

HERMIN-S4
A four-sector structural model of the
Spanish Economy for the analysis of
COMMUNITY SUPPORT FRAMEWORKS
by
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Abstract

This paper describes the main features of HERMIN-S4, a macroeconomic model of the Spanish economy. HERMIN-S4 is a model with four sectors: the public sector (G), the exposed tradable sector (T) that coincides with the manufacturing industry, the protected non-tradable sector (N) that includes marketed services, building and construction and energy, and the agricultural sector (A).

The basic philosophy underlying the design of HERMIN-S4 is twofold. On the one hand, we try to construct a fairly simple and flexible core model of our economy, which could, nevertheless, replicate its main relationships. On the other hand, it requires strict comparability with other similar models built for Greece, Ireland and Portugal, in order to use them in a joint research project to assess the effects of the Community Support Frameworks on growth in the European periphery.

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I. INTRODUCTION

This paper describes the results of on going research aimed at the construction, testing and regular use for policy analysis of a long-run structural econometric model of the Spanish economy. It contains thus the full model specification at four sector disaggregation, its estimation and a series of simulations of policy-induced or exogenous shocks. The results here presented are preliminary in the sense that both estimation and simulation have been kept as simple as possible although they will be refined in the near future. A comprehensive document describing a three sector version of the model is also available (Herce and Sosvilla (1994)).

The primary use of the model will be the analysis of Community Support Frameworks. For this, the model demanded strict comparability between the four peripheral countries of the E.U.: Greece, Spain, Ireland and Portugal.

There was also needed a very simple model favoring progressive sectoral disaggregation at no excessive data cost, focused in the long-run properties of the economy and suited to the analysis of both the supply and demand side effects of the structural funds from the E.U. to its less developed member states. We are thus mainly interested in the medium to long-run properties of the model, as well as comparability with the models built by the other teams from Greece, Ireland and Portugal, rather than the analysis of short-term fluctuations and forecasting.

HERMIN-S4 is thus the model that will serve that purpose. HERMIN owes its name to the HERMES model, a nine sector model developed in ten EC countries, during

the 1980s, at the request of the EC Commission. In the case of the Irish and Portuguese models, it results actually from a contraction to four sectors and many other simplifications to obtain a mini-HERMES, from whence its name. As Spain lacked an operational HERMES model, we developed HERMIN-S4 which is the HERMIN version, four sectors, for the Spanish economy. The next step will be to develop its ability to fully assess Community Support Frameworks (CSF) effects.

These effects are wider than the conventional demand and current account implications. CSF grants to member States increase considerably the expenditure capacity of the receiving public administrations. For certain regions, in Spain, annualized European Fund for Regional Development (EFRD) transfers plus the additional funds to which national administrations are obliged under the CSF conventions amounted to almost 3% of their GDP. Such a shock to aggregate demand is several times larger than the conventional ones policy analysts usually consider in their models.

Public capital formation is greatly encouraged by this shock. The current account also registers positively the impact of CSF capital transfers. Part of the total grants can be directly transferred to firms for targeted expenditures by them. Finally, a fairly significant portion of CSF associated expenditure finances human capital enhancing activities.

It is well known that expansionary demand shocks will temporarily raise both output and prices. The long-term persistence of these changes will depend on the characteristics of the economy: expectations formation, types of rationing suffered by firms, degree of competition in their factor and product markets, etc.

CSF effects will also depend on how the extra expenditure will affect the supply side of the economy. Transport and telecommunications infrastructure, for instance, is vital for the efficiency of all types of operators. The research on the supply side effects of productive public expenditure is very active at present [see Draper and Herce, (1993) for a survey on this literature] and some of their best established results can be very easily incorporated in a model like HERMIN-S4.

Of course, these supply side effects are not as certain as the demand ones. They will only come about if the projects on which the money is spent are actually needed and efficiently operated. The microeconomic evaluation of these projects is of paramount importance to ensure this.

One specificity of the CSF in Spain, not present in the other three countries mentioned above, concerns the "north-south" divide of our economy. CSF funds are mostly directed towards nine less developed "Comunidades Autónomas" or regions of the seventeen that make the whole territory. This fact will force us to further develop HERMIN-Spain to capture differentiated growth in different groups of regions. This is a stimulating perspective from the modelling point of view for the purpose of CSF funds is actually to promote the catching-up of these regions.

One question remains that concerns the whole exercise of model building. Is it worthwhile to do this kind of exercise today? The reader is directed to Fair (1993), Helliwell (1993) and Taylor (1993). These authors emphasize how econometric models could be adapted in order to continue to be unavoidable policy analysis tools: through testing of their properties, if possible against alternative structural models (rather than

against VAR or Autoregressive Components models); developing the linkages between national models to capture globalisation trends; or to take account of rational expectations based behaviour, credibility issues, growth, etc. In sum, the research programme before macroeconomic modellers seems to be intense and attractive.

One final question refers to the transparency of model building as argued by Wallis, (1993). An important requirement in modelling work is that it should be fully documented and completely open, so that the results can be replicated and compared with those from other macroeconometric models. When economists disagree, it is usually because they are making different assumptions or placing relative emphasis on parts of the system. If the assumptions are not made public, sensible discussion cannot proceed. The Spanish case is particularly lucky in this respect. We already mentioned the availability of the MOISEES model for comparison of results.

The rest of the paper is organized as follows. The sectoral desaggregation and the theoretical foundations of the behavioural equations of the model are discussed in Section 2 where also the data problems are mentioned. Section 3 is devoted to the estimation of the behavioral equations of the model. In Section 4 several policy simulations help to illustrate the properties of HERMIN-S4 in its present formulation and to explore the likely long-term growth patterns that would follow the Spanish economy under changing circumstances. Concluding comments on the whole exercise and future research agenda of the HERMIN-Spain team are the object of Section 5. A series of technical appendices contains the full model description, variables listing, etc.

II. THE HERMIN-S4 MODEL FRAMEWORK

2.1. The Sectoral Breakdown

The HERMIN-S4 model has been conceived as a four sector model of the Spanish economy. The progressive sectoral breakdown for HERMIN-Spain is as indicated in the Table 2.1.

The choice of the sectoral disaggregation is justified by the desire of keeping the model as small and simple as possible while separating sectors with different behaviour and driven by different forces:

- i) the public sector (G) is dependent on Government policy decisions, with expenditure and tax rates as instruments.
- ii) the exposed tradable sector (T) is driven by both domestic and foreign demand, and by international cost competitiveness.
- iii) the protected non-tradeable sector (N) is driven by domestic demand, and
- iv) the agricultural sector (A) is treated as mainly exogenous.

Table 2.1 Sectoral breakdown in HERMIN-SPAIN		
2 Sectors	3 Sectors	4 Sectors
S1. Government (G)	S1. Government (G)	S1. Government (G)
S2. Private (P)	S2.1. Private Non Ag.(NA)	S2.1.1. Tradable (T): Industry
		S2.1.2. Non Tradable (N): Energy, Building and Construction and Private Services
	S2.2. Agriculture (A)	S2.2. Agriculture (A)

2.2. General overview of the model

Table 2.2 contains the basic structure of the model that is detailed below. Only behavioural equations are listed in the table. The rest of the equations of the model, most of them identities, can be found in the model listing in Appendix 1.

Table 2.2 The General Structure of HERMIN-S4 Behavioural Equations
Output and factors demand Output = $f(\text{Final Domestic Demand, World Output, Competitiveness})$ Investment/Output = $f(\text{Relative Factor Costs})$ Employment/Output = $f(\text{Relative Factor Costs})$
Wages Wage Rate = $f(\text{Consumer Prices, Productivity, Unemployment Rate, Tax Wedge})$
Prices Deflator = $f(\text{GDP}_{FC} \text{ deflator, Price of imports, Indirect taxes})$ Deflators for: Private Consumption, Public Consumption, Residential Investment, Public Investment, Private Investment, NA Sector Investment, A Sector Investment, T Sector Exports and N Sector Exports (tourism and non-tourism).
Labour Supply Participation Rate = $f(\text{Unemployment Ratio})$ Labour Force = Participation Rate * Working Age Population Unemployment Rate = $100 * ((\text{Labour Force} - \text{Employment}) / \text{Labour Force})$
Absorption Equations Private Consumption = $f(\text{Personal disposable income, Public debt})$ Residential Investment = $f(\text{Pers. disp. income, population})$ Non-residential Private Investment = see above in Factors Demand Exports = $f(\text{World output, competitiveness})$ Imports = $FD + DS - GDPM - STATDIS$

2.3. The Theoretical Framework

In building the HERMIN-S4 model, we have opted for simple and encompassing theoretical foundations sufficiently established in other modelling exercises similar to this one. The way output, employment wages, prices, unemployment and aggregate demand are determined by the corresponding agents in the different sectors of the economy is explained in this chapter.

Taking into account that the model is going to be used for long-run policy analysis, the behavior of the agents we are considering is not going to be affected by cyclical factors. This allows us to simplify further the specifications by just considering the fundamental determinants of the agents' decisions in agreement with the underlying theories. In what follows we will concentrate on the most important behavioural equations in HERMIN-S4. The complete listing of the model can be found in Appendix 1.

2.3.1. The CES-based joint factor demand system (cost minimization)

Concerning output and factors demand decisions, we will opt for a CES production function that, under the assumption of cost minimization, will allow us to obtain demands for the services of labour and capital as functions of their relative prices, wages in the case of labour and user cost in the case of capital. In order to apply the cost minimization assumption, it will be further assumed that output is determined by final domestic demand, world output and the competitiveness of the economy. Once output is determined, cost minimizing employment per unit of output will be just a function of relative factor costs and a series of technology parameters proper to the CES specification that will be explained below. Equally, cost minimizing

capital demand per unit of output will also be a function of relative factor prices and its own technology parameters.

The CES production function, following Bradley et al. (1993), can be formulated as:

$$O = A\{\delta(\exp(\lambda_L t)L)^{-\rho} + (1-\delta)(\exp(\lambda_K t)K)^{-\rho}\}^{-(1/\rho)} \quad (2.1)$$

where O , L and K are, respectively, added-value, employment and the capital stock. A is a scale parameter, $1/(1+\rho)=\sigma$ is the elasticity of substitution, δ is a factor intensity parameter and λ_L and λ_K are the rates of technical progress embodied, respectively, in labour and capital. Whenever λ is positive the technological progress will be factor saving.

Cost minimization for a given level of output restricted to fulfill equation (2.1) above will give factor demands as:

$$K = G(O, w/c) \quad (2.2)$$

and

$$L = H(O, w/c) \quad (2.3)$$

where, c is the user cost of capital and w the wage rate.

Equivalently, by dividing by O , factor demands per unit of output can be expressed as:

$$K/O = g(w/c) \quad (3.2')$$

and

$$L/O = h(w/c) \quad (2.3')$$

Furthermore, in order to apply the estimation techniques to the existing data on employment and capital formation we take gross investment instead of the capital stock. The huge simplification this procedure entails can be justified assuming that the flow of gross investment is a proxy for the latest vintage of capital in a "putty-clay" world. Thus our final joint demand system will be:

$$I/O = g(w/c); \text{ with } g' > 0 \quad (2.2'')$$

and

$$L/O = h(w/c); \text{ with } h' < 0 \quad (2.3'')$$

where I stands for gross investment.

Once I is computed, one can build a proxy for the capital stock following the perpetual inventory rule:

$$K_t = I_t + (1-\alpha)K_{(t-1)} \quad (2.4)$$

As indicated above, given the cost minimization criterion adopted, we need an alternative determination of the level of output in every period in order to derive the levels of employment and investment.

The equation for output in the tradable sector is:

$$OT = f(FDDWOT, OW, CCOMPT)$$

where OT is the tradable sector added-value at factor cost, FDDWOT is a measure of final domestic demand where each of its components is weighted by their private domestic T sector added-value content (see Appendix 3), OW is a measure of world trade, and CCOMPT is a measure of relative (to the rest of the world) cost competitiveness in the tradable sector. CCOMPT is defined as follows:

$$CCOMPT = ULCT/ULCEC11 \quad (2.5)$$

Where ULCT are nominal labour costs in the tradable sector and ULCEC11 are nominal (in pesetas) unit labour costs in the European Community countries except Spain, weighted by their share of total GDP.

Output in the non-tradable sector (ON) is assumed to be demand driven, the driving variable being final demand where its components are weighted by their private domestic N sector added-value content (FDWON see Appendix 3):

$$ON = f(FDWON) \quad (2.6)$$

Output and employment in the agricultural and public sectors will be estimated differently (see section 3.1).

2.3.2. Wage determination and wage bargaining

Wages result out of a process of wage bargaining between employers and trade unions. Of the very many elements that are relevant in this process (Layard, Nickel and Jackman, 1991; De Lamo y Dolado 1993) we will only consider consumption prices, productivity of labour, the unemployment rate and the tax wedge.

In the bargaining process, unions will, above all, try to translate price and productivity increases into nominal wages and, as long as they realize them fully, do the same with all kind of taxes that diminish their disposable income and/or its purchasing power. In doing so they will be restrained by the state of the labour market reflected in the current unemployment rate or its rate of change. Clearly, their power in the negotiation will be endangered by an excessive unemployment level. This is the so-called "Phillips curve" effect.

The proposed equation for the determination of wages, consistent with the above description of the bargaining process will thus be:

$$W = f(PC, PROD, UR, WEDGE) \quad (2.7)$$

where PC is the private consumption deflator, PROD is the productivity of labour obtained as real output over employment in the corresponding sector, UR is the percentage unemployment ratio and WEDGE is the ratio of $(1 + \text{the indirect implicit tax rate})$ over $(1 - \text{the direct implicit tax rate})$ (inclusive of social contributions).

Again, only in the private non-agricultural (i.e., T and N) sector wages will be modelled in this way. In the government and in the agricultural sectors, wages will simply be assumed as following wage setting patterns in the T sector.

2.3.3. Price determination

All the prices (deflators) for which equations are estimated in HERMIN-S4 are formed upon the evolution of either the GDP_{FC} deflator (PGDPFC) or the consumption deflator (PC). According, however, to the deflator considered, other variables have been taken into account. In general, prices will evolve driven by a combination of two factors: costs, notably labour costs and so mark-up pricing, and international prices. Exposure to competition at home and abroad will determine the weights in the above mentioned combination. Costs at home will be proxied by the deflator of GDP_{FC} and international prices will be represented by the imports deflator (PMP).

HERMIN-S4 contains equations for the following deflators:

$$PC = f(PGDPFC, PMP, \text{indirect taxes}); \text{ consumption deflator} \quad (2.8)$$

$$PG = f(PGDPFC); \text{ public consumption deflator} \quad (2.9)$$

$$PIH = f(PGDPFC, PMP); \text{ residential investment deflator} \quad (2.10)$$

$$PIG = f(PGDPFC, PMP); \text{ public investment deflator} \quad (2.11)$$

$$PIP = f(PGDPFC, PMP); \text{ private investment deflator} \quad (2.12)$$

$$PXT = f(PGDPFC, PMP); \text{ T sector exports deflator} \quad (2.13)$$

$$PXNTUR = f(PC); \text{ Non-turistic services exports deflator} \quad (2.14)$$

$$PXTUR = f(PC); \text{ Turistic exports deflator} \quad (2.15)$$

$$PGSUB = f(POP); \text{ deflator of Government subsidies} \quad (2.16)$$

$$PGTE = f(PC); \text{ deflator of Government indirect tax revenue} \quad (2.17)$$

2.3.4. Labour force participation

The extent to which the working age population (N1564, or total population of age between 15 and 64 years old) opts for participating into the labour force (LF) depends, leaving apart demographic factors captured here by a time trend, on the situation of the labour market given by the unemployment rate. In a rather simplistic way, thus, we will represent the labour supply by the following set of equations:

$$LFPRF = f(UR, \text{time}) \quad (2.18)$$

$$LFPRM = f(UR, \text{time}) \quad (2.19)$$

$$LFPR = LFPRM + LFPRF \quad (2.20)$$

$$LF = LFPR * N1564 \quad (2.21)$$

$$UR = 100*((LF-L)/LF) \quad (2.22)$$

where LFPRF, LFPRM and LFPR are female, male and total labour force participation rates respectively, UR the unemployment ratio, time a time trend, and L employment. The effect of UR on the participation rates, the encouragement effect, should have a negative sign (as established by several authors -see e.g., De Hevia and Novales, 1992), that is, the greater UR, the lower LFPRF or LFPRM. No sectoral breakdown is adopted for this part of the model.

2.3.5. Private consumption

Consumption by households is the largest single item in aggregated demand. A liquidity constrained consumption function is used, linking private consumption to real personal disposable income and real financial wealth.

The consumption function is thus:

$$\text{CONS} = f(\text{YRPERD}, \text{RGNDD}) \quad (2.23)$$

where YRPERD is real personal disposable income (see Appendix 1 for a precise definition of how it is derived) and RGNDD is the outstanding debt of the government held by domestic residents, in real terms (as a proxy for financial wealth).

2.3.6. Total investment

The way factors demand were estimated saves us the separate specification of a private non residential investment equation. Total (gross) fixed investment, I , results out of the following identity:

$$I = IP + IH + IG \quad (2.24)$$

$$IP = IT + IN + IA \quad (2.25)$$

where IP is gross fixed private non residential investment; IT , IN and IA is the split of IP between the tradable, non-tradable and the agricultural sectors; IH is the gross fixed private residential investment; and IG is gross fixed public investment.

Residential investment, IH , will be a function of personal disposable income, $YRPERD$, both expressed in *per capita* terms:

$$IH = f(YRPERD, N1564) \quad (2.26)$$

Public investment, IG , is an exogenous variable.

2.3.7. Imports, exports and the balance of trade

In order to assure the closing of the model it was decided that imports should not be modelled behaviourally but rather determined residually once output and exports had been estimated (see Appendix 1 for details). Exports in the private sector, XP , are:

$$XP = XT + XN + XA$$

that is, exports in the T sector, XT , exports in the N sector, XN , and agricultural exports, XA .

Agricultural exports (XA) are estimated as a ratio to agricultural output against a constant and a time trend.

It is well known (see, e.g., Fernández and Sebastián, 1991) that industrial exports in Spain increase when domestic producers find difficulties to sell their products at home.

Manufacturing sector exports (XT) are thus estimated as follows:

$$XT = f(OW, GNPDOT, CCOMPT, DUMCEE)$$

that is, XT is a function of world output, the rate of growth of gross national product (proxing the economic cycle), cost competitiveness, and a dummy variable to take account of the joining of Spain to the European Community in 1986 since this fact changed the trade regime of the Spanish economy.

Exports of the N sector have been split into tourism exports (XTUR) and non-tourism ones (XNTUR). The former are assumed dependent of world output and (cost) competitiveness, and the latter only of world output. Indeed, touristic exports are known to be highly dependent on the western economies cycle.

