Impact Project

Impact Research Centre, The University of Melbourne,
153 Barry Street, Carlton, Victoria 3053 Australia.

Telephone: (03) 344 7417 (*from overseas:* 61 3 344 7417)
Telex: AA 35185 UNIMEL Telegrams: UNIMELB, Parkville
Facsimile: (03) 344 5104 (*from overseas:* 61 3 344 5104)

Paper presented to the Conference ***Fiscal Policy and the Current Account*** *organized by the Centre for Economic Policy Research, Australian National University in association with the Commonwealth Treasury, Canberra, 5th-6th June 1989*

THE EFFECTS OF FISCAL RESTRAINT ON THE AUSTRALIAN ECONOMY AS PROJECTED BY THE MURPHY AND MSG2 MODELS: A COMPARISON

by

Bruce F. PARSELL
Institute of Applied Economic & Social Research

Alan A. POWELL and Peter J. WILCOXEN
Impact Project Research Centre

University of Melbourne

Preliminary Working Paper No. IP-41 Melbourne July 1989

The views expressed in this paper do not necessarily reflect the opinions of the participating agencies, nor of the Commonwealth Government.

ISSN 1031 9034 ISBN 0 642 10376 3

IMPACT is an economic and demographic research project which aims to improve the publicly accessible policy information system available to government, private and academic analysts. The Project is conducted by Commonwealth Government agencies in association with the University of Melbourne, La Trobe University, and the Australian National University.

THE EFFECTS OF FISCAL RESTRAINT ON THE AUSTRALIAN ECONOMY AS PROJECTED BY THE MURPHY AND MSG2 MODELS: A COMPARISON

by

Bruce F. PARSELL, Alan A. POWELL and Peter J. WILCOXEN
University of Melbourne

Abstract

In the aftermath of the rational expectations debate and the onslaught of the New Classical economics, some builders of macroeconometric models have begun to change some of their habits, arguably for the better. In particular, neoclassical discipline is increasingly respected in the formation of the steady states or balanced growth solutions of the latest versions of several models (e.g., Australia's Murphy Model, and the McKibbin-Sachs Global [MSG2] Model). As well, the behaviour of certain variables (especially exchange rates and investment) increasingly tends to be linked to intertemporal optimization. In this paper we report on simulations made with the Murphy and MSG2 models of the effects of an unanticipated cut in government spending lasting for five years. We explain the results largely in terms of the innovative features mentioned above.

Contents

Tables

Appendix Tables

Figures

Charts

THE EFFECTS OF FISCAL RESTRAINT ON THE AUSTRALIAN ECONOMY AS PROJECTED BY THE MURPHY AND MSG2 MODELS: A COMPARISON

by

Bruce F. PARSELL, Alan A. POWELL and Peter J. WILCOXEN*

University of Melbourne

1. *Preview*

The tasks we set ourselves in this paper are as follows:

(i) to describe briefly some of the salient features of the MSG2 and Murphy Models, concentrating on those aspects which seem important in accounting for the results obtained from them in simulating the effects of fiscal restraint;

(ii) to give a synoptic report of the simulation results obtained by Warwick McKibbin and Chris Murphy with their respective models;

(iii) to attempt to explain, in terms of the more important mechanisms at work in the models, why McKibbin and Murphy get these results;

(iv) to identify those components of the models that 'matter' in these simulations, yet about which there is considerable scope for disagreement;

---

* Quite apart from the acknowledgements made elsewhere, we would like to thank Chris Murphy for his helpful comments on an earlier partial draft.

and finally, in the light of all of the above,

(v) to suggest areas for future research where the social pay-offs are likely to be high.

The structure of our paper reflects this plan. In Section 2 common features of MSG2 and the Murphy Model (MM) are identified, as well as differences. Although from some viewpoints the latter are substantial, these two models are *very* close together on the spectrum represented at this Conference.

In Section 3 we describe the fiscal shock and reproduce brief accounts by each of the model-builders explaining how the shock is injected into his model, and identifying the principal mechanisms for accommodating it. We then summarize the simulation results, which are qualitatively similar for both models. Then follows in Section 4 our attempt to explain the results. This is done in two stages for each model in turn. In the first stage we focus on the response in the early part of the simulations while the cut in government spending is still in operation; in the second we concentrate on the steady-state or long-run results, which may take fifteen years or more to eventuate. In the fifth and final Section we consider the agenda for further research.

We should perhaps warn readers of what *not* to expect in this paper. We have very little to say about estimation: certainly we have not attempted to discuss many features of MM which will be of interest to applied econometricians.[1] Secondly, we make no

1 For example, the implementation of the general-to-specific methodology of Hendry and Mizon; the approach used in establishing whether an empirical lag distribution is acceptable; the use of a wide range of specification tests and the model-builder's response to the outcomes of these tests.

comments about the models as descriptors of reality -- we have had too little experience with using them to warrant any such judgment.[1] Hopefully though, our attempts to exposit the main mechanisms responsible for results will assist readers to assess the overall plausibility of the models for themselves. Finally, we do not discuss the dynamics of the models.

2. *Description of the Models*

The Murphy and MSG2 models are quite similiar in many respects. Both have a number of important features which distinguish them from the other models discussed at this conference, namely:

(i) forward-looking behaviour in which agents in financial markets are assumed to know the model's projections of the time paths of the exchange and interest rates, and to base their actions upon these model-consistent expectations;

(ii) uncovered interest parity (UIP) linking exchange rates and interest rates; and

(iii) the existence of a well-defined neo-classical balanced growth path towards which the simulated economy converges after transitory disturbances brought about by an exogenous shock.

