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Developing a dynamic multi-sectoral CGE model of the New Zealand economy

Ganesh Nana*

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Abstract

Forward looking behaviour on the part of investors and consumers is incorporated into a previously static CGE model, forming the inter-temporal links in a new dynamic multi-sectoral model of the New Zealand economy. A model at the seven sector level of disaggregation is constructed and the *Gempack* suite of programs is used to obtain solutions, involving linearisation of the model's equations and matrix inversion, a la Johansen. Associated procedures to generate a multi-sectoral database consistent with the inter-temporal behaviour postulated and some sufficient conditions required to produce a balanced-growth steady-state solution are discussed. Simulations presented show a permanent effect on investment and GDP from a disturbance to relative prices, but no aggregate effect from an internal demand shock. The sensitivity of these comparative dynamic experiments are explored and they are found to be base independent and invariant to the length of the time horizon.

Key words

CGE models, inter-temporal behaviour, comparative dynamics

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I Introduction

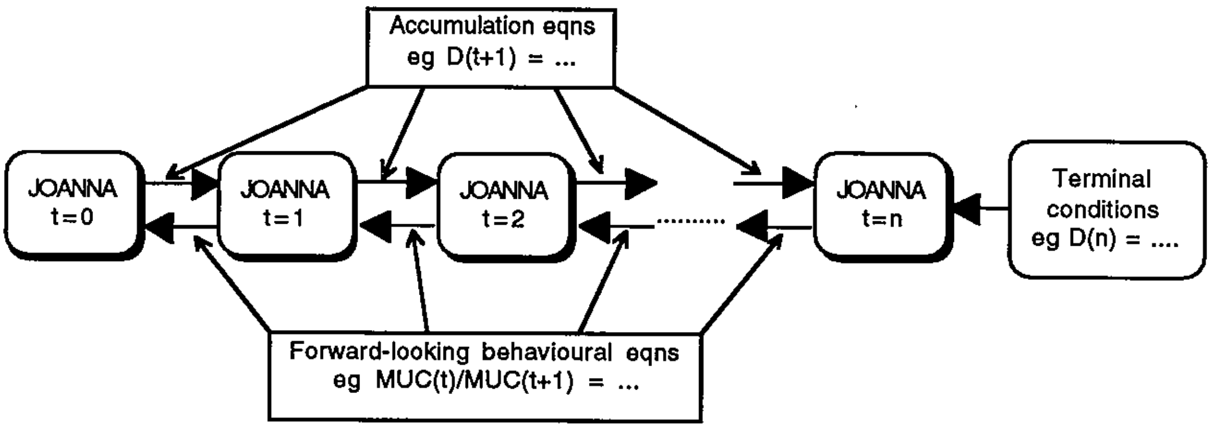
Since 1973 the Research Project on Economic Planning (RPEP) has progressively developed a suite of multi-sectoral computable models of the New Zealand economy, primarily designed to look at structural issues relating to the sectoral allocation of productive resources. Until recently these models have been limited to comparative static forms of analysis, providing "snapshot" views of the economy at specific points in time[1]. This paper reports on work which continues the enhancement of this modelling suite by introducing the time dimension, thereby enabling comparative dynamic analysis - that is, the comparison of alternative paths rather than alternative snapshots.

The starting point for this work is the static CGE of the Johansen-type named *Joanna*, upon which the dynamic *Jody* model is based. The *Joanna* model, developed independently by RPEP, is similar to the Australian *Orani* model developed by the Impact team[2]. The ease of solution for a model expressed in "percentage changes", in comparison to one expressed in "level form", was the principal reason for the choice of this model-type. The *Gempack*[3] suite of programs is used to generate the model programs as well as solving the model.

The overall approach adopted is similar to that described by Malakellis (1992 & 1993), and this is described in the next section. The inter-temporal behaviour explicitly incorporated in the dynamic model is restricted to two areas, namely those of sectoral investment and household consumption. Sections III and IV outline the process by which a suitable "dynamically-consistent" database and control scenario is produced. Section V presents some comparative dynamic analysis using the model with the following section addressing the sensitivity of the results obtained.

II Structure of model

The structure of the dynamic CGE model developed consists, essentially, of a multiple number of atemporal (static) sub-models with several inter-temporal links between each sub-model to reflect the dynamic behaviour to be captured, as pictured below.



1 See Philpott (1989) for a summary and bibliography of RPEP research.

2 For details on the *Joanna* model refer to Nana and Philpott (1983) and Poot et al (1988). The *Orani* model is detailed in Dixon et al (1982).

3 Codsi and Pearson (1988) and Pearson (1988) give an outline of this package. Version 5.0 of *Gempack* has been used in the work that is described below.

IIa Static *Joanna*

The "standard" static *Joanna* model is a multi-sectoral, input-output based computable general equilibrium model of the Johansen type. Its variables are expressed and solved for in percentage change form, in which the model is linear. The endogenous determination of relative prices and costs within the model (and the simulation of responses to them) simultaneously with the determination of supply and demand (and the responses to them) are features of the model.

The model identifies 22 production sectors each combining materials and primary factors, capital and labour, to produce a commodity. These commodities can be used for various purposes: by other production sectors as intermediate inputs; by sectors for the production of capital goods; combined with others to make up composite commodities which are then exported; to make up composite commodities which are consumed by domestic households; to contribute to stock holdings or consumed by the public sector. A "market-clearing" assumption for each commodity ensures that each sector's output is equal to the total usage of that particular commodity across the economy.

In each[4] of these activities the domestically produced commodity is competing against an (imperfectly substitutable) imported product. Movements in relative prices are the driving force in altering market shares within this competitive system. The price of the domestic commodity hinges on a "zero pure-profits" assumption while the price of the imported product can change if its world price, the exchange rate and/or its tariff rate changes. It should be noted that the degree of substitutability is less than infinite; being set by appropriate elasticities reflecting the level of aggregation as well as the technical comparability of the competing products. Such substitution follows a CES specification in the "standard" model, although more generalised functional forms can be handled if so desired.

A similar form of substitution is modelled in the use of primary factors, where labour and capital are imperfect substitutes in the production process of each sector. Again shifts in relative prices are behind any changes in factor intensity. The price of capital (the "profit rate") in each sector moves to equilibrate the demand for and supply of capital. This in turn interacts (consistent with the zero pure-profits assumption) with conditions in the market for each sector's output so as to ensure market-clearing in the product markets. The price of labour adjusts to clear the labour market, with the supply of labour being determined outside (exogenous to) the model. An alternative specification, however, can be adopted where excess labour is assumed to exist with the labour market clearing via a quantity adjustment at a fixed price.

The total supply of capital and, therefore, capital goods production (investment) in the "standard" static *Joanna* is determined outside the model. This, however, is the focus of the inter-temporal elements introduced into the *Jody* model and is described in the following section.

Domestically produced goods which are exported also face competition based on relative price movements. The price of the competing products produced elsewhere are external to the model, while NZ's export's are priced consistent with the zero pure-profits assumption. That is, according to the prices of the relevant domestic commodities adjusted by the exchange rate.

Private households obtain income in accordance with data from the Household Income and Outlay Accounts. This consists of wage payments to labour, as well as a portion of the returns to capital reflecting self-employed income (eg farmers), dividend receipts and imputed returns to owner-occupiers of dwellings. Income is also obtained from interest as well as national superannuation, unemployment benefits and other transfers via

4 Except the exporting activity.

welfare payments. In the static model total private consumption is driven by the household sector's current income. Expenditure is allocated across eight[5] composite consumption commodities in response to relative price changes given appropriate income, own and cross-price elasticities according to an LES system.

In common with all "Walrasian" general equilibrium models, the *Joanna* model does not determine (nor is responsive to) the absolute price level, rather it determines and responds to prices relative to an exogenous numeraire. This "numeraire" role is usually served by the exchange rate variable, as the model does not explain international financial capital flows which are assumed to be external to the model.

From the framework of such a static representation of the economy, a dynamic model has been constructed through the addition of inter-temporal relationships in two areas. The first area addresses the process of capital formation (investment) and the second concerns private consumption expenditure. At this pilot testing stage the dynamic model is based on a condensed seven sector version of the standard *Joanna* model with a provisionally estimated input-output database for the 1989/90 year - derived from the latest official 1986/87 input-output figures[6]. In future versions of the model it is hoped to increase the level of disaggregation subject to computing resources available and solution times required.

IIb Inter-temporal behaviour : investment

i) "neo-classical"

The "neo-classical" criteria that an activity is undertaken up to the point where the marginal revenue equates to the marginal cost is incorporated with respect to investment (ie the construction and purchase of new capital goods) as described below.

The timing of investment expenditure is assumed to be structured in the following way. The decision to invest in sector j is made at the beginning of period t and the capital item is constructed during period t. The item is purchased (expenditure is undertaken) at the end of period t at price P_{jt}, thus foregoing possible interest receipts in the next period of $P_{jt}RR_{t+1}$, where RR_{t+1} is the (riskless) rate of interest over period t+1. Note, however, that the possibility of sector-specific risk or premium being accepted by the entrepreneur is incorporated through a "risk factor" variable RSK_{jt}. The item purchased is then used during period t+1 in the production of output, and is available to be resold at the end of period t+1.

Thus the marginal cost of acquiring and using for one period an additional capital good involves:

1) the interest or opportunity cost of the purchase price (construction cost) of the capital item - viz: $P_{jt}R_{jt+1}$, where $R_{jt+1} = RR_{t+1} * RSK_{jt+1}$.
2) the depreciation cost $\delta_j P_{jt+1}$, where δ_j is the rate of depreciation in sector j.

and the marginal revenue involves:

1) the revenue from the extra output produced by the addition to the capital stock - ie the marginal revenue product of capital, denoted M_{jt+1}.
2) any capital gain (loss) arising from changes over time in the purchase (resale) price of the capital good $(P_{jt+1} - P_{jt})$.

Therefore, the criteria of marginal cost equalling marginal revenue can be expressed:

5 Corresponding to the eight major groups in the Household Expenditure and Income Survey.
6 Refer to Philpott and Nana (1993) for details of the 1989/90 input-output tables.

$$P_{jt}R_{jt+1} + \delta_j P_{jt+1} = M_{jt+1} + (P_{jt+1} - P_{jt})$$

or $$P_{jt}(1+R_{jt+1}) = M_{jt+1} + P_{jt+1}(1-\delta_j)$$

Assuming that investment in period t=0 is past history then the above holds for all periods t = 1... n-1. Differentiating and rearranging to obtain a "percentage change" expression suitable for inclusion in the *Jody* model yields:

$$p_{jt} = \left[\frac{1}{1 + R_{jt+1}}\right]\left\{\frac{M_{jt+1}}{P_{jt}} m_{jt+1} + \frac{[1 - \delta_j]P_{jt+1}}{P_{jt}} p_{jt+1} - R_{jt+1} r_{jt+1}\right\} \qquad \text{for } t = 1 \ldots n\text{-}1$$

where the smaller case characters are "percentage change" expressions related to the respective upper case letters as follows:

$$x = 100\frac{\Delta X}{X}$$

In order to solve for investment in the remaining period (t=n), a terminal (or end-period) condition is required. To be consistent with a steady-state solution this takes the form:

$$\frac{I_n}{K_n} = \frac{I_{n-1}}{K_{n-1}}$$

Associated with the above behavioural relationships the dynamic model requires the introduction of the accumulation identity:

$$K_{jt+1} = (1-\delta_j)K_{jt} + I_{jt} \qquad t = 0 \ldots. n\text{-}1$$

where, consistent with the timing of investment as specified above, K_{jt} is the capital stock in sector j available at the beginning of period t. Note, furthermore, it is assumed that K_{jt} at time t=0 is past history, and so no equation is required for its determination.

ii) an alternative investment routine : constant real profit rates

As an alternative to the "neo-classical" schema above, some experiments were conducted with a "constant real profit rate" criteria thus:

$$\left(\frac{\Pi}{PX}\right)_{jt+1} = \left(\frac{\Pi}{PX}\right)_{jt} \qquad t = 0 \ldots. n\text{-}1$$

where
P = rental price per unit of capital employed
PX = price of gross output

It should be noted that government "non-market" real investment is not included within either of these investment regimens - rather it is set exogenously.

IIc Inter-temporal behaviour : consumption

In the dynamic model it is postulated that the household allocates total income over the planning horizon period in determining its consumption expenditure pattern across time. This contrasts with the "static" model's one-period income determination of expenditure.

Assuming that utility is additively separable over time and that t=0 is past history, the household's problem is to choose $C_1 \ldots C_n$ at the beginning of period t=1 to maximise utility constrained by their total income over the period as follows:

$$\text{maximise } U = \sum_{t=1}^{t=n} \frac{U_t}{[1+\rho]^t} \qquad \text{subject to } Y = \sum_{t=1}^{t=n} \left\{ \frac{P_tC_t}{\prod_{s=1}^{s=t}[1+RM_s]} \right\}$$

where

U_t is utility obtained by consumption spending in period t of C_t

ρ is the rate of time preference

P_t is the consumer price index for period t

RM_t is the "retail market" rate of interest for time period t and is related to the "riskless rate" via a retail bank "margin" thus: $RM_t = RR_t{*}RBM_t$

Y is the present value (as at the beginning of time t=1) of income gained over the periods t = 1...n and, furthermore, is exogenous to the household.

