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An Empirical Analysis on Optimal Macroeconomic Policy Coordination in EMU Countries

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1 Introduction

The European single currency (Euro), which was launched on January 1, 1999, involves the following eleven countries: Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Portugal and Spain.¹ These countries form what is now known as the European Monetary Union (EMU). As a result, the Euro Area's monetary policy is centralized by the European Central Bank (ECB). The primary policy target of the ECB is to stabilize the Euro Area's prices.² For the stabilization of prices, the ECB operates short-term interest rates by facilities and open market operations. The ECB also has control over foreign exchange rates and Euro Area's reserves.

Fiscal policy (another macroeconomic policy) has not been centralized by any institution,³ therefore if a member country is confronted with asymmetric shocks, this country has to solve the problem by its own fiscal policy - however, fiscal policy leaves budget deficits, which bring the value and credibility of the Euro unstable.

To initiate the EMU, the Euro 11 has made every effort to converge their economies. Though they succeeded in the convergence to a certain degree, their business cycles are not parallel to one another.⁴ Hence, it is difficult for the ECB and each government to operate under these policies.

There are several studies on monetary and fiscal policies in the EMU countries. As for monetary policy, the political independence of the ECB has been discussed [Grilli et al. 1991, De Grauwe 1997]. On other aspects of the monetary policy, Estrella and Mishkin [1997] did a comparative study on the term structure of interest rates for the U.S. and Europe. Dornbusch, Favero and Giavazzi [1998] estimated reaction functions of major EU countries and showed that effects of common monetary policy were different between each country. Both Estrella et al. [1997] and Dornbusch et al. [1998] presented interesting policy implications on the ECB. For fiscal policy under the EMU, many papers analyzed whether the EMU needed fiscal federalism [Bayoumi and Masson 1995, Fatás 1998, Obstfeld and Peri 1998] and the Stability and Growth Pact [De Grauwe 1997, Eichengreen and Wyplosz 1998].

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¹ We call these eleven countries the Euro Area or the Euro 11.

² The ECB defines stabilizing prices as the HICP (Harmonized Index of Consumer Prices) being lower than 2% in the medium-term.

³ Though fiscal policy has been decentralized, there is a restriction on the operation of fiscal policy. This rule is called the Stability and Growth Pact. In this pact, each EMU member has to maintain its ratio of budget deficits per GDP under 3%.

⁴ See *The Economist*, May 29, 1999, pp. 48-49.

These previous studies discussed details of monetary or fiscal policy of EMU countries, however, they did not analyze both monetary and fiscal policies as a whole. As one of the papers on macroeconomic policy⁵ under the EMU presented, Meade and Weale [1995] analyzed the policy assignment problem of monetary and fiscal authorities. It is necessary for the EMU to implement a well-balanced macroeconomic policy.⁶ Though quantitative analysis of macroeconomic policy must be produced to seek concrete stabilization policies for the EMU, there are only few empirical analyses on this theme.

In this paper we have constructed an internationally-linked macroeconomic model of the Euro 11 and estimated their policy reaction functions. Section 2 defines social welfare functions and derives at policy reaction functions. Section 3 explains the structure of the model. Section 4 provides a part of the empirical results. Section 5 discusses simulation results. Finally, Section 6 shows certain conclusions.

2 Macroeconomic Policy Objectives

2.1 Social Welfare Function

A social welfare function is a kind of utility function that puts together policy objectives (e.g. economic growth, inflation, trade balance, etc.).

In this study, social welfare function is defined as a quadratic loss function. A general form of quadratic loss function (F) can be written as:

$$(2.1) \quad F = \sum_i w_i (Y_i - Y_i^*)^2 + \sum_j w_j (X_j - X_j^*)^2$$

where w_i is weights of policy objective variables, w_j is weights of policy instruments, Y_i is policy objective variables, Y_i^* is targets of policy objective variables, X_j is policy instruments and X_j^* is targets of policy instruments.

In Equation 2.1, targets and weights of both policy objective variables and policy instruments are unknown. The targets of both variables can be obtained by the results of domestic or international political bargaining, whereas the weights can be estimated econometrically by using time-series data.

2.2 Policy Reaction Function

A quadratic loss function is a non-linear function that presents a country's value. Hence, we cannot directly put this loss function into a simulation model. In order to simulate a model by using information of a quadratic loss function, we must derive a policy reaction function from this loss function, then insert this policy reaction function into an econometric model. A policy reaction function can be formulated as a partial derivative of a quadratic loss function with respect to a policy instrument. We show an example of a quadratic loss function that has one policy objective variable and one policy instrument. In this case, Equation 2.1 can be rewritten as:

⁵ In this paper macroeconomic policy means both monetary and fiscal policies.