Differences in the models are almost entirely confined to the way short-term dynamics are specified. In particular, MM includes a number of lagged adjustment terms which lead to slower (and often oscillating) adjustments to shocks. These lagged terms are estimated in the Wharton tradition: various structures were tested in search of a

---

1 We have, however, made rigorous attempts to check the models for internal consistency.

Table 1

A Brief Comparison of the Murphy and MSG2 Models

Attribute	Murphy Model	MSG2 Model
Size	94 eqns in about 136 variables (eqns include 77 identities)	approx. 60 eqns in 79 variables per fully modelled[b] entity: Total of about 260 eqns in 328 variables
Scope	One country (Australia)	Four countries (Australia, U.S., Japan, Germany) plus four *groups of countries* (the rest of the EMS, the rest of the OECD, non-oil LDC's and OPEC)
Focus	General macro policy issues for Australia, short- and medium-run forecasting	Macro interactions among national economies, policy analysis for a single country
Time Unit	Quarter	Year
Steady State[a]	Exists; along neoclassical lines	As for Murphy
Model-consistent Expectations	Important in determining the exchange rate and the bond rate	As for Murphy; model consistent expectations are also important in MSG2 in determining the targets towards which exports adjust, and in determining (parts of) consumption and investment
Uncovered Interest Parity	An important mechanism	As for Murphy
Special treatment of:		
Oil	No	Yes
Housing	Yes	No
Technical change[c]	Harrod-neutral (0.81 per cent per year)	Harrod-neutral (1.0 per cent per year)
Labour force growth[c]	1.7 per cent per annum	2 per cent per annum

a Strictly speaking, 'asymptotic balanced growth path'.

b For LDCs and OPEC, only current and capital accounts are modelled.

c The sum of the Harrod-neutral rate of technical change and the rate of labour force growth gives the steady-state growth rates of the models; namely, 2.51 and 3 per cent per year for Murphy and MSG2, respectively.

specification producing good within-sample test statistics. MSG2, on the other hand, includes lagged adjustment only in the determination of wages.[1] Other differences and similarities between MM and MSG2 are displayed in Table 1.

The relationships among real variables in MM, and among the real variables for a single country (Australia) in MSG2, are displayed in Figures 1-6. Before discussing them, a short digression on the use of neoclassical economics in MM is necessary. This perhaps can best be handled by a concrete example; we illustrate with the price *PYD* of the domestic good (see Figure 1).

To project *PYD*, MM starts with last period's value and then makes some adjustments towards a moving equilibrium. The medium-run equilibrium value of *PYD* will be written *PYDMR* . This is a general feature of the model -- the current values of endogenous variables reflect the various frictions imbedded in the 'stochastic equations' S01-S16 of MM. The latter equations, far from appearing neoclassical, have a strong Wharton School flavour. To locate the neoclassical heart of MM, one must use the rear entrance -- the 80 or so 'identities' of the model. Twelve of these (I15-I26) embody static optimizing behaviour of minimising costs and maximizing revenue subject to the nested CES/CET technology pictured in Figure 1. The values of the decision variables endogenized within this framework are *target* variables towards which the actual (Wharton-style) variables adjust over simulated time. For example, in the medium run (the length of time within which capital stocks in use can be considered

1 In fact, for the most part MSG2 does not take an applied econometric approach to the question of parameter determination. Because it is a multicountry model, a work programme to generate a parameter file using the applied econometric approach would absorb several person-decades. In MM an applied econometric approach may be necessary because the model is used for forecasting.

