made products more expensive. Some social and labor programs provided unemployed workers with monetary and in-kind assistance and may extend the period for job search.

This paper attempts to extend the IS-MP-IA model (Romer, 2000) to determine how economic policies and macroeconomic and financial variables would affect the German output and has several different aspects. First, to the author's knowledge, few studies have employed the IS-MP-IA model to examine short run economic fluctuations for Germany mainly because the IS-LM-AS model has been taught as a standard approach in the determination of the equilibrium output and interest rate. Second, in the IS-MP-IA model, the monetary policy (MP) function follows the Taylor rule (1993, 1998a, 1998b, 1999) in that the interest rate is determined by the inflation rate, output, and other related variables. Therefore, the central bank targets the interest rate instead of the quantity of money. Third, additional variables such as stock prices and the world interest rate are considered in the paper in order to measure the wealth effect, the balance sheet effect, and the possible response of the German interest rate to the world interest rate. Fourth, Engle's (1982, 2001) GARCH model is applied in order to determine whether error variance may be affected by past squared errors and past error variances.

2. Literature Survey

Several recent articles studied the German monetary policy, fiscal policy, exchange rates, and impacts of the EMU. Jondeau and Le Bihan (2002) examined monetary policy rules for Germany and the U.S. based on a macroeconomic model including the IS curve, the monetary policy rule,

and the Phillips curve. They found that the optimal policy for Germany would require a stronger and more persistent reaction to output and inflation than the U.S. Using a sample for Germany, France, and Netherlands during 1976-99 and applying the cointegration test, Saiti (2002) found that interest rates in Netherlands and France were strongly influenced by the German interest rate, that money supply is primarily used to contain inflation, that monetary policy formulation was not directed toward exchange rate determination, and that all 3 countries placed more emphasis on inflation stability than output stability. In studying fiscal and monetary policy for Germany, France and the Euro area during 1979-2000, Bruneau and De Bandt (2003) showed that a significant correlation of monetary shocks between Germany and France was found whereas fiscal shocks were not correlated and that monetary policy has a more significant impact than fiscal policy. Their empirical results are consistent with the IS-LM model. Worms (2003) showed that a tight monetary policy in Germany would cause banks to reduce their lending and that the credit channel existed but was weakened due to the structure of the banking institution.

Bravo and Silvestre (2002) employed the cointegration technique to test fiscal sustainability for 11 EU member states and found that Germany, France, U.K., Austria and the Netherlands exhibited fiscal sustainability whereas the other 5 member countries did not show sustainable fiscal paths. Based on a sample of 7 industrialized nations including Germany during 1950-97 and applying the impulse response function, Giorgioni and Holden (2003) examined the impact of government taxation and spending on consumption. They reported that the expansionary fiscal contraction (EFC) model applied to the response of consumption to government taxation and the Keynesian model applied to the reaction of consumption to government spending

In investigating the impact of currency depreciation on the price level for five euro nations including Germany, Hufner and Schroder (2003) applied the error correction model and found that a depreciation of the euro by 10% would lead to a 0.4% increase in the consumer price index by the end of 12 months and a 0.8% increase in the long run. In examining the effect of currency deprecation on stock prices for six industrialized countries including Germany during 1974-99, Apergis and Eleftheriou (2003) reported that currency depreciation led to a lower stock price for U.K., Canada, and Italy and a higher stock price for Germany, France, and Japan.

Collard and Dellas (2002) found that under the EMU, output volatility for Germany increases but inflation volatility decreases but the opposite impacts hold for France. Under EMU, supply shocks of individual countries would cause a strong international transmission and intensify their role.

3. Theoretical Model

Suppose that household consumption spending is a function of disposable income, the real interest rate, and stock prices, business investment spending is determined by the real interest rate and stock prices, net exports are influenced by the real exchange rate, the monetary policy (MP) function is determined by the inflation gap, the output gap, the exchange rate gap, and the world interest rate, and the inflation rate depends on the expected inflation rate, the output gap, and the nominal exchange rate. Extending Romer's (2000) model, the IS, MP, and IA functions for the German economy can be expressed as

$$Y = C(Y - T, R, S) + I(R, S) + G + NX[e(P^f / P)]$$
$$R = R(\pi - \pi^*, Y - Y^*, e, R^W) \quad (1)$$
$$\pi = \pi^e + \alpha(Y - Y^*) + \beta e$$

where

Y = real GDP,
C = consumption function,
T = government tax revenues,
R = the real interest rate,
S = price of financial stocks,
I = the investment function,
G = real government spending,
NX = real net exports,
e = the real effective exchange rate,
P^f = the foreign price level,
P = the domestic price level,
π = the inflation rate,
π^* = the inflation target,
Y* = potential output,
R^W = the world interest rate,
π^e = the expected inflation rate.