Note that this specification assumes that consumption, while determined at the beginning of time t=1, is undertaken at the end of each period - including that for period t=1.

The first-order conditions for this constrained maximisation problem yields a multi-period version of the familiar two-period criteria:

$$\Rightarrow \frac{\left[\frac{MU_t}{Pt}\right]}{\left[\frac{MU_{t+1}}{P_{t+1}}\right]} = \frac{1+RM_{t+1}}{1+\rho} \qquad \text{for } t = 1 \ldots n\text{-}1$$

where MU_t = is marginal utility of consumption at time t, ie $\frac{\partial U_t}{\partial C_t}$.

Consistent with the LES consumer demand specification described for the "static" model, utility for each period t (U_t) takes the form

$$U_t = \sum_{i=1}^{i=8} \beta_i \ln[C_{it} - \gamma_i]$$

where

β_i represents the share of commodity i in total "discretionary" spending

γ_i is the "minimum" or "committed" quantity of i consumed

Noting that

$$P_{it}[C_{it} - \gamma_i] = \beta_i \sum_{s=1}^{s=8} P_{st}[C_{st} - \gamma_s] \quad \text{and} \quad \sum_{s=1}^{s=8} P_{st}C_{st} = P_tC_t$$

after differentiating with respect to C_t and rearranging gives:

$$\frac{MU_t}{P_t} = \frac{1}{E_t}$$

where $E_t = P_tC_t - \sum_{s=1}^{s=8} P_{st}\gamma_s$ = total "discretionary" expenditure (in nominal terms).

So the first order conditions for the solution to the household's dynamic allocation problem can be expressed as:

$$\frac{E_{t+1}}{E_t} = \frac{1+RM_{t+1}}{1+\rho} \qquad \text{for } t = 1 \ldots n\text{-}1$$

Differentiating and rearranging to obtain the *Jody* model "percentage change" equations gives:

$$\Rightarrow e_{t+1} - e_t = \frac{R_{t+1}}{1+R_{t+1}} r_{t+1} \qquad \text{for } t = 1 \ldots n\text{-}1$$

and using the identity: $P_tC_t = E_t + \sum_{i=1}^{i=8} P_{it}\gamma_i$

yields the *Jody* model equation for consumption in time t :

$$P_tC_t[c_t + p_t] = E_te_t + \sum_{i=1}^{i=8} [P_{it}\gamma_i]p_{it}$$

remembering the notation whereby lower case characters represent "percentage changes" while upper case letters represent the "level" forms of the respective variables.

The economy's accumulation of foreign debt is captured by the following relationship:

$$D_{t+1} = \frac{\Phi_{t+1}}{\Phi_t} D_t[1 + RM_{t+1}] - [X_{t+1} - M_{t+1}] \qquad t = 0 \ldots n\text{-}1$$

where, consistent with the timing of expenditure described above, D_t is the stock of debt (expressed in NZ$) at the end of period t and debt at time t=0 is assumed to be past history. Furthermore :

Φ_t is the exchange rate $\left(\frac{\$NZ}{\$world}\right)$

X_t is aggregate export receipts in period t in NZ$

M_t is aggregate import payments in period t in NZ$

Note that consumption in the terminal period (t=n) is not determined by the above system, but requires a further condition. Consistent with a steady-state solution such a condition takes the form:

$$\frac{D_n}{GDP_n} = \frac{D_{n-1}}{GDP_{n-1}} \qquad \text{where GDP is nominal GDP}$$

IId (Exogenous) interest rates

It should be noted that the absence of monetary or financial capital flows means that the determination of interest rates are fundamentally exogenous. No arbitrage requires:

$$(1+RR_t) = \frac{\Phi_{t+1}}{\Phi_t}(1+RF_t) \qquad t = 0 \ldots n\text{-}1$$

where RF_t = "foreign" interest rate, and consistency with a steady-state solution implies:

$$RR_n = RR_{n-1}$$

With the model relationships all expressed in "percentage change" form, solving the resulting set of linear simultaneous equations which make up the model is achieved simply via a matrix inversion routine. The *Gempack* package contains such a routing which, furthermore, is specifically suited to these types of models as it exploits the sparse nature of the matrix. It should also be noted, that *Gempack* incorporates several features (including an extrapolation method) which overcomes the majority of the implicit "linearisation errors" inherent in such a modelling approach.

The model experiments presented, in all except the final section, assume a "period" to be equivalent to a year, with 2010 as the terminal year. At this seven sector level, therefore, a database is needed at 21 time points[7]. Furthermore, for this database to be of any use it needs to satisfy or conform to the dynamic relationships postulated above.

III Solving for a dynamically-consistent base

It is at this stage that the contrast between a model expressed and solved in the levels of the model's variables and our choice of a percentage change form becomes apparent. A "levels" model would (generally) require appropriate data for period t=0 and then the model's equations would be solved to generate the remainder of the database for the periods t=1 up to t=n. This, of course, would entail the use of a (usually complex) non-linear solution algorithm with iterations within each time period as well as model-wide iterations over the whole time horizon where forward-looking expectations are incorporated.

The advantage of the percentage change form model is that it eliminates the need for such (in cases model-specific) solution algorithms to be developed. One disadvantage, however, is that a more involved procedure is required to generate a base data set. In particular, solving the model's equations would yield percentage changes, but it is not immediately clear just what are the levels to which these changes should be applied. The procedure is best illustrated via a numerical example, as in the table below - which focuses on the capital accumulation equation over 5 time points.

The initial step is to replicate the starting (t=0, ie 1990) static base as many times as required - once for each of the static sub-models. As indicated above, we begin with a time horizon extending 21 years to 2010, implying 21 static sub-models and hence 21 static bases. But 21 lots of static bases[8] is not of much use for modelling - not for the obvious reason that t=20 (ie 2010) is going to be substantially different from t=0, but, more importantly, for the reason that the database will inevitably be out of alignment with the dynamic equations in the model.

In the example below, which for the sake of brevity assumes just 5 time points, this initial base is represented by the columns COL1 and COL4. Also included in the original base a "slack" variable representing the degree of the "dynamic alignment" problem alluded to previously. The column COL7 portrays such a "slack" variable in the example below.

7 The model as structured comprises 3436 variables, of which 2330 are endogenous. However, only 40914 (less than 0.75%) of the elements of the 2330x2330 matrix are non-zero. Solution of the model takes approximately 10 minutes on a 8mb Mac IIci.

8 Malakellis terms such a base as a "clonal quasi-scenario".

Table 1 The dynamic-alignment problem

	COL1	COL2	COL3	COL4	COL5	COL6	COL7	COL8	COL9
	Capital stock (as at beginning of t)			Gross investment during t			Slack variable		
	Original database value	Model variable value	Updated database value	Original database value	Model variable value	Updated database value	Original database value	Model variable value	Updated database value
t	K $m	k %	K $m	I $m	i %	I $m	S $m	ΔS $m	S $m
0	5000.0	0.000	5000.0	325.0	0.000	325.0	-75.0	75.0	0.0
1	5000.0	1.500	5075.0	325.0	1.750	330.7	-75.0	75.0	0.0
2	5000.0	3.039	5151.9	325.0	3.800	337.4	-75.0	75.0	0.0
3	5000.0	4.634	5231.7	325.0	5.500	342.9	-75.0	75.0	0.0
4	5000.0	6.260	5313.0	325.0	7.126	348.2	0.0	0.0	0.0

Thus for the t=0 up to t=n-1 the value of the "slack" variable (S) is measured by the "error" as implied by the capital stock accumulation equation. That is:

$$COL7_t = COL1_{t+1} - [\ (1-0.05)*COL1_t + COL4_t\ ] \qquad \text{for } t = 0...3$$

and for the terminal period t=n the value of S is measured by the "error" implied by the terminal condition stated in section II.1 above, thus:

$$COL7_n = \frac{COL4_n}{COL1_n} - \frac{COL4_{n-1}}{COL1_{n-1}} \qquad \text{where } n=4$$

To turn this base into a useful dynamic base a model simulation is undertaken (starting from this sequence of static bases) incorporating shocks to the numerous exogenous variables (eg export shift factors, technical change, real wage rates) reflecting their prospective paths over the relevant time from t=0 (1990). In addition, (in order to correctly "align" the database with the dynamic equations) all the inter-temporal "slack" variables are shocked by an amount so as to return their level value to zero - thereby implying that the relevant dynamic equations are then correctly satisfied[9]

Note that the "slack" variable S enters the model in the form of its <u>absolute change</u> rather than percentage change in order to avoid complications arising from taking percentage changes of negative numbers. So, the exogenous shocks to S_t are listed in COL8, with the value of S_t in the post-shock new updated database being calculated as:

$$COL9_t = COL7_t + COL8_t \qquad \forall t$$

Rewriting the capital stock accumulation identity from the previous section as (leaving out the j subscripts):

$$K_{t+1} = (1-\delta)K_t + I_t + S_t \qquad t = 0 \ .... \ n-1$$

and the terminal condition as:

$$\frac{I_n}{K_n} = \frac{I_{n-1}}{K_{n-1}} + S_n$$

the percentage change forms that enter the model (obtained by differentiating, multiplying by 100 and rearranging) look like:

$$K_{t+1}k_{t+1} = (1-\delta)K_tk_t + I_ti_t + 100\Delta S_t \qquad t = 0 \ .... \ n-1$$

9 The resulting base is equivalent to Malakellis' "control path solution".

and $\frac{I_n}{K_n}(i_n - k_n) = \frac{I_{n-1}}{K_{n-1}}(i_{n-1} - k_{n-1}) + 100\Delta S_n$

remembering the notation using lower case characters for percentage change.

These expressions yield (from the model's solution) values for the capital stock variable for all but the initial period (ie k_{t+1} for t=0 to n-1) and for the terminal investment variable (i_n), thus:

$$COL2_{t+1} = \frac{(1-0.05)*COL1_t*COL2_t + COL4_t*COL5_t + 100*COL8_t}{COL1_{t+1}}$$

for t = 0...3

and $$COL5_n = \frac{COL1_n}{COL4_n}\left[\frac{COL4_{n-1}}{COL1_{n-1}}(COL5_{n-1} - COL2_{n-1}) + COL2_n + 100*COL8_n \right]$$

where n=4

The value of k at t=0 (ie $COL2_0$) is not determined by the model but is set exogenously, while the remaining values of i_t (t=0...n-1, $COL5_0$ to $COL5_3$) would come from the model's solution to the inter-temporal optimisation problem described in section IIa above, dependent on the general equilibrium solution to all the other variables in the model.

The resulting percentage changes (as listed in columns COL2 and COL5) when applied to the original database values yield the levels values of the variables in the new updated (post-shock) data set. That is:

$$COL3_t = COL1_t\left(1 + \frac{COL2_t}{100} \right) \qquad \forall t$$

and $$COL6_t = COL4_t\left(1 + \frac{COL5_t}{100} \right) \qquad \forall t$$

It can be checked that the stock of capital numbers obtained for the new data set (COL3) are consistent with the post-shock investment figures (COL6), given a depreciation rate of 5%. Furthermore, the investment in the final period is such that the implied growth of capital from t=4 to t=5 is equivalent to the growth experienced in moving from t=3 to t=4.

Thus a "slack" variable has to be associated with each of the inter-temporal relationships incorporated in the model and added to the model's database. The model simulation designed to generate a base over the desired time horizon is therefore augmented by shocks to these "slack" variables by amounts necessary to ensure their levels values revert to zero in the post-shock database.

IV Generating a balanced growth path solution

The object of this exercise is not to obtain a "forecast" of the economy but, rather, to construct a base or control solution to the model upon which some "response to shocks" or comparative dynamic simulations can be performed. In this regard the aim is to find a solution to which the model converges in the long-run and represents some type of "steady-state" in the sense that the resultant structure of the economy is unchanging each year except for some constant real growth factor.

This requires the setting of all exogenous real variables at a "balanced growth rate" and all exogenous price variables at a constant level or zero change. Remembering that the model is crucially dependent (like all Walrasian GE models) on relative prices a "balanced growth path" equates to a constant level of competitiveness (ie constant real exchange rate). Thus technical change, which is exogenous, is also set at a path which converges to zero change in the long run. For the results presented below a balance growth rate of 2% per annum has been assumed.

Appropriate settings of the exogenous variables with this in mind yield a picture as represented by the solid lines on Figs 1, 2 and 3, labelled "neo-classical run01". Such a scenario involves a sizable increase in the level of competitiveness in the first year - indicated by the fall in consumer prices of 5% (relative to the world price level). Thereafter prices (and, hence, competitiveness) stabilise at this new level, which is ultimately sufficient to produce a constant debt-to-GDP ratio.

