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# A MEDIUM-TERM MACROECONOMIC MODEL FOR THE EUROPEAN ECONOMIC COMMUNITY

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CORE REPRINT No. 232

CENTER FOR OPERATIONS RESEARCH & ECONOMETRICS

UNIVERSITE CATHOLIQUE DE LOUVAIN

European Economic Review 7 (1976) 63–115. © North-Holland Publishing Company

# COMET*

## A medium-term macroeconomic model for the European Economic Community

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Received May 1975

COMET is a macroeconomic medium-term model for the European Economic Community. It basically consists of eight similarly specified country models which are linked by bilateral trade equations and equations specifying the formation of import and export prices. The medium-term nature is reflected in the role played by the degree of capacity utilization. Section 2 discusses the basic (structural) assumptions of the model, section 3 the performance of the model as a whole.

## 1. Introduction

### *1.1. General overview*

The nine countries which at present form the European Economic Community display intensive mutual economic relations. Over the years these relations have increased in strength, a tendency which will presumably continue in the near future. As a consequence the economies of these countries are becoming more and more interdependent. At the same time, the member countries have retained formally a high degree of freedom for their economic policy, but it is obvious that without co-ordination between the member countries their individual economic policies cannot be very effective in reaching major national economic targets while their impact on partner countries might not be desirable. Beside the necessary political agreement on objectives a clear insight in the consequences of alternative joint economic policies within and across partner countries

*The model described in this article was developed under contract with the European Economic Commission. The authors wish to express their thanks to the various staff members of the Commission who have in many ways been involved in the project. They nor the Commission can be held responsible for the views expressed in this article, for which the responsibility resides exclusively with the authors. The model itself, as presented here, is the research version of the COMET project. It differs in some coefficient values and in the assumed future time path of exogenous variables from the version in use at the Staff of the European Commission.

is required. For this purpose a set of interrelated medium-term macroeconomic models for the EEC countries has been developed and simulated since the autumn of 1970 at the Center for Operations Research and Econometrics (CORE). It was named the 'COmmon market MEdium Term model' (COMET). The latest version is presented here but it can be called neither final nor complete. As it is intended to be used for policy-making by the Commission of the EEC, it is subject to continuous revision to better suit its purpose.

The model consists of eight national models, one each for the Federal Republic of Germany, France, Italy, the Netherlands, Belgium, the United Kingdom, Ireland and Denmark, respectively. A model has been estimated for Luxemburg but is not yet integrated in the whole. Time series for the national accounts on an annual basis were provided by the Commission of the EEC when not taken from OECD or IMF sources as mentioned below. The specifications of the structural equations were kept similar for the various countries in order to know clearly what type of questions about policy alternatives can be answered by the model, and what not. Similarity facilitates also meaningful inter-country comparison of the numerical values of coefficients. Moreover, it was logical to emphasize the similarities of the various economies and to use comparable concepts in view of the elaboration of co-ordinated policies.

As opposed to pure short-run or demand explanations on the one hand and to long-run or supply models on the other, COMET is a medium-term model where the interaction between demand and supply is explained within the model. This feature and its dynamic nature makes it suitable for predictions of time paths over 5 to 10 years. The data for the period 1953–1972 display more or less stable long-run exponential growth. This made it attractive to choose linear logarithmic relations for most of the estimated equations. Because of its non-linear character due to the combination of accounting identities with linear and nonlinear logarithmic relations, the model is solved by iteration techniques.

About the estimation methods: for large-scale dynamic models, nonlinear in the coefficients and with presumably non-zero autocorrelation of various orders among the structural disturbances, no convenient consistent estimation procedure is available apart from the instrumental variables approach. This method is rather sensitive to the choice of the instrumental variables, while no 'natural' instruments present themselves in the COMET context. Since the sample period is anyway rather small, the structural equations have been estimated by the ordinary least squares method, sometimes applied iteratively when nonlinearities in the coefficients occurred. Moreover, the final results were obtained after various respecifications of the relations in the light of their simulation performance within the context of the complete model. Specifications were revised and coefficients derived or fixed at theoretically plausible values to obtain empirically acceptable dynamic simulation results for the complete model.