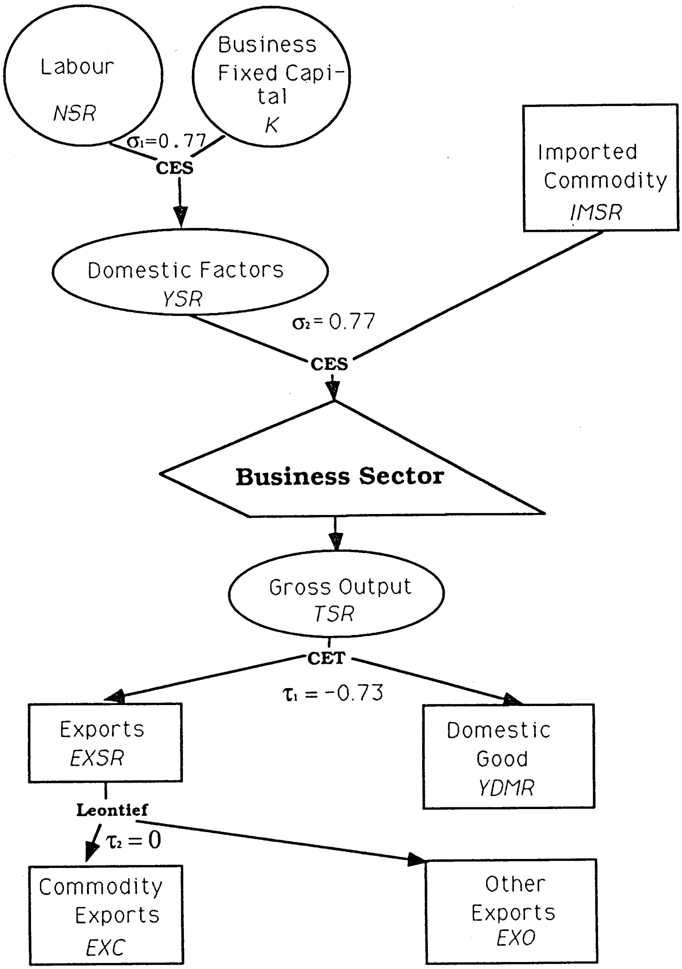


Figure 1: Input-output Structure of Business Sector in Steady-state Murphy Model

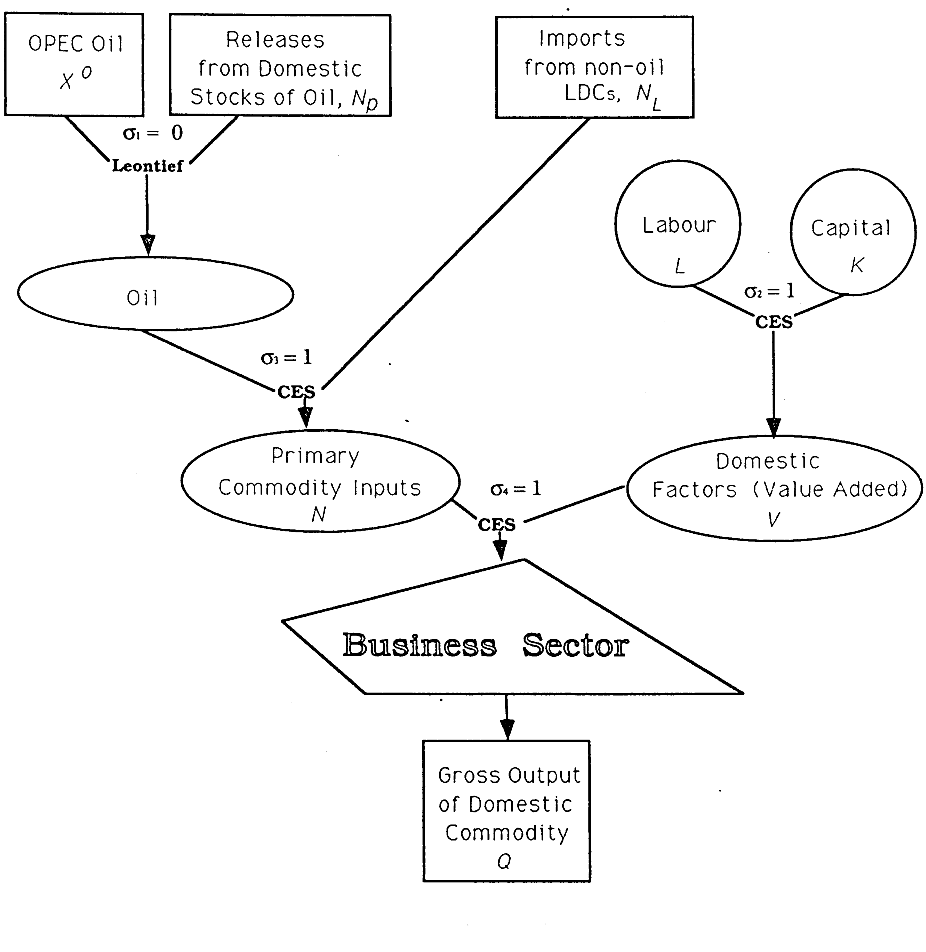


Figure 2: Input-output Structure of Business Sector in MSG2 Model

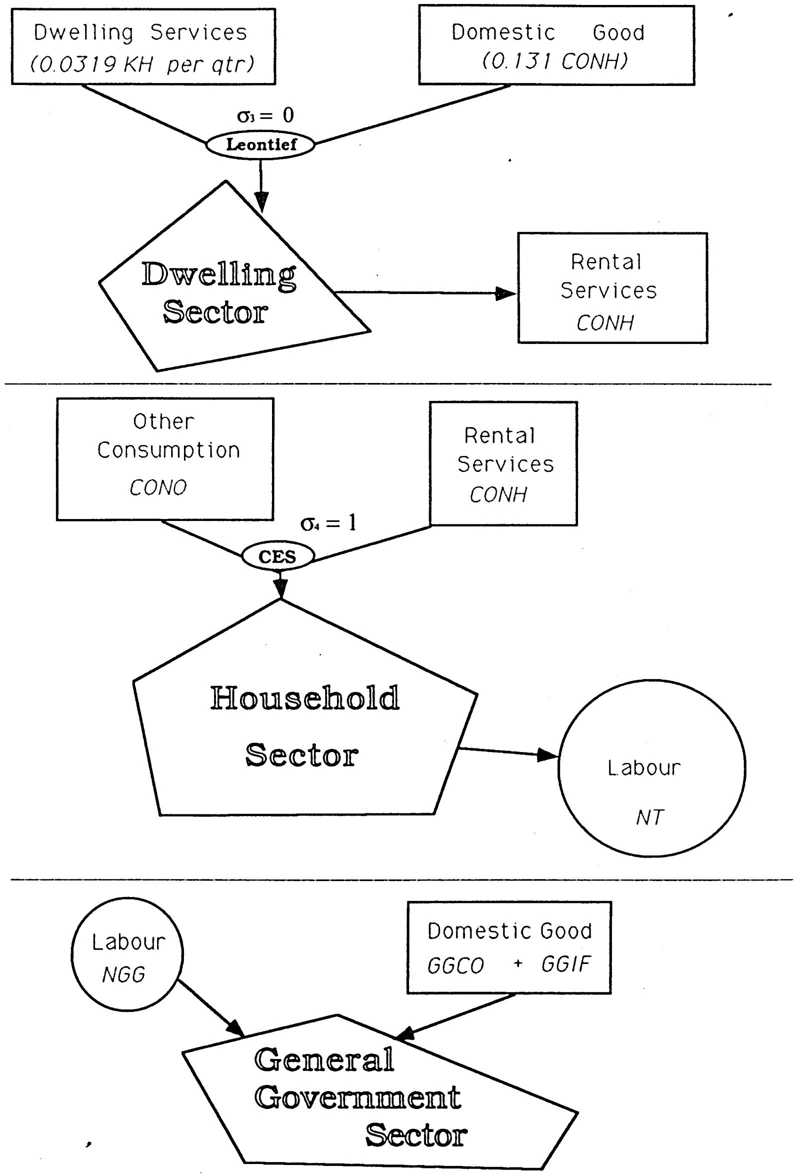