The adjustment imposed to obtain the "neo-classical" optimal investment allocation requires substantial variation in investment levels over the first five years or so, as indicated in the charts on Fig 2. Most noticeable is the initial surge in investment in manufacturing and the initial plummet in the buildings sector. The influences determining investment at this stage can be categorised into the following:

(1) the rate of return criteria : the need to satisfy the "neo-classical" condition equating the revenue arising from the extra capital to the opportunity cost of investing (with due allowance for any capital gain).

(2) the difference between the current (base) rate of growth of the capital stock (implied from the currently existing level of investment) in each sector and the overall "steady-state" rate of growth.

(3) the sectoral demand for capital required as derived from the demand for each sector's output (after allowing for any relative price substitution towards or away from labour).

The currently existing rates of return and capital growth rates are listed in Table 2.

Table 2 Base (1990) rates of return and growth rates of capital stock

Sector	ROR	"risk"	risk-adj ROR	%ΔK
Agriculture	0.81	0.33	2.45	0.61
Forestry	18.25	6.00	3.04	2.67
Energy	1.39	1.00	1.39	0.81
Manufacturing	3.71	1.00	3.71	0.35
Building	13.82	4.00	3.46	-1.63
Transport	6.10	1.50	4.07	5.93
Services	3.34	1.00	3.34	3.71

Incorporating information from the model results for sectoral output demand, the directions of these three influences on investment can be summarised as in Table 3 below. This summary can be helpful in explaining the outcome for sectoral investment in the first year. For example, the surge in investment in manufacturing can be traced to the combination of positive influences from all three sources identified. That is, the risk-adjusted rate of return is above the (exogenous) required rate (3%) thus encouraging greater investment; the current level of investment indicates 0.35% growth of capital, below the 2% "balanced growth rate"; and the overall increased demand for manufactures ensures a positive effect on investment from that source. By contrast, in the building sector the positive influences from the first two identified sources are outweighed by the effects of a fall in demand for building sector output. This latter effect results from the overall shift to tradeables (real exchange rate depreciation) arising out of the model's general equilibrium solution, given the relationships and the terminal conditions incorporated.

Table 3 Influences on investment in the initial year

Sector	INFLUENCE NUMBER (1)	(2)	(3)	Investment
Agriculture	-	+	+	-
Forestry	+	-	+	+
Energy	-	+	+	-
Manufacturing	+	+	+	+
Building	+	+	-	-
Transport	+	-	+	+
Services	+	-	+	-

IVa An alternative investment regime

Using the alternative investment regime outlined in section 1 above yields a "balanced growth path" solution as indicated by the dotted lines of Fig 1, 2 and 3 - labelled "constant profit rate run03". It is noticeable from the aggregate picture that there is little qualitative difference between the two versions - in this case producing a larger initial increase in competitiveness and consequent lower ultimate debt-to-GDP ratio. Not surprisingly the prime difference between the two simulations lies in the investment profile, with sectoral profiles illustrated in Fig 2 showing a less "violent" initial adjustment with this alternative scheme. Furthermore there are also noticeable differences in the ultimate level of investment in the building, manufacturing, energy and transport sectors; but almost no difference in the agriculture and services sectors.

From the model results we can observe the rate of return to which each sector converges given this constant real profit rate criteria and compare such a rate of return to that achieved in the "neo-classical" version (which is, of course, the riskless rate (3%) adjusted for the sector-specific risk factor). Such a comparison is provided in Table 4, where the last column lists the risk factors that are "implicit" in the constant real profit rate scenario.

Table 4 Risk factors for different investment criteria

	RUN01		RUN03	
Sector	"risk"	2010 ROR	2010 ROR	"implied risk"
Agriculture	0.33	1.00	1.03	0.3433
Forestry	6.00	18.00	18.71	6.2367
Energy	1.00	3.00	1.65	0.5500
Manufacturing	1.00	3.00	3.83	1.2767
Building	4.00	12.00	8.27	2.7567
Transport	1.50	4.50	5.77	1.9233
Services	1.00	3.00	2.97	0.9900

Comparing the risk factors allows us to explain the differences in the ultimate "balanced growth path" level of investment in each sector. Thus in agriculture the risk factors are almost identical in the two simulations accounting for the relatively similar outcome for the level of investment in that sector. Likewise for the services sector. The building and energy sectors record lower risk in run03 translating to a higher level of investment, while in the manufacturing and transport sectors the converse applies.

This comparison can be taken further, as in Fig 3, where the real profit rates in the two simulations are illustrated. This shows that the lower risk, higher investment in the building and energy sectors equates to a lower real profit rate (comparing run03 with run01); while the higher risk, lower investment outcome in the manufacturing and transport sectors equates to a higher real profit rate.

To complete this comparison, a simulation was undertaken using the "neo-classical" allocation routine but imposing the "implied risk factors" obtained from the "constant real profit rate" scenario (that is, as per the fourth column of Table 4). This yielded the same result as was achieved for run03, confirming that the "neo-classical" criteria is equivalent to the "constant real profit rate" criteria given an appropriate set of sectoral risk differentials.

V Comparative dynamics

Two shocks are explored in this section. Both shocks are postulated to occur in 1995 and are permanent changes in the relevant items. They consist of :

(1) a price shock : being a change to the world terms of trade - designed as a movement "against" agricultural and other non-manufactures.

(2) a demand shock : being an increase in government consumption expenditure in real terms.

Implicit in the investment and consumption behavioural equations are expectations of the future formed on the basis of the outcome of the model. In other words, agents expect the future outcome to be what the model predicts as that outcome and, hence, their expectations are fulfilled. This form of "model-consistent" expectations need not, however, rule out uncertainty. The future is not certain in the sense that events external to the model's set of knowledge[10] are possible. If such a "surprise" occurs then the model will predict a different outcome and, simultaneously, investors and consumers will expect that different outcome and so adjust their behaviour on that basis[11].

These model experiments, therefore, require a consideration of the nature of the shock within such an environment. An external price shock in this context is not too difficult to envisage, involving a change in world demand. This could arise, perhaps, from a change in overseas consumer tastes. An internal demand shock as described, could have credibility implications in the sense that agents may not believe such a shock to be a "one-off". Such a belief is not catered for in the postulated "model-consistent" behaviour, where agents only have knowledge as per the model. Nevertheless, such a shock remains of interest if only to highlight the implications of the behaviour that is assumed. Note that the current version of the model treats the government as purely exogenous. Incorporating the government as an economic agent, with appropriate behavioural assumptions would, no doubt, change the nature of the model and any demand shock as well as the response to any such shock.

Response to a price shock

The response of a shock to the world terms of trade are illustrated in Fig 4 and 5 attached, with the control (run01) contrasted with the surprise shock outcome, labelled run15. The "neo-classical" investment criteria is adopted in both cases with the risk factors as for

10 And, implicitly, external to the agents' knowledge base.

11 An argument could be made that such behaviour is, in fact, myopic in that agents' take no information into account other than that specified in the behavioural equations of section II.

run01, as tabulated above. The shock is imposed assuming an excess supply of labour and, hence, an exogenously fixed real wage rate.

Given the commodity disaggregation of exports available in the model this shock involved a rise in the world price of all imports and in the world price of competing manufactured exports only. First-round effects of the shock may improve the competitiveness of NZ's manufactured exports and of NZ goods on the domestic market (vis-a-vis imported items), although other NZ export commodities are still faced with competitors' unchanged prices on the world market. While this shock, therefore, incorporates a direct change to relative prices it is unclear, a priori, whether this involves a competitiveness gain or loss in the aggregate. Such a measure being influenced not only by the relative size of non-manufactures in our export base, but also by the effect of import prices on the domestic level of costs (and hence on the costs of producing all exports, not just manufactures).

The aggregate result as pictured in Fig 4 shows an overall increase in competitiveness indicated by the increase in export volumes concurrent with the shock in 1995 and the ultimately lower level of the debt-to-GDP ratio. This result, however, is only achieved by a marked lowering of the level of domestic demand - which restrains the cost pressures flowing from the relative price shock. Both consumption and investment demand is adjusted downwards in 1995 (compared to the control) resulting in a similar outcome for overall real GDP. Despite this lower demand, consumer prices still rise (albeit marginally) above control in 1995 - another indication of the cost influences of the shock.

These cost pressures lead investment plans to be adjusted - resulting in a lower level of capital available, consistent with the outcome for GDP output. The greater fall in employment compared to capital, is an indication of the price of labour relative to that of capital (the profit rate) increases - which follows from the exogenously fixed real wage rate assumption. If this assumption were replaced with an exogenously determined level of aggregate labour (demand) then the cost pressures arising from the shock evident in this simulation would be muted as some of the adjustment is absorbed by wage earners.

Not surprisingly, a relative price shock in this model has lasting repercussions on the level of demand and thus capital requirements. This is indicated for each sector in Fig 5, which indicates the "long run" level of investment is adjusted downwards in the domestic-demand driven services, energy and transport sectors. The more export-oriented agriculture and manufacturing sectors appear to be essentially unaffected. There are likely to be intra-sectoral movements here, however, as the domestically-oriented manufactures would be subject to influences and pressures similar to the services sector. Such adjustments would, no doubt, be uncovered in a less aggregated version of the model.

Response to a demand shock

Another comparative dynamic exercise is illustrated in Fig 6 and 7, which show the response to a demand shock - again using the "neo-classical" run01 as control. This experiment consists of a sustained increase in the level of government consumption expenditure of 5% beginning in 1995. Again, this shock is analysed assuming an excess supply of labour and thus exogenously unchanged real wage rates.

In the aggregate picture we can see that the largest response is in real private consumption. This adjusts to a lower level immediately, but thereafter resumes its 2% growth consistent with the "balanced steady-state" scenario. The slight increase in GDP is consistent with the increase in labour employed, resulting from the expansion in the relatively labour intensive services sector - the principal "beneficiary" through the inter-industry relationships of an increase in government consumption demand.

Compositional changes in the allocation of investment amongst the sectors accounts for the marginal rise in aggregate investment in the year of the shock. In the aggregate, however, this rise can be almost ignored as indicated by the result for the real capital stock, in aggregate, which is barely altered by the shock. The rise in GDP, therefore, is negligible and the overall outcome can be summarised as one where private consumption is crowded-out by the increase in public consumption. It could be argued that such "crowding-out" is effected through the need to raise tax rates to fund the extra expenditure. Such an explicit link, however, must await a future version of the model incorporating an inter-temporal government budget constraint.

Given this aggregate outcome there is minimal effect on prices and thus on competitiveness, leading to no change in the ultimate level of the debt-to-GDP ratio.

The response of sectoral investment (illustrated in Fig 7) indicates a short-term adjustment in the year of the shock - most noticeably a rise in the building and services sectors and a fall in the agriculture and transport sectors. These adjustments are driven by the changes to demands for sectoral output arising from the shock - leading to one-off shifts in the level of capital stock in each sector. The ultimate (long-run) level of investment in each sector, however, remains invariant to this shock as is consistent with there being no change in either risks or required rates of return.

Experimenting further with the government expenditure shock by assuming that there is an anticipated response (two years before implementation of the shock) produces run11 - illustrated in Fig 8 and 9. The principal finding that the public consumption increase "crowds-out" private consumption in this model remains, although there is now a small but noticeable one-off rise in real GDP occurring in 1994 (one year following anticipation but one year before implementation of the shock). This response comes from the behaviour of investors given the expectation (which is fulfilled) of a capital gain. Although small, the effect succeeds in bringing forward and magnifying the investment adjustment, sufficient to provide a slight rise to the level of the capital stock. Accompanied by a larger (than in run12) rise in labour employed (for similar reasons) the gain to GDP results.

The "capital gain" arises from the lower price level in 1993 (the first year of adjustment) resulting from the downward adjustment of private consumption and thus lower overall demand in that year (compared to the no-shock control run01). This lower price level is followed in 1994 (the year of the shock) by a higher (than control) price level, resulting from the increased demand that year. This expectation is the source of the "capital gain" which encourages the change in the investment adjustment, although in the "long-run" investment spending ultimately reverts to the control levels, again consistent with no change in required rates of return or risk factors.

VI Sensitivity analyses

Base dependency ?

The question of whether the above results are dependent on the "control" path was addressed in experiments labelled run06 and run16, illustrated on Fig 10 and 11.

i) two control bases compared

For this exercise a new "control" path was generated - using the same procedures as described in sections III and IV above. The "balanced" growth rate, though, was set at 3%, compared to 2%, previously. The solid lines (run06) on Fig 10 and 11 represent this new control base - constructed to produce an economy growing in a "steady-state" fashion at the real rate of 3%pa. Overall, this new base is of little qualitative difference to that labelled run01 and described in the previous sections. There is an immediate increase in competitiveness, as indicated by the sharp fall in consumer prices in the first year, followed by a gradual convergence to a constant level of competitiveness by the tenth year. This is similar to the result of the previous control simulation (run01).