The article is divided into two main parts following this introduction. In section 2 the theoretical basis underlying all the behavioural equations is



Table 1

Symbols for main variables (alphabetic list).

| | |
|---|---|
| *CGO, CGU, PCG* | Public consumption |
| *CPO, CPU, PC* | Private consumption |
| *DPU* | Depreciation |
| *DTC* | Direct taxes on corporations |
| *DUC* | Degree of capacity utilization (1963–90) |
| *e* | Residual term |
| *EX* | Exchange rate |
| *EXE* | Auxiliary variable for flexible exchange rate |
| *FDO, FDU, PFD* | Final demand |
| *FMO, FMU, PFM* | Calculated total import contents |
| *FSO, FSU, PFS* | Final demand excl. variations of stocks |
| *IO, IU, PI* | Gross domestic fixed asset formation |
| *ITR* | Indirect taxes minus subsidies, divided by *YU* |
| *LI* | Long-run interest rate |
| *MGO, MGU, PMG* | Import of goods (also with $ suffix) |
| *MGUxi* | Import of goods of country *x* from country *i* (also with $ suffix) |
| *MIO, MIU, PMI* | Import of invisibles |
| *MTO, MTU, PM* | Import of goods and services including factor income |
| *N* | Total employed labour in millions of man-years |
| *NA* | Available labour in millions of man-years |
| *ND* | Occupied employees in millions of man-years |
| *ON* | Other income incl. profits of corporations |
| *POP* | Total population in millions of man-years |
| *POPA* | Population between the age of 15 and 65, millions of man-years |
| *PWG* | Competitive export price |
| *PMIW* | Auxiliary variable for PMI |
| *SI* | Short-run interest rate |
| *SSC* | Employers' contribution to social security |
| *STO, STU, PST* | Variation in stocks |
| *SUB* | Subsidies |
| *TBR* | Trade balance in percentage of *YU* |
| *UR* | Unemployment rate |
| *V* | Capital user's cost |
| *WBU* | Compensation of employees |
| *WR* | Wage rate |
| *XGO, XGU, PXG* | Exports of goods (also with $ suffix) |
| *XGW$* | Exports of goods to non-EEC member countries |
| *XIO, XIU, PXI* | Exports of invisibles |
| *XTO, XTU, PX* | Exports of goods and services incl. factor income |
| *YD* | Disposable income of households and private non-profit institutions |
| *YN* | National income at factor cost |
| *YO, YU, PY* | Gross national product at market prices |
| *t* | Time trend (1953 = 1) |

described. In section 3 simulation and projection results of various experiments are reported and commented. In the first appendix of the article the regression results are given in tabular form. In order to save continuous redefinition of the same symbols for the variables used in the text, the present introduction concludes with a guide to the variables used in the model, the sources from which the data were taken, and the symbols used to represent them.

### *1.2. The COMET variables: Symbols and data sources*

In principle, variables with *U* added to their symbol are expressed in current prices, a capital *O* at the end indicates that they are in constant prices with base year 1963. A capital *P* followed by the symbol of a variable stands for the price indices (equal to 100 in 1963). The aggregates are defined in millions of pounds sterling for the UK and IR, and in billions ($10^9$) of local currency for the other countries. Population or labour series are in millions of man-years. A symbol ending with *R* represents a ratio. When a dollar sign $ is added, the variable is expressed in millions of US dollars.