Figure 3: Top panel - Production function of the Dwelling Sector in the Murphy Model
Lower two panels - Commodity and service flows absorbed by Households and by General Government in the Murphy Model

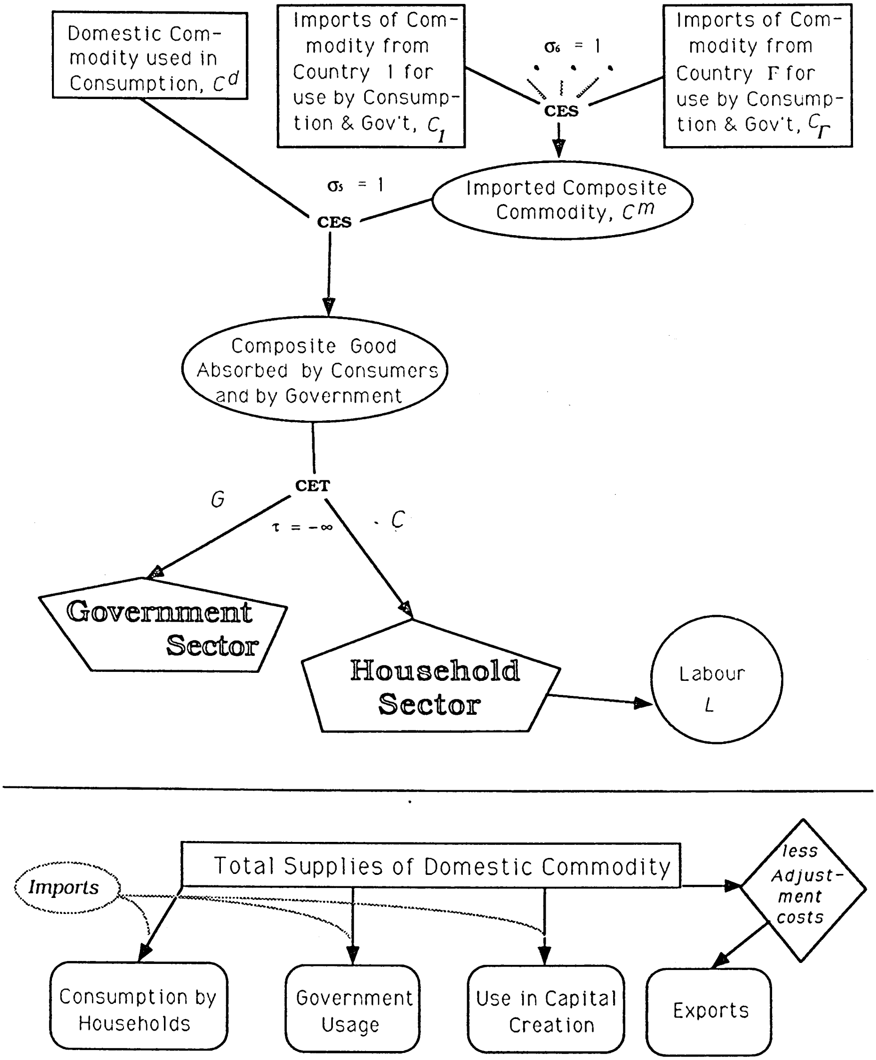


Figure 4: Top panel -- Commodity and service flows absorbed by Households and by Government in the MSG2 Model