The high income elasticity of Spanish imports is also well documented (see, e.g., Sebastián, 1991). This fact is properly captured by the way imports are residually determined in HERMIN-S4.

2.4. The HERMIN-S4 data

The HERMIN-S4 model has 225 variables of which 46 are exogenous, 39 behavioral and the other 140 derived through identities. This means that data series for a large number of variables, ranging between 1964 and 1990 had to be constructed. Of them, a large number were already available in the public domain MOISSES data base "DEMO" (M/DEMO here after) [Molinas, Sebastián and Zabalza (eds.) 1991], although the range was 1964-1988 which required extension of the series using the standard sources. Although a complete listing of the variables names and sources is

offered in Appendix 2, we refer here to those for which *ad hoc* procedures had to be used.

Linkage of series expressed in different base years.

The Spanish National Accounts (CNE) offer data series starting in 1964. These series have a break in 1985-1988 due to the change of the base year from 1980 to 1986. We have linked the different subperiods by multiplying the observations from 1988 on by x_{80}^{86}/x_{86}^{86} , where x_{yy}^{86} is the 1986 observation for the variable X computed in yy base year. This simple procedure harmonizes the level of both subseries while keeping the profile unchanged. All real variables are expressed at 1980 prices. While nominal variables can be either obtained directly from their respective sources or through their deflators.

As it is well known, however, the bias introduced by this procedure increases with time. The procedure has, nevertheless, been used to push the series from 1988 up to 1990 and the bias is small. As the Statistical Office issues more recent data, a linkage procedure will be devised in order to link backwards the 1986-base series down from 1985.

The above mentioned linkage procedure has been applied to all series listed in Appendix 2 whose sources are in M/DEMO and/or CNE (see Appendix 2 for a precise definition of the Sources).

The obtention of sectoral data has been proved particularly difficult and we had to adopt several *ad hoc* procedures. Given that we wanted to build-up also a

four sectors model, it was decided to gather data on capital formation, employment, compensation of employees, added value and exports at the R6 level (i.e., six branches) of the National Accounts system. The six branches are: agriculture, energy, manufacturing, building and construction, marketed services and non-marketed services. The last branch is identified with the Government sector.

From this sectoral breakdown we collapsed the data to the four sectors level described in Section 2.1 above. The *ad hoc* procedures used are described in what follows.

Added value

The Spanish Statistical Office has recently published data for added value at branch level in the base year 1986 for the period 1964-1991 (see INE (1992)). From this publication we obtained the sectoral shares in gross added-value and applied then to the linked series in base 1980 obtained from M/DEMO and CNE sources:

$$AV \text{ Sector}_{1980}^{1980} = \left(\frac{AV \text{ Sector}_{1986}}{GAV_{1986}} \right)^{1986} \cdot GAV_{1980}^{1980}$$

$$AV \text{ Sector}_{1980}^{1986} = \left(\frac{AV \text{ Sector}_{1986}}{GAV_{1986}} \right)^{1986} \cdot GAV_{1980}^{1986}$$

for constant (i.e., 1980) and current (cc) prices magnitudes.

Employment and wage-earners

Employment in the Government sector (LG) has been taken from the Labour Force Survey (EPA) for the years 1977-1992. The years before were obtained projecting backwards the 1977 figure with the corresponding growth rates for this variable obtained from the M/DEMO data base.

Once LG was obtained we subtracted this from the total employment series taken from García Perea (1992) and EPA to derive private total employment (LP).

From LP we obtained the sectoral series multiplying it by the sectoral employment shares (in private employment) computed from M/DEMO and EPA.

These procedures were needed due to the frequency with which the employment series change their methodology in Spain. The only harmonized series for total employment and wage-earners are those offered by García Perea (1992).

The procedures followed in order to construct the sectoral wage-earners series were exactly the same than in the previous case.

Compensation of employees

These data are only available since 1970, when a first figure was published, for the different branches, by the Statistical Office. No data is available between 1970 and 1980, when yearly data publication was resumed. We proceeded to the linkage of the different base years as explained above, but the data for 1971 though

1979 was intrapolated, for each sector, after computation of the average annual growth rate. We further ensured that the sectoral figures added-up to the aggregate figure published by the Statistical Office.

Capital formation

The aggregate series for capital formation by the private sector and by the government were obtained, after linking the different base years, from M/DEMO and CNE. Then, to the private capital formation, we applied the sectoral shares computed from the corresponding sectoral series (volume and current prices) of the MIDE model data base. These series are only available since 1970.

Capital stock

We computed the capital stock for the A, T, N and G sectors using the perpetual inventory formula:

$$K = (1 - \delta) * K(-1) + I$$

where we arbitrarily chose a depreciation rate of 5% (i.e., $\delta = 0.05$) for the A and the G sectors, and a 10% depreciation rate (i.e., $\delta = 0.1$) for the T and N sectors.

The capital stock in 1969 was fixed as follows:

K (69) in T = 2,800 bn. Pta. (1980 prices)

K (69) in N = 4,200 bn. Pta. (1980 prices)

K (69) in A = 700 bn. Pta. (1980 prices)

$K(63) \text{ in } G = 1,227 \text{ bn. Pta. (1980 prices)}$

The figures for G and P sectors were obtained from M/DEMO data base. The T, N and A sectors totals were obtained using capital formation data in the sample period to infer the shares of the three sectors.

User cost of capital

The conventional formula to compute the cost of capital services:

$$PK = PI * (i - \pi + \delta)$$

(where, i is an interest rate, π is an inflation rate and δ is the depreciation rate), produced very volatile results due to the excessive variation of real interest rates. We averaged $(i - \pi + \delta)$ through the sample period so that, in fact, PK for each sector resulted in a constant proportion of the price of investment in the corresponding sector.

Final demand measures

These are FDDWOT and FDWON and result of a weighted sum of the Final Domestic Demand and Final Demand components, where the weights reflect respectively, the T and N sectors output contents of those components. See Appendix 3 for a detailed discussion of their construction.

Variables set to zero

The variables IGVOTH, IHG an IHGV have been set to zero due to insufficient disaggregation of the National Accounts data. Their true values are however recovered in other variables, so that the aggregate out of them are correct.

III. ESTIMATING HERMIN-S4

In this section we present the results obtained when the behavioural equations in HERMIN-S4 were estimated using annual time series. Each set of estimation results is preceded by a short description of the equation, with reference to the theoretical model described in Section II. A mathematical formulation of the equation is then presented, followed by estimation results from the econometric package TSP 4.2, which are largely self-explanatory, as well as by some brief remarks on the implications of the results.

In spite of the simultaneity of the system, the equations in HERMIN-S4 are estimated by ordinary least squares (OLS). In some cases, correction for first order serial-correlation is added. Instead of using ordinary Cochrane-Orchutt corrections, we use the Beach and McKinnon's (1978) maximum-likelihood estimation that assumes that the disturbance term follows a stationary first-order autoregressive process. The small sample properties of the estimators obtained from this method (that we describe as AR1 estimation for brevity) are preferable to those of the conventional procedures.

After the four-sector prototypical models have been completed for all countries involved in the present research project (Greece, Ireland, Portugal and Spain), it is intended to address the issues of the possible non-stationarity of the time series and the dynamic specification of the equations making use of the so-called "cointegration analysis" (see Dolado, et. al. 1990, for a survey) and its associated concept of error correction model, combining the latter flexibility in the dynamic specification with desirable long-run properties (see Hendry and Richard, 1983).

3.1. The Supply Side of HERMIN-S4

3.1.1. Tradable private sector behavioural equations

As mentioned in Section 2.2.1, T sector output is determined in an equation involving final demand weighted by T sector output content (FDDWOT), world output (OW) and cost competitiveness (CCOMPT). The equation was estimated by OLS using data for the period 1970-1990; where a time trend was included to account for variations in the weights used in composing FDDWOT from the 1987 input-output tables:

$\log(OT) = a_0 + a_1 \log(FDDWOT) + a_2 \log(OW) + a_3 \log(CCOMPT) + a_4 \text{TIME} + a_5 \log(OT(-1))$			
Variable	Estimated Coefficient	Standard Error	t-statistic
C	-0.231923	0.397142	-0.583981
$\log(FDDWOT)$	0.250150	0.049036	5.10136
$\log(OW)$	0.278061	0.047865	5.80929
$\log(CCOMPT)$	-0.216175	0.043311	-4.99128
TIME	-0.013854	0.002003	-6.91551
$\log(OT(-1))$	0.561483	0.042354	13.2570
Std. error of regression = 0.008106 $R^2 = 0.995201$			
Durbin's h = 0.796963 F-statistic (zero slopes) = 539.201			

From this estimated equation, the long-run elasticity of T sector output with respect to final domestic demand weighted by T sector output content, world output and expected cost competitiveness are 0.57, 0.64 and -0.50, respectively.

Concerning the estimation of the parameters of the CES production function in the T sector, although the static CES function is probably too simple to capture the structure and dynamics of factor demands, estimation yielded plausible

estimates. Our justification for this simplified CES approach is that we are mainly interested in the medium to long-run properties of the model, rather than in the short-run dynamics and tracking performance.

The estimation method is however rather complex (see Bradley and Fanning, 1984, Appendix 3.1). Recall that the marginal production function can be approximate a by:

$$Q = A\{\delta(\exp(\lambda_L t)LT)^{-\rho} + (1-\delta)(\exp(\lambda_K t)IT)^{-\rho}\}^{-(1/\rho)}$$

It can hence be deduced that cost-minimisation implies the factor proportions equation

$$\log\left(\frac{IT}{LT}\right) = \log\left(\frac{1-\delta}{\delta}\right) + \sigma \log(RFPT) + (1-\sigma)(\lambda_L - \lambda_K)t$$

where RFPT is the relative factor price in the T sector. Using AR1 over 1970-1990 yields the estimated cost-minimising factor proportions equation:

$\log(IT/LT) = a_0 + a_1 \log(RFPT) + a_2 \text{TIME}$			
Variable	Estimated Coefficient	Standard Error	t-statistic
C	-2.95296	1.18368	-2.49472
$\log(RFPT)$	0.774984	0.4659595	1.66320
TIME	0.023819	0.013912	1.71211
Std. error of regression = 0.078932		$R^2 = 0.827685$	
DW = 1.59391		F-statistic (zero slopes) = 42.8406	
Rho (autocorr. coef.) = 0.748041		t-statistic for rho = 5.28019	

Two of the production function parameters can be recovered from this equation: σ (a_1) and δ , together with the bias of technical change. We solve the factor proportions equation and production function for the long-run labour demand, yielding the equation:

$$\log(LT) - \log(A) + \frac{\sigma}{1-\sigma} \log(\delta) + \log(OT) + \frac{\sigma}{1-\sigma} \log \left[\left(\frac{\delta}{1-\delta} \right)^{\delta} RFP T^{-(1-\sigma)} e^{-(\sigma-1)(\lambda_L \lambda_L^T + 1)} \right] - \lambda_L^T$$

Taking everything except the first and last right-hand-side terms over to the left-hand-side gives us a regression in a constant and a time trend from which we can trivially estimate all the remaining parameters of the production function. The estimated parameters are as follows:

A (the scale parameter) = 0.6882

σ (the elasticity of substitution) = 0.7750

δ (the factor intensity parameter) = 0.9783

λ_L (the rate of technical progress embodied in labour) = 0.0371

λ_K (the rate of technical progress embodied in capital) = - 0.0687

Notice that we therefore estimate technical progress to be capital using and labour saving at a rate of 6.9 and 3.7 percent *per annum*, respectively.

In HERMIN-S4, the price of the T sector output (POT) is determined in an equation involving the world price (PWORLD) and unit labour costs (ULCT). Price homogeneity in PWORLD, not rejected by the data, is imposed for simplicity. Estimation by AR1 over 1969-1990 yields the following:

$\log(\text{POT/PWORLD}) = a_0 + a_1 \log(\text{ULCT/PWORLD})$			
Variable	Estimated Coefficient	Standard Error	t-statistic
C	0.527761	0.122508	4.30798
$\log(\text{ULCT/PWORLD})$	0.595135	0.121148	4.91245
Std. error of regression = 0.069125 $R^2 = 0.520087$			
DW = 1.36351 F-statistic (zero slopes) = 21.0940			
Rho (autocorr. coef.) = 0.907934 t-statistic for rho = 13.0198			

As mentioned in Section 2.3.2, nominal wages in the T sector (WT) are modelled as the outcome of bargaining between employers and trade unions, the relevant explanatory variables being private consumption deflator (PC), labour productivity in the T sector (PRODT), the rate of unemployment (UR), and the "wedge" driven by taxes between the wage denominated in the employer's (output) price and the take-home consumption wage enjoyed by workers (WEDGE). Estimation by AR1 using data for the period 1970-1990 yields:

$\log(\text{WT}) = a_0 + a_1 \log(\text{PC}) + a_2 \log(\text{PC}) * \text{DUMMON} + a_3 \log(\text{PRODT}) + a_4 \text{UR} + a_5 \text{DUMCEE}$			
Variable	Estimated Coefficient	Standard Error	t-statistic
C	-0.209846	0.043440	-4.83072
$\log(\text{PC})$	0.989634	0.045530	21.7358
$\log(\text{PC}) * \text{DUMMON}$	-0.066273	0.035867	-1.84773
$\log(\text{PRODT})$	0.699066	0.138986	5.02977
UR	-0.004952	0.002741	-1.80650
DUMCEE	-0.040250	0.21667	-1.85766
Std. error of regression = 0.018037 $R^2 = 0.999094$			
DW = 1.57651 F-statistic (zero slopes) = 3306.51			
Rho (autocorr. coef.) = 0.475912 t-statistic for rho = 2.21786			

Notice that, in contrast to the Irish case, we did not find a significant tax-wedge effect. Regarding this, it has been argued that the wedge variable could have very strong short-run effects, but its long-run effects could be not very well determined. Layard, Nickell and Jackman (1991) state that "the effect of the wedge on wage pressure probably does not last for ever" (p. 33). Anderson (1993) finds that

the tax wedge effects in Spain are only present in the short-run dynamics. Note that a dummy variable DUMMON taking the value 1 from 1978 and zero before was introduced to represent the move to a more centralized, and moderate, wage outcome with the the Moncloa Agreements signed by trade unions and employers. The estimated equation shows a change in the elasticity of wages in the T sector with respect to consumption prices after the Moncloa Agreements: before 1978 there was a strict over-indexation of wages to prices, and after that year an under-indexation. Notice also that productivity gains are not fully translated into wages, since the coefficient on $\log(\text{PRODT})$ is 0.70. The Phillips curve effect (-0.005) is roughly half the size to that reported for Spain in Drèze and Bean (1990, p. 23), and also much smaller than those obtained for Ireland (-0.026) (Bradley and Wright, 1994) and Portugal (-0.046) (Modesto and Neves, 1993). Finally, we find a significant and negative effect for a dummy variable proxing Spanish integration into the EC (DUMCEE). This may well have been driving by the removal of trade barriers after entry into the Community.

3.1.2. Non-tradable sector behavioural equations

Output in the non-tradable sector (ON) is determined by final demand weighted by N sector output content (FDWON), and a time trend, to take account of variations in the weights from their 1987 input-output values. OLS estimation using the 1971-1990 period yields the following:

$\log(\text{ON}) = a_0 + a_1 \log(\text{FDWON}) + a_2 \text{TIME}$			
Variable	Estimated Coefficient	Standard Error	t-statistic
C	2.66923	0.204848	13.0303
$\log(\text{FDWON})$	0.708337	0.024092	29.4019
TIME	0.006742	0.005785	11.6551
Std. error of regression = 0.005991 $R^2 = 0.998318$			
DW = 1.70821 F-statistic (zero slopes) = 5046.47			

Concerning the estimation of the parameters of the CES production function in the N sector, using data for the 1965-1990 period, AR1 estimation of the cost minimizing marginal factor proportions equations yields:

$\log(\text{IN}/\text{LN}) = a_0 + a_1 \log(\text{RFPN}) + a_2 \text{TIME}$			
Variable	Estimated Coefficient	Standard Error	t-statistic
C	-2.48847	0.195426	-12.7335
$\log(\text{RFPN})$	0.510530	0.189658	2.69184
TIME	-0.002480	0.001265	-1.96046
Std. error of regression = 0.077044 $R^2 = 0.882159$			
DW = 1.77694 F-statistic (zero slopes) = 86.0746			
Rho (autocorr. coef.) = 0.745267 t-statistic for rho = 5.65370			

The values obtain for the elasticity of substitution (σ) is 0.51, suggesting that substitution possibilities at smaller in this sector than in the tradables sector. Technical progress in this sector is estimated to be both capital and labour using ($\lambda_L = 0.028$ and $\lambda_K = 0.023$). The scale parametre (A) is estimated to be 1.17, and the factor intensity parameter (δ) is found to be 0.99.

Prices in the N sector are determined by a mark up on labour cost (ULCN). Using AR1 with data for the 1970-1990 period yields:

$\log(\text{PON}/\text{ULCN}) = a_0$			
Variable	Estimated Coefficient	Standard Error	t-statistic
C	0.916051	0.040142	22.8201
Std. error of regression = 0.027455		$R^2 = 0.859638$	
DW = 1.57822			
Rho (autocorr. coef.) = 0.887135		t-statistic for rho = 10.3193	

Wage determination in the non-tradable sector is identical to wage formation in the tradable sector. Nominal wages (WN) are determined by private consumption deflator (PC), labour productivity (PRODN), and the rate of unemployment (UR). The estimation results using OLS over the 1964-1990 period are as follows:

$\log(\text{WN}) = a_0 + a_1 \log(\text{PC}) + a_2 \log(\text{PC}) * \text{DUMMON} + a_3 \log(\text{PRODN}) + a_4 \text{UR}$			
Variable	Estimated Coefficient	Standard Error	t-statistic
C	-0.741919	0.091795	-8.08237
$\log(\text{PC})$	1.14279	0.043653	26.1791
$\log(\text{PC}) * \text{DUMMON}$	-0.219773	0.042322	-5.19290
$\log(\text{PRODN})$	1.69200	0.141088	11.9925
UR	-0.007254	0.003095	-2.34376
Std. error of regression = 0.035328		$R^2 = 0.999355$	
DW = 1.96061		F-statistic (zero slopes) = 8522.29	

Note again, that no significant tax-wedge effect was found, and that a dummy variable DUMMON was introduced to take into account the deceleration in wage inflation following the Moncloa Agreements in 1978. The estimated equation shows a change in the elasticity of wages in the N sector with respect to consumption prices after 1978: before that year there was over-indexation of wages to prices and, after that year, under-indexation. Notice also that productivity gains are more than fully translated into wages, since the coefficient on $\log(\text{PRODN})$ is 1.69. Finally, the

Phillips curve effect (-0.007) is greater than that estimated for the tradable-sector wages (-0.005).