⁶ Meade and Weale [1995] stated that the EMU would collapse unless monetary and fiscal authorities cooperated carefully.

$$(2.2) \quad F = w_1(Y - Y^*)^2 + w_x(X - X^*)^2$$

where w_1 is a weight of a policy objective variable, w_x is a weight of a policy instrument, Y is a policy objective variable, Y^* is a target of a policy objective variable, X is a policy instrument and X^* is a target of policy instrument. We differentiate Equation 2.2 with respect to a policy instrument (X) to derive a policy reaction function. A policy reaction function can be written as:

$$(2.3) \quad X = X^* + (w_1/w_x)(Y - Y^*)(\partial Y/\partial X).$$

Pissarides [1972] and Friedlaender [1973] can be regarded in previous studies. They analyzed the British and the U.S. macroeconomic policy respectively.

3 An Overview of the Model

The structure of the model is explained in this section. The model has two blocks: macroeconomic and trade linkage. The macroeconomic block is constructed on the basis of the Keynesian approach. Each country's macroeconomic block is linked through the trade linkage block. We adopt the Constant Value Share (CVS) method as trade linkage.

3.1 Macroeconomic Block

The macroeconomic block is constructed by the Keynesian framework. Our benchmark model is L. R. Klein's skeleton model [Klein 1983]. Summation of each final demand components equals gross national products (GNP) and determines national production outputs.

3.1.1 Variables

Endogenous Variables

Z_t : GNP (real)	L_t : Employment
C_t : Private final consumption (real)	LF_t : Labor force
I_t : Gross fixed capital formation (real)	r_t : Interest rate (nominal)
EX_t : Exports (real)	T_{rt} : Transfer payments (nominal)
IM_t : Imports (real)	Y_t : Disposable income (nominal)
K_t : Capital stock (real)	$\bar{\delta}_t$: Corporate profits (nominal)
D_t : Depreciation (real)	T_{1t} : Indirect tax (nominal)
P_t : Prices	T_{2t} : Personal tax (nominal)
w_t : Wage rate	T_{3t} : Corporate tax (nominal)

Exogenous Variables

G_t : Government spending (real)	PM_t : Import prices
WT_t : World trade transactions (real)	PW_t : World trade price
N_t : Population	MS_t : Money supply (nominal)

3.1.2 *Definitional Equations*

Real GNP

$$(3.1) \quad C_t + I_t + G_t + EX_t - IM_t = Z_t$$

The real GNP is explained by this definitional equation. From the principle of effective demand, the left side of the gross national expenditure components determines the production output of a country.

Nominal GNP

$$(3.2) \quad P_t Z_t - T_{1t} - P_t D_t = Y_t + T_{2t} + T_{3t} - T_{rt}$$

This equation defines the nominal GNP. By transforming this equation we explain the nominal disposable personal income.

National Income

$$(3.3) \quad w_t L_t + \mathbf{p}_t = Y_t + T_{2t} + T_{3t} - T_{rt}$$

Though this is the definitional equation of the national income, the nominal corporate profits are accounted for by this equation.

Capital Stock

$$(3.4) \quad K_t = K_{t-1} + I_t - D_t$$

The increase of the capital stock of this period equals the gross fixed capital formation minus the depreciation. The end of last period's capital stock plus the increase of this period become the capital stock of this period.

3.1.3 *Behavior and Technological Equations*

Consumption

$$(3.5) \quad C_t = a_0 + a_1(Y_t/P_t) + a_2 C_{t-1}$$

We adopt the Brown-type consumption function whose dependent variables are the real disposable income and the lagged consumption expenditure.

Investment

$$(3.6) \quad I_t = b_0 + b_1 Z_t + b_2 r_t + b_3 K_{t-1}$$

The end period's capital stock and the real GNP explain investments. In this function the interest rate is added as one of the explanatory variables because most companies invest by borrowing.

Export

$$(3.7) \quad EX_t = c_0 + c_1 WT_t + c_2 (PW_t/P_t) + c_3 EX_{t-1}$$

Fluctuations of trade transactions depend on changes of income and relative prices. The more trade partners' income increase, the more exports increase. If export prices are lower than importer's prices, exports increase. World trade transactions represent importers' income and the world trade prices stand for the other countries' prices.