Bottom panel -- Disposal of Australian Domestic Good in the MSG2 Model

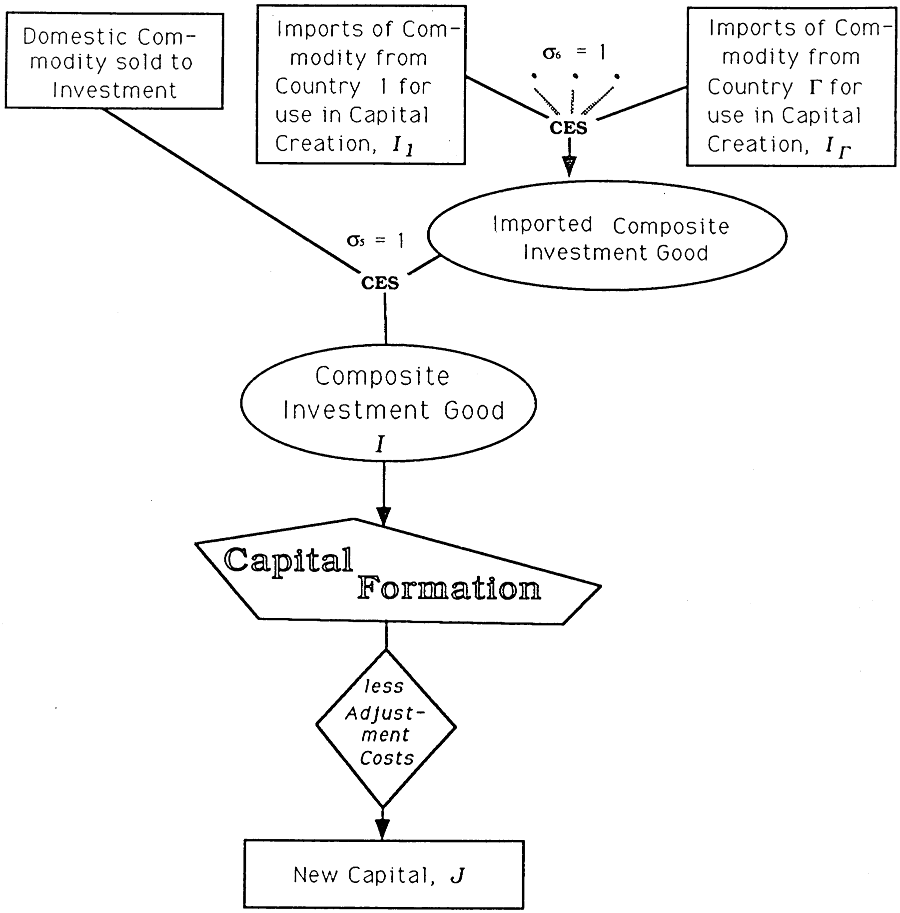


Figure 5: Commodity and service flows absorbed by Capital Formation in the MSG2 Model

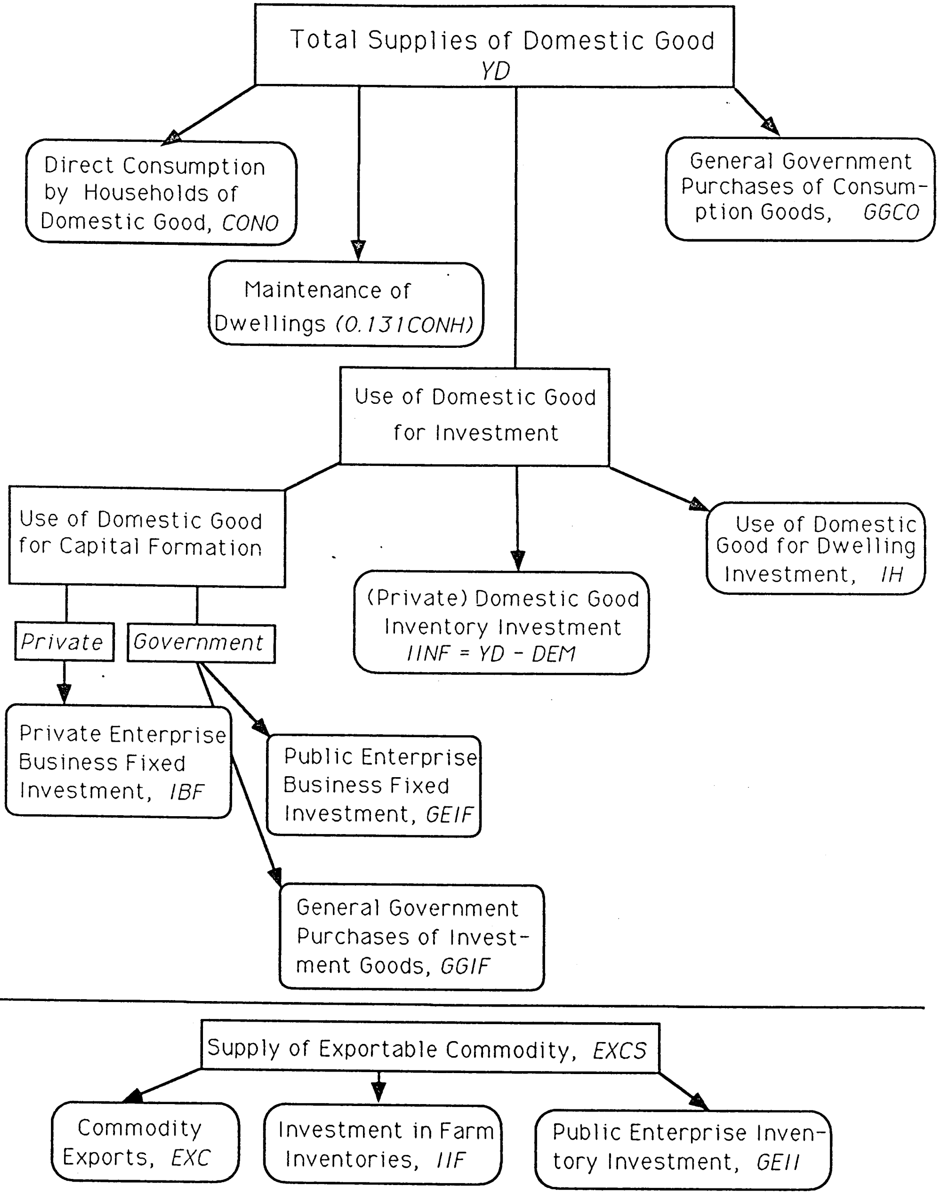


Figure 6: Top panel -- Disposal of Domestic Good in Murphy Model
Bottom panel - Disposal of Exportable Good in Murphy Model

exogenous but all other inputs and outputs are choice variables for the firm) *PYD* will have adjusted to a target *PYDMR*, which can be interpreted as the marginal cost of producing *YD*. At this point production of *YD* is at the level which would have been selected by neoclassical producing agents with fixed capital stocks.