At the sectoral level there is similar concordance in most of the results except in that for the building sector. Here, it is quite clear that the steady-state growth rate has a profound influence on the nature of the short-term adjustment. To explain this outcome, it is helpful to remember the initial year influences on investment in the building sector. Table 5 below provides a summary of the directions of these influences for the two control simulations.

Table 5 Influences on investment in the building sector in the initial year

Building sector	INFLUENCE NUMBER (1)	(2)	(3)	Investment
Run01	+	+	-	-
Run06	+	+	+	+

As discussed in section IV, there were positive influences from the "neo-classical" rate of return criteria as well as from the difference between the current growth rate of capital stock and the steady-state growth rate. In run01, however, these two influences on investment in the building sector were outweighed by the effects of a fall in demand for building sector output resulting from the overall shift to tradeables. This yielded a sharp fall in the first year in investment in this sector. The new control run06, by contrast, contains a larger positive influence from the second source due to the higher steady-state rate. In addition, the higher steady-state rate also yields a positive influence from the third source as now the shift to tradeables is incorporated within a greater overall expansion.

The importance of the steady-state rate is most pronounced for the building sector because if its large dependence, through input-output linkages, on aggregate investment demand which is related to the required level of capital implicit in the chosen steady-state rate of growth. Thus, while the aggregate picture leads to a qualitatively similar outcome in the two control bases, the quantitative difference between them is sufficient to create some noticeable disparity in the short-term adjustment at the disaggregated level.

ii) comparative dynamics compared

Using this new control (run06) a comparative dynamic exercise was undertaken and this is illustrated in Fig 10 where the response to a price shock is labelled run16. Such an experiment indicates a response to the relative price change similar to that described in section V above. There is a similar increase in export volumes concurrent with the shock in 1995 achieved by a large reduction in the level of domestic demand which helps restrain the cost pressures from the higher priced imports. The response of sectoral investment to this price shock as shown in Fig 11 also reveals a similar impact as reported in section V.

An experiment (not shown[12]) imposing a demand shock on this new control came to the same findings as before.

The results of this investigation into the sensitivity of the model outcome reinforces the suitability of the model for the comparative dynamic type of analysis undertaken here. However, the model would need to be re-specified if required for "forecasting" purposes, as is indicated by differences found at the sectoral level in the results for run01 and run06.

12 Details available from the author on request.

Length of time horizon

Of similar importance is ensuring that the comparative dynamic exercises described in section V are not sensitive to the length of the time horizon - or to put it another way, to ensure that enough time has been allowed for all the adjustments to the shock to take place and the economy return to a "steady-state" or "balanced growth" path. To investigate this aspect the terminal year was re-specified to be 2025, instead of 2010, thus extending the time horizon of the model by 15 years - from 21 to 36 years. The experiments illustrated on Fig 12 and 13 are:

(1) control run101 : the original "neo-classical" control simulation (run01) but solved over the longer horizon (solid line).

(2) end year=2025 run215 : the response to price shock simulation presented in the previous section but solved over the longer horizon (dashed line).

(3) end year=2010 run15 : the response to price shock as in the above section solved over the original 21 year horizon repeated here for ease of comparison (dotted line)

The extension of the horizon for the control simulation (run101) resulted in no differences when compared to the original outcome (run01), in both the short and the long run - an unsurprising result given the identical relative price structure of each experiment. Furthermore, as there is (almost) no relative price change in the demand shock investigated above it was relatively trivial to replicate the results of run12 and of run11 over the longer time horizon (not illustrated). However, the relative price shock required an explicit treatment of the time horizon issue. The comparison between the results for run215 and those for run15 show satisfying evidence in this regard. All the aggregate measures and the sectoral investment paths illustrated show an almost identical response to the shock. Further inspection of other model results show a similar degree of concordance.

The one variable shown that did show a degree of sensitivity to the time horizon was the debt-to-GDP ratio, as can be seen. This, however, is purely an indication of a "linearising error" encountered in the model solution routine. Inspecting, in particular, each of the components of the current account balance show a more than satisfactory equivalence between the two simulations. However, small differences in the debt levels do accumulate with the "errors" being further compounded by interest payments. In the table attached[13] it can be seen how errors of less the 0.5% in all of the source components of debt (ie export receipts, import volumes and net factor payments) are accumulated to the visible difference in the debt-to-GDP ratio shown. This is unfortunate visually, but does appear to provide an indication that the model result, in terms of the resource (investment) allocation response to the price shock is indeed insensitive to the length of the time horizon, beyond a minimum length of around 20 years.

VII Conclusions - further development

This paper has described the development of the *Jody* model - beginning from its static counterpart, the *Joanna* model. The specification of inter-temporal behaviour has followed "standard" neo-classical lines, although such behaviour is restricted to private consumers and investors only. While the choice of a model expressed and solved for in percentage change form simplifies the solution of the model, the generation of a dynamically-consistent database is more complex. The results of several comparative dynamic exercises reinforce the crucial role of relative prices and, hence, competitiveness

13 Refer to appendix

in such a model structure. The results obtained show a time horizon of 20 years to be sufficient for the short-term adjustments to have taken place and the model economy to have reverted to a steady-state path.

An emphasis is apparent in this paper on the comparative dynamic forms of analysis to which this model, as presently constructed, is ideally suited. A re-formulation of the model specifications would be required, however, if it was desired to use the model in a forecasting role.

Aspects of the model's response to these shocks highlight avenues for developing the modelling structure. A high priority is endogenising the government's budgetary flows which would, in turn, allow explicit treatment of the government as an economic agent with some postulated behavioural function along with a budget constraint. This would introduce the public debt into the model and also be a pre-requisite for the incorporation of monetary and financial capital flows. In addition, future work on this model should include the exploration of differing inter-temporal behaviour as well as the inclusion of varying (sector-specific) gestation lags between investment expenditure and capital formation.

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FIGURES - simulation results

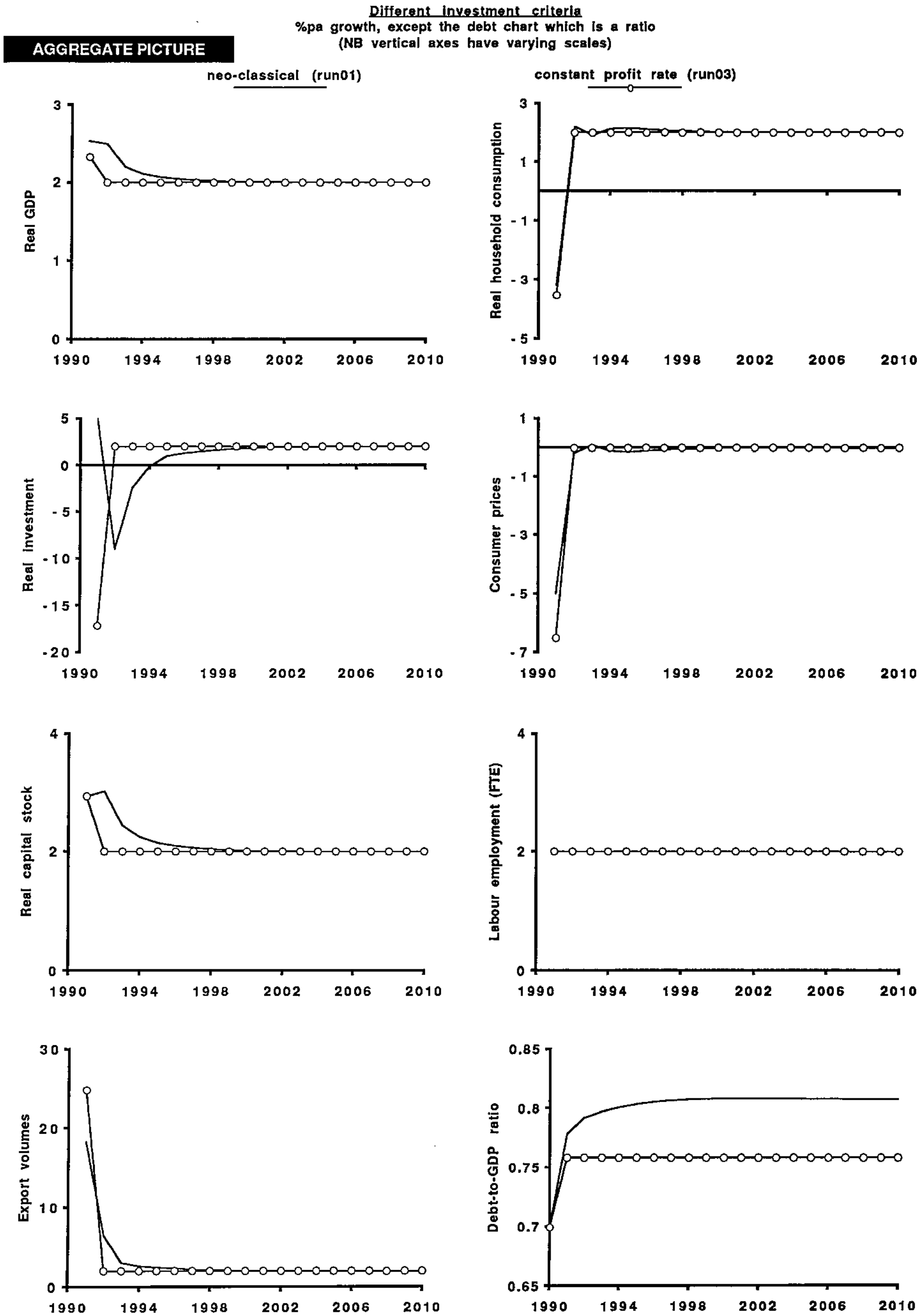

AGGREGATE PICTURE
Different investment criteria
%pa growth, except the debt chart which is a ratio
(NB vertical axes have varying scales)
neo-classical (run01)
constant profit rate (run03)
Real GDP
Real household consumption
Real investment
Consumer prices
Real capital stock
Labour employment (FTE)
Export volumes
Debt-to-GDP ratio