3.1.3. Agricultural sector behavioural equations

HERMIN-S4 does not attempt to model the agricultural sector behaviourally. Nevertheless, in order to isolate agricultural activities from the rest of the private sector, we model agricultural output (OA), employment (LA) and the capital/output ratio (KA/OA) by simple time trends. The results obtained by OLS for the period 1970-1990 are as follows, where no attempt is made to correct by serial correlation except in the case of LA.

$\log(OA) = a_0 + a_1 \text{TIME}$			
Variable	Estimated Coefficient	Standard Error	t-statistic
C	6.57849	0.034730	189.418
TIME	0.014400	0.0019245	7.48224
Std. error of regression = 0.053403		$R^2 = 0.7333$	
DW = 1.52613		F-statistic (zero slopes) = 55.9838	

$\log(LA) = a_0 + a_1 \text{TIME}$			
Variable	Estimated Coefficient	Standard Error	t-statistic
C	8.56141	0.036673	233.450
TIME	-0.048716	0.197822E-02	-24.6261
Std. error of regression = 0.021921		$R^2 = 0.999$	
DW = 1.09		F-statistic (zero slopes) = 25823.5	
Rho (autocorr. coef.) = 0.7048		t-statistic for rho = 4.6919	

$\log(KA/OA) = a_0 + a_1 \text{TIME}$			
Variable	Estimated Coefficient	Standard Error	t-statistic
C	-0.758034	0.034989	-21.6650
TIME	-0.014449	0.001899	-7.60899
Std. error of regression = 0.048969 $R^2 = 0.762836$			
DW = 1.75917 F-statistic (zero slopes) = 57.8967			

3.1.4. Public sector behavioural equations

Real output in the public sector (OG) is driven in our model by public sector employment (LG). Estimation by AR1 using data for the period 1971-1990 yields:

$\log(OG) = a_0 + a_1 \log(LG)$			
Variable	Estimated Coefficient	Standard Error	t-statistic
C	2.24529	0.914530	2.45513
$\log(LG)$	0.709490	0.124999	5.67597
Std. error of regression = 0.35021 $R^2 = 0.991554$			
DW = 1.56426 F-statistic (zero slopes) = 1500.87			
Rho (autocorr. coef.) = 0.970600 t-statistic for rho = 25.5473			

In HERMIN-S4 the wage rate in the public sector (WG) is assumed to follow the wage rate in the tradable sector (WT). Estimation by AR1 for the period 1971-1990 yields:

$\log(WG) = a_0 + a_1 \log(WT)$			
Variable	Estimated Coefficient	Standard Error	t-statistic
C	0.144472	0.030005	4.81490
$\log(WT)$	0.950830	0.030620	31.0525
Std. error of regression = 0.047269 $R^2 = 0.982064$			
DW = 1.38088 F-statistic (zero slopes) = 980.425			
Rho (autocorr. coef.) = 0.663980 t-statistic for rho = 3.67897			

Finally, since public sector output is largely measured by labour cost inputs, the deflator (POG) is modelled as a function of WG. The results obtained by AR1 using data for the period 1965-1990 are as follows:

$\log(POG) = a_0 + a_1 \log(WG)$			
Variable	Estimated Coefficient	Standard Error	t-statistic
C	0.007179	0.014414	-0.498033
$\log(WG)$	0.977915	0.017451	56.0391
Std. error of regression = 0.037101 $R^2 = 0.994086$			
DW = 1.71064 F-statistic (zero slopes) = 3192.48			
Rho (autocorr. coef.) = 0.440693 t-statistic for rho = 2.03173			

3.1.5. Labour supply equations

As mentioned in Section 2.3.4, the female and male labour force participation rates (LFPRF and LFPRM) are a function of the rate of unemployment (UR) and demographic factors captured by a time trend. OLS and AR1 estimation for the period 1970-1990 yields the following for LFPRF and LFPRM, respectively:

$$\text{LFPRF} = a_0 + a_1 \text{UR} + a_2 \text{TIME}$$

Variable	Estimated Coefficient	Standard Error	t-statistic
C	1.1126961	0.003498	32.2746
UR	-0.002093	0.000275	-7.62077
TIME	0.005128	0.000355	14.4388

Std. error of regression = 0.003698 $R^2 = 0.961073$
 DW = 1.56821 F-statistic (zero slopes) = 222.202

$$\text{LFPRM} = a_0 + a_1 \text{UR}$$

Variable	Coefficient	Estimated Error	Standard t-statistic
C	0.440187	0.015962	27.5764
UR	-0.001494	0.000675	-2.21448

Std. error of regression = 0.005144 $R^2 = 0.970078$
 DW = 2.08693 F-statistic (zero slopes) = 498.165
 Rho (autocorr. coef.) = 0.956572 t-statistic for rho = 17.5288

Notice that the time trend does not appear in the male participation ratio equation due to colinearity with UR given also its negative sign. Indeed, female participation is steadily growing while the downwards trend in male participation has been overtaken by rapidly rising unemployment.

3.2. The Absorption Side of HERMIN-S4

3.2.1. Private consumption

As mentioned in Section 2.3.5, households consumption in constant prices (CONS) is a function of real personal disposable income (YRPERD) and real financial wealth, proxied by government debt held by residents deflated by PC (GNDD/PC). The long-run interest rate proved non-significant. Estimation by OLS for the period 1970-1990 yields:

$\log(\text{CONS}) = a_0 + a_1 \log(\text{YRPERD}) + a_2 \log(\text{GNDD/PC}) + a_3 \text{DUM7680}$			
Variable	Estimated Coefficient	Standard Error	t-statistic
C	0.203490	0.414424	0.491018
$\log(\text{YRPERD})$	0.941484	0.052685	17.8702
$\log(\text{GNDD/PC})$	0.031340	0.014724	2.12851
DUM7680	0.011997	0.006150	1.95084
Std. error of regression = 0.010617 $R^2 = 0.999849$			
DW = 1.74483 F-statistic (zero slopes) = 34704.4			
Rho (autocorr. coef.) = 0.769160 t-statistic for rho = 5.52984			

We obtain a marginal propensity to consume of 0.94, which implies a marginal propensity to save of 0.06. DUM7680 is a dummy variable taking the value 1 in 1976 and 1980 0 in the rest of the period. The wealth effect is of the expected sign and size.

3.2.2. Residential investment

In HERMIN-S4 residential investment *per capita* (IHP/N1564) is assumed to be dependent on real personal disposable income *per capita* (YRPERD/N1564). AR1 estimation for the period 1970-1990 yields the following:

$\log(\text{IHP/N1564}) = a_0 + a_1 \log(\text{YRPERD/N1564})$			
Variable	Estimated Coefficient	Standard Error	t-statistic
C	-2.45682	0.330485	-7.43398
$\log(\text{YRPERD/N1564})$	0.863444	0.337093	2.56144
Std. error of regression = 0.057284 $R^2 = 0.898936$			
DW = 1.58424 F-statistic (zero slopes) = 124.020			
Rho (autocorr. coef.) = 0.969767 t-statistic for rho = 26.5437			

3.2.3. Agricultural exports

The ratio of agricultural exports (XA) to agricultural output (OA) is modelled as a simple time trend. OLS estimation for the period 1965-1990 yields:

$\log(XA/OA) = a_0 + a_1 \text{TIME}$			
Variable	Estimated Coefficient	Standard Error	t-statistic
C	-2.61047	0.122148	-21.3713
TIME	0.070829	0.006096	11.6189
Std. error of regression = 0.112405		$R^2 = 0.8993$	
DW = 1.87920		F-statistic (zero slopes) = 134.998	

3.2.4. Exports of the tradable sector

Export of the tradable sector (XT) are assumed to be driven by world output (OW), relative cost competitiveness (CCOMPT), and the Spanish economic cycle represented by GNPDOT. The results obtained by OLS using data for the period 1970-1990 are as follows, where DUMCEE is a dummy variable taking the value 1 from 1986 on and 0 before that year:

$\log(XT) = a_0 + a_1 \log(OW) + a_2 \log(CCOMPT) + a_3 \text{GNPDOT} + a_4 \text{DUMCEE}$			
Variable	Estimated Coefficient	Standard Error	t-statistic
C	-8.71971	0.831932	-10.4813
$\log(OW)$	2.18404	0.116358	18.7700
$\log(CCOMPT)$	-0.716689	0.228317	-3.1301
GNPDOT	-0.029517	0.008128	-3.63156
DUMCEE	-0.421001	0.071797	-5.86380
Std. error of regression = 0.070577		$R^2 = 0.984580$	
DW = 1.50250		F-statistic (zero slopes) = 255.399	

3.2.5. Exports in the non tradable sector

Exports in this sector are divided into turistic services exports (XTUR) and non turistic exports (XNTUR). Both are dependent on world output (OW), and XTUR also on cost competitiveness (CCOMPEN).

Estimation by AR1 over 1970-1990 yields for XNTUR the following:

$\log(XNTUR) = a_0 + a_1 \log(OW)$			
	Estimated	Standard	
Variable	Coefficient	Error	t-statistic
C	-0.403892	1.61089	-0.250726
$\log(OW)$	0.906958	0.222193	4.08185
Std. error of regression = 0.091806		$R^2 = 0.960790$	
DW = 2.02228		F-statistic (zero slopes) = 437.575	
Rho (autocorr. coef.) = 0.853483		t-statistic for rho = 8.19720	

Estimation by OLS over 1970-1990 yields for XTUR:

$\log(XTUR) = a_0 + a_1 \log(OW) + a_2 \log(CCOMPEN)$			
	Estimated	Standard	
Variable	Coefficient	Error	t-statistic
C	-1.93381	0.731815	-2.64249
$\log(OW)$	1.05101	0.08832	11.8447
$\log(CCOMPEN)$	-1.15872	0.165307	-7.00953
Std. error of regression = 0.058884		$R^2 = 0.902658$	
DW = 1.52751		F-statistic (zero slopes) = 83.4578	

3.2.6. Imports

In HERMIN-S4, for simulation purposes, imports are obtained residually from the product expenditure equation, so they are not estimated. Given the effect of

GNPDOT on exports this procedure ensures that imports will increase with aggregated demand.

3.3. Income Distribution in HERMIN-S4

3.3.1. Absorption price determination equations

The majority of the absorption deflators (PABS) are modelled in the following way:

$$\log(\text{PABS}) = a_0 + a_1 \log(\text{PGDPFC}) + (1-a_1) \log(\text{PMP})$$

where PGDPFC is the deflator of total GDP at factor cost and PMP is the deflator of total imports. The only exceptions are the consumption deflator (PC), where we add a term to account for the influence of net indirect taxes (TINC) on consumer prices, the price of public consumption, the price of exports of turistic and non turistic services and the price of residential investment, where no significant effect was found for PMP. The results obtained by AR1 for the period 1970-1990 are as follows:

Price of private consumption:

$\log(\text{PC}/\text{PMP}) = a_0 + a_1 \log(\text{PGDPFC}/\text{PMP}) + a_2 \text{TINC}$			
Variable	Estimated Coefficient	Standard Error	t-statistic
C	-0.040047	0.010088	-3.96961
$\log(\text{PGDPFC}/\text{PMP})$	0.911377	0.010646	85.6081
TINC	0.801966	0.146720	5.46596
Std. error of regression = 0.004698		$R^2 = 0.997992$	
DW = 2.17703		F-statistic (zero slopes) = 4457.08	
Rho (autocorr. coef.) = 0.662359		t-statistic for rho = 3.99628	

From this estimated equation, a one percentage point rise in the net indirect tax rate (TINC) will be translated in an increase in the consumption deflator rate by 0.80 percentage points, *ceteris paribus*. This effect is smaller than those computed for Ireland (1.14) (Bradley and Wright, 1994) and Portugal (0.996) (Modesto and Neves, 1993).

ii) Price of public consumption:

$\log(\text{PG}/\text{PGDPFC}) = a_0$			
Variable	Estimated Coefficient	Standard Error	t-statistic
C	-0.066345	0.037878	-1.75153
Std. error of regression = 0.018575 $R^2 = 0.298225$ DW = 1.84783			

iii) Price of investment in housing:

$\log(\text{PIH}) = a_0 + a_1 \log(\text{PGDPFC}) + A_2 \log(\text{PMP}) + A_3 \text{DUM7579}$			
Variable	Estimated Coefficient	Standard Error	t-statistic
C	-0.141479	0.041669	-3.39530
$\log(\text{PGDPFC})$	0.986156	0.075182	13.1169
$\log(\text{PMP})$	0.150947	0.077958	1.93626
DUM7579	0.033860	0.019518	1.73485
Std. error of regression = 0.034126 $R^2 = 0.985475$			
DW = 1.37446 F-statistic (zero slopes) = 520.157			
Rho (autocorr. coef.) = 0.858524 t-statistic for rho = 9.63050			

where the dummy variable DUM7579 eliminates the anomalous data for the years 1975 and 1979.

v) Price of government investment:

$\log(\text{PIG}/\text{PMP}) = a_0 + a_1 \log(\text{PGDPFC}/\text{PMP})$			
Variable	Estimated Coefficient	Standard Error	t-statistic
C	-0.025714	0.012442	-2.06675
$\log(\text{PGDPFC}/\text{PMP})$	0.846676	0.032039	26.4268
Std. error of regression = 0.012829		$R^2 = 0.986754$	
DW = 1.95996		F-statistic (zero slopes) = 718.042	
Rho (autocorr. coef.) = 0.747927		t-statistic for rho = 3.42613	

v) Price of private investment:

$\log(\text{PIP}) = a_0 + a_1 \log(\text{PGDPFC}) + a_2 \log(\text{PMP})$			
Variable	Estimated Coefficient	Standard Error	t-statistic
C	0.034973	0.020610	1.69692
$\log(\text{PGDPFC})$	0.701771	0.036031	19.4767
$\log(\text{PMP})$	0.199739	0.037068	5.38840
Std. error of regression = 0.017284		$R^2 = 0.993466$	
DW = 1.87963		F-statistic (zero slopes) = 1791.34	
Rho (autocorr. coef.) = 0.854160		t-statistic for rho = 8.52036	

vi) Price of the tradable-sector exports:

$\log(\text{PXT}/\text{PMP}) = a_0 + a_1 \log(\text{PGDPFC}/\text{PMP})$			
Variable	Estimated Coefficient	Standard Error	t-statistic
C	0.167846	0.152186	1.10290
$\log(\text{PGDPFC}/\text{PMP})$	0.604886	0.0889837	6.73311
Std. error of regression = 0.042277		$R^2 = 0.773124$	
DW = 1.46982		F-statistic (zero slopes) = 47.7438	
Rho (autocorr. coef.) = 0.969868		t-statistic for rho = 24.7677	

vii) Price of the non-turistic services exports:

$\log(\text{PXNTUR}) = a_0 + a_1 \log(\text{PC})$			
Variable	Estimated Coefficient	Standard Error	t-statistic
C	-0.168051	0.117206	-1.43382
$\log(\text{PC})$	0.888203	0.108468	8.18861
Std. error of regression = 0.106252 $R^2 = 0.787764$			
DW = 1.67452 F-statistic (zero slopes) = 74.7513			
Rho (autocorr. coef.) = 0.835234 t-statistic for rho = 7.37681			

Note that here we take the price of private consumption to be the relevant national deflator of the exports of non-turistic services.

viii) Price of turistic exports

$\log(\text{PXTUR}) = a_0 + a_1 \log(\text{PC})$			
Variable	Estimated Coefficient	Standard Error	t-statistic
C	0.065948	0.036785	1.79277
$\log(\text{PC})$	1.04780	0.030088	34.8243
Std. error of regression = 0.025306 $R^2 = 0.983018$			
DW = 1.61464 F-statistic (zeroslopes) = 1085.09			
Rho (autocorr. coef.) = 0.884385 t-statistic for rho = 10.2019			

ix) Deflator of Government subsidies:

$\log(\text{PGSUB}) = a_0 + a_1 \log(\text{POP})$			
Variable	Estimated Coefficient	Standard Error	t-statistic
C	0.054346	0.062754	0.866007
$\log(\text{POP})$	1.11636	0.056653	19.7052
Std. error of regression = 0.104859 $R^2 = 0.942603$			
DW = 1.72034 F-statistic (zeroslopes) = 426.287			
Rho (autocorr. coef.) = 0.671388 t-statistic for rho = 4.64869			

x) Deflator of Government indirect tax revenue:

$\log(\text{PGTE}) = a_0 + a_1 \log(\text{PC}) + a_2 \log(\text{PGTE}(-1))$			
Variable	Estimated Coefficient	Standard Error	t-statistic
C	0.116149	0.013602	8.5392
$\log(\text{PC})$	0.295930	0.111269	2.65960
$\log(\text{PGTE}(-1))$	0.701844	0.104955	6.68707
Std. error of regression = 0.060178		$R^2 = 0.994757$	
Durbin's h = 0.833295		F-statistic (zero slopes) = 1612.76	

Both the deflator for government subsidies and that for taxes on production and imports are estimated in order to have proper real adjustments for the corresponding nominal magnitudes, being thus able to compute real GDD at market prices out of real GDD at factor costs.

3.3.2. Income Determination Behavioural Equations

There are only two estimated equations in the income determination part of the model: total depreciation and undistributed profits. The rest of the magnitudes are derived through identities (see Appendix 1).

i) Total depreciation:

Total depreciation (DEP) is determined in a "technical" relation as a function of the value of total private capital stock (PIP*KP). OLS estimation over the period 1965-1990 yields the following:

$\log(\text{DEP}) = a_0 + a_1 \log(\text{PIP*KP}) + a_2 \log(\text{DEP}(-1))$			
Variable	Estimated Coefficient	Standard Error	t-statistic
C	-0.768496	0.075860	-10.1305
$\log(\text{PIP*KP})$	0.389622	0.030180	12.9098
$\log(\text{DEP}(-1))$	0.606215	0.030223	20.0583
Std. error of regression = 0.017524		$R^2 = 0.999807$	
Durbin's h = -0.543162		F-statistic (zero slopes) = 59726.2	

ii) Undistributed profits:

Undistributed (i.e. retained) profits (YCU) are cyclically influenced by the growth rate of GNP (GNPDOT) and by total profits (YC) . Estimation by OLS for the period 1971-1990 yields the following:

$\log(\text{YCU}) = a_0 + a_1 \text{GNPDOT} + a_2 \log(\text{YC})$			
Variable	Estimated Coefficient	Standard Error	t-statistic
C	-2.41208	0.402197	-5.99727
GNPDOT	0.020343	0.010637	1.91239
$\log(\text{YC})$	1.11213	0.046441	23.9470
Std. error of regression = 0.82984		$R^2 = 0.972778$	
DW = 1.68055		F-statistic (zero slopes) = 321.923	
Rho (autocorr. coef.) = 0.623431		t-statistic for rho = 3.48755	

Notice that these results imply that the undistributed profits increase both as company income rises and during recoveries.