Import

$$(3.8) \quad IM_t = d_0 + d_1 Z_t + d_2 (P_t/PM_t) + d_3 IM_{t-1}$$

The real GNP, the ratio of prices and import prices explain imports.

Employment

$$(3.9) \quad \ln L_t = e_0 + e_1 \ln Z_t + e_2 \ln K_{t-1} + e_3 \ln L_{t-1}$$

In this model, employment is determined by using the production function.

Prices

$$(3.10) \quad P_t = f_0 + f_1 (w_t L_t / Z_t) + f_2 PM_t$$

Prices depend on the unit labor cost (markup pricing) and import prices (cost-push inflation).

Wages

$$(3.11) \quad \Delta \ln w_t = g_0 + g_1 [LF_t / (LF_t - L_t)] + g_2 \Delta \ln P_t$$

The Phillips curve, which explains the relation between the unemployment rate and inflation, determines wages.

Labor Force

$$(3.12) \quad LF_t / N_t = h_0 + h_1 [(LF_t - L_t) / LF_t] + h_2 (w_t / P_t)$$

The unemployment rate and the real wages explain the labor force.

Velocity of Circulation of Money

$$(3.13) \quad \ln(P_t Z_t / MS_t) = i_0 + i_1 r_t + i_2 \Delta \ln P_t$$

The interest rate and inflation explain the velocity of money circulation. From this function, the interest rate is determined.

Depreciation

$$(3.14) \quad D_t = j_0 K_{t-1}$$

The depreciation is estimated at a certain rate of the last period's capital stock.

3.1.4 *Institutional Equations*

Indirect Tax

$$(3.15) \quad T_{1t} = k_0 + k_1 (P_t Z_t)$$

Indirect taxes are explained by the nominal GNP.

Personal Tax

$$(3.16) \quad T_{2t} = l_0 + l_1 Y_t$$

Personal taxes depend on the nominal disposable personal income.

Corporate Tax

$$(3.17) \quad T_{3t} = m_0 + m_1 P_t$$

Corporate profits explain corporate taxes.

Transfer Payments

$$(3.18) \quad T_{rt} = n_0 + n_1 (LF_t - L_t) + n_2 w_t$$

In reference to the unemployment insurance, transfer payments depend on unemployment and wages.

The exchange rate function is not in the Klein's skeleton model. In this study we show the Filatov-Klein exchange rate function.⁷ This function is written as:

⁷ See De Grauwe and Peeters [1983].

$$(3.19) \quad \ln e_t = o_0 + o_1 \ln(P_t/P_{US,t}) + o_2(r_t - r_{US,t}) + o_3(Bal_t/P_t Z_t)$$

where $P_{US,t}$ is the prices of the US, $r_{US,t}$ is the nominal US interest rate and Bal_t is the current account.

The Filatov-Klein model explains the exchange rate by relative prices between the host country and the US, the interest rate differences and the nominal current account per the nominal GNP. The exchange rate is basically determined by the purchasing power parity. Its short-term fluctuation depends on the interest rate differences and the current account.

3.2 Trade Linkage Block

General macroeconometric models treat export and import prices that are determined by foreign economies as exogenous variables. However, these variables can become endogenous variables by adding a trade linkage model to a macroeconometric model. In this study, we use the constant value share (CVS) method as a trade linkage model. This method assumes the nominal trade matrix to be constant through the timeframe of a simulation. Nominal import and export prices are transferred to the trade linkage block, then nominal export and import prices are returned to the macroeconomic block via the nominal trade matrix. The CVS model can be written as:

$$(3.20) \quad EX_{ij} = V_{ij} XV_{ij} / PX_i$$

$$(3.21) \quad IM_j = \sum_i EX_{ij}$$

$$(3.22) \quad A_{ij} = EX_{ij} / IM_j$$

$$(3.23) \quad PM_j = \sum_i A_{ij} PX_i$$

$$(3.24) \quad EX_i = \sum_j EX_{ij}$$

where PX_i is export prices of the i th country, EX_{ij} is real export of the i th country to the j th country, V_{ij} is nominal trade share from the i th country to the j th country, XV_j is nominal import of the j th country, IM_j is real import of the j th country, A_{ij} is real trade share from the i th country to the j th country, PM_j is import prices of the j th country and EX_i is export of the i th country. This model supposes that nominal trade share (V) is fixed. Hence real trade share (A) is changeable.

I. Empirical Results

Section 4 shows estimation results of policy reaction functions of monetary and fiscal authorities. All equations are estimated by ordinary least squares. Please note: Adj. R^2 is

the corrected R square, S. E. is the standard error, D. W. is the Durbin-Watson statistic. Upper and lower parentheses indicate t-statistic and p-value respectively.