Solving for Y, R, and π in equation (1), the equilibrium output is given by

$$\overline{Y} = \overline{Y}[\pi^e, G, T, S, e(P^f / P), R^W; \alpha, \beta, \pi^*, Y^*] \quad (2)$$

We expect that equilibrium output has a negative relation with the expected inflation rate, tax revenues, the world interest rate and a positive relation with government spending and stock prices. The relation with the exchange rate is unclear. A higher expected inflation rate would shift the aggregate supply curve to the right and result in a higher inflation rate and lower output in the inflation-output diagram. Increased government spending or a tax cut or both would shift aggregate demand to the right and cause output to rise. However, the Ricardian-equivalence hypothesis (Barro, 1989) suggested that deficit-financed spending may have a neutral effect in the long run.

Currency depreciation is expected to stimulate net exports and shift aggregate demand to the right. On the other hand, the depreciation may cause import prices and domestic inflation to rise, which would shift aggregate supply to the left. Some studies showed that currency depreciation or devaluation may have a positive, neutral, or negative impact on real output, depending upon the specification of a model, the methodology used in empirical work, the country under study, and the short-run versus the long-run (Edwards, 1986; Morley, 1992; Upadhyaya, 1999; Bahmani-Oskooee and Miteza, 2003).

Higher stock prices are likely to allow households to increase consumption via the wealth effect and firms to investment more via the balance sheet effect (Mishkin, 1995; Kuttner and Mosser, 2002). If Germany responds positively to a higher world interest rate by raising the domestic interest rate, it would decrease consumption and investment spending.

Some of these relations can be analyzed by comparative-static analysis. Assume that equations in (1) have continuous partial derivatives. Let

$$C_Y > 0, C_S > 0, C_R < 0, I_R < 0, I_S > 0, NX_e < 0, R_\pi > 0, R_Y > 0, R_e < 0, R_{R^W} > 0, \alpha > 0, \beta < 0.$$

The endogenous-variable Jacobian is given by (3) and has a positive value.

$$|J| = (1 - C_Y) - \alpha R_\pi (C_R + I_R) - R_Y (C_R + I_R) > 0. \tag{3}$$

It can be shown that the impact of a change in the exchange rate on equilibrium output can be written as

$$\begin{aligned} \frac{\partial \overline{Y}}{\partial (e)} &= \frac{NX_e (P^f / P) + \beta R_\pi (C_R + I_R) + R_e (C_R + I_R)}{|J|} \\ &> 0 \; if \; \left| NX_e (P^f / P) \right| < \left| \beta R_\pi (C_R + I_R) + R_e (C_R + I_R) \right| \\ &< 0 \; if \; \left| NX_e (P^f / P) \right| > \left| \beta R_\pi (C_R + I_R) + R_e (C_R + I_R) \right| \end{aligned} \tag{4}$$

Whether currency appreciation would affect equilibrium output positively or negatively depends on the difference between the expected negative impact on net exports and expected positive impacts of increased consumption and investment expenditures due to a lower interest rate.

The impacts of a change in stock prices and the world interest rate on equilibrium output are given by (5) and (6), respectively. As shown, increased stock prices are expected to raise equilibrium output. A higher world interest rate would reduce equilibrium output due to the response of the domestic interest rate and reduced consumption and investment spending. A recent theoretical analysis of the IS-MP-IA model can be found in Hsing (2004).

$$\frac{\partial \overline{Y}}{\partial (S)} = (C_S + I_S) / |J| > 0 \tag{5}$$

$$\frac{\partial \overline{Y}}{\partial (R^W)} = R_{R^W} (C_R + I_R) / |J| < 0 \tag{6}$$

4. Empirical Results

The sample consists of annual data ranging from 1975 to 2003. The data were taken from the *International financial Statistics* published by the International Monetary Fund. Real GDP is

expressed in billions at the 1995 price. The expected inflation rate is the weighted average inflation rate of past four years (Davidson and MacKinnon, 1985). Due to a high degree of multicollinearity between G and T and to following the EU guideline for government deficit spending, fiscal policy is expressed as the deficit/GDP ratio or DY = (G-T)/Y*100%. When the real effective exchange rate increases, it means real appreciation, and vice versa. The stock price is the share price index compiled by the IMF. The U.S. federal funds rate is used to represent the world interest rate because of its worldwide influence. We assume that the inflation target is a constant. Following Romer (2000), potential output is treated as a vertical line. All variables except for the deficit/GDP ratio are measured in logarithmic scale.