FIGURE 1

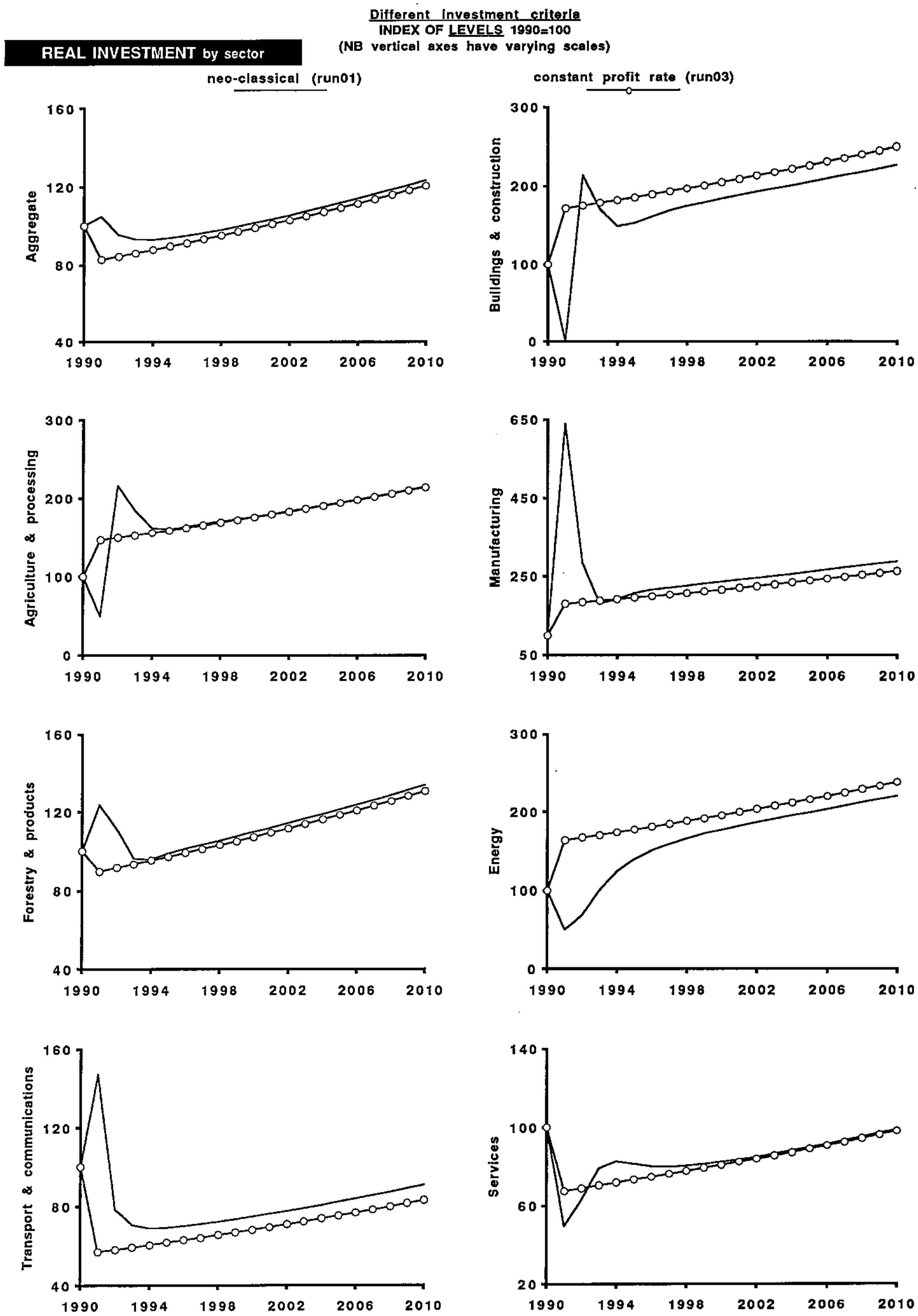
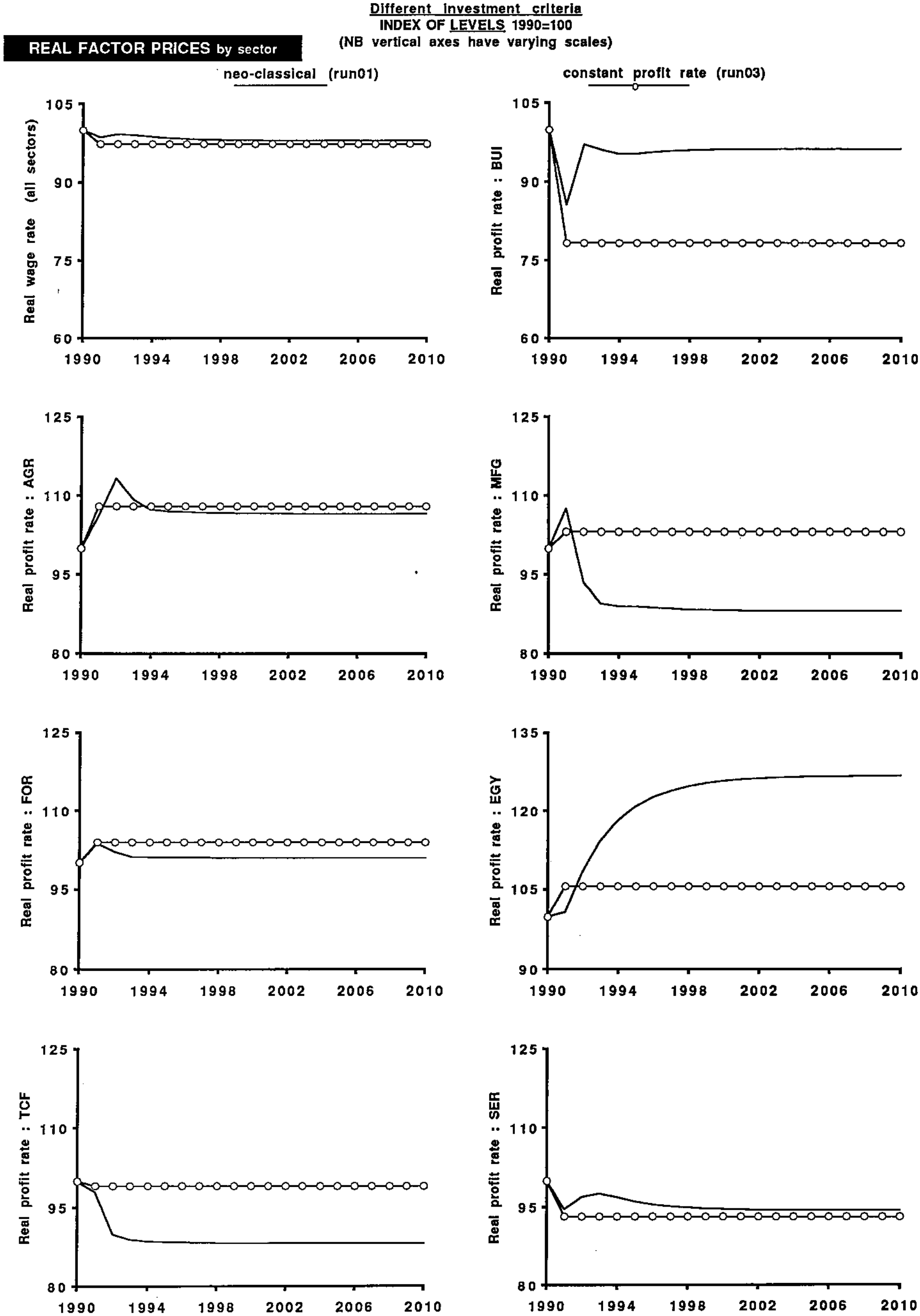

REAL INVESTMENT by sector
Different investment criteria
INDEX OF LEVELS 1990=100
(NB vertical axes have varying scales)
neo-classical (run01)
constant profit rate (run03)
Aggregate
Buildings & construction
Agriculture & processing
Manufacturing
Forestry & products
Energy
Transport & communications
Services
1990
1994
1998
2002
2006
2010

FIGURE 2



Different investment criteria
INDEX OF LEVELS 1990=100
(NB vertical axes have varying scales)
REAL FACTOR PRICES by sector
neo-classical (run01)
constant profit rate (run03)
Real wage rate (all sectors)
Real profit rate : BUI
Real profit rate : AGR
Real profit rate : MFG
Real profit rate : FOR
Real profit rate : EGY
Real profit rate : TCF
Real profit rate : SER
1990
1994
1998
2002
2006
2010

FIGURE 3

AGGREGATE PICTURE

Response to price shock
%pa growth, except the debt chart which is a ratio
(NB vertical axes have varying scales)

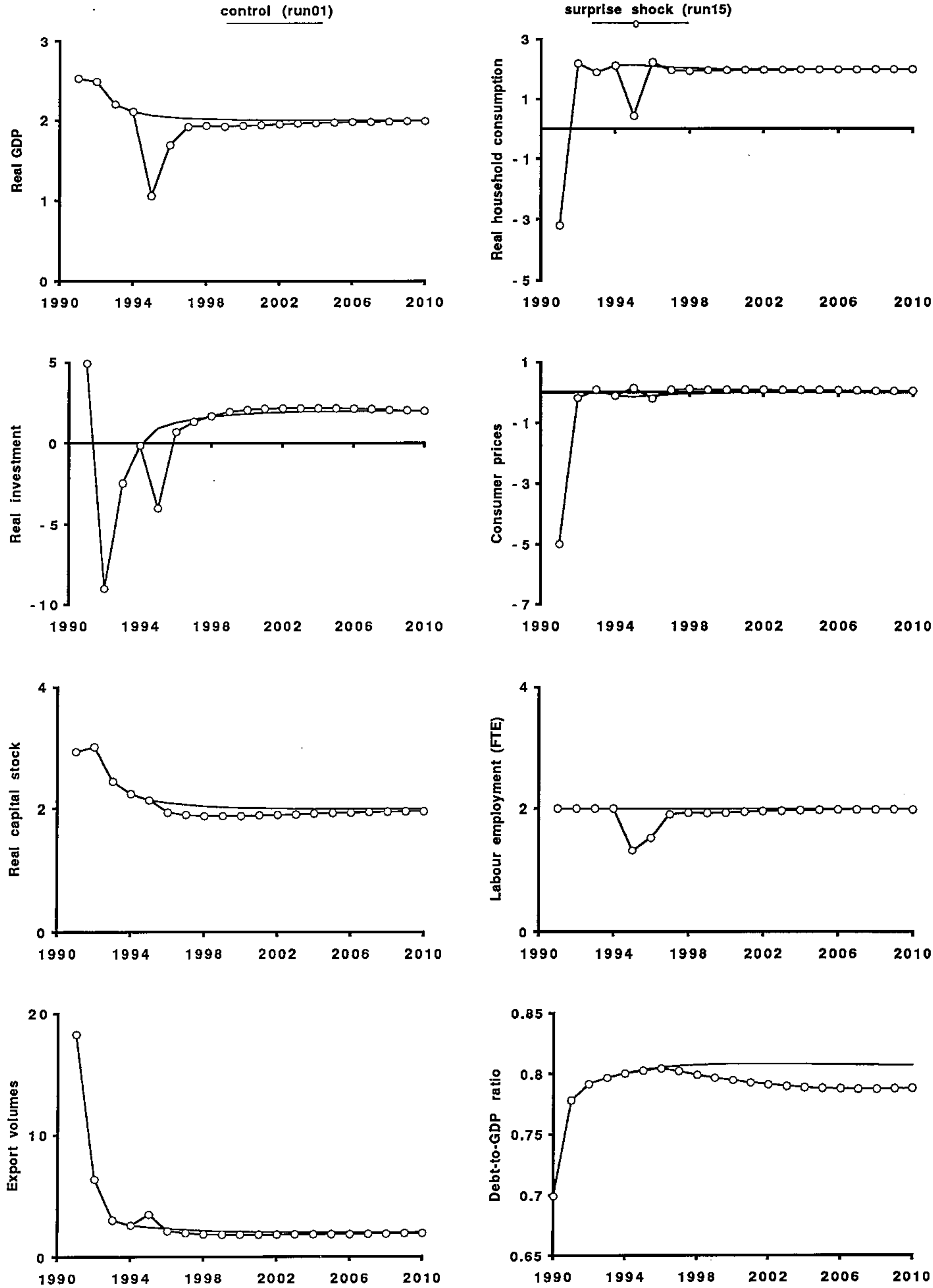


FIGURE 4

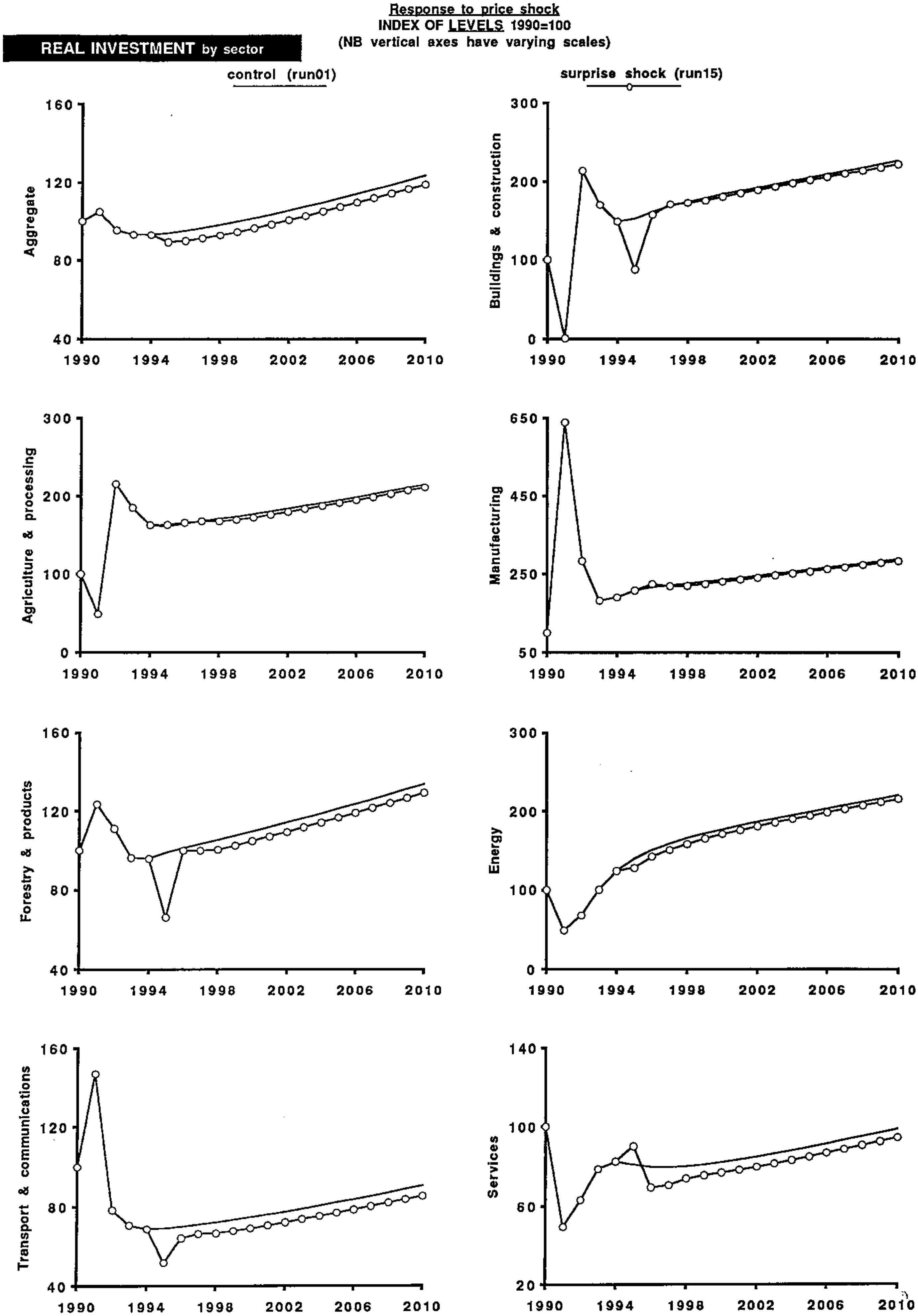

Response to price shock
INDEX OF LEVELS 1990=100
(NB vertical axes have varying scales)
REAL INVESTMENT by sector
control (run01)
surprise shock (run15)
Aggregate
Buildings & construction
Agriculture & processing
Manufacturing
Forestry & products
Energy
Transport & communications
Services
1990
1994
1998
2002
2006
2010