The Keynesian twist comes in MM's short-run, in which *PYD* is taken as given. Actual output of the domestic good *YD* is determined by aggregate demand. This mechanism is *external* to any explicitly modelled decisions taken by firms. Their short-run static optimization problem may be stated as:

Given an exogenous wage rate *W*, a fixed capital stock *K*, the demand-determined output level *YD* for the domestic good and exogenous import, export and domestic product prices *PM, PX* and *PYD*, respectively,

find the level *NSR* of private sector employment, the quantity of imports *IMSR*, and the quantity of exports *EXSR*, which jointly

maximize net revenue; i.e., which maximize

PYD.YD + PX.EXSR - W.NSR - PM.IMSR

subject to the CES/CET production technology set out in Figure 1.

It will be noted that there is no explicit theory explaining what actions are taken by micro agents to drive the actual price of the domestic good *PYD* to the medium-run equilibrium value; rather, this convergence is achieved in MM via an *ad hoc* empirical relationship.

In the long run the influence of temporary capital fixity (and therefore of transient returns on capital out of line with rates on the world market) is eliminated by requiring that capital and output of the domestic good adjust to yield the externally given real rate of return on capital. The long-run equilibrium price of domestic output satisfying these conditions is denoted *PYDLR*. The main effect of MM's incorporation of neoclassical shadow or target variables such as *PYDMR* and *PYDLR* is to guarantee that the model converges to an interpretable neoclassical balanced growth path.[1]

In MSG2, on the other hand, some consumers, some investors, and all export facilitators are modelled as intertemporal optimizers. Specifically, thirty per cent[2] of consumers maximize the present value[3] of the utility of their planned consumption stream, thirty per cent of investors maximize the present value[4] of the foreseen net revenue stream (where the latter is net of the costs of investment, including adjustment costs, as well as of the costs of current inputs), and all export facilitators maximize the present value[5] of net revenue subject to penalties which are incurred whenever the flow rate of exports changes. The first two of these agents are constrained, respectively, by their given initial net worth (consumers) and by their production technology (investors). The export facilitators are a dummy agency introduced (into the Australian sub-model only) to incur the costs of changing rates of

1 It will be seen in Section 3 that neo-classical aspects of MM are quite helpful in giving a stylized account of the simulated path of the economy during the first year after the instant at which the cut in government spending is implemented.

2 This percentage is not hard-wired; it is entered as a parameter. Note that since the personal income distribution does not appear in the model, a more precise statement would be to say that thirty percent of the optimal consumption of an agent whose net wealth is equal to that of consumers at large contributes to the aggregate value of consumption.

3 Present value is computed using the pure time-preference discount rate.

4 Present value is computed using the short-term market interest rates that apply at the various future dates of the plan.

5 See previous footnote.

export flow. Given that the domestic good in MSG2 is a perfect substitute[1] for the exportable, such costs are necessary to calibrate the model so that simulated responses are credible. The behaviour of consumption and investment in MSG2 is distinguished from that in MM not only by the former's element of intertemporal optimizing, but also by the assumption that the intertemporal optimizers have model-consistent expectations (loosely speaking, perfect foresight).

3. *The Simulations*

3.1 *The Shock*

The shock specified by the organizers of this Conference was as follows:

1. The core run should be a 2 percentage points *reduction* in the budget deficit to GDP ratio via a decrease in government spending; i.e., government spending should change so that the budget deficit to GDP ratio is 2 percentage points lower *throughout* the five years. All components of spending, *excluding* transfer payments, should be reduced by the same percentage. Financing should be through a reduction in bond supply.

2. The exchange rate is to be endogenous. However, where this is not possible, an alternative, with the real or nominal exchange rate fixed, should be run. (Extra simulations may need to be run to isolate the effects of the exchange rate assumption.)

3. The time horizon for the simulations is to be 5 years. Where a model requires a shock to be reversed this should be *after* 5 years.

---

1 Strictly speaking, perfect transformate. In terms of MM concepts, the transformation elasticity $\tau_I = -\infty$ in MSG2.

4. The shock should be treated as permanent and unanticipated. Modellers are however free to consider the implications of alternative assumptions where they are of importance.