4.1 Policy Reaction Function of Monetary Authority

The most important target of monetary policy is the stabilization of prices. Hence, one of the policy objective variables of monetary policy is the inflation rate. In this model, the inflation rate is normalized by the set target. We set the inflation rate target at 1% per annum.

Germany

$$\begin{aligned}
 (4.1) \quad RMMGER &= 0.31874 \\
 &(1.505134) \\
 &[0.1465] \\
 &+ 0.32185 * ((GR4_PC91GER - GR4_PC91GER^*) / GR4_PC91GER^*) \\
 &(3.572103) \\
 &[0.0017] \\
 &+ 0.20033114 * (@SEAS(1)) - 1.410186511e-05 * (@SEAS(2)) \\
 &(1.319743) \quad (-9.28E-05) \\
 &[0.2005] \quad [0.9999] \\
 &- 0.01768676226 * (@SEAS(3)) + 0.8014599283 * RMMGER_{-1} \\
 &(-0.116466) \quad (14.58430) \\
 &[0.9083] \quad [0.0000]
 \end{aligned}$$

Adj. R² = 0.985105 S.E. = 0.283776 D. W. = 0.878629 Sample: 1991:3-1998:2

The money market rate of Germany (RMMGER) is explained by the normalized inflation rate from the previous four quarters by its inflation target $((GR4_PC91GER - GR4_PC91GER^*) / GR4_PC91GER^*)$, dummy variables for the first, second and third seasons (@SEAS(1), @SEAS(2), @SEAS(3))⁸ and the lagged money market rate. This reaction function is statistically well-estimated aside from the Durbin-Watson statistic.

Ireland

$$\begin{aligned}
 (4.2) \quad RMMIRE &= 3.24458 \\
 &(3.264563) \\
 &[0.0085] \\
 &+ 0.64425 * ((GR_PC90IRE - GR_PC90IRE^*) / GR_PC90IRE^*) \\
 &(1.674266) \\
 &[0.1250] \\
 &+ 0.48675 * RMMGBR \\
 &(3.552801) \\
 &[0.0052]
 \end{aligned}$$

⁸ Data of Germany is not seasonally adjusted. Hence we need seasonal dummy variables to estimate equations of Germany.

Adj. $R^2 = 0.773484$ S.E. = 1.134877 D. W. = 2.490554 Sample: 1985-1997

The normalized inflation rate by its inflation target $((GR_PC90IRE - GR_PC90IRE^*) / GR_PC90IRE^*)$ and the money market rate of Great Britain (RMMGBR) determine the Irish money market rate (RMMIRE). Though a general estimate could be obtained, there are several problems. The degree of freedom does not reach its appropriate number. The normalized inflation rate is rejected at the 5% significant level. The corrected R square is lower than that of Germany's. These problems can be overcome by using more data in the estimation.

4.2 Policy Reaction Function of Fiscal Authority

We suppose that one of the targets of fiscal authority is economic growth. The policy objective variable is the real GDP or the unemployment rate.

Germany

$$(4.3) \quad G91GER = 154692.9747 + 3021.97701*URGER - 24475.05402*(@SEAS(1)) \\ (40.62179) \quad (6.451464) \quad (-12.49055) \\ [0.0000] \quad [0.0000] \quad [0.0000] \\ - 13996.31839*(@SEAS(2)) - 13446.52471*(@SEAS(3)) \\ (-7.301022) \quad (-7.031567) \\ [0.0000] \quad [0.0000]$$

Adj. $R^2 = 0.845613$ S.E. = 3824.599 D. W. = 0.704050 Sample: 1990:3-1998:2

German government spending (G91GER) depends on its unemployment rate (URGER) and seasonal dummy variables. Though most statistics show good results, we can recognize a serial correlation with the Durbin-Watson statistic.

Ireland

$$(4.4) \quad CG90IRE = 762.74205 + 0.01428*GDP90IRE \\ (2.415959) \quad (2.300899) \\ [0.0265] \quad [0.0336] \\ + 0.74259*CG90IRE(-1) \\ (7.183836) \\ [0.0000]$$

Adj. $R^2 = 0.906916$ S.E. = 117.2200 D. W. = 1.291164 Sample: 1976-1996

We can explain Irish government consumption by the real Irish GDP (GDP90IRE) and the lagged Irish government consumption. Judging from this statistic, the reaction function is well-estimated.