IV. POLICY ANALYSIS WITH HERMIN-S4

Empirical econometric models can be tested in two complementary ways. First, its ability to track the evolution of the relevant aggregate and sectoral variables over the sample period can be studied, by carrying out static and dynamic system simulations and then examining the differences between the simulated and historical values of the endogenous variables. Second, the partial derivatives or multiplier properties of the model can be examined by constructing a benchmark or baseline simulation and then re-run the model over the same period after shocking one or more exogenous variables. The perturbed values of the new simulation can then be compared to the baseline values providing an assesment of the consequences of the shock over time.

The first form of testing is less relevant here as the model was not constructed to be a short-term forecasting model. Nevertheless, the within-sample simulation errors were reasonably small. The second type of analysis requires a full understanding of the system-wide properties of the model, not all of which will be obvious from an isolated analysis of the component equations.

In this chapter we study the effects of variations in the settings of some policy instruments or other exogenous variables included in the specification of HERMIN-S4 by comparing their effects on a baseline projection for the years 1990-2010. Section 4.1 describes the assumptions concerning the baseline simulation. Section 4.2 investigates how the model behaves under changes in fiscal policy and other government exogenous variables. Section 4.3 illustrates how the model describes the effects on the Spanish economy of an increase in world economy activity. Finally, section 4.4 explores the effects of an increase in working age population.

4.1. A Baseline for 1990-2010

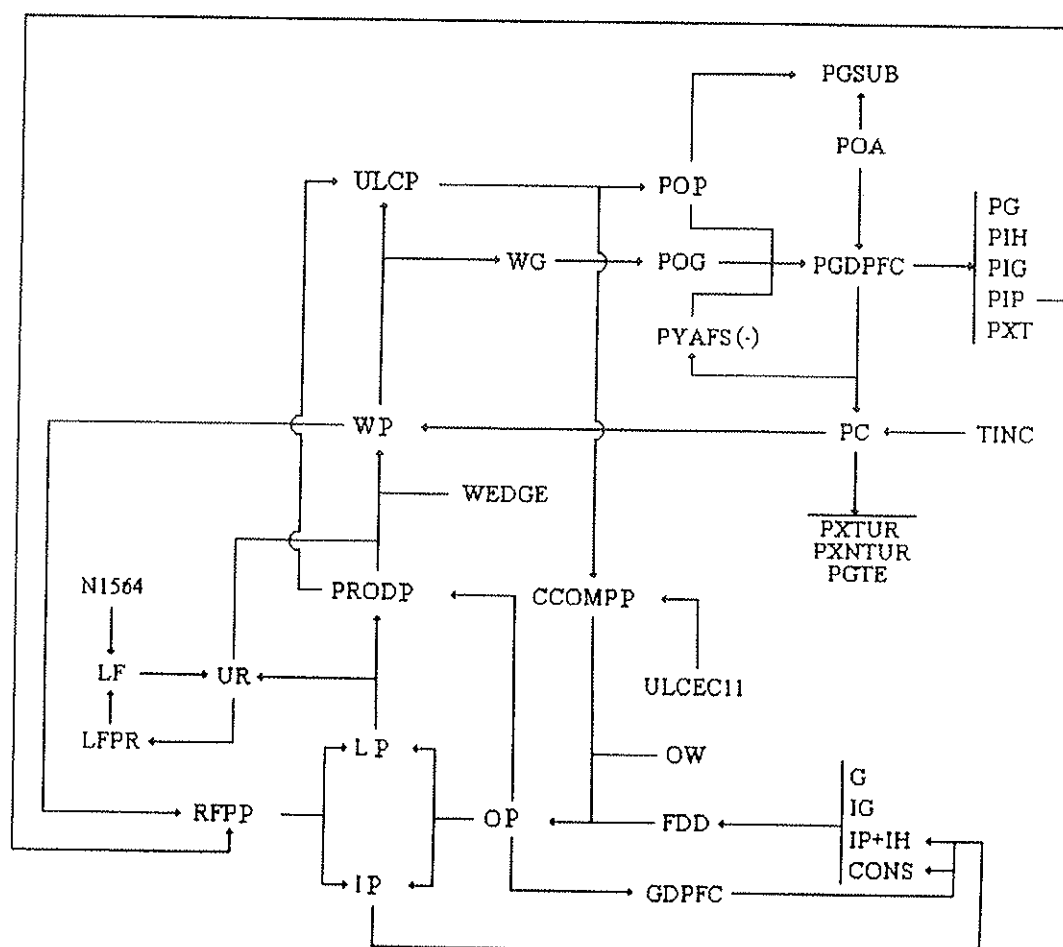
The baseline against which we carry out our experiments was obtained as follows. For the period 1978-1990, the core model was forced to track the historical data exactly by means of additive constant adjustments in the behavioural equations. For the period 1991-2010, we project the exogenous variables assuming a 'no-change' or 'neutral' policy stance, a non-inflationary international environment, and a 3% growth in world output. This is not intended to be a realistic economic projection, the construction of which would require much more work.

Before explaining the consequences of the various shocks, it will be useful to look at the way the model translates the shocks to the different endogenous variables. This will be done with the help of the flow diagram shown in Figure 4.0

Two basic blocks can be distinguished: a wage-price block (nominal) and a product/employment block (real) the link between the two are wages (here represented by WP-i.e., wages in the private sector).

As can be seen in the lower-right corner of the diagram, an increase in demand (e.g. through IG) will be translated to output and employment in the private sectors (OP, LP). This will increase wages through the Phillips curve effect (a decrease in UR) which will, in turn, fuel the wage-price round-about and increase the relative factor price thus leading to a lower employment/output ratio. This would not necessarily prevent prices and nominal wages from raising moderately as it turns to be the case within HERMIN-S4. The product/income/demand feed-back is also represented in the lower-right corner of the diagram.

THE STRUCTURE OF HERMINS⁴



Exogenous shocks through: POA, OW, G, IG, TINC, ULCEC11, WEDGE

4.2. Domestic Policy Shocks

To study the effects in the model of changes in fiscal policy, four simulations were carried out concerning public sector employment, public investment and tax rates.

i) A shock to public employment

Table 4.1 and Figure 4.1 present the model's response to a 5% sustained rise in the number of public sector employees above its baseline level starting in 1991. In this simulation, tax rates are exogeneous, extra public expenditure being financed by public borrowing at fixed debt interest rates.

As can be seen, the impact on consumption is positive and thus expands GDP. The initial impact on the labour market is to increase total employment and decrease the unemployment rate. The reduced unemployment rate acts through the Phillips curve to drive up wages and prices. The rise in wages leads to a strong downwards correction in employment. Since the subsequent rise in wages is lower than the rise in the user cost of capital, there is also a similar decrease in investment.

The strong effect on consumption also leads to increased tax revenue. Since the increase in public consumption is greater than the increase in tax revenue, public borrowing increases. On the other hand, there is a rise in imports following the increase in GDP which also induces a fall in exports. This however keeps relatively stable the current account.

ii) A shock to public investment

Table 4.2 and Figure 4.2 show the model's response to a sustained increase in public sector investment of 1 % of GDP above its baseline level. At this stage no specific supply side responses (such as externalities) are assumed.

The impact on domestic demand is positive, increasing GDP. There are an increase in private employment and a decrease in the unemployment rate, which leads to an increase in wages and prices that is translated into a fall in competitiveness. Exports go up and imports decrease, causing an increase in the trade balance/GNP ratio.

The increase in the level of activity affects positively private investment. The lower unemployment and higher wages increase personal disposable income, increasing consumption and residential investment, and this brings a further increase in domestic demand.

The increase in public borrowing as percentage of GNP following the increase in public sector investment is less than 1 %, since higher activity leads to higher Government revenues and lower Government transfers.

Notice the differentiated response of output employment and wages in the T and N sectors due to the fall in competitiveness after an expansionary demand shock.

iii) A shock to indirect taxation

Table 4.3 and Figure 4.3 present the model's response to a sustained rise in the implicit indirect tax rate of ten percent points above its baseline level.

An increase in the indirect tax rate forces the consumption price to go up, reducing real private consumption, forcing a decrease in both GDP and investment. The recession in turn leads to a decrease in imports and to a fall in employment and an increase in the unemployment rate. As the latter increases, the Phillips curve effect begins to push wages downwards, but this effect is not sufficient to boost employment. Government revenues decrease due to the diminishing activity. Finally, there is a rise in exports since the increase in GDP and imports is greater than the increase in final demand.

iv) A shock to direct taxation

Table 4.4 and Figure 4.4 show the model's response to a sustained rise in the implicit personal income tax rate of a ten percent points above its baseline level.

The decline in real disposable income negatively affects. Both consumption and investment are negatively affected by this shock. The contraction in aggregate demand leads to a decrease in GDP and a strong reduction in the rate of inflation the former reducing further investment. Despite the latter, the decrease in activity implies a fall in employment and a rise of the unemployment rate. Since imports decrease due to the reduction in aggregate demand and exports increase subsequently, the balance of payments also improves. Finally, the increase on the rate of personal income tax rate increases Government revenues, despite the reduction in

the level of activity and in consumption which in turn means a reduction of public deficit.

4.3. World Demand Shock

Table 4.5 and Figure 4.5 present the model's response to a sustained 1 % increase in the level of world economic activity above its baseline level.

As can be seen, GDP responds initially by about 0.12% declining latter to about 0.04 in the year 2010. Both T production and exports go up, having a positive effect on employment. The increase in employment and wage leads to an increase in personal disposable income, which in turn means an increase in consumption. Both the increased activity and higher wages induce a rise in investment. The rises in consumption and investment lead to an increase in imports. Finally, there is an increased tax revenue an, therefore, a reduction in public borrowing.

4.4. A Shock in Working Age Population

Table 4.6 and Figure 4.6 show the once and for all expansion of the labour force by 1 % that leads to a rise in the unemployment rate, which, through the Phillips curve effect, reduces wages. Employment increases, but this increase is not enough to offset the rise in the labour force.

In the first years, the increased number of unemployed reduced consumption and GDP, leading to a reduction in the rate of inflation. As employment raises, so does consumption and GDP.

Greater transfers to the unemployed leads to an increase in public borrowing and lower domestic prices induce a fall in imports. There is a reduction in exports since the fall in GDP and imports is greater than the fall in final demand.

TABLE 4.1. Effects of a sustained 5% increase in Public Employment .

	1991	1992	1993	1994	1996	1998	2000
Gross domestic product at market prices*	1,43	1,64	1,54	1,46	1,36	1,28	1,21
Consumption*	1,25	1,87	1,67	1,56	1,48	1,42	1,36
Investment*	0,74	1,01	0,92	0,86	0,79	0,75	0,70
Total exports*	-3,75	-2,00	-1,45	-1,46	-1,53	-1,55	-1,58
Total imports*	-0,08	2,05	2,20	2,07	1,88	1,70	1,50
Total employment*	1,95	2,16	2,11	2,08	2,04	2,00	1,97
(GDP deflator)**	0,05	0,06	0,06	0,07	0,07	0,07	0,08
(Consumption deflator)**	0,05	0,06	0,06	0,06	0,06	0,07	0,07
Wages in private sector**	0,07	0,08	0,08	0,08	0,09	0,09	0,10
Unemployment rate**	-1,09	-1,20	-1,17	-1,14	-1,12	-1,09	-1,07
Public Borrowing as per cent of GNP**	0,81	0,70	0,58	0,59	0,62	0,66	0,69
Trade Balance as per cent of GNP**	-0,41	-0,48	-0,43	-0,43	-0,45	-0,45	0,45
Debt as per cent of GNP**	0,04	0,62	1,20	1,79	2,95	4,07	5,18

* Percent deviation from baseline

** Deviation from baseline.

TABLE 4.2. Effects of a sustained 1% GDP equivalent decrease in Public Investment.

	1991	1992	1993	1994	1996	1998	2000
Gross domestic product at market prices*	0,51	0,61	0,62	0,61	0,60	0,60	0,59
Consumption*	0,45	0,62	0,58	0,57	0,56	0,55	0,53
Investment*	4,09	4,19	4,18	4,16	4,11	4,03	3,93
Total exports*	-1,18	-0,57	-0,41	-0,41	-0,42	-0,41	-0,40
Total imports*	2,21	2,75	2,71	2,60	2,40	2,20	2,00
Total employment*	0,39	0,48	0,49	0,50	0,51	0,50	0,49
(GDP deflator)**	0,39	0,48	0,49	0,50	0,51	0,50	0,49
(Consumption deflator)**	0,01	0,02	0,02	0,02	0,02	0,02	0,02
Wages in private sector**	0,02	0,02	0,02	0,02	0,02	0,02	0,03
Unemployment rate**	-0,22	-0,27	-0,27	-0,28	-0,28	-0,28	-0,27
Public Borrowing as per cent of GNP**	0,89	0,81	0,77	0,77	0,73	0,73	0,74
Trade Balance as per cent of GNP**	-0,60	-0,58	-0,55	-0,54	-0,52	-0,49	-0,47
Debt as per cent of GNP**	0,66	1,41	2,15	2,87	4,20	5,40	6,54

* Percent deviation from baseline

** Deviation from baseline.

TABLE 4.3. Effects of a sustained 10% increase in Indirect Tax Rate

	1991	1992	1993	1994	1996	1998	2000
Gross domestic product at market prices*	0,68	0,68	0,55	0,45	0,34	0,29	0,26
Consumption*	-0,68	-0,46	-0,64	-0,73	-0,81	-0,84	-0,86
Investment*	0,00	0,04	-0,08	-0,16	-0,25	-0,31	-0,34
Total exports*	-2,41	-1,36	-1,08	-1,11	-1,17	-1,20	-1,22
Total imports*	-5,60	-4,21	-3,98	-3,91	-3,78	-3,64	-3,53
Total employment*	-0,32	-0,28	-0,36	-0,42	-0,49	-0,53	-0,56
(GDP deflator)**	0,05	0,05	0,05	0,05	0,06	0,06	0,06
(Consumption deflator)**	0,06	0,07	0,07	0,07	0,07	0,07	0,07
Wages in private sector**	0,06	0,06	0,06	0,06	0,06	0,07	0,07
Unemployment rate*	0,18	0,16	0,20	0,23	0,27	0,29	0,31
Public Borrowing as per cent of GNP*	-0,79	-0,93	-1,02	-1,00	-0,92	-0,94	-0,96
Trade Balance as per cent of GNP*	0,93	0,85	0,85	0,81	0,75	0,71	0,68
Debt as per cent of GNP*	-1,37	-2,31	-3,25	-4,16	-5,82	-7,31	-8,76

* Percent deviation from baseline

** Deviation from baseline.

TABLE 4.4. Effects of a sustained 10% increase in Direct Tax Rate.

	1991	1992	1993	1994	1996	1998	2000
Gross domestic product at market prices*	-1,33	-1,57	-1,54	-1,52	1,49	-1,47	-1,45
Consumption*	-4,28	-4,71	-4,55	-4,48	4,42	-4,35	-4,32
Investment*	2,63	-1,88	-1,87	-1,86	1,86	-1,85	-1,84
Total exports*	3,19	1,46	1,00	1,00	1,02	1,04	1,05
Total imports*	-4,10	-5,63	-5,56	-5,30	4,89	-4,51	-4,19
Total employment*	-1,02	-1,23	-1,23	-1,23	1,23	-1,22	-1,21
(GDP deflator)**	-0,03	-0,04	-0,04	-0,04	0,04	-0,05	-0,05
(Consumption deflator)**	-0,03	-0,04	-0,04	-0,04	0,04	-0,04	-0,04
Wages in private sector**	-0,04	-0,05	-0,05	-0,05	0,06	-0,06	-0,06
Unemployment rate**	-0,57	-0,69	-0,68	-0,68	0,68	-0,67	-0,66
Public Borrowing as per cent of GNP**	-2,27	-2,09	-1,98	-1,98	1,90	-1,95	-2,02
Trade Balance as per cent of GNP**	1,28	1,26	1,17	1,14	1,11	1,07	1,05
Debt as per cent of GNP**	-1,69	-3,64	-5,55	-7,41	10,89	-14,08	-17,20

* Percent deviation from baseline

** Deviation from baseline.

TABLE 4.5. Effects of a sustained 1 % increase in World Output.

	1991	1992	1993	1994	1996	1998	2000
Gross domestic product at market prices*	0,22	0,35	0,44	0,50	0,58	0,63	0,66
Consumption*	0,19	0,34	0,41	0,47	0,53	0,56	0,58
Investment*	0,24	0,40	0,51	0,59	0,70	0,77	0,81
Total exports*	1,05	1,12	1,17	1,18	1,21	1,23	1,25
Total imports*	0,74	0,87	0,91	0,92	0,94	0,96	0,98
Total employment*	0,18	0,30	0,38	0,44	0,52	0,56	0,59
(GDP deflator)**	0,00	0,01	0,01	0,01	0,01	0,01	0,02
(Consumption deflator)**	0,00	0,01	0,01	0,01	0,01	0,01	0,01
Wages in private sector**	0,01	0,01	0,01	0,01	0,02	0,02	0,02
Unemployment rate**	-0,10	0,17	-0,21	-0,24	-0,29	-0,31	-0,32
Public Borrowing as per cent of GNP**	-0,02	-0,07	-0,12	-0,15	-0,18	-0,20	-0,21
Trade Balance as per cent of GNP**	-0,08	-0,09	-0,11	-0,12	-0,13	-0,14	-0,15
Debt as per cent of GNP**	-0,11	-0,24	-0,39	-0,56	-0,92	-1,27	-1,62

* Percent deviation from baseline

** Deviation from baseline.

TABLE 4.6. Effects of a sustained 1 % increase in Working Age Population.