Table 2

Symbols of countries (used as suffix).

| | |
|---|---|
| D | Federal Republic of Germany |
| F | France |
| I | Italy |
| NL | Netherlands |
| B | Belgium |
| L | Luxemburg |
| BL | Belgian–Luxemburg Economic Union (BLEU) |
| UK | United Kingdom (incl. Northern Ireland) |
| IR | Ireland |
| DK | Denmark |

The variables: *CPU*, *CPO*, *CGO*, *IU*, *IO*, *STU*, *STO*, *XTU*, *XTO*, *MTU*, *MTO*, (*YU*), *CGU*, (*YO*), *DPU*, *ITR*, *SUB*, (*YN*), *WBU*, *SSC*; *DTC*, *YD*, *N*, *ND*, *NA* and *POP* were taken from Volkswirtschaftliche Gesamtrechnungen/Comptes Nationaux, published or still to be published by the Statistical Office of the European Communities.

*PXG$*, *PMG$*, *EX*, *SI*, *LI* were obtained from the International Financial Statistics, Vol. XXV, published by the International Monetary Fund.

The date for the Import Allocation Model, *XGU$*, *MGU$* and the disaggregation of *MGU$* over the EEC countries: *MGU$*.D, *MGU$*.F, *MGU$*.I, *MGU$*.NL, *MGU$*.BL, *MGU$*.UK, *MGU$*.IR, *MGU$*.DK were taken from the Foreign Trade Statistics Bulletins, Series A, published by the OECD.; the most recent updates to be found in the successive volumes have been chosen.



*POPA* was taken from the Demographic Yearbook 1969, published by the United Nations.

All other variables in the model are derived from these series.

## 2. Structural specifications

COMET is essentially a model of the real sector. Monetary and financial aspects of the economy are represented only by short- and long-run interest rates which are kept exogenous. The model puts the emphasis on the interdependency of the national economies by the description of the trade flows between the member countries and of commodity import and export price formation. Mobility of primary production factors, in particular labour migration and financial transfers, are not treated explicitly but the possibility of such mobility is taken into account to some extent: a labour supply function was specified, depending on both demographic factors and the conditions on the labour market, implying, therefore, the possibility of net migration of foreign labour. For the explanation of investments a loanable funds approach was considered to be inadequate since investment in the EEC is not necessarily financed within the country where the investment occurs; a substantial part of net investment takes place in local subsidiaries of international concerns; therefore local production needs and cost conditions have been preferred to explain investments.

The various groups of structural equations are discussed next, in separate subsections, which are again subdivided for each structural equation.

The last subsection (2.8) will deal with some aspects of the functioning of the model as a whole.

### *2.1. The degree of utilization of capacity (DUC)*

The discrepancy between demand and potential supply of domestic production, which is to be explained in a medium-term model, is reflected by a variable called degree of utilization of capacity and defined as the ratio between gross national product in constant prices (*YO*) and total production capacity. The numerator stands for total demand which is endogenous; the denominator stands for potential supply. This concept is approximated by the use of an estimated production function with the total available quantities of production factors as arguments, which are also endogenous in the model. The role of *DUC* in the model is to explain part of the demand for production factors and part of the change in the prices of demand categories reflecting a tendency towards an 'optimal' tension between supply and demand conditions.[1]

[1] The idea of using an endogenous capacity variable in a medium-term model was applied for the first time by Van den Beld (1968).

The first step in the creation of the *DUC* variable was to formulate and estimate a domestic production function. To avoid the construction of a capital stock series the following vintage production function was postulated:

$$\ln YO_t = \text{constant} + \alpha \ln N_t + \beta \sum_{i=0}^{\infty} \eta^i (\ln IO_{t-1-i} + \ln IO_{t-i})/2 + \gamma t + e_t, \tag{1}$$

where $N$ is the employed labour force, $IO$ real gross investment in fixed assets, $t$ the time trend and $e_t$ an error term. According to this specification it takes on average a half year's delay before an investment becomes productive. Gross investment rather than net investment is used to take into account the fact that the replacements of capital goods usually represent a quite different level of technology. It can easily be shown that if gross investment in fixed assets grows at a constant rate per year and if the rate of depreciation of capital is constant, this specification is related to the Cobb–Douglas production function; under those conditions the distributed lag in investment, further defined as $\kappa_0$, equals a constant plus $1/(1-\eta)$ times the logarithm of capital while the rate of technical depreciation equals $1-\eta$, $\eta$ being the rate of technological survival; $\alpha+\beta/(1-\eta)$ would consequently represent the returns to scale as defined in the corresponding Cobb–Douglas function. The $\gamma$ reflects 'neutral' technical progress.