5 Simulation Results

Simulation results are presented in this section. The simulation time period is 1995-2000. We have provided Germany and Ireland's simulation results.

5.1 Assumptions on Exogenous Variables

There are two types of exogenous variables in this model. One is the variable that increases with time. As for this type of exogenous variables, we calculated its growth rate and extended it by the growth rate. The other is the fluctuation which does not have any relation to time. With regard to these exogenous variables, their averages were used for input.

5.2 Scenario Simulations

We prepared two scenarios for this simulation analysis.

Scenario 1: *Business As Usual (BAU) Scenario*

We simulated the model from 1995 to 2000 without any consideration to policy instruments. Monetary and fiscal policy variables are determined by each policy reaction function in the BAU scenario.

Scenario 2: *Common Monetary Policy (CMP) Scenario*

We examined the effects of adopting the common money market rate in Scenario 2. The common interest rate that is operated by the ECB is computed as the weighted average of the Euro Area's eleven money market rates. The money market rate of the ECB is formulated as:

$$(5.1) \quad \begin{aligned} r_{ECB,t} &= \sum_i^{11} w_i r_i \\ w_i &= (Z_i e_i) / \sum_i^{11} Z_i e_i \end{aligned}$$

where $r_{ECB,t}$ is the money market rate of the ECB, w_i is the weight of the i th country, r_i is the money market rate of the i th country, Z_i is the real GDP of the i th country and e_i is the exchange rate of the i th country. Each country's weight is assumed as its country's real GDP (in US dollar) per the Euro Area's real GDP (in US dollar). We applied the ECB's common monetary policy from 1998 to 2000, meaning that the Euro 11 has the same money market rate for those years.

5.3 Results

Money Market Rate

Figure 1 shows the money market rate of Germany for scenarios 1 and 2. The BAU scenario result implicates a decrease to 1.36% of the money market rate in the fourth

quarter of 1998, then an increase to the level of roughly 2.5%. The ECB's money market rate will be an approximate 3.67% from 1998 to 2000. As a result of being a member of the EMU, the money market rate of Germany will be higher than its fundamental rate.

The money market rate of Ireland is presented in Figure 2. Ireland's money market rate from 1998 to 2000 is forecasted as roughly 7%. The difference between scenarios 1 and 2 is over 3%. Ireland's economy is growing faster than that of the major Euro Area's members'. Though Ireland needs to slow down its economy by increasing its interest rates, the common interest rate will prove to be lower than expected.

Economic Growth

Economic growth rates of Germany and Ireland are provided in Table 1. The economic growth rate of Germany from the first quarter of 1991 to the fourth quarter of 2000 is approximately 0.3%. Though the growth rate from the first quarter of 1991 to the fourth quarter of 1997 is roughly 0.3%, it is expected to be 0.1% from the first quarter of 1998 to the fourth quarter of 2000.

Ireland's economy will grow at the rate of 7% from 1991 to 2000. In contrast to Germany, Ireland's growth rate from 1998 to 2000 is higher than from 1991 to 1997. The difference in timeframe is 0.3%.

This is due to the implementation of the ECB's common interest rate.

Inflation Rate

Table 2 presents inflation rates of both Germany and Ireland. Germany's consumer prices will increase at 0.6% from the first quarter of 1991 to the fourth quarter of 2000. In detail, it will grow at the rate of 0.7% from the first quarter of 1991 to the fourth quarter of 1997, and at 0.4% from the first quarter of 1998 to the fourth quarter of 2000. The ECB's interest rate will decrease the inflation rate at roughly 0.4 points.

The inflation rate of Ireland is approximately 3%. On the contrary, the inflation rate from 1998 to 2000 is expected to be 2%, the difference between scenarios 1 and 2 being roughly 0.4 points. The ECB's monetary policy will increase Ireland's consumer prices at 0.4%.

6 Concluding Remarks

In this paper we constructed an internationally-linked model of the Euro 11 and evaluated the effects of the common monetary policy. The forecasted results show that the ECB's money market rate will be at approximately 3.6% from 1998 to 2000. Quantitative effects of the common monetary policy will not be great, however, directional effects will differ in each country due to differences in their business cycles. It is difficult for the ECB to improvise successful operations of the monetary policy while recognizing the overall fundamentals pertaining to the Euro 11.

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Figure 1 Money Market Rate of Germany

Figure 2 Money Market Rate of Ireland

Table 1 Economic Growth Rates of Germany and Ireland (Unit: %)

Table 2 Inflation Rates of Germany and Ireland (Unit: %)