	1991	1992	1993	1994	1996	1998	2000
Gross domestic product at market prices*	-0,04	0,04	0,10	0,14	0,18	0,20	0,22
Consumption*	-0,05	0,11	0,18	0,21	0,24	0,26	0,27
Investment*	-0,12	-0,03	0,02	0,06	0,10	0,12	0,14
Total exports*	0,78	0,52	0,54	0,56	0,57	0,059	0,59
Total imports*	0,54	0,48	0,51	0,52	0,51	0,51	0,51
Total employment*	0,05	0,10	0,14	0,17	0,20	0,21	0,23
(GDPM deflator)**	-0,03	-0,02	-0,02	-0,02	-0,02	-0,03	-0,03
(Consumption deflator)**	-0,02	-0,02	-0,02	-0,02	-0,02	-0,02	-0,02
Wages in private sector**	-0,03	-0,03	-0,03	-0,03	-0,03	-0,03	-0,04
Unemployment rate**	0,53	0,50	0,47	0,46	0,44	0,43	0,42
Public Borrowing as per cent of GNP**	0,03	0,15	0,14	0,12	0,10	0,09	0,09
Trade Balance as per cent of GNP**	-0,09	-0,12	-0,11	-0,10	-0,09	-0,08	-0,08
Debt as per cent of GNP**	0,27	0,39	0,50	0,60	0,76	0,89	1,01

* Percent deviation from baseline

** Deviation from baseline.

FIGURE 4.1. Effects of a sustained 5% increase in Public Employment

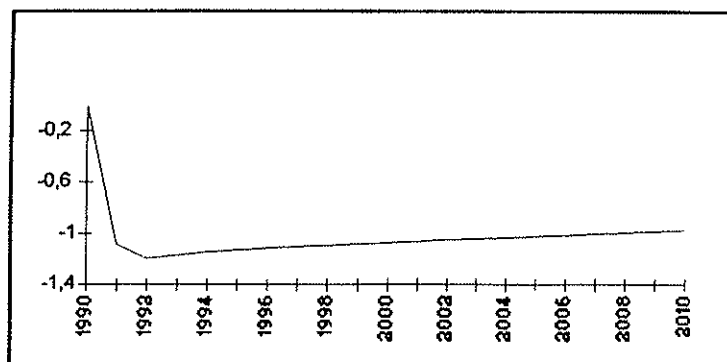
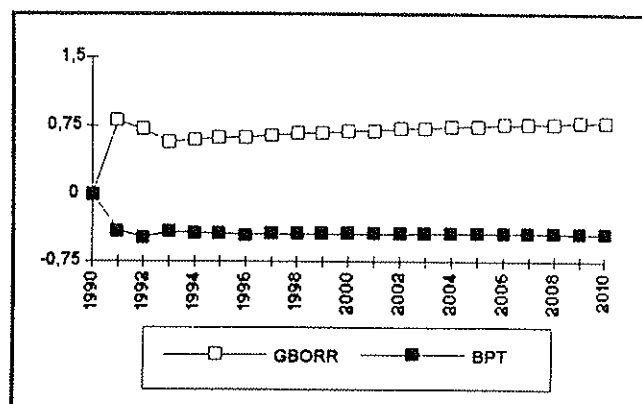
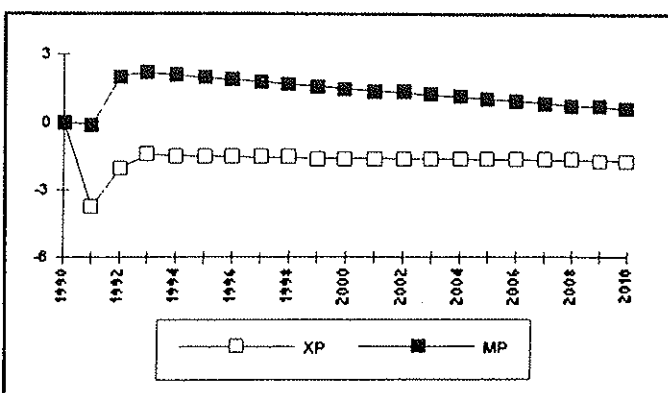
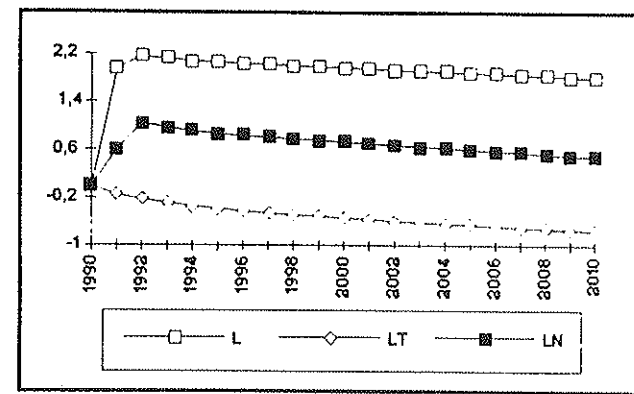
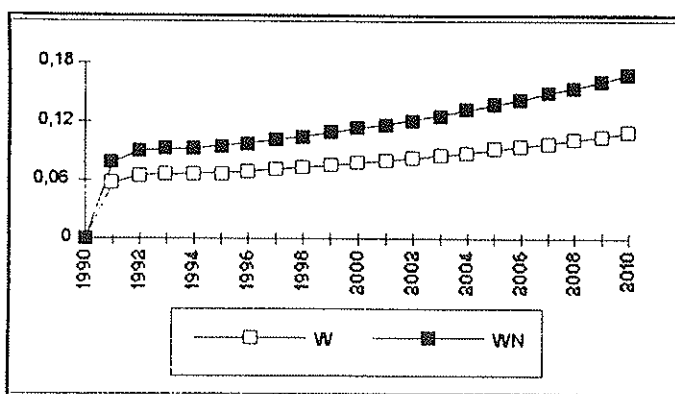
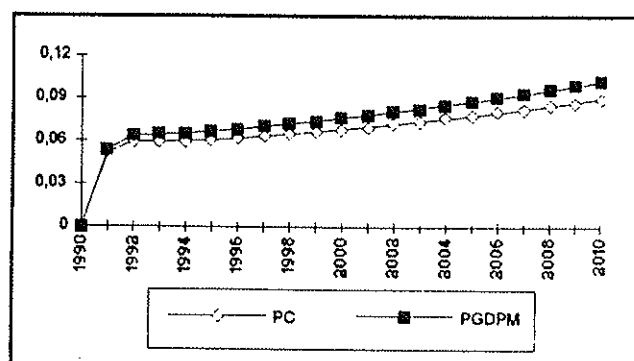
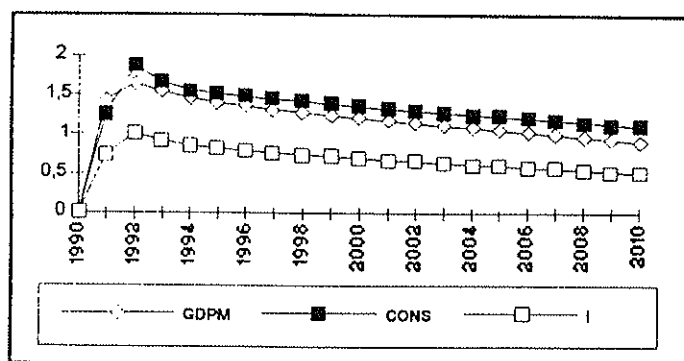


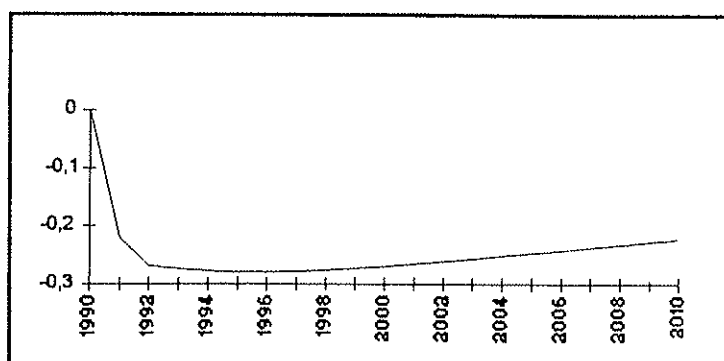
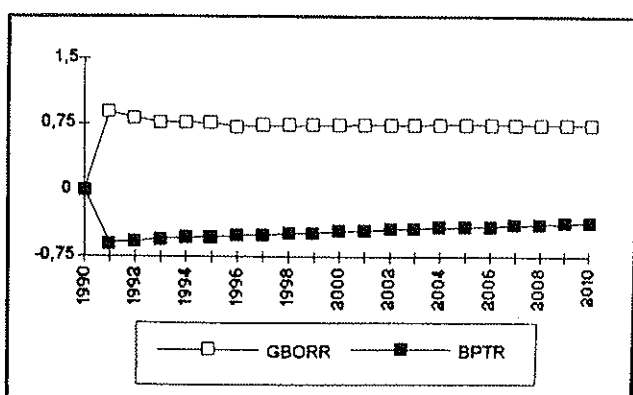
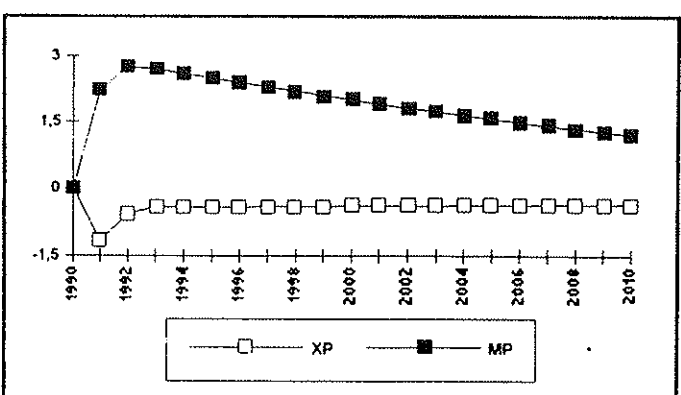
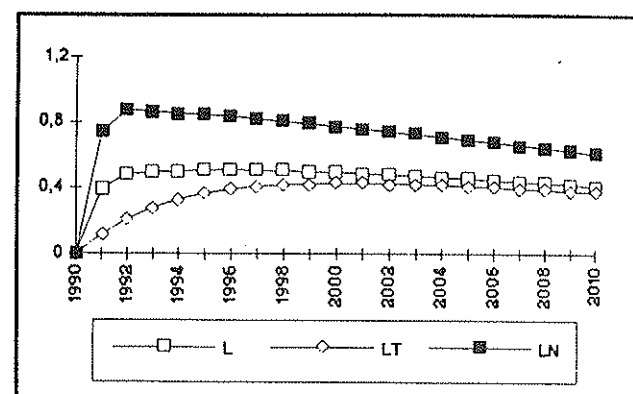
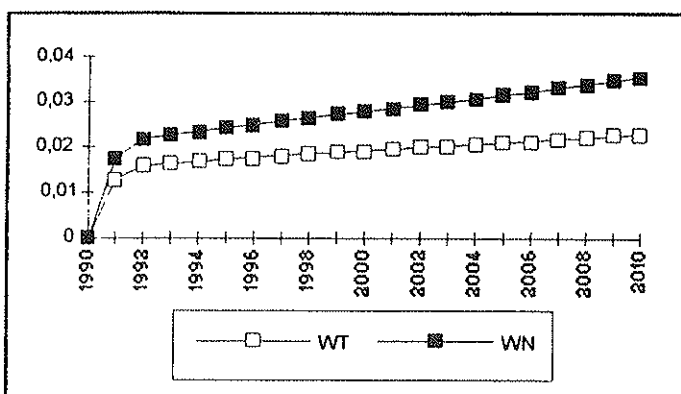
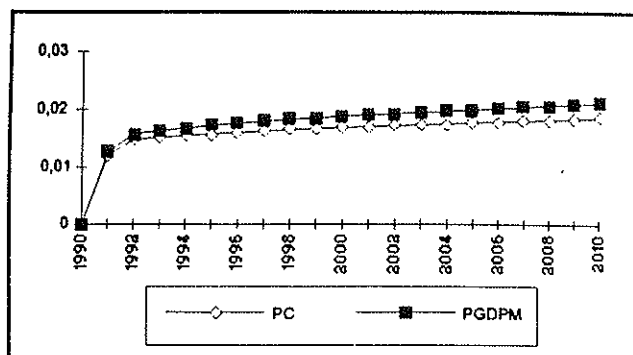
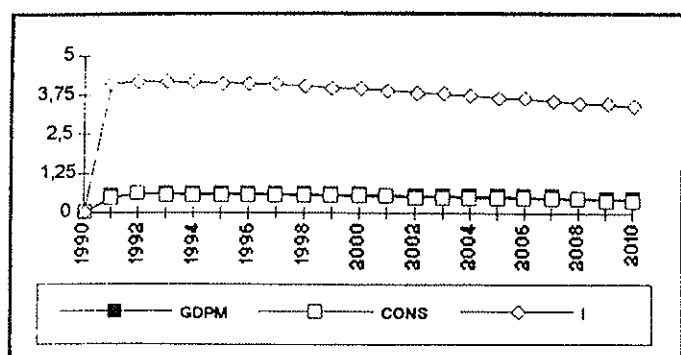
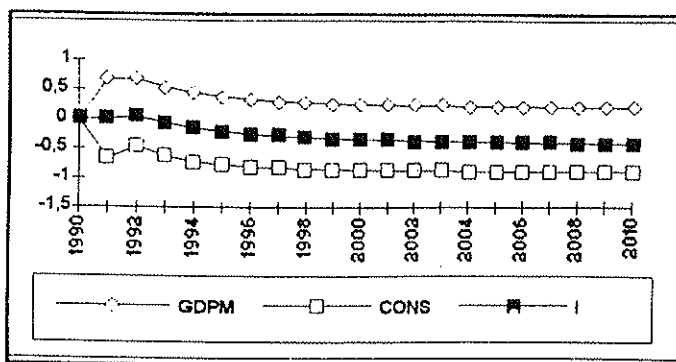
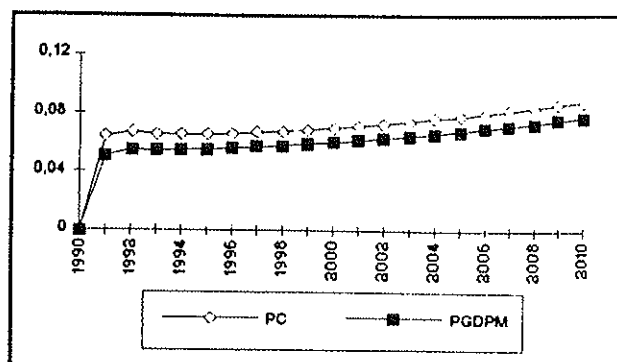
FIGURE 4.2. Effects of a sustained 1% increase in Public Investment.

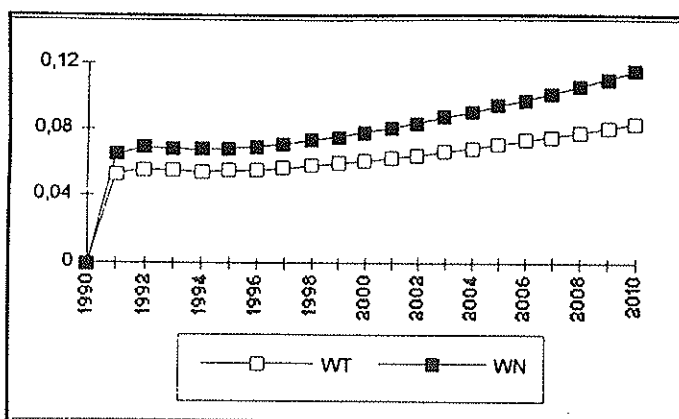
FIGURE 4.3. Effects of a sustained 10% increase in Indirect Tax Rate.



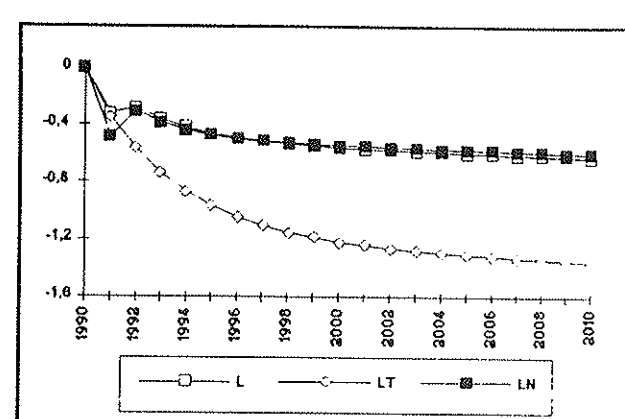
Percent deviation of GDP, CONS and I from baseline



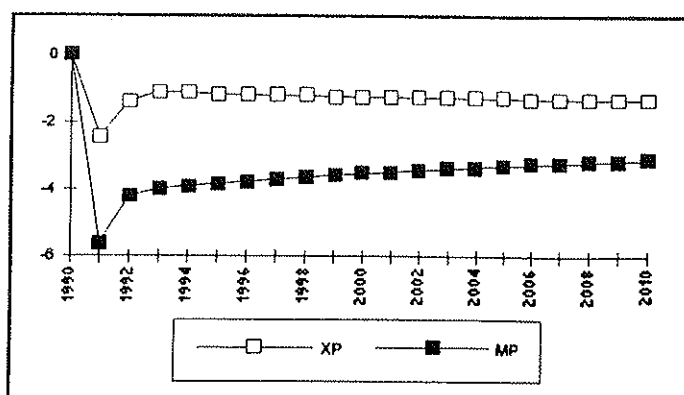
Deviation of Prices from baseline



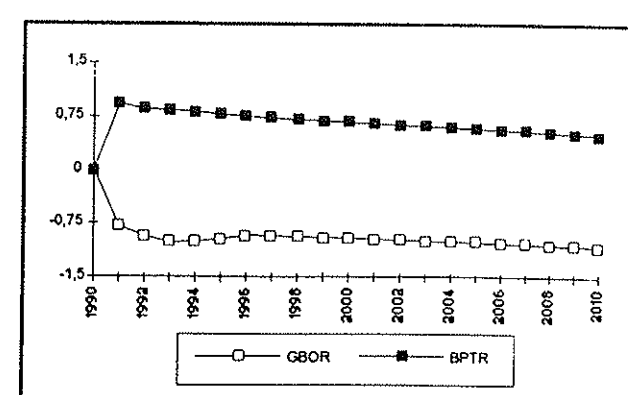
Deviation of Wages from baseline



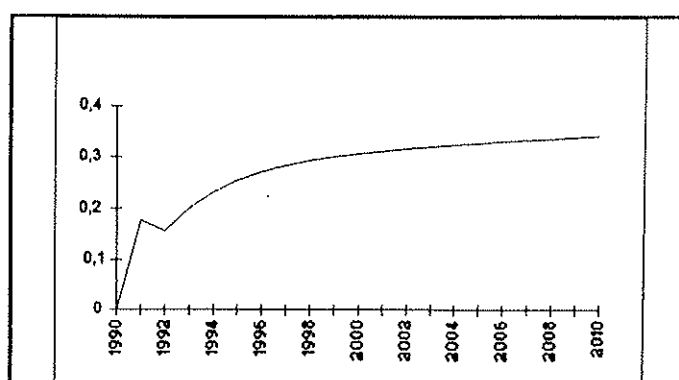
Percent deviation of L, LT and LN from baseline



Percent deviation of EXPORTS and IMPORTS from baseline

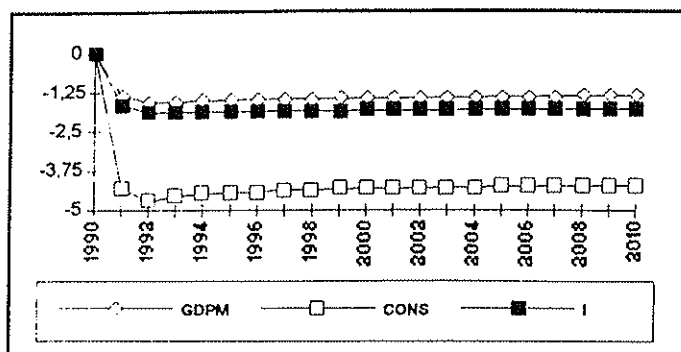


Deviation of GBOR and BPTR from baseline

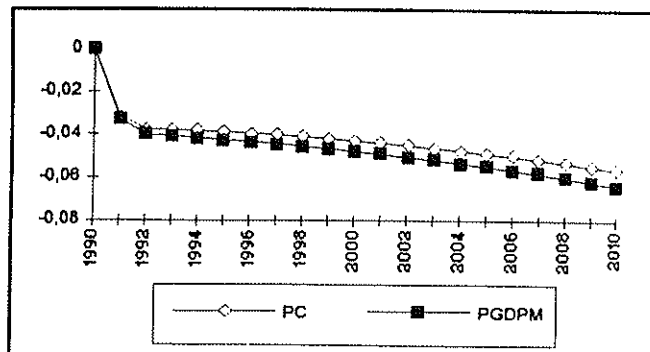


Deviation of Unemployment Rate from baseline

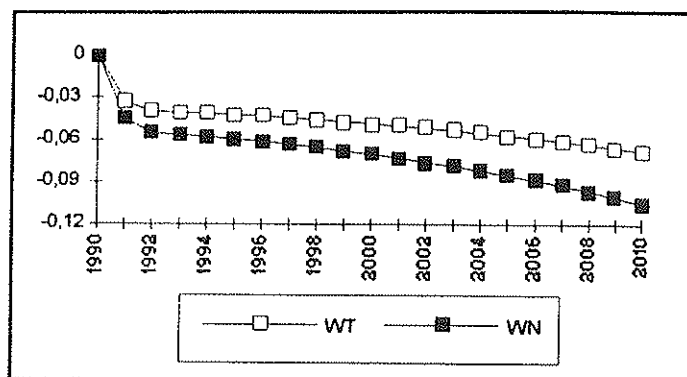
FIGURE 4.4. Effects of a sustained 10% increase in Direct Tax Rate.