FIGURE 5

AGGREGATE PICTURE

Response to demand shock (surprise)
%pa growth, except the debt chart which is a ratio
(NB vertical axes have varying scales)

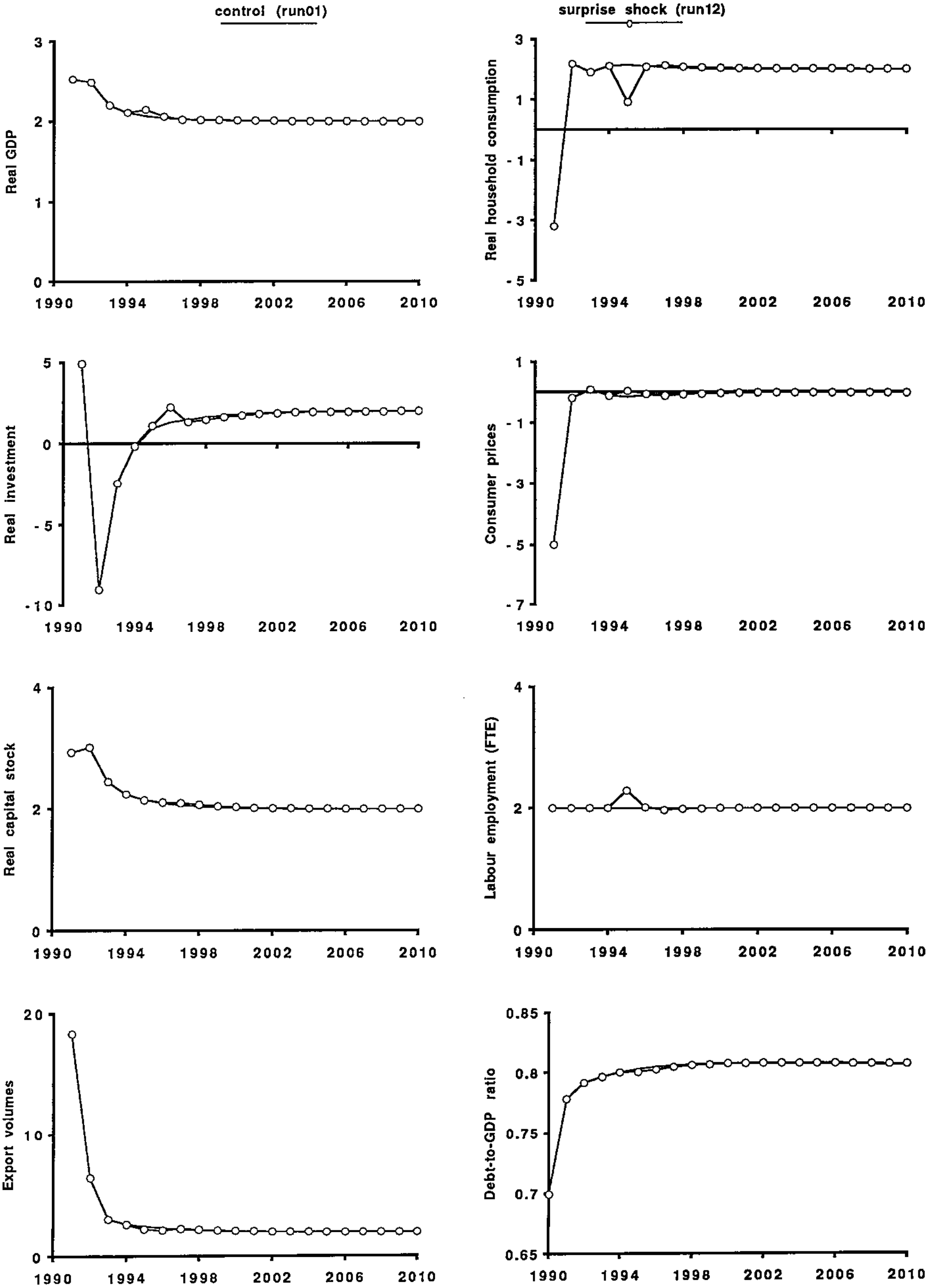


FIGURE 6

Response to demand shock (surprise)
INDEX OF LEVELS 1990=100
(NB vertical axes have varying scales)

REAL INVESTMENT by sector

control (run01) — surprise shock (run12)

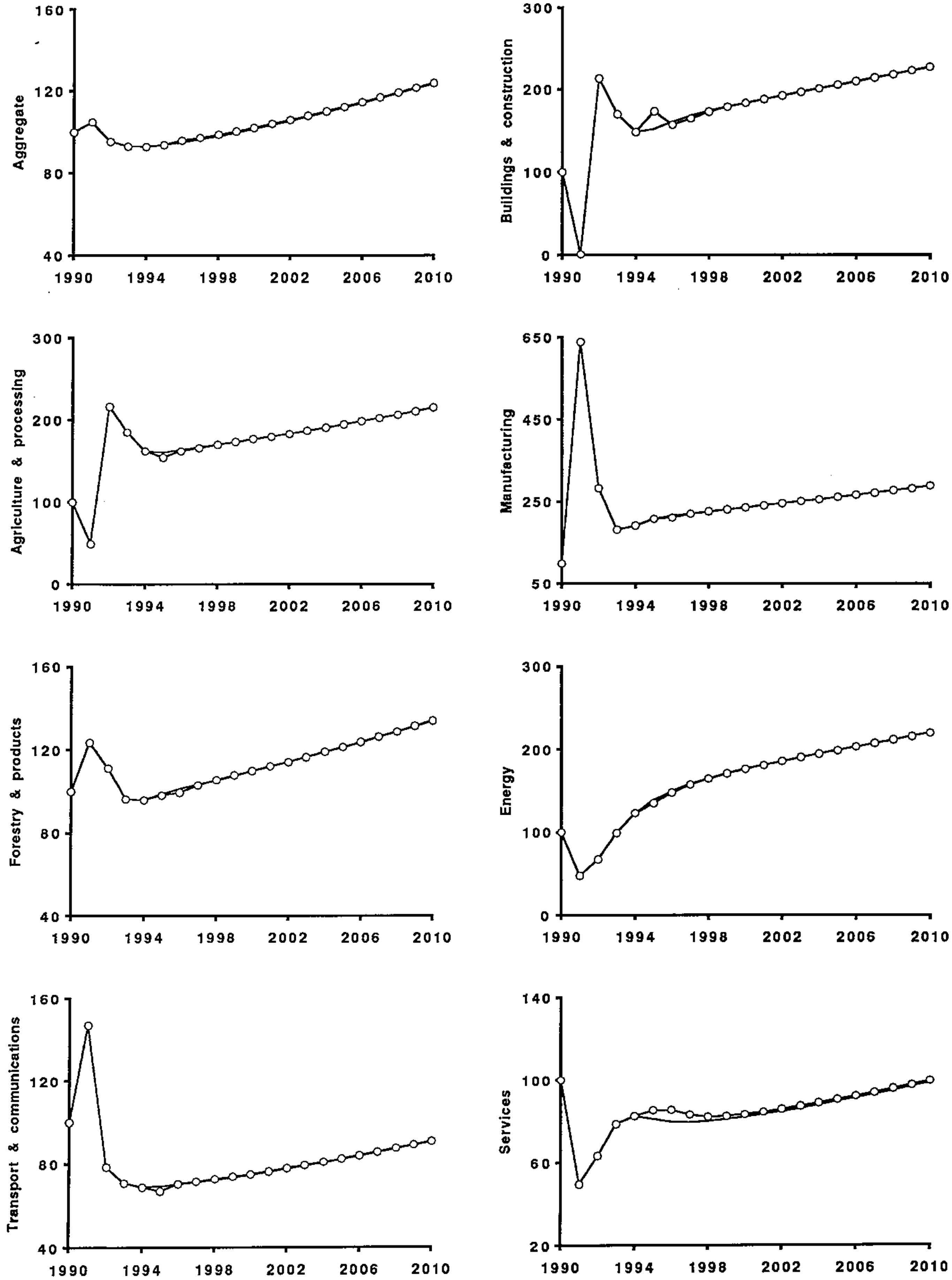


FIGURE 7

Response to demand shock (anticipated)
%pa growth, except the debt chart which is a ratio
(NB vertical axes have varying scales)

AGGREGATE PICTURE

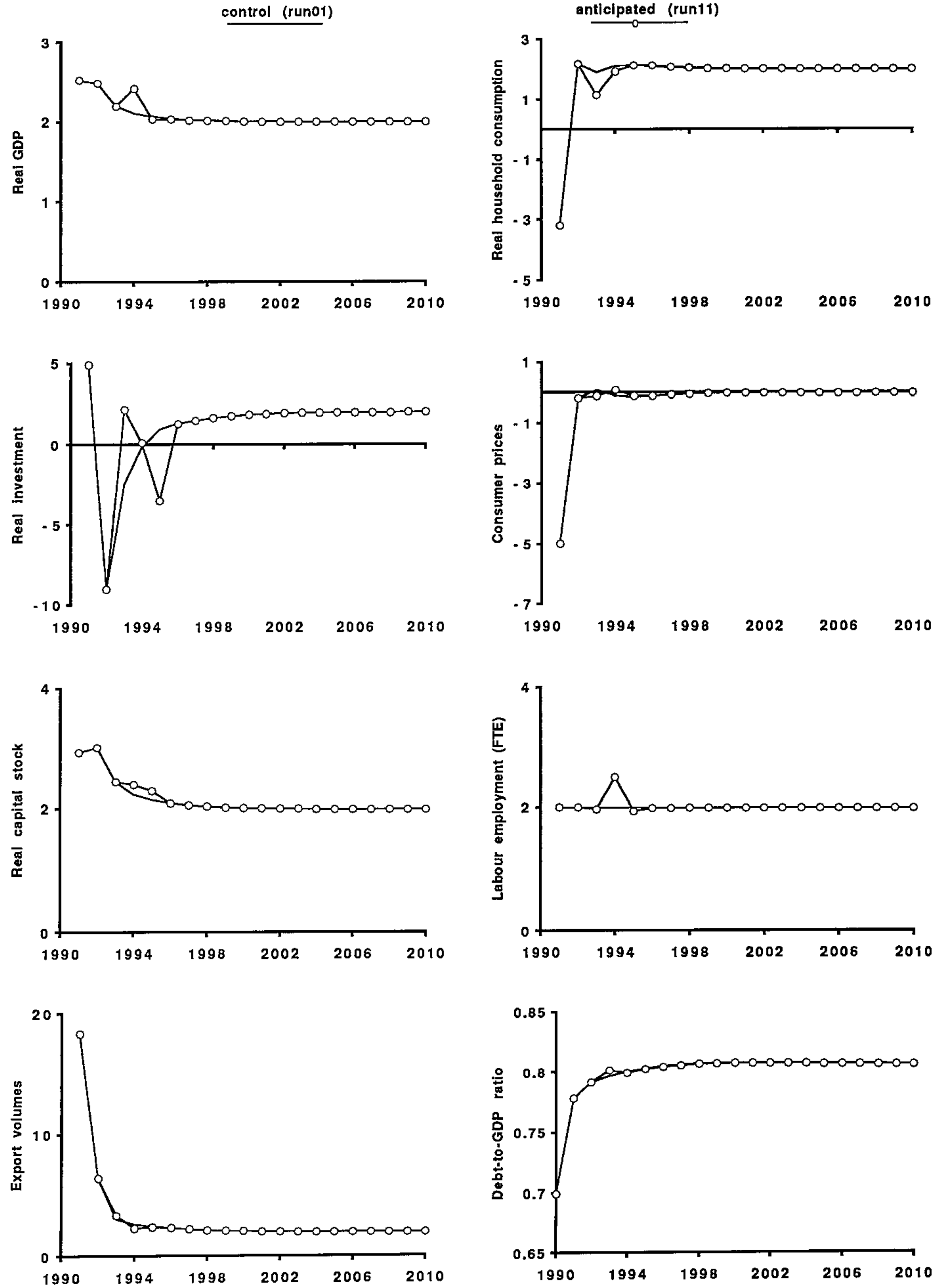


FIGURE 8

Response to demand shock (anticipated)
INDEX OF LEVELS 1990=100
(NB vertical axes have varying scales)