3.2 *Mechanisms for Accommodating the Shock in MM*

There is no problem about endogeneity of the exchange rate in either model. Chris Murphy describes the injection of the shock into MM, and the associated mechanisms for adjusting to it, in these terms:

> 'The [core] simulation .... involves a decrease in government purchases of the domestic good of 2 per cent of GDP sustained for 5 years. There are three economic categories of public final demand in the model: (i) purchases of the domestic good by the general government sector, (ii) general government sector employment, and (iii) public enterprise investment which cumulates into an associated capital stock, half of which is included in the model measure of business fixed capital. The simulation only affects category (i). During the [initial] five years the public sector deficit is decreased by the same money amount as the decrease in government purchases. Variations in the public sector deficit are "bond financed", i.e., they are reflected in changes in the stock of public sector debt held by the private sector. After the five years, the decrease in the deficit is reduced to the amount which is consistent with the *growth rate* of the stock of public financial liabilities returning to baseline. This still implies a public sector deficit below the baseline level (because the public sector deficit equals the change in the stock of public sector financial liabilities and that change will now be smaller for a given growth rate because the stock has been reduced by the bond financing of the five year decrease in the deficit) .... The residual in the public sector deficit identity is the rate of lump sum tax, *POL3*, so it takes up any slack caused by endogenous changes in

> components of the public sector deficit resulting from the shocks.[1] '

In fact it turns out that in the MM simulations, after a small hiccup in the first quarter, relative to control the lump sum tax rate falls continuously for almost five years, and then approaches its new (lower) steady-state value via a damped cyclical path. At the height of the roll-back, 0.9 per cent of GDP is returned to the private sector.

3.3 *Mechanisms for Accommodating the Shock in MSG2*

McKibbin and Elliott (1989) describe the implementation of the shock as follows:

> 'The fiscal shock we implement is a temporary, credible reduction in government expenditure on goods and services, equal to 2 per cent of baseline GDP, balanced by a decrease in debt (as discussed below). The spending cut lasts for 5 years, after which, spending returns to its previous level.
>
> To understand the mechanics of how we implement the simulation there are several useful features of fiscal policy in the model that are worth highlighting. In solving the model we impose the transversality condition that debt has value, i.e., we assume:
>
> $$\lim_{(t \to \infty)} B_t e^{-(r_t - n)t} = constant,$$
>
> where B is the debt to GDP ratio, r is the real rate of return on debt, and n is the steady state real growth rate. Because we assume $r > n$, this means that either the debt to GDP ratio must stabilize or the price of debt must go to zero.

---

1 Private communication, May 1989.

From the debt accumulation equation

$$dB_t/dt = (r_t - n)\, B_t + G_t - T_t \quad ,$$

where G is real government spending on goods and services as a proportion of GDP and T is total taxes as a proportion of GDP, it can be seen that, beginning from a steady state in which the debt to GDP ratio is stable, the decrease in real government expenditure would lead to falling interest payments on declining public debt; the deficit would tend to fall over time in the absence of compensating rises in expenditure or cuts in taxes. To avoid this, we assume that over time the fall in interest payments resulting from the spending change is offset by reduced tax revenues. This is accomplished by introducing an endogenously determined lump-sum tax on labour income.

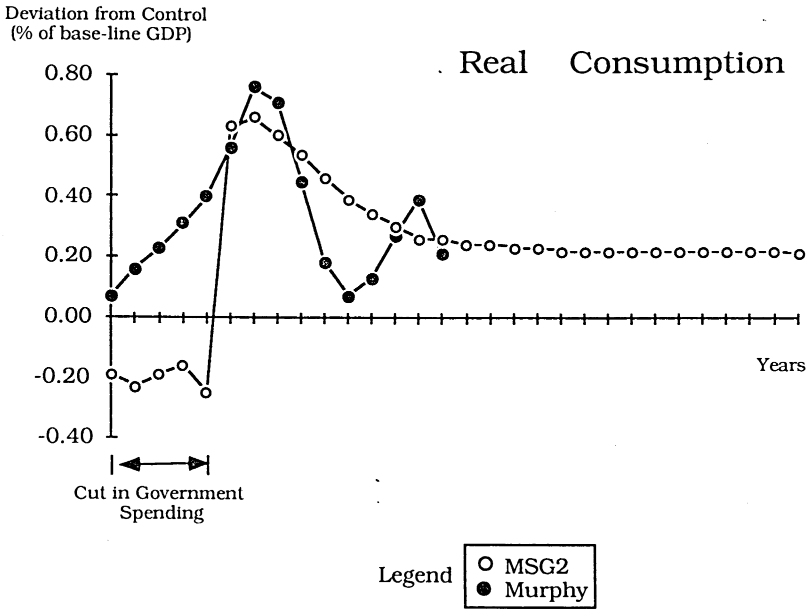
The Australian economy is assumed to have a steady-state growth rate of 3 per cent per annum. In steady-state equilibrium, with this additional condition, a constant total fiscal deficit is compatible with a fixed debt to GDP ratio, as long as the increase in debt due to the deficit causes the level of total debt to grow at 3 per cent per year. This means that the change in the steady-state debt to GDP ratio is equal to the change in the steady-state deficit to GDP ratio divided by .03. For example, a permanent fall in the deficit by 2 per cent of GDP reduces the debt to GDP ratio by 66 per cent of GDP.'

3.4 *The Main Results*

Given Australia's size in the world economy, we do not expect other entities to be much affected in MSG2 by the shock to the local economy. Principally, we require that bond holders in the rest of the world stand ready to arbitrage asset markets to ensure that uncovered interest parity holds (to help them along, they have model-consistent expectations about all interest and exchange rates). Changes in our imports and exports will also have small (perhaps infinitesimal) effects on the other entities modelled. The discussion of the MSG2 results in this paper, however, is restricted to Australia. The principal results for both models are summarized in Charts 1-4 and in Appendix Tables A1 and A2.