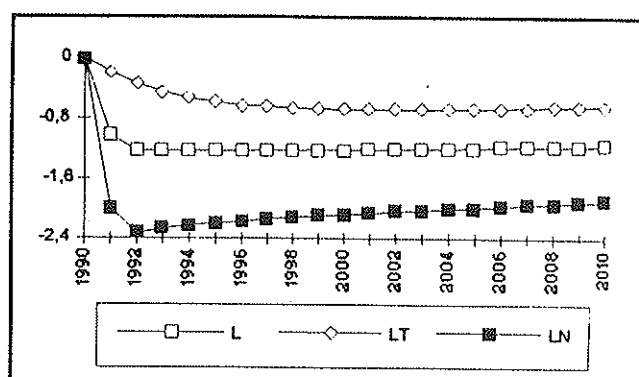
Percent deviation of GDP, CONS and I from baseline



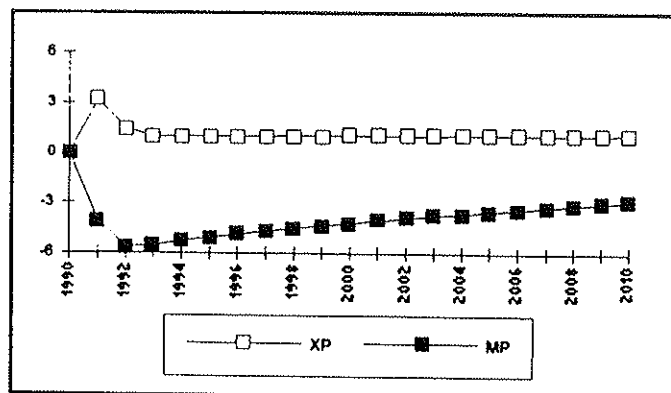
Deviation of Prices from baseline



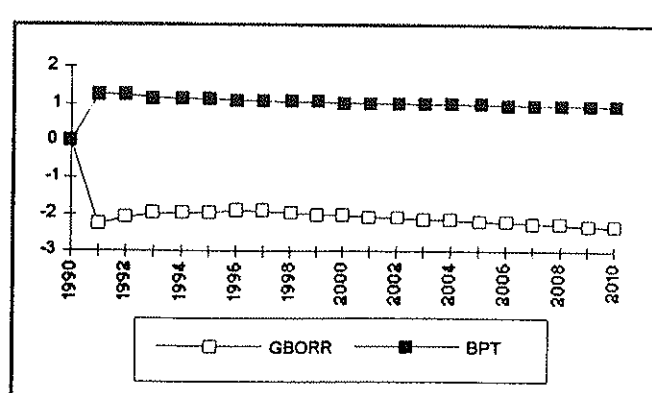
Deviation of Wages from baseline



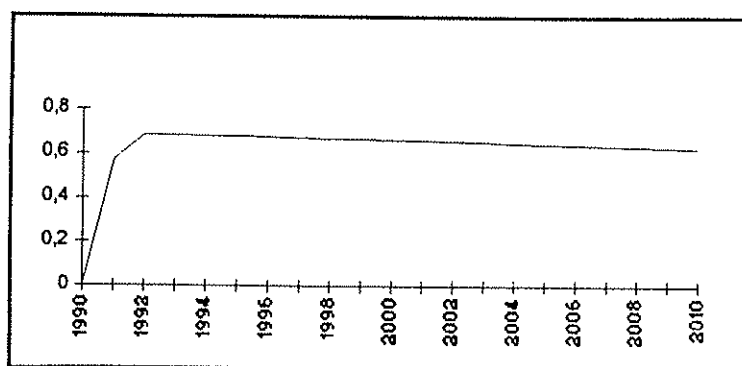
Percent deviation of L, LT and LN from baseline



Percent deviation of EXPORTS and IMPORTS from baseline

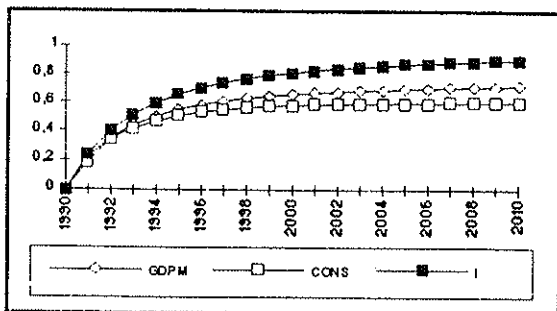


Deviation of GBORR and BPTR from baseline

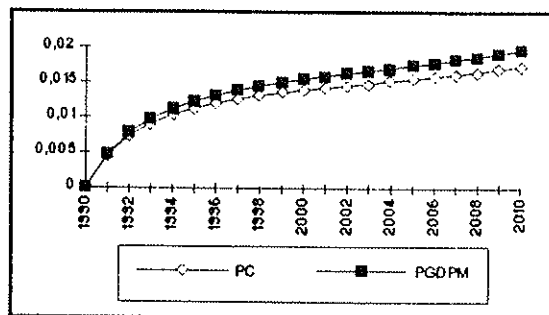


Deviation of Unemployment Rate from baseline

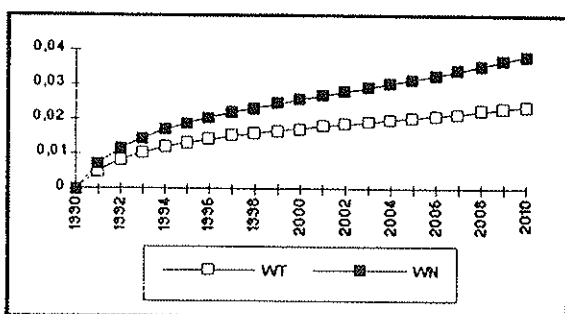
FIGURE 4.5. Effects of a sustained 1% increase in World Output.



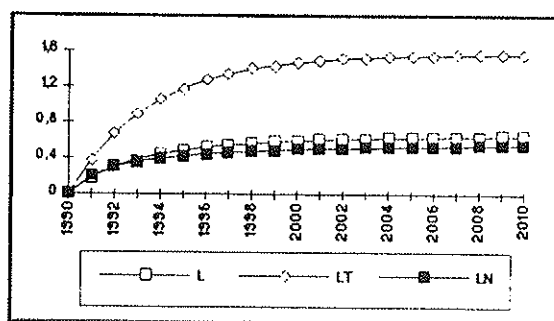
Percent deviation of GDP and OW from baseline



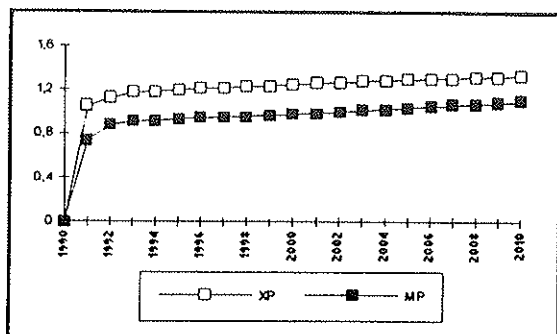
Percent deviation of Prices from baseline



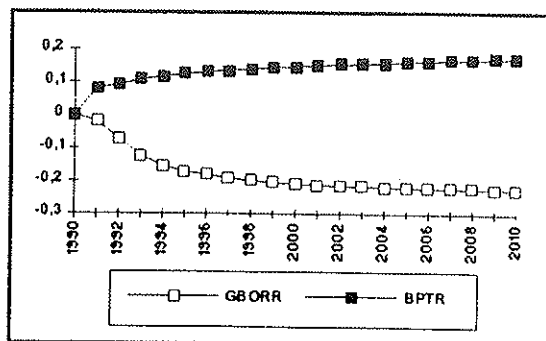
Percent deviation of Wages from baseline



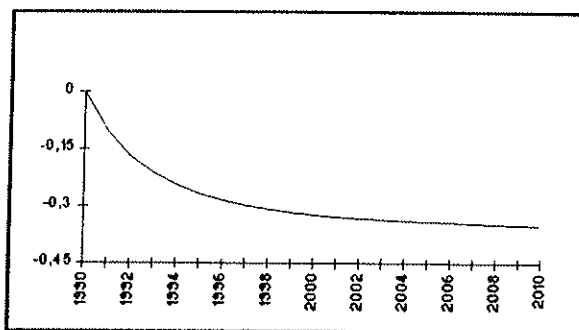
Percent deviation of L, LN and LT from baseline



Percent deviation of EXPORTS and IMPORTS from baseline

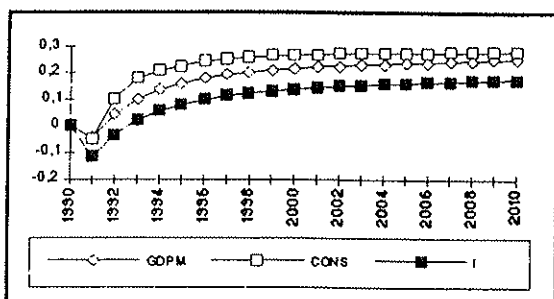


Percent deviation of GBORR and BPTR from baseline

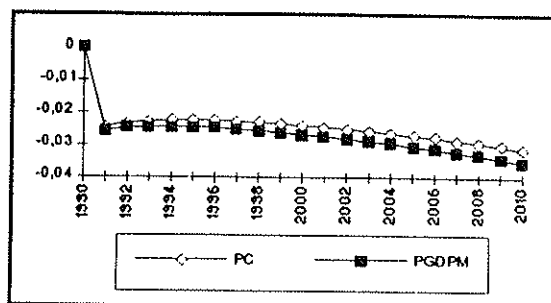


Deviation of Unemployment Rate from baseline

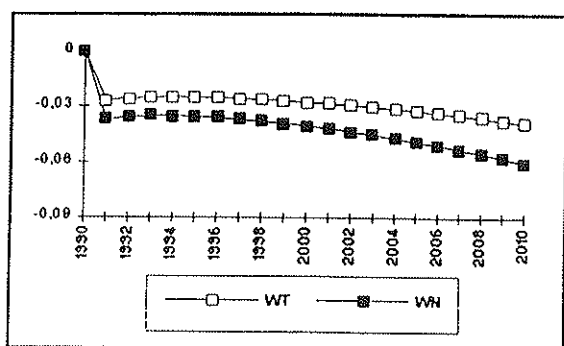
FIGURE 4.6. Effects of a sustained 1% increase in Working Age Population.



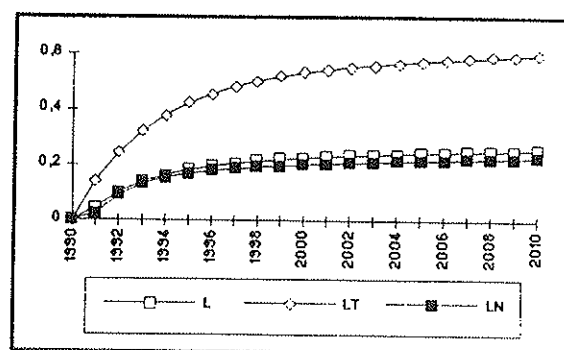
Percent deviation of GDP, CONS and I from baseline



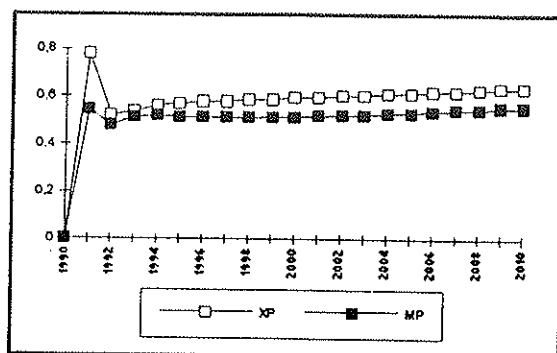
Deviation of Prices from baseline



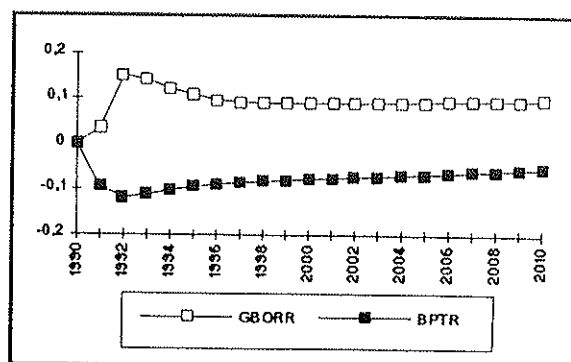
Deviation of Wages from baseline



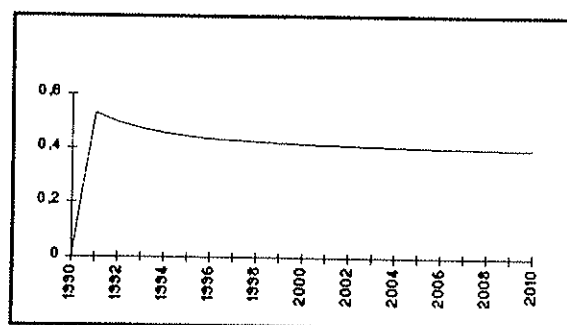
Percent deviation of L, LN and LT from baseline



Percent deviation of EXPORTS and IMPORTS from baseline



Deviation of GBORR and BPTR from baseline



Deviation of Unemployment Rate from baseline

V. CONCLUDING REMARKS

In its present format, HERMIN-S4 captures in a very simplified way the structure of the Spanish economy and allows the analysis of conventional policy shocks. The estimation of the behavioral equations of the model, given the standard specifications imposed, is quite acceptable. We always found the expected signs of the coefficients and multipliers, whose size is in line with those obtained for Portugal and Ireland, countries for which we have similar models. As the improvement of sectoral data continues, we hope to obtain better fits for the standard behavioral relationships of the supply side of the model.

The results of the simulations show that HERMIN-S4 has the desirable properties concerning the stability of the multipliers, their size and signs. This multipliers compare well with those derived from alternative models of the Spanish economy.

We believe that, based on the work done so far, HERMIN-S4 has a suitable formulation to attempt more ambitious tasks in the immediate future. First is to carefully develop the theoretical foundations of the presumed supply-side effects of CSF funds. This involves an effort in order to import into the simple framework of HERMIN type models the relevant parts of the recent literature on growth. Next is to add to HERMIN-S4 a north/south "module" to give the model the ability to supply differentiated results in regions eligible for CSF and regions not eligible. Finally, to further develop the very simple econometrics of the model, proceeding to block simultaneous estimation and differentiated short-run/long-run specifications for the relevant behavioral relationships of the model in order to apply it to medium term macroeconomic analysis of the Spanish economy.