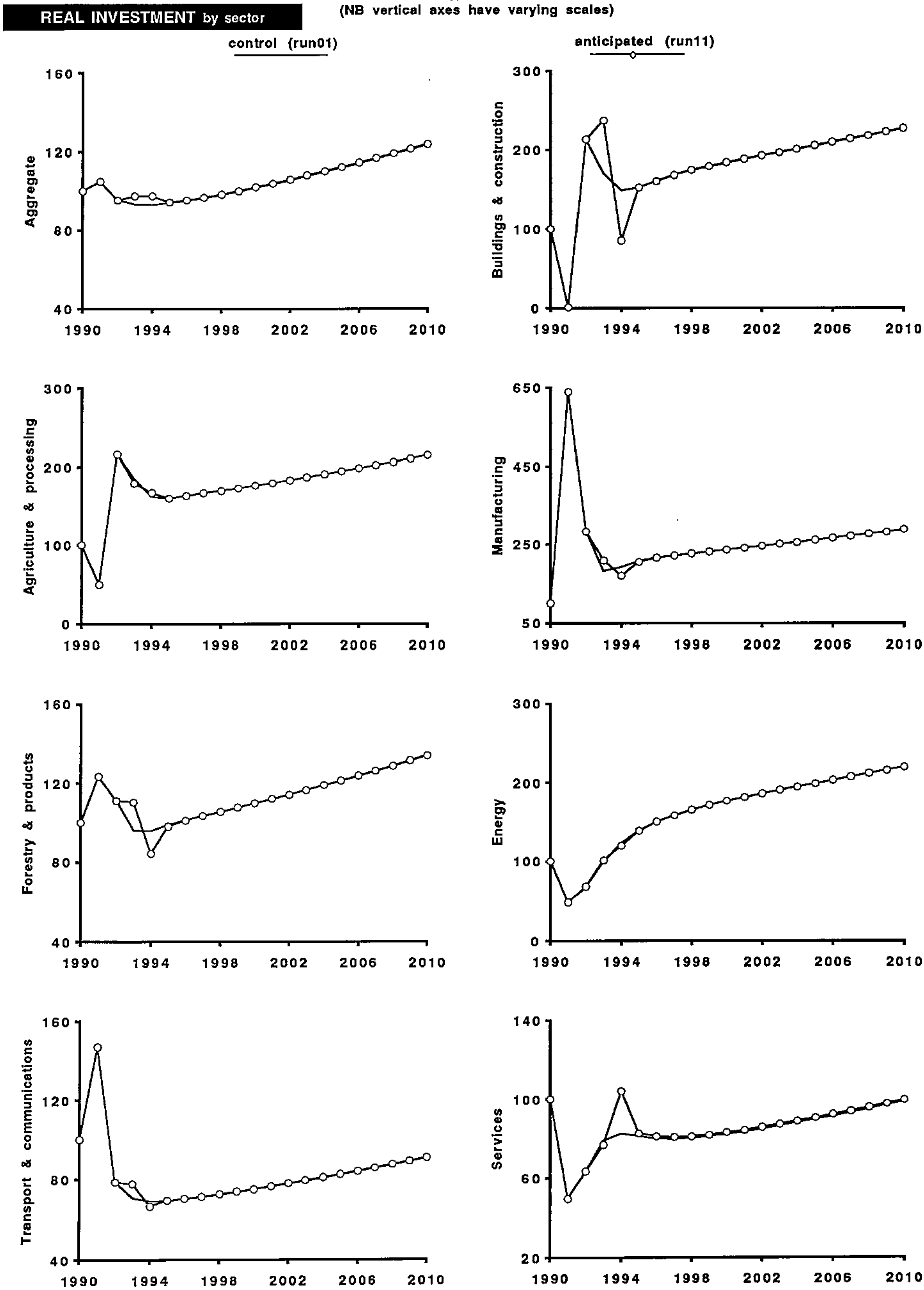


FIGURE 9

AGGREGATE PICTURE

An alternative base
%pa growth, except the debt chart which is a ratio
(NB vertical axes have varying scales)

control (run06) surprise shock (run16)

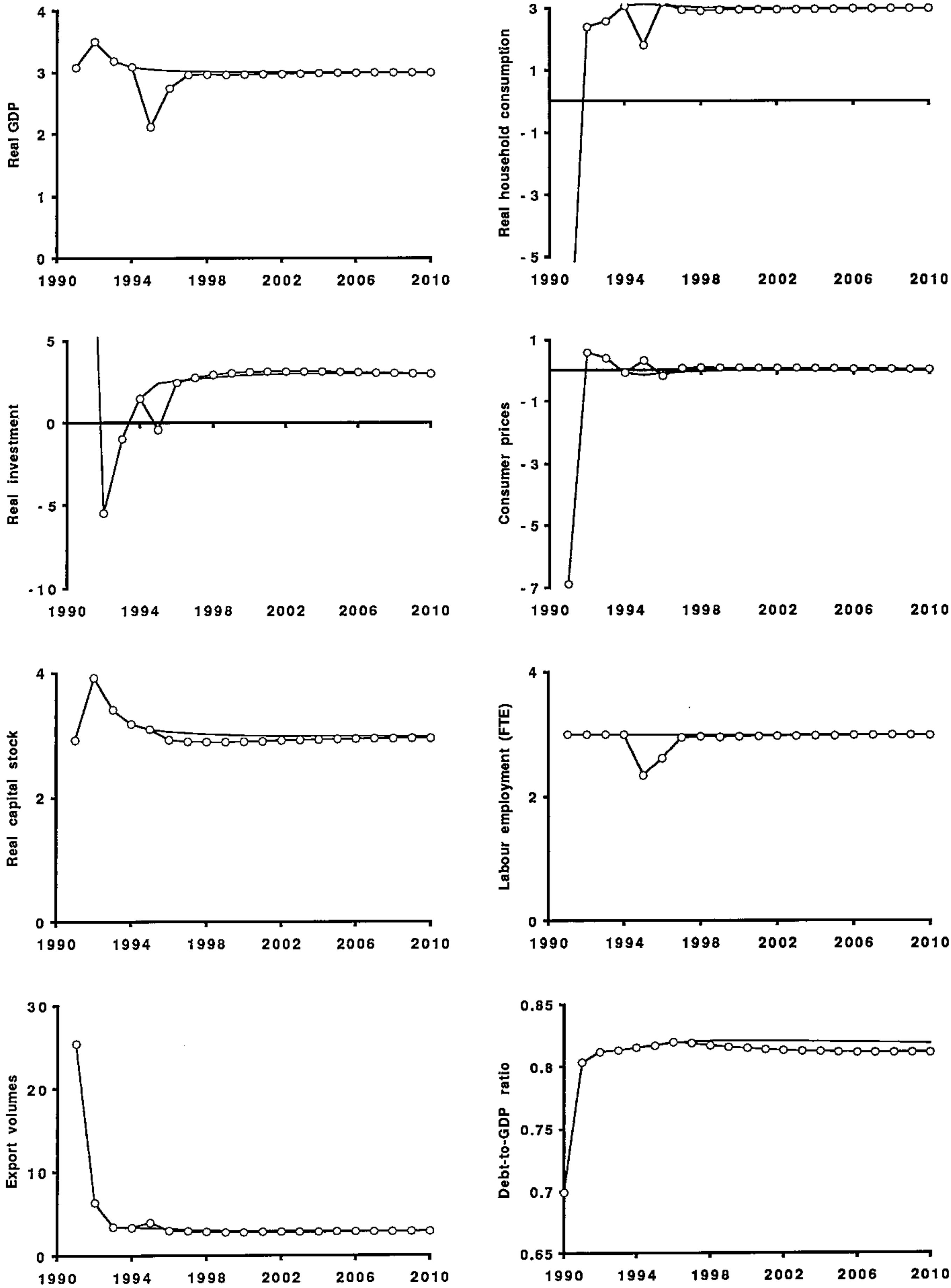


FIGURE 10

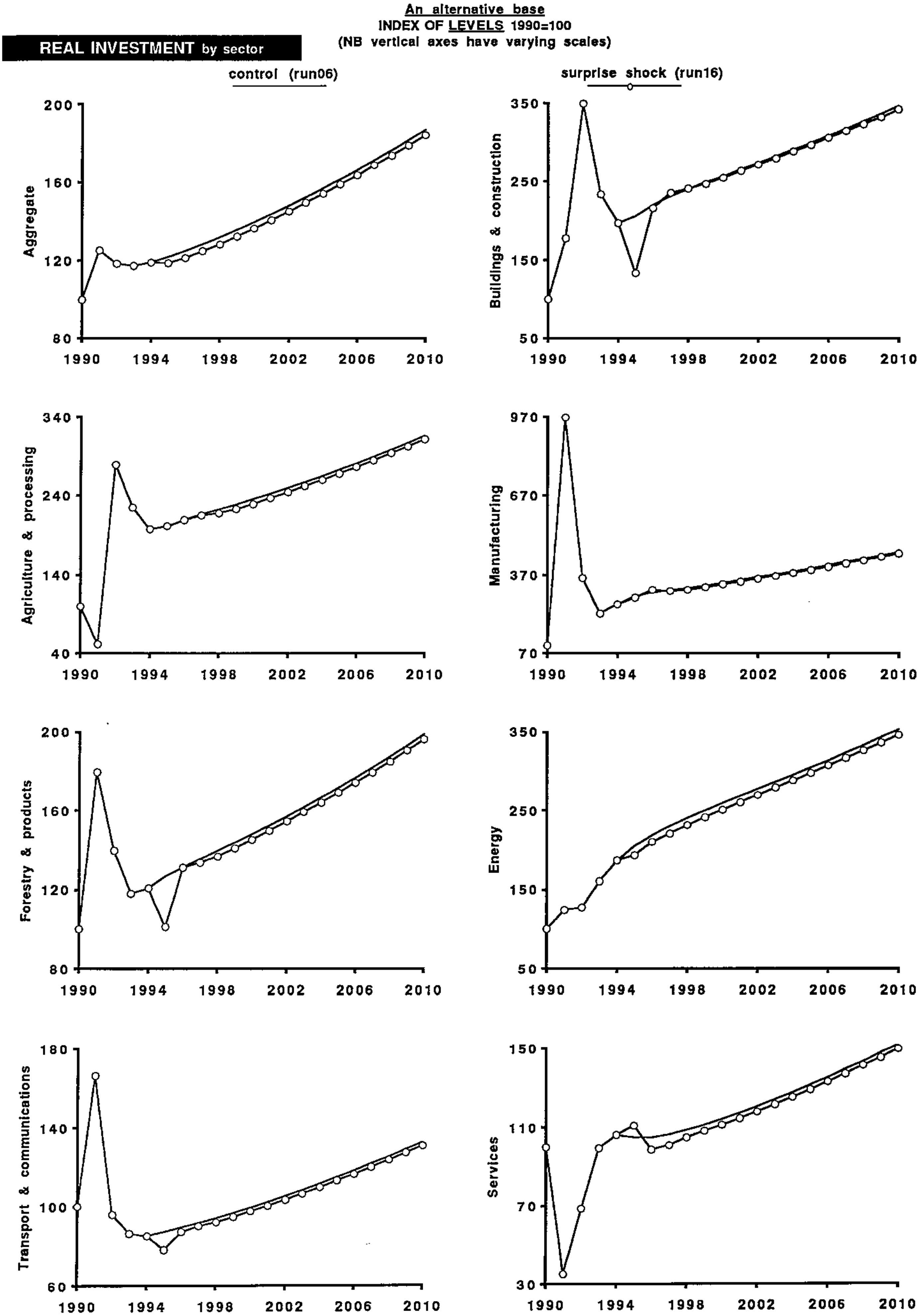

An alternative base
INDEX OF LEVELS 1990=100
(NB vertical axes have varying scales)
REAL INVESTMENT by sector
control (run06)
surprise shock (run16)
Aggregate
Buildings & construction
Agriculture & processing
Manufacturing
Forestry & products
Energy
Transport & communications
Services
1990
1994
1998
2002
2006
2010

FIGURE 11

Extending the time horizon
%pa growth, except the debt chart which is a ratio
(NB vertical axes have varying scales)