Central to understanding the projections of either model is the behaviour of the exchange and interest rates. Fortunately, both models give qualitatively similar trajectories for these variables (Chart 3), the principal difference being the presence of (damped) cycles in the MM results.[1] Both models show an initial depreciation of the Australian dollar against other currencies: this is a direct reflection of the operation of uncovered interest parity (UIP), which equates the (correctly) anticipated time rate of change in the foreign currency value of the Australian dollar (per cent per year, say) with the percentage point interest differential prevailing between Australia and the rest of the world. The world interest rate is unaffected by the domestic cut in government spending, and so the deviation from control of the time rate of change of the exchange rate ($ foreign per

1 The widespread use of lag distributions in MM is responsible for this cyclical behaviour; it is a characteristic difference evident in most comparisons of MSG2 with MM results.



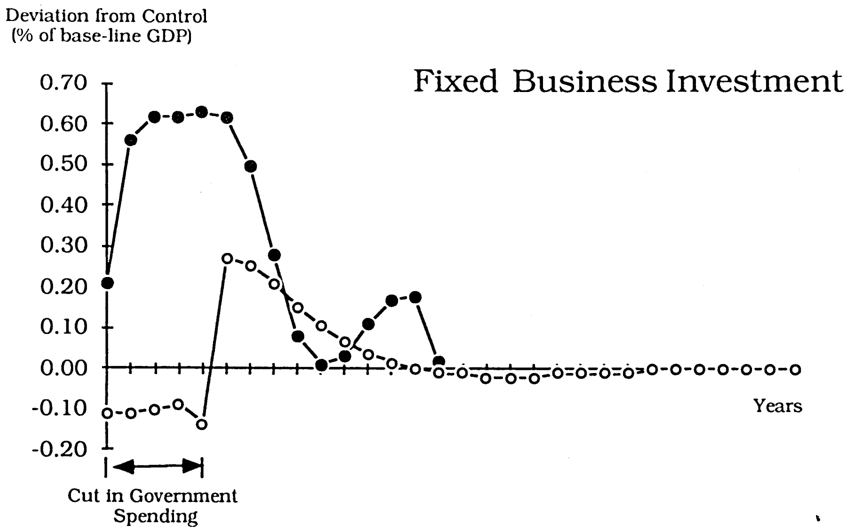


Chart 1: Top panel -- Simulated time path of real consumption
Bottom panel -- Simulated time path of real fixed business investment

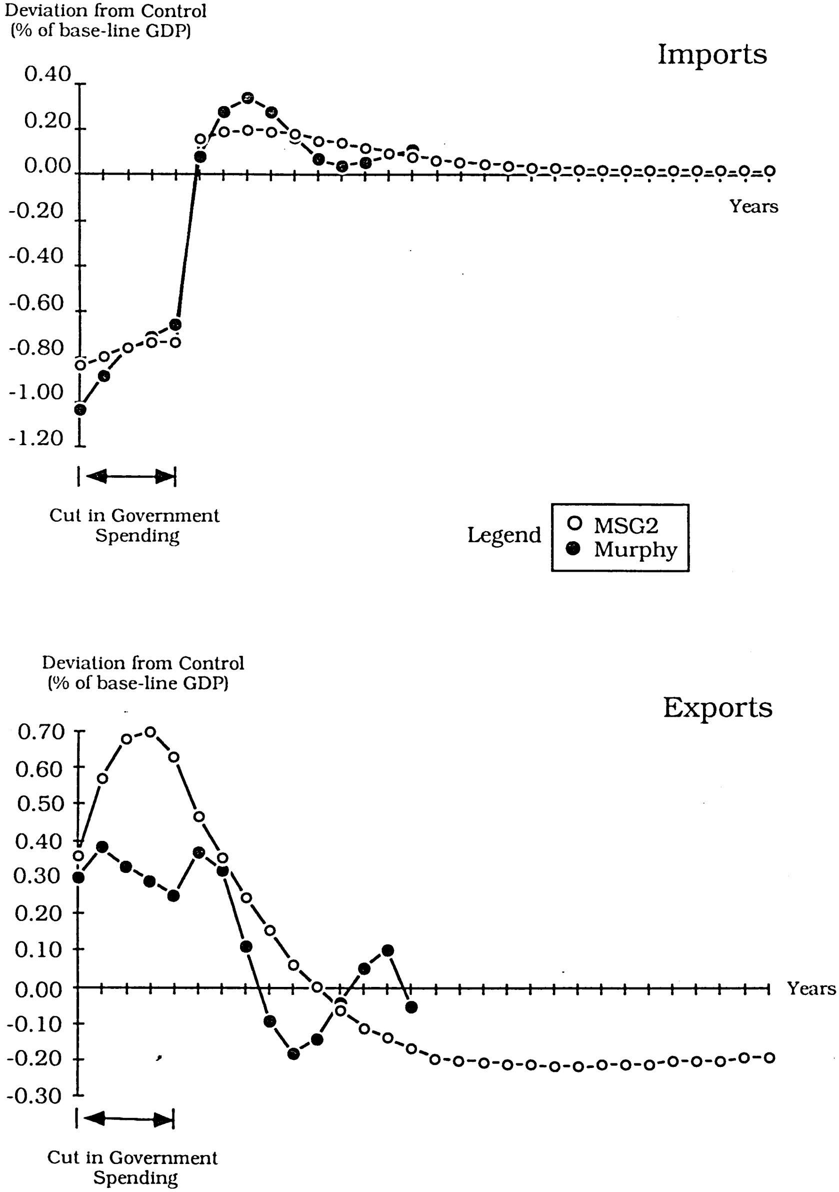