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APPENDIX 1

THE SIMPC VERSION OF THE HERMIN-S4 FOUR-SECTOR MODEL OF SPAIN

(T) : Tradable sector - Industry (excluding energy)

(N) : Non-tradable sector - Private services, building and construction and energy

(A) : Agriculture sector - Agriculture, forestry & fishing

(G) : Public sector - Public administration, health and education

FEDEA: May 11, 1994

Exogenous variables in the model are as follows:

External variables	Interest rates	Public sector			Other
BPYPOTH : POA	RGDI :	GCNWR	GTRSWR	IHGV	DPARAT
GREVF : MP	RL :	GREVO	GOSG	LG	DS
OW : ULCEC11		GSUBR	GTYOR		DSV
PMP :	Demographic	GTER	GTYP		YAFSR
PWORLD :		IGINFV	GTYCR		YFN
PXA :	N1665 :	GNDFIX	IGVOTH		IMERAT
		GEKO	GREVDIV		LAEMRAT
		UBENEFR	SCPR		LNAEMRAT
		PTROTH	PTRSWR		STATDIS

Production and the supply side

Tradable sector equations

IDENT FDDWOTEQ

$$FDDWOT = 0.231 * CONS + 0.084 * G + 0.158 * (IBC + IH) + 0.391 * IME$$

FRML OTEQ

$$0(OT) = \log(OT) - (AOT1 + AOT2 * \log(FDDWOT) + AOT3 * \log(OW) + AOT4 * \log(CCOMPT) + AOT5 * T + AOT6 * \log(OT(-1)))$$

FRML LTEQ

$$0(LT) = (\log(LT/OT) - ((((-\log(AT))) + SIGT/(1-SIGT) * (\log(DELT))) - LAMLT * T) + SIGT/(1-SIGT) * (\log((DELT/(1-DELT)) ** (-SIGT * RFPT ** (SIGT-1) * (\exp((1-SIGT) * (LAMLT-LAMKT) * T)) + 1))))))$$

FRML ITEQ

$$0(IT) = \log(IT/OT) - ((((-\log(AT))) + SIGT/(1-SIGT) * (\log(1-DELT))) - LAMKT * T) + SIGT/(1-SIGT) * (\log((DELT/(1-DELT)) ** SIGT * RFPT ** (1-SIGT) * (\exp((SIGT-1) * (LAMLT-LAMKT) * T)) + 1))))$$

IDENT KTEQ

```

KT=IT+(1-0.1)*KT(-1)
;
FRML POTEQ
0(POT)=log(POT)-(APOT1+APOT2*log(ULCT)+(1-APOT2)*log(PWORLD))
;
IDENT PRODTEQ
PRODT = OT/LT
;
FRML WTEQ
0(WT)=log(WT)-(AWT1+(AWT2+AWT3*DUMMON)*LOG(PC)
+AWT4*LOG(PRODT)+AWT5*UR+AWT6*DUMCEE)
;
IDENT PKTEQ
PKT = PIT*(0.030646+0.10)
;
IDENT RFPTEQ
RFPT = WT/PKT
;
IDENT ERFPTQ
ERFPT=(RFPT+RFPT(-1))/2
;
IDENT ULCTEQ
ULCT = YWT/OT
;
IDENT LTEMQ
LTEM = LTEMRAT*LT
;
IDENT YWTEQ
YWT = LTEM * WT
;
IDENT CCOMPTEQ
CCOMPT = ULCT/ULCEC11
;
IDENT ECCOMPTEQ
ECCOMPT = (CCOMPT+CCOMPT(-1))/2
;
IDENT OTVEQ
OTV = POT*OT
;
IDENT LSHRTEQ
LSHRT = 100*YWT/OTV
;
?
? Non-tradable sector equations
?
IDENT FDWONEQ
FDWON=0.478*CONS+0.116*G+0.628*(IBC+IH)+0.206*IME+0.215*XP
;
IDENT FDDWONEQ
FDDWON=0.478*CONS+0.116*G+0.628*(IBC+IH)+0.206*IME
;

```

```

FRML ONEQ
0(ON)=log(ON)-(AON1+AON2*log(FDWON)+AON3*T)
;
?FRML ONEQ
?0(ON)=log(ON)-(AON1+AON2*log(FDDWON)+AON3*LOG(OW))
?;
FRML INEQ
0(IN)=LOG(IN/ON)-(((((-LOG(AN)))+SIGN/(1-SIGN)*(LOG(1-DELN)))-LAMKN*T)
+SIGN/(1-SIGN)*(LOG((DELN/(1-DELN))**SIGN*RFPN**(1-SIGN)*
(EXP((SIGN-1)*(LAMLN-LAMKN)*T))+1))))
;
FRML LNEQ
0(LN)=(LOG(LN/ON))-(((((-LOG(AN)))+SIGN/(1-SIGN)*(LOG(DELN)))-LAMLN*T)
+SIGN/(1-SIGN)*(LOG((DELN/(1-DELN))**(-SIGN)*RFPN**(SIGN-1)*
(EXP((1-SIGN)*(LAMLN-LAMKN)*T))+1))))
;
IDENT KNEQ
KN=IN+(1-0.1)*KN(-1)
;
FRML PONEQ
0(PON)=log(PON)-(APON1+1.00*log(ULCN))
;
IDENT PRODNEQ
PRODN = ON/LN
;
FRML WNEQ
0(WN)=log(WN)-(AWN1+(AWN2+AWN3*DUMMON)*LOG(PC)
+AWN4*LOG(PRODN)+AWN5*UR)
;
IDENT PKNEQ
PKN = PIN*(0.030646+0.10)
;
IDENT RFPNEQ
RFPN = WN/PKN
;
IDENT ERFPNEQ
ERFPN=(RFPN+RFPN(-1))/2
;
IDENT ULCNEQ
ULCN = YWN/ON
;
IDENT LNEQ
LNEM = LNEMRAT*LN
;
IDENT YWNEQ
YWN = LNEM * WN
;
IDENT CCOMPNEQ
CCOMP = ULCN/ULCEC11
;
IDENT ECCOMPNEQ

```

ECCOMP_N = (CCOMP_N + CCOMP_N(-1))/2

;

IDENT ONVEQ

ONV = PON*ON

;

IDENT LSHRNEQ

LSHRN = 100*YWN/ONV

;

?

? Agriculture sector

?

FRML OAEQ

0(OA) = LOG(OA) - (AOA1 + AOA2*T)

;

FRML LAEQ

0(LA) = LOG(LA) - (ALA1 + ALA2*T)

;

FRML KAEQ

0(KA) = LOG(KA/OA) - (AKA1 + AKA2*T)

;

IDENT IAEQ

IA = KA - (1 - 0.05)*KA(-1)

;

IDENT PKAEQ

PKA = PIA*(0.04 + 0.05)

;

IDENT OAVEQ

OAV = POA*OA

;

IDENT YWAEQ

YWA = LAEM*WA

;

FRML WAEQ

0(WA) = (WA/WA(-1) - 1) - (WT/WT(-1) - 1)

;

IDENT LAEMEQ

LAEM = LAEMRAT*LA

;

IDENT DEPAEQ

DEPA = DEPARAT*(PIA*KA)

;

?

? Public Sector

?

FRML OGEQ

0(OG) = log(OG) - (AOG1 + AOG2*log(LG))

;

IDENT OGVEQ

OGV = POG*OG

;

IDENT WPEQ

```

WP=(YWA + YWT + YWN)/(LAEM + LTEM + LNEM)
;
FRML WGEQ
O(WG)=log(WG)-(AWG1 + AWG2*log(WT))
;
FRML POGEQ
O(POG)=log(POG)-(APOG1 + APOG2*log(WG))
;
IDENT YWGEQ
YWG = LG * WG
;
?
? Labour supply equations:
?
FRML LFPRMEQ
LFPRM = ALFPRM1 + ALFPRM2*UR
;
FRML LFPRFEQ
LFPRF = ALFPRF1 + ALFPRF2*UR + ALFPRF3*T
;
IDENT LFPREQ
LFPR = LFPRM + LFPRF
;
IDENT LFEQ
LF = LFPR * N1564
;
IDENT LEQ
L = LT + LN + LA + LG
;
IDENT UEQ
U = LF - L
;
IDENT UREQ
UR = 100*(U/LF)
;
? -----
? Absorption
? -----
?
? Domestic absorption determination
?
FRML CONSEQ
O(CONS) = LOG(CONS) - (ACONS1 + ACONS2*LOG(YRPERD) + ACONS3*LOG(GNDD/PC)
                    + ACONS4*DUM7680)
;
IDENT CONSVEQ
CONSV = PC * CONS
;
IDENT SEQ
S = YPERD - CONSV
;

```

```

IDENT SAVRATEQ
SAVRAT = 1 - CONSV/YPERD
;
IDENT GVEQ
GV = YWG + GCNW
;
IDENT GEQ
G = GV/PG
;
FRML IHPEQ
0(IHP)=log(IHP/N1564)-(AIHP1 + AIHP2*log(YRPERD/N1564))
;
IDENT IHGEQ
IHG = IHGV/PIH
;
IDENT IHEQ
IH = IHG + IHP
;
IDENT IPQ
IP = IT + IN + IA
;
IDENT IEQ
I = IP + IG + IH
;
IDENT IVEQ
IV = PIP*IP + IGV + PIH*IH
;
IDENT PIEQ
PI = IV/I
;
IDENT IMEEQ
IME = IMERAT* (I - IH)
;
IDENT IBCEQ
IBC = I - (IME+IH)
;
?
? Foreign absorption and trade
?
FRML XNTUREQ
0(XNTUR)=log(XNTUR)-(AXNTUR1 + AXNTUR2*LOG(OW))
;
IDENT XNTURVEQ
XNTURV = PXNTUR*XNTUR
;
FRML XAEQ
0(XA)=log(XA/OA)-(AXA1 + AXA2*T)
;
IDENT XAVEQ
XAV = PXA * XA
;

```

```

FRML XTEQ
0(XT)=log(XT)-(AXT1+AXT2*LOG(OW)+AXT3*LOG(CCOMPT)+AXT4*GNPDOT+AXT5*DUMCE
E)
;
IDENT XTVEQ
XTV = PXT * XT
;
FRML XTUREQ
0(XTUR)=log(XTUR)-(AXTUR1+AXTUR2*LOG(OW)+AXTUR3*LOG(CCOMPNT))
;
IDENT XTURVEQ
XTURV = PXTUR * XTUR
;
IDENT XPEQ
XP = XT + XNTUR + XTUR + XA
;
IDENT XPVEQ
XPV = XTV + XNTURV + XTURV + XAV
;
?
? NOTE: MP is residually determined
?
IDENT MPEQ
MP = FD + DS - GDPM - STATDIS
;
IDENT MPVEQ
MPV = PMP*MP
;
IDENT GDPEEQ
GDPE = CONS + I + G + DS + XP - MP
;
IDENT GDPEVEQ
GDPEV = CONSV + IV + GV + DSV + XPV - MPV
;
IDENT PGDPEEQ
PGDPE = GDPEV/GDPE
;
IDENT BPTEQ
BPT = XPV - MPV
;
IDENT BPTREQ
BPTR = 100*(BPT/GNPV)
;
IDENT BPOTHEQ
BPOTH = BPYPOTH + GREVF - GTRNDF
;
IDENT BPEQ
BP = BPT + YFN + BPOTH
;
IDENT BPREQ
BPR = 100*(BP/GNPV)

```

```

;
IDENT FDDEQ
FDD = CONS + I + G
;
IDENT FDEQ
FD = CONS + I + G + XP
;
? -----
? Income distribution
? -----
?
? Absorption prices
?
FRML PCEQ
0(PC)=log(PC)-(APC1+APC2*log(PGDPFC)+(1-APC2)*log(PMP)+APC3*TINC)
;
IDENT INFPCEQ
INFPC=PC/PC(-1)-1
;
FRML PGEQ
0(PG)=log(PG)-(APG1+1.00*log(PGDPFC))
;
FRML PIHEQ
0(PIH)=log(PIH)-(APIH1+APIH2*log(PGDPFC)+APIH3*LOG(PMP))
;
FRML PIGEQ
0(PIG)=log(PIG)-(APIG1+APIG2*log(PGDPFC)+(1-APIG2)*log(PMP))
;
FRML PIPEQ
0(PIP)=log(PIP)-(APIP1+APIP2*log(PGDPFC)+APIP3*LOG(PMP))
;
IDENT PITEQ
PIT = PIP
;
IDENT PINEQ
PIN = PIP
;
IDENT PIAEQ
PIA = PIP
;
FRML PXTEQ
0(PXT)=log(PXT)-(APXT1+APXT2*log(PGDPFC)+(1-APXT2)*log(PMP))
;
FRML PXTUREQ
0(PXTUR)=log(PXTUR)-(APXTUR1+APXTUR2*log(PC))
;
FRML PXNTUREQ
0(PXNTUR)=log(PXNTUR)-(APXNTUR1+APXNTUR2*log(PC))
;
FRML PGTEEQ
0(PGTE)=LOG(PGTE)-(APGTE1+APGTE2*LOG(PC)+APGTE3*LOG(PGTE(-1)))

```

```

;
FRML PGSUBEQ
0(PGSUB)=LOG(PGSUB)-(APGSUB1+APGSUB2*LOG(POP))
;
?
? Public Sector - public expenditure
?
IDENT GEWEQ
GEW = YWG
;
IDENT GCNW
GCNW = GCNWR * GNPV
;
IDENT GSUBEQ
GSUB = GSUBR * GNPV
;
IDENT UBENEFEQ
UBENEF = UBENEFR * U
;
IDENT GTRUEQ
GTRU = GTRUR * UBENEF
;
FRML GTRUREQ
0(GTRUR)=(GTRUR/GTRUR(-1)-1)-(1.0*(WT/WT(-1)-1))
;
IDENT GTRSWEQ
GTRSW = GTRSWR * GNPV
;
IDENT PTRSWEQ
PTRSW = PTRSWR * (YWT + YWN + YWA)
;
IDENT GTRNDIEQ
GTRNDI = (RGDI) * (GND + GND(-1))/2
;
IDENT GTRNDDEQ
GTRNDD = (RGDI) * (GNDD + GNDD(-1))/2
;
IDENT GTRNDFEQ
GTRNDF = (RGDI) * (GNDF + GNDF(-1))/2
;
IDENT GTREQ
GTR = GTRU + GTRSW + GTRNDD
;
IDENT GEEQ
GE = GV + GSUB + GTR
;
IDENT IGINFVEQ
IGINFV=IGINF*PIG
;
IDENT IGVEQ
IGV=IGINFV+IGVOTH

```

```
;
IDENT GEKEQ
GEK = IHGV + IGV + GEKO
;
IDENT IGEQ
IG = IGV/PIG
;
IDENT KGEQ
KG = IG + (1-0.05)*KG(-1)
;
?
? Public Sector - government revenue
?
IDENT GTEEQ
GTE = GTER * GNPV
;
IDENT TINCEQ
TINC = GTER - GSUBR
;
IDENT GTYPEQ
GTYP = GTYPR * YPERT
;
IDENT SCPEQ
SCP = SCPR * (YWT + YWN + YWA)
;
IDENT WEDGEQ
WEDGE=(1+GTER)/(1-GTYPR)
;
IDENT GTYCEQ
GTYC = GTYCR * YC(-1)
;
IDENT GTYOEQ
GTYO = GTYOR * GNPV
;
IDENT GTYEQ
GTY = GTYP + GTYC + GTYO
;
IDENT GREVEQ
GREV = GOSG + GTE + GTY + GREVO + GREVDIV + GREVF
;
?
? Public Sector - borrowing and debt accumulation
?
IDENT GBOREQ
GBOR = GE + GEK - GREV + GTRNDF
;
IDENT GBORREQ
GBORR = 100*(GBOR/GNPV)
;
IDENT GNDEQ
GND = GNDD + GNDF + GNDFIX
```

```

;
IDENT GNDDEQ
GNDD = GNDDR * GNPV
;
IDENT GBORDEQ
GBORD = GNDD - GNDD(-1)
;
IDENT GBORFEQ
GBORF = GBOR - GBORD
;
IDENT GNDFEQ
GNDF = GNDF(-1)*FXPD(-1)/FXPD + GBORF
;
IDENT RDEBTEQ
RDEBT = 100 * (GND/GNPV)
;
?
? Private and personal incomes
?
IDENT OPEQ
OP=OT + ON + OA
;
IDENT OPVEQ
OPV=OTV + ONV + OAV
;
IDENT POPEQ
POP=OPV/OP
;
IDENT GDPFCVEQ
GDPFCV = OTV + ONV + OAV + OGV - YAFS
;
IDENT GDPFCEQ
GDPFC = OT + ON + OA + OG - YRAFS
;
IDENT PGDPFCEQ
PGDPFC = GDPFCV/GDPFC
;
IDENT INFDEFEQ
INFDEF=PGDPFC/PGDPFC(-1)-1
;
IDENT YAFSEQ
YAFS = YAFSR*GNPV
;
IDENT YRAFSEQ
YRAFS = YAFS/PYAFS
;
FRML PYAFSEQ
0(PYAFS) = LOG(PYAFS) - (APYAFS1 + APYAFS2*LOG(PGDPFC))
;
IDENT GDPMVEQ
GDPMV = GDPFCV + GTE - GSUB

```

```

;
IDENT GDPMEQ
GDPM = GDPFC + GTRE - GRSUB
;
IDENT PGDPMEQ
PGDPM = GDPMV/GDPM
;
IDENT GTREEQ
GTRE = GTE/PGTE
;
IDENT GRSUBEQ
GRSUB = GSUB/PGSUB
;
IDENT GNPVEQ
GNPV = GDPMV + YFN
;
IDENT GNPEQ
GNP = GDPM + YRFN
;
IDENT PYFNEQ
PYFN = PMP
;
IDENT GNPDOEQ
GNPDOT = 100*((GNP-GNP(-1))/GNP(-1))
;
IDENT YRFNEQ
YRFN = YFN/PMP
;
IDENT PGNPEQ
PGNP = GNPV/GNP
;
FRML DEPEQ
0(DEP)=log(DEP)-(ADEP1+ADEP2*log(PIP*(KT+KN+KA))+ADEP3*LOG(DEP(-1)))
;
IDENT NDPFCVEQ
NDPFCV = GDPFCV - DEP
;
IDENT NNPFCVEQ
NNPFCV = NDPFCV + YFN
;
IDENT YPEQ
YP = NNPFCV + GTRU + GTRSW + GTRNDD + BPYPOTH
;
IDENT YWEQ
YW = YWT + YWN + YWA + YWG
;
IDENT YCEQ
YC = NDPFCV - YW
;
FRML YCUEQ
0(YCU)=LOG(YCU)-(AYCU1+AYCU2*GNPDOT+AYCU3*LOG(YC))

```

```

;
IDENT YPEREQ
YPER = YP - YCU + PTROTH + PTRSW
;
IDENT YPERDEQ
YPERD = YPER -(GTYP+GTYO+SCP)
;
IDENT YRPERDEQ
YRPERD = YPERD/PC
;
IDENT YPOEQ
YPO=YC-YCU+GTRNDD+YFN
;
IDENT YPERTEQ
YPERT = YW + YPO(-1)
;
?
? The following parameters are estimated econometrically
?
PARAM AOT1  -1.41355;
PARAM AOT2   0.11506;
PARAM AOT3   0.38865;
PARAM AOT4  -0.11251;
PARAM AOT5  -0.016647;
PARAM AOT6   0.75004;

PARAM APOT1  0.52776;
PARAM APOT2  0.59514;

PARAM AWT1  -0.20985;
PARAM AWT2  0.98963;
PARAM AWT3  -0.066273;
PARAM AWT4  0.69907;
PARAM AWT5  -0.0049515;
PARAM AWT6  -0.040250;

PARAM AON1   2.66923;
PARAM AON2   0.70834;
PARAM AON3   0.0067420;

PARAM APON1  0.91605;

PARAM AWN1  -0.74192;
PARAM AWN2  1.14279;
PARAM AWN3  -0.21977;
PARAM AWN4  1.69200;
PARAM AWN5  -0.0072540;

PARAM AOA1   6.57849;
PARAM AOA2   0.014400;

```

PARAM ALA1 8.56141;
PARAM ALA2 -0.048716;

PARAM AKA1 -0.75803;
PARAM AKA2 -0.014449;

PARAM AOG1 2.24529;
PARAM AOG2 0.70949;

PARAM AWG1 0.14447;
PARAM AWG2 0.95083;

PARAM APOG1 -0.0071785;
PARAM APOG2 0.97792;