Estimating the parameters of (1) turned out to be a far from trivial matter. In order to obtain plausible results, eq. (1) was rewritten as

$$\ln YO_t = \alpha_0 + \kappa_0(\beta\eta^{t-t_0}) + \alpha \ln N_t + \beta \sum_{i=0}^{t-t_0-1} \eta^i (\ln IO_{t-1-i} + \ln IO_{t-i})/2 + \gamma t + e_t, \tag{2}$$

where $t_0$ is the last year before the period of observation, and

$$\kappa_0 = \sum_{i=0}^{\infty} \eta^i (\ln IO_{t_0-1-i} + \ln IO_{t_0-i})/2,$$

being an unknown constant to be estimated. For a limited set of given values for $\alpha$, $\beta$ and $\eta$, estimates for $\alpha_0$, $\kappa_0$ and $\gamma$ were obtained.

The final set of coefficients is given in table A.1. Note that the low variables for the Durbin–Watson statistic (*DW*) indicate a strong positive autocorrelation among the error terms. This is to be expected since this error term should reflect cyclical variations in the use of capacity.

The value found for $\kappa_0$ can be used to construct a time series

$$\kappa_t = \eta\kappa_{t-1} + (\ln IO_{t-1} + \ln IO_t)/2,$$



so that (1) is rewritten as

$$\ln YO_t = \text{constant} + \alpha \ln N_t + \beta\kappa_t + \gamma t + e_t. \tag{3}$$

Total productive capacity can be approximated by replacing $N_t$ by $NA_t$ (labour supply) in (3) and deleting the error term $e_t$ which is taken to represent slack in the use of existing fixed capital. Consequently, by definition

$$\ln DUC_t = \text{constant} + \ln YO_t - \alpha \ln NA_t - \beta\kappa_t - \gamma t, \tag{4}$$

where the intercept was set at a value such that $DUC_{1963} = 90$. An alternative expression is obtained for $\ln DUC_t$ after substitution of $\ln YO_t$ in (4) by the right-hand side of the production function (3), namely

$$\ln DUC_t = \text{constant} + \alpha(\ln N_t - \ln NA_t) + e_t, \tag{5}$$

where $\ln N_t - \ln NA_t$ comes close to minus the unemployment rate $(NA_t - N_t)/NA_t$. However, as far as the past is concerned, the presence of $e_t$ makes the $DUC_t$ different from the unemployment rate as an indicator of slack in the economy. The correlation between the two series varies between $-0.11$ for the United Kingdom and $-0.83$ for Belgium.

Eliminating $\kappa_t$ from (4) by means of a Koyck transformation leads, with some rearranging of terms, to the expression for *DUC* used in the model, namely

$$\ln DUC_t = \text{constant} + \ln YO_t - \eta \ln YO_{t-1} - \alpha(\ln NA_t - \eta \ln NA_{t-1}) - \beta(\ln IO_{t-1} + \ln IO_t)/2 - \gamma(1-\eta)t + \eta \ln DUC_{t-1}. \tag{6}$$

In the COMET model the production function (2) does not appear explicitly but it is used to derive the equations for investment in fixed assets and for demand for labour.

### 2.2. *Consumption (CPU, CGU and YD)*

#### 2.2.1. *Private consumption (CPU)*

The equation for private consumption was estimated in the form

$$\ln(CPU_t/POP_t) = \alpha_0 + \alpha_1 \ln(YD_t/POP_t) + \alpha_2 \ln(YD_{t-1}/POP_{t-1}) + \alpha_3 \ln PC_t + \alpha_4 \ln PC_{t-1} + \alpha_5 \ln(SI_t/LI_t) + \alpha_6 \ln(CPU_{t-1}/POP_{t-1}) + e_t. \tag{7}$$