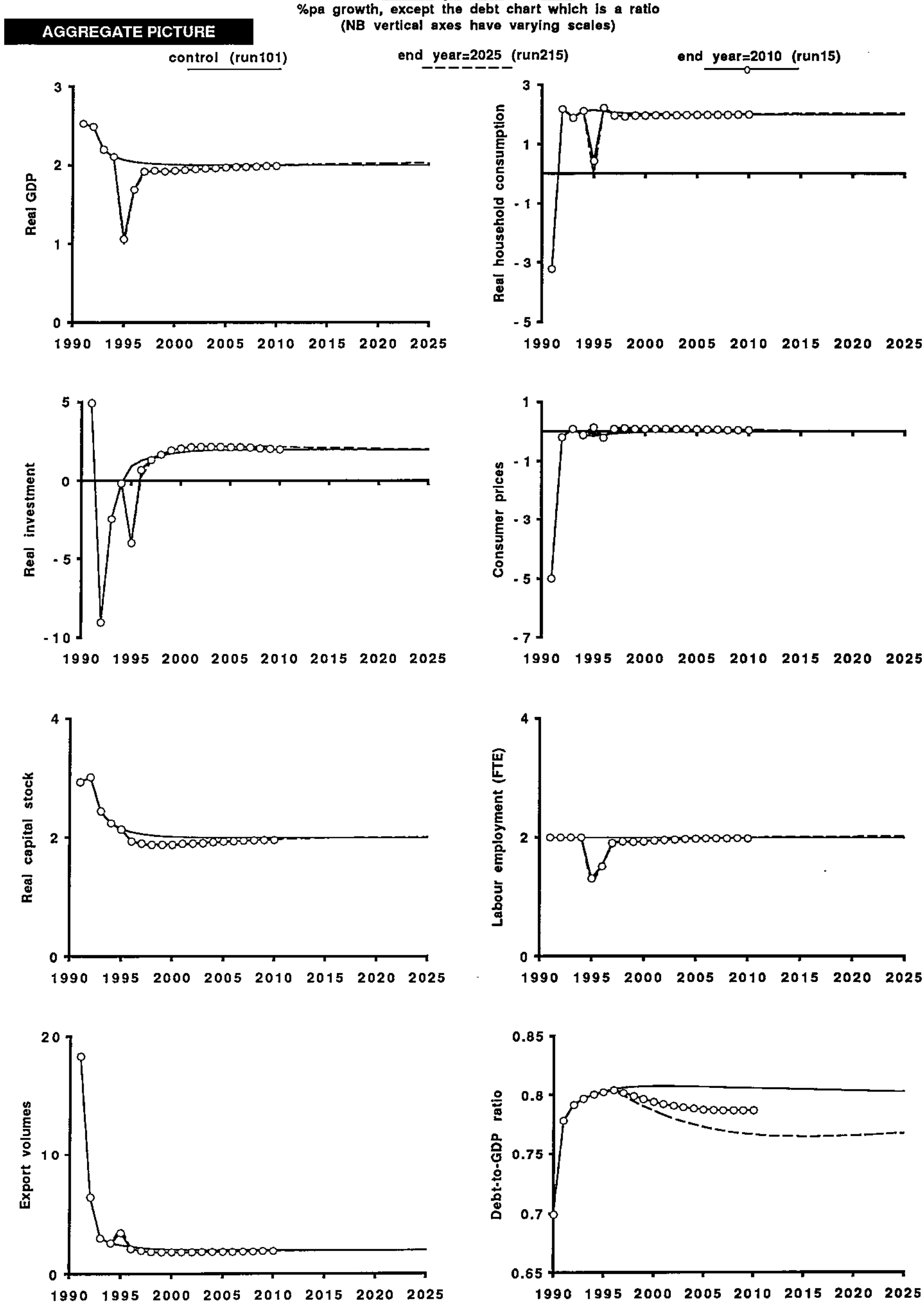


FIGURE 12

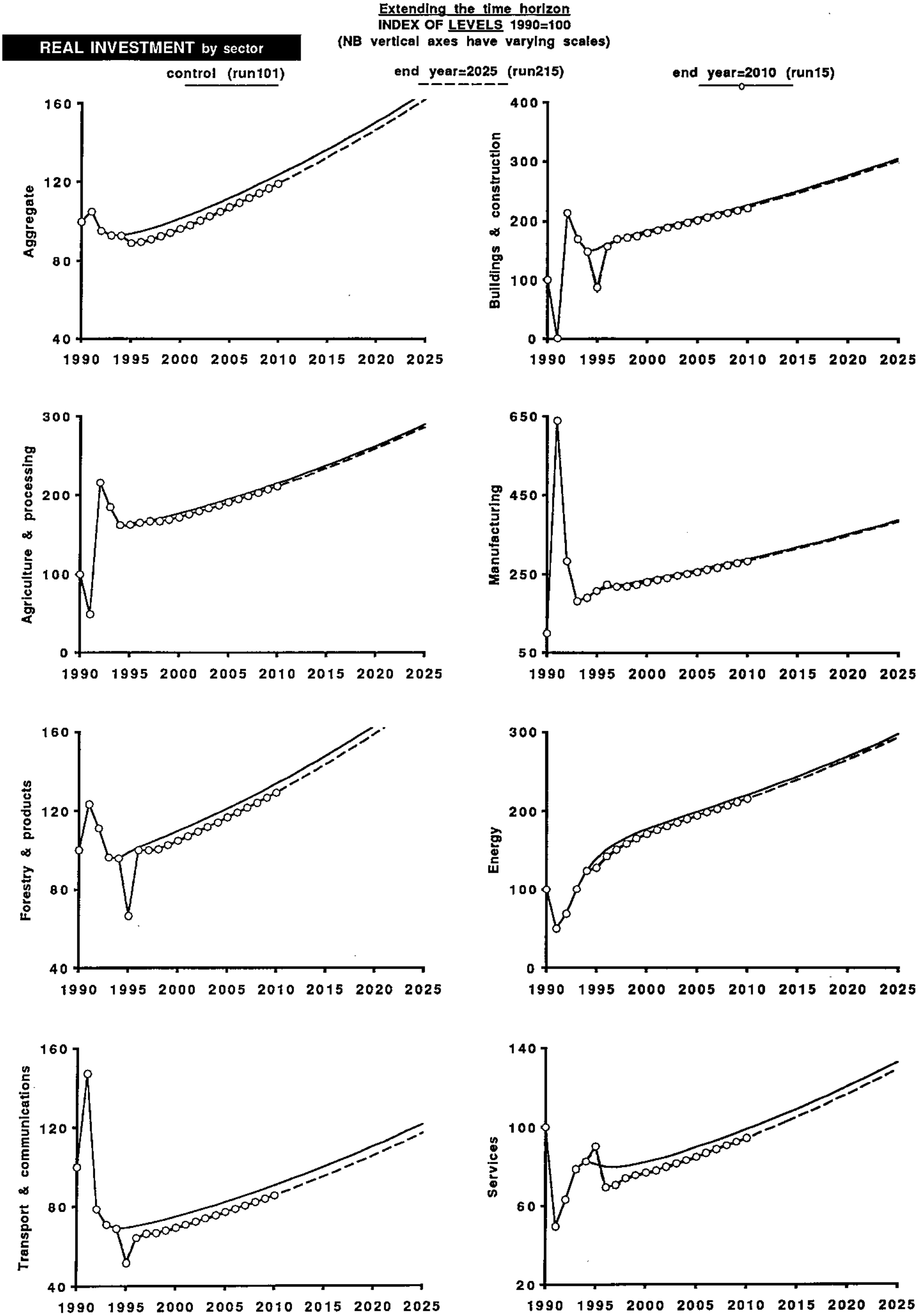

Extending the time horizon
INDEX OF LEVELS 1990=100
(NB vertical axes have varying scales)
REAL INVESTMENT by sector
control (run101)
end year=2025 (run215)
end year=2010 (run15)
Aggregate
Buildings & construction
Agriculture & processing
Manufacturing
Forestry & products
Energy
Transport & communications
Services
1990 1995 2000 2005 2010 2015 2020 2025

FIGURE 13

THE DEBT-TO-GDP RATIO - SENSITIVITY TO THE TIME HORIZON

The difference between run215 (36-year horizon) and run15 (21-year horizon):

run215 - run15 ($m)

	Nominal GDP	Export receipts	Import payments	Trade balance	Net factor payments	CAB	Interest on debt	Borrowing (implied)	Debt	D/GDP
1990	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0000
1991	-3.2	1.9	0.7	1.2	-0.1	1.3	0.0	-1.3	-1.3	0.0000
1992	-3.1	2.6	0.1	2.5	-0.1	2.6	-0.1	-2.6	-3.9	0.0000
1993	-3.1	3.0	-0.5	3.5	-0.1	3.6	-0.2	-3.8	-7.7	-0.0001
1994	-3.2	3.1	-0.6	3.7	-0.1	3.8	-0.4	-4.2	-11.9	-0.0001
1995	-215.3	91.3	-30.8	122.1	-5.4	127.5	-0.6	-128.1	-140.0	0.0004
1996	-244.3	108.7	-39.2	147.9	-6.1	154.0	-7.1	-161.1	-301.0	-0.0014
1997	-243.9	104.9	-52.9	157.8	-6.1	163.9	-15.2	-179.1	-480.2	-0.0037
1998	-247.0	99.2	-62.2	161.4	-6.2	167.6	-24.3	-191.9	-672.0	-0.0061
1999	-253.3	93.7	-66.1	159.8	-6.3	166.1	-34.0	-200.1	-872.2	-0.0084
2000	-259.8	88.8	-68.5	157.3	-6.5	163.8	-44.1	-207.9	-1080.1	-0.0108
2001	-265.8	84.0	-70.6	154.6	-6.6	161.2	-54.7	-215.9	-1296.0	-0.0132
2002	-271.3	79.3	-72.8	152.1	-6.8	158.9	-65.6	-224.5	-1520.5	-0.0155
2003	-276.6	74.9	-74.6	149.5	-6.9	156.4	-76.9	-233.4	-1753.8	-0.0179
2004	-281.3	70.8	-76.0	146.8	-7.0	153.8	-88.7	-242.6	-1996.4	-0.0203
2005	-285.4	66.9	-76.9	143.8	-7.1	150.9	-101.0	-252.0	-2248.3	-0.0227
2006	-288.4	63.2	-76.7	139.9	-7.2	147.1	-113.8	-260.9	-2509.2	-0.0251
2007	-290.1	59.7	-75.0	134.7	-7.3	142.0	-127.0	-268.9	-2778.1	-0.0274
2008	-289.3	56.5	-71.0	127.5	-7.2	134.7	-140.6	-275.3	-3053.4	-0.0298
2009	-284.5	53.5	-63.8	117.3	-7.1	124.4	-154.5	-278.9	-3332.4	-0.0322
2010	-274.0	50.6	-54.1	104.7	-6.8	111.6	-168.6	-280.2	-3612.5	-0.0344

The difference between run215 (36-year horizon) and run15 (21-year horizon):

run215 - run15 (%)

	Nominal GDP	Export receipts	Import payments	Trade balance	Net factor payments	CAB	Interest on debt	Borrowing (implied)	Debt	D/GDP
1990	0.00	0.00	0.00	0.00	0.00	0.00			0.00	0.00
1991	0.00	0.01	0.00	0.18	0.00	-0.12	0.00	-0.04	0.00	0.00
1992	0.00	0.01	0.00	0.11	0.00	0.45	0.00	-0.12	-0.01	0.00
1993	0.00	0.01	0.00	0.12	0.00	0.29	-0.01	-0.24	-0.01	-0.01
1994	0.00	0.01	0.00	0.11	0.00	0.25	-0.01	-0.30	-0.02	-0.02
1995	-0.29	0.38	-0.15	3.02	-0.29	5.80	-0.02	-16.57	-0.24	0.06
1996	-0.33	0.44	-0.19	3.80	-0.33	7.64	-0.24	-16.23	-0.50	-0.17
1997	-0.32	0.41	-0.25	3.94	-0.32	7.83	-0.50	-18.54	-0.78	-0.46
1998	-0.32	0.39	-0.29	3.93	-0.32	7.78	-0.78	-20.12	-1.08	-0.76
1999	-0.32	0.36	-0.30	3.83	-0.32	7.63	-1.08	-20.43	-1.38	-1.06
2000	-0.32	0.33	-0.30	3.73	-0.32	7.50	-1.38	-20.32	-1.68	-1.36
2001	-0.32	0.31	-0.31	3.63	-0.32	7.38	-1.68	-20.13	-1.98	-1.66
2002	-0.32	0.29	-0.31	3.54	-0.32	7.26	-1.98	-19.97	-2.28	-1.97
2003	-0.32	0.27	-0.31	3.44	-0.32	7.13	-2.28	-19.83	-2.59	-2.27
2004	-0.32	0.25	-0.31	3.34	-0.32	7.00	-2.59	-19.70	-2.89	-2.58
2005	-0.32	0.23	-0.31	3.23	-0.32	6.85	-2.89	-19.59	-3.20	-2.89
2006	-0.32	0.21	-0.30	3.11	-0.32	6.64	-3.20	-19.45	-3.50	-3.20
2007	-0.31	0.20	-0.29	2.95	-0.31	6.37	-3.50	-19.27	-3.80	-3.50
2008	-0.30	0.18	-0.27	2.76	-0.30	6.00	-3.80	-19.01	-4.10	-3.81
2009	-0.29	0.17	-0.24	2.50	-0.29	5.48	-4.10	-18.61	-4.39	-4.11
2010	-0.28	0.16	-0.20	2.20	-0.28	4.86	-4.39	-18.11	-4.66	-4.40

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