PARAM ALFPRM1 0.44019;
PARAM ALFPRM2 -0.0014941;

PARAM ALFPRF1 0.11290;
PARAM ALFPRF2 -0.0020932;
PARAM ALFPRF3 0.20349;

PARAM ACONS1 0.20349;
PARAM ACONS2 0.94148;
PARAM ACONS3 0.031340;
PARAM ACONS4 0.011997;

PARAM AIHP1 -2.45682;
PARAM AIHP2 0.86344;

PARAM AXA1 -2.61047;
PARAM AXA2 0.070829;

PARAM AXT1 -8.71971;
PARAM AXT2 2.18404;
PARAM AXT3 -0.71669;
PARAM AXT4 -0.029517;
PARAM AXT5 -0.42100;

PARAM AXTUR1 -1.93381;
PARAM AXTUR2 1.05101;
PARAM AXTUR3 -1.15872;

PARAM AXNTUR1 -0.40389;
PARAM AXNTUR2 0.90696;

PARAM APC1 -0.040047;
PARAM APC2 0.91138;
PARAM APC3 0.80197;

PARAM APG1 -0.066345;

PARAM APIH1 -0.14148;
PARAM APIH2 0.98616;
PARAM APIH3 0.15095;
PARAM APIH4 0.033860;

PARAM APIG1 -0.023513;
PARAM APIG2 0.83973;

PARAM APIP1 0.034973;
PARAM APIP2 0.70177;
PARAM APIP3 0.19974;

PARAM APXT1 0.16785;
PARAM APXT2 0.60489;

PARAM APXNTUR1 -0.16805;
PARAM APXNTUR2 0.88820;

PARAM APXTUR1 0.065948;
PARAM APXTUR2 1.04780;

PARAM APGTE1 0.11615;
PARAM APGTE2 0.29593;
PARAM APGTE3 0.70184;

PARAM APGSUB1 0.054346;
PARAM APGSUB2 1.11636;

PARAM APYAFS1 0.25882;
PARAM APYAFS2 1.21574;

PARAM ADEP1 -0.76850;
PARAM ADEP2 0.38962;
PARAM ADEP3 0.60621;

PARAM AYCU1 -2.41208;
PARAM AYCU2 0.020343;
PARAM AYCU3 1.11213;

PARAM AT 0.68820;
PARAM SIGT 0.77498;
PARAM LAMLT 0.037137;
PARAM LAMKT -0.068719;
PARAM DELT 0.97834;

PARAM AN 1.17334;
PARAM SIGN 0.51053;
PARAM LAMLN 0.022571;
PARAM LAMKN 0.027637;
PARAM DELN 0.99242;
END;

APENDIX 2: Variables Description

The table below lists all the variables defined in HERMINS3. "Type" refers to identities (I), behavioural (B) or exogenous (E) variables. Those variables for which no source is indicated are obtained through an identity in the TSP data generation file irrespectively of the role (I, B or E) they play in the model. For example PC (the private consumption deflator) is a behavioural variable in the model, however, the data generation file defines it as CONSV/CONS. These two variables have proper sources in the National Accounts. Nevertheless, in the model, CONSV is obtained through an identity.

VARIABLE	TYPE	DESCRIPTION	SOURCE
BP	I	Balance of payments surplus	
BPOTH	I	Net non-trade balance of payments flows	
BPR	I	Balance of payments surplus as per cent of GNP	
BPT	I	Balance of trade	
BPTR	I	Balance of trade as per cent of GNP	
BPYPOTH	E	BPOTH to the private sector	M/DEMO + CNE
CCOMP	I	Cost competitiveness measure in Non-Tradable Sector	
CCOMPT	I	Cost competitiveness measure in Tradable Sector	
CONS	B	Private consumption, volume	M/DEMO + CNE
CONSV	I	Private consumption, value	M/DEMO + CNE
DEP	B	Total depreciation	M/DEMO + CNE
DEPA	I	Depreciation in Agricultural Sector	
DEPARAT	E	Agricultural Sector depreciation rate	M/DEMO + CNE
DS	E	Total stock change, volume	M/DEMO + CNE
DSV	E	Total stock change, value	
DUMCEE	E	Dummy variable for the accession of Spain to the E.U.	
DUMMON	E	Dummy variable for the Moncloa Agreements	
ECCOMP	I	Expectation on CCOMP	
ECCOMPT	I	Expectation on CCOMPT	
ERFPN	I	Expectation on RFPN	
ERFPT	I	Expectation on RFPT	
FD	I	Final demand	
FDD	I	Final domestic demand	
FDDWON	I	Final domestic demand weighted by non-tradable output contents	TIO
FDDWOT	I	Final domestic demand weighted by tradable output contents	TIO
FDWON	I	Final demand weighted by non-tradable output contents	

FXPD	E	Exchange rate Pta./Dollar	M/DEMO
G	I	Public consumption, volume	M/DEMO + CNE
GBOR	I	Public Sector total borrowing	
GBORD	I	Domestic Public Sector total borrowing	
GBORF	I	Foreing Public Sector total borrowing	
GBORR	I	GBOR rate as per cent of GNP	
GCNW	I	Non-wage government consumption	
GCNWR	E	GCNW as a ratio to GNPV	
GDPE	I	Gross domestic product on expenditure basis, volume	
GDPEV	I	GDPE , value	
GDPFC	I	GDP at factor costs, volume	
GDPFCV	I	GDP at factor costs, value	
GDPM	I	GDP at market prices, volume	
GDPMV	I	GDP at market prices, value	
GE	I	Total public expenditure	
GEK	I	Public capital expenditure	
GEKO	E	Other public capital expenditure	M/DEMO + CNE
GEW	I	Public Sector wage expenditures	
GND	I	Public debt	M/DEMO
GNDD	I	Public debt held by residents	CFBE
GNDDR	E	GND as ratio to GNPV	
GNDF	I	Public debt held by non-resident	CFBE
GNDFIX	E	Debt repayments	
GNP	I	Gross National Product, volume	
GNPDOT	I	Annual percentage change in GNP	
GNPV	I	Gross National Product, value	
GOSG	E	Government gross operating surplus	M/DEMO + CNE
GREV	I	Total government revenue	
GREVDIV	E	Government revenues on dividends	M/DEMO + CNE
GREVF	E	Total government revenue from abroad	M/DEMO + CNE
GREVO	E	Other government revenue	M/DEMO + CNE
GRSUB	I	Public sector expenditure on subsidies, volume	M/DEMO + CNE
GSUB	I	Public Sector expenditure on subsidies, value	M/DEMO + CNE
GSUBR	E	GSUB as per cent of GNPV	
GTE	I	Government indirect tax revenue	M/DEMO + AEBE
GTER	E	Implicit indirect tax rate	
GTR	I	Total public expenditure on transfers	
GTRRE	I	Real indirect tax revenue	
GTRNDD	I	Net debt interest paid by Government to residents	

GTRNDF	I	Net debt interest paid by Government to non-residents	
GTRNDI	I	Net debt interest paid by Government	M/DEMO + CNE
GTRSW	I	Social welfare transfer payments by the Government	M/DEMO + CNE
GTRSWR	E	GTRSW as a per cent of GNP	
GTRU	I	Unemployment transfer payments	AEBE
GTRUR	B	Average payments per beneficiary	
GTY	I	Total direct tax revenue	
GTYC	I	Revenue from corporation tax	M/DEMO + CNE
GTYCR	E	Average corporation tax rate	
GTYO	I	Other direct tax revenue	M/DEMO + CNE
GTYOR	E	GTYO as per cent of GNP	
GTYP	I	Personal direct tax revenue	M/DEMO + CNE
GTYP R	E	Implicit personal direct tax rate	
GV	I	Public consumption, value	M/DEMO + CNE
I	I	Total Investment, volume	
IA	I	Agricultural investment, volume	
IBC	I	Investment in building and construction, volume	
IG	I	Government investment, volume	
IGINF	E	Public investment in infrastructure, volume	M/DEMO + CNE
IGINFV	I	Public investment in infrastructure, value	M/DEMO + CNE
IGV	I	Government investment, value	
IGVOTH	E	Other Government investment	Set to zero
IH	I	Total housing investment, volume	M/DEMO + CNE
IHG	I	Public housing investment, volume	Set to zero
IHGV	E	Public housing investment, value	Set to zero
IHP	B	Private housing investment, volume	
IME	I	Investment in machinery and equipment, volume	CNE
IMERAT	E	Machinery and equipment investment ratio over (I-IH)	
IN	B	Non-tradable Investment, volume	MIDE + CNE
INFDEF	I	Inflation (GDPFC deflator)	
INFPC	I	Inflation (PC)	
IP	I	Private investment, volume	
IT	B	Tradable Sector investment, volume	
IV	I	Total investment, value	
KA	B	Capital stock in Agricultural Sector	See section 3.4
KG	I	Capital stock in Public Sector	See section 3.4
KN	I	Capital stock in Non-Tradable Sector	See section 3.4
KT	I	Capital stock in Tradable Sector	See section 3.4
L	I	Total employment	

LA	B	Agricultural employment	EPA + G. Perea (1991)
LAEM	I	Agricultural wage-earners	EPA + G. Perea (1991)
LAEMRAT	E	Agricultural wage-earners ratio over LA	
LF	I	Total labour force	EPA
LFPR	I	Labour force participation rate	
LFPRF	B	Female labour force participation rate	EPA + OCDELFS
LFPRM	B	Male labour force participation rate	EPA + OCDELFS
LG	E	Public sector employment	EPA + M/DEMO
LN	B	Non-Tradable employment	EPA + G. Perea (1991)
LNEM	I	Non-Tradable wage-earners	EPA + G. Perea (1991)
LNEMRAT	E	Non-Tradable wage-earners ratio over LNA	
LSHRN	I	Labour share of added value in Non-Tradable sector	
LSHRT	I	Labour share of added value in Tradable sector	
LT	B	Tradable employment	
LTEM	I	Tradable wage-earners	
LTEMRAT	E	Tradable wage-earners ratio over LT	
MP	I	Total imports, volume	M/DEMO + CNE
MPV	I	Total imports, value	M/DEMO + CNE
N1564	E	Population from 15 to 64	EPA
NDPFCV	I	Net domestic product at factor cost, value	
NNPFCV	I	Net national product at factor cost, value	
OA	B	Added value in Agricultural Sector, volume	M/DEMO + CNE
OAV	I	Added value in Agricultural Sector, value	M/DEMO + CNE
OG	B	Added value in Public Sector, volume	CNE
OGV	I	Added value in Public Sector, value	CNE
ON	B	Added value in Non-Tradable Sector, volume	M/DEMO + CNE
ONV	I	Added value in Non-Tradable Sector, value	M/DEMO + CNE
OP	I	Private output, volume	
OPV	I	Private output, value	
OT	B	Tradable output, volume	
OTV	I	Tradable output, value	
OW	E	Index of world trade, volume	M/DEMO
PC	B	Price deflator for private consumption	
PG	B	Price deflator for G	
PGDPE	I	Price deflator, GDPE	
PGDPFC	I	Price deflator, GDPFC	
PGDPM	I	Price deflator, GDPM	
PGNP	I	Price deflator, GNP	
PGSUB	B	Price deflator, GSUB	

PGTE	B	Price deflator, GTE	
PI	I	Price deflator, total investment	
PIA	I	Price deflator, Agricultural investment	MIDE + CNE
PIG	B	Price deflator, Public Sector investment	M/DEMO + CNE
PIH	B	Price deflator, housing investment	M/DEMO + CNE
PIN	I	Price deflator, Non-Tradable investment	M/DEMO + CNE
PIP	B	Price deflator, Private investment	
PIT	I	Price deflator, Tradable investment	
PKA	I	Cost of capital, Agricultural Sector	See section 3.4
PKN	I	Cost of capital, Non-Tradable Sector	See section 3.4
PKT	I	Cost of capital, Tradable Sector	
PMP	E	Price deflator, Imports	
POA	E	Price deflator, Agricultural output	
POG	B	Price deflator, Public Sector output	
PON	B	Price deflator, Non-Tradable Sector output	
POP	I	Price deflator, Private output	
POT	B	Price delator, Tradable output	
PRODN	I	Non-Tradable productivity	
PRODT	I	Tradable productivity	
PTROTH	E	Other Private transfers to households	M/DEMO + CNE
PTRSW	I	Social welfare Private transfers to households	M/DEMO + CNE
PTRSWR	E	Social welfare Private transfers ratio over wage bill	M/DEMO + CNE
PWORLD	E	Price deflator, World output	M/DEMO
PXA	E	Price deflator, Agricultural exports	
PXNTUR	B	Price deflator, Non-Tourism exports	
PXT	B	Price deflator, T Sector exports	
PXTUR	B	Price delator, Tourism exports	
PYAFS	B	Price deflator of YAFS	
PYFN	I	Price deflator, net national income from abroad	
RDEBT	I	Debt/GNP Ratio (per cent)	
RFPN	I	Relative factor prices, Non-Tradable Sector	
RFPT	I	Relative factor prices, Tradable Sector	
RGDI	E	Implicit interest rate of national debt	
S	I	Household savings, volume	
SAVRAT	I	Personal savings ratio	
SCP	I	Private Social contributions	M/DEMO + CNE
SCPR	E	Private Social contributions ratio over wage bill	
STATDIS	E	Statistical discrepancy, between GDPE and GDPM	
T	E	Time trend	

TINC	I	Index of net indirect taxes	
U	I	Numbers unemployed (In thousands)	
UBENEF	I	Beneficiaries of unemployment benefits	BEL
UBENEFR	E	UBENEF as per cent of GNP	
ULCEC11	E	Unit labour costs in the EC except Spain	EE (1993)
ULCN	I	Unit labour costs, Non-Tradable Sector	
ULCT	I	Unit labour costs, Tradable Sector	
UR	I	Unemployment rate as per cent of labour force	
WA	B	Agricultural average wage	
WEDGE	I	Tax wedge	
WG	B	Wage rate, Public Sector	
WN	B	Wage rate, total Non-Tradable Sector	
WP	I	Wage rate, Private Sector	
WT	B	Wage rate, total Tradable Sector	
XA	B	Agricultural exports, volume	MEH
XAV	I	Agricultural exports, value	MEH
XNTUR	B	Non-turism exports, volume	M/DEMO
XNTURV	I	Non-Tourism exports, value	M/DEMO
XP	I	Total exports, volume	
XPV	I	Total exports, value	
XT	B	T Sector exports, volume	M/DEMO
XTUR	B	Tourism exports, volume	M/DEMO
XTURV	I	Tourism exports, value	M/DEMO
XTV	I	T Sector exports, value	M/DEMO
YAFS	I	Adjustment for financial services, value	M/DEMO + CNE
YAFSR	E	Ratio of YAFS over GNPV	
YC	I	Total company profits	
YCU	B	Undistributed company profits	M/DEMO + CNE
YFN	E	Net factor income from abroad, value	M/DEMO + CNE
YP	I	Private income	
YPER	I	Household income	
YPERD	I	Household disposable income	
YPERT	I	Household taxable income	
YPO	I	Non-wage household income	
YRAFS	I	Adjustment for financial services, volume	M/DEMO
YRFN	I	Net factor income from abroad, volume	M/DEMO + CNE
YRPERD	I	Real household disposable income	
YW	I	Wage bill, whole economy	
YWA	I	Wage bill, Agricultural Sector	M/DEMO + CNE

YWG	I	Wage bill, Public sector	M/DEMO + CNE
YWN	I	Wage bill, Non-Tradable Sector	M/DEMO + CNE
YWT	I	Wage bill, Tradable Sector	

AEBE:	Statistical Yearbook-Bank of Spain
B:	Behavioural variables
BEL:	Labour Statistics Bulletin-Spanish Ministry of Labour
CNE:	National Accounts-Spanish Statistical Office
E:	Exogenous variables
EPA:	Labour force survey-Spanish Statistical Office
I:	Variable derived THROUGH AN IDENTITY
M/DEMO:	Data base of the MOISEES model
MEH:	Spanish Ministry of Economics and Finance (various departments)
MIDE:	Data Base of the MOISEES model
OCDE LFS:	OCDE labour force statistics
TIO:	Input/Output Table (1987) of the Spanish Economy

APPENDIX 3: Computation of FDDWOT and FDWON

Final domestic demand (FDD) and final demand (FD) are in HERMIN-S4 the major determinants of, respectively, output in the N and T sectors. In order to derive measures of FDD and FD that adequately reflect the sectoral output content of each of their components, we have computed two variables, FDDWOT and FDWON, defined as follows:

$$\text{FDDWOT} = a_1 * \text{CONS} + a_2 * \text{G} + a_3 * \text{IBC} + a_4 * \text{IME}$$

$$\text{FDWON} = b_1 * \text{CONS} + b_2 * \text{G} + b_3 * \text{IBC} + b_4 * \text{IME} + b_5 * \text{XP}$$

where the a and b coefficients have been derived from the Input/Output Tables of the Spanish economy for 1987 (TIO, 1991) according to the following expression:

$$\text{PI} * (\text{I} - \text{A})^{-1} * \text{FD} \tag{1}$$

in which:

PI is the matrix of primary inputs coefficients for the A, T, N and G sectors. Primary inputs have been simplified to three: Value-added (VA), Imports (MP) and Taxes on production and imports net of subsidies (Net Tax). Only the first, in the T and N sector, are however relevant for computation of the a and b coefficients.

$(\text{I} - \text{A})^{-1}$ is the Leontieff inverse matrix.

FD is the final demand matrix where rows represent sectors and columns FD components. Each element of the matrix has been divided by its corresponding column total.

The result of computing expression (1) above is shown in the table below. Each figure amounts to the value-added, imports or taxes (net of subsidies) generated, in the corresponding sector, by a unit increase in each of the final demand components.

Primary inputs content coefficients for FD components						
	CONS	G	IBC	IME	XP	FD
VA in A	0.047	0.013	0.021	0.054	0.86	0.047
MP in A	0.008	0.002	0.004	0.009	0.014	0.008
Net Tax in A	-0.001	0.000	-0.001	-0.001	-0.002	-0.001
VA in T	0.231	0.084	0.158	0.391	0.366	0.241
MP in T	0.140	0.051	0.096	0.237	0.222	0.146
Net Tax in T	0.049	0.018	0.034	0.083	0.078	0.051
VA in N	0.478	0.116	0.628	0.206	0.215	0.390
MP in N	0.016	0.004	0.005	0.007	0.007	0.012
Net Tax in N	0.030	0.007	0.056	0.013	0.013	0.026
VA in G	0.001	0.706	0.000	0.000	0.000	0.081
MP in G	0.000	0.000	0.000	0.000	0.000	0.000
Net Tax in G	0.000	0.000	0.000	0.000	0.000	0.000

VA: Value Added; MP: Imports; Net Tax: Taxes on production and imports net of subsidies

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