Let's first test for unit roots. Based on the ADF or the Phillips-Perron test, the critical values are -3.68, -2.97, and -2.62 at the 1%, 5%, and 10% levels, respectively. All the variables except for DY have unit roots in levels and are stationary in first difference at the 5% level. According to the Johansen test, the null hypothesis of a zero cointegrating relationship is tested against the alternative hypothesis of one cointegrating relationship. The trace statistic is 134.74 compared with the critical value of 103.18 at the 1% level. Thus, the null hypothesis of a zero cointegrating relationship can be rejected. Hence, equilibrium output and these variables have a long-term stable relationship.

The estimated regression and related statistics are presented in Table I. The GARCH(1,1) process is employed in estimating the variance equation. Because the coefficients for ARCH(1) and GARCH(1) are significant at the 10% or 1% level, error variance is a function of past squared error and past error variance. In the estimated regression, 92.4% of the variation in equilibrium output can be explained by the five right-hand side variables. All the coefficients are significant at the 2.5% level, except that the coefficient for the world interest rate is significant at the 10% level. Equilibrium output is negatively associated with the expected inflation rate, the budget deficit/GDP ratio, and the U.S. federal funds rate and positively influenced by stock prices and real appreciation.

Specifically, an increase in the expected inflation rate by 1% would reduce equilibrium output by 0.092%. It is interesting to find that the coefficient of the government deficit/GDP ratio is negative and significant. An increase in the deficit/GDP ratio by 1 percentage point would reduce equilibrium output in logarithmic scale by 0.047. Possible reasons include that increased government debt to finance the deficit would raise the long-term interest rate and dampen consumption and investment spending and that the change in the portfolio among different assets including money, government bonds, stocks, etc, may not affect consumption and other expenditures much.

An increase in share stock index by 1% would raise equilibrium GDP by 0.105% because higher stock prices would stimulate consumption and investment expenditures through the wealth effect and the balance sheet effect. An increase in the real effective exchange rate rises by 1% would cause equilibrium output to rise by 0.688%. If the Federal Reserve Bank raises the federal funds rate by 1%, equilibrium output would decline by 0.026%.

5. Summary and Conclusions

In this study, the author has examined the determinants of equilibrium GDP for Germany based on an extended IS-MP-IA model developed by Romer (2000). Engle's (1982, 2001) GARCH process is applied in empirical work. Major findings are that a lower expected inflation rate, a lower deficit spending/GDP ratio, real appreciation, higher stock prices, and a lower U.S. federal funds rate would help raise equilibrium GDP.

There are several policy implications. The European Central Bank needs to continue to maintain price stability and contain inflation because of the negative impact of rising expected inflation on output. The negative relation between the deficit/GDP ratio and equilibrium GDP suggests that fiscal discipline is needed. Recent increases in the dollar/euro exchange rate hurt net exports and aggregate demand. However, the overall impact of real appreciation of the euro on the German output is positive, suggesting that the appreciation may not be a concern for the German real output but would be worried by some sectors which may lose competitiveness in the world market.

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Table I. Estimated GARCH Regression of Real GDP for Germany

Dependent Variable: $\overline{Y}$
Method: ML - ARCH (Marquardt)
Sample: 1975 2003
Bollerslev-Wooldrige robust standard errors & covariance
Variance backcast: ON

	Coefficient	Std. Error	z-Statistic	Prob.
C	4.596900	0.353008	13.02209	0.0000
π^e	-0.092243	0.018117	-5.091430	0.0000
DY	-0.047431	0.020152	-2.353731	0.0186
S	0.104836	0.028514	3.676710	0.0002
ε	0.688175	0.094710	7.266151	0.0000
R^W	-0.025540	0.013446	-1.899515	0.0575
	Variance Equation			
C	-7.79E-05	5.62E-08	-1385.542	0.0000
ARCH(1)	0.313161	0.181136	1.728873	0.0838
GARCH(1)	0.617349	0.147993	4.171477	0.0000
R-squared	0.924071	Mean dependent var		8.003717
Adjusted R-squared	0.893700	S.D. dependent var		0.220251
S.E. of regression	0.071810	Akaike info criterion		-2.885878
Sum squared resid	0.103133	Schwarz criterion		-2.461545
Log likelihood	50.84523	F-statistic		30.42563

Notes:

π^e is the expected inflation rate.
DY is the budget deficit/GDP ratio.
S is share stock price index.
ε is the real effective exchange rate.
R^W is the U.S. federal funds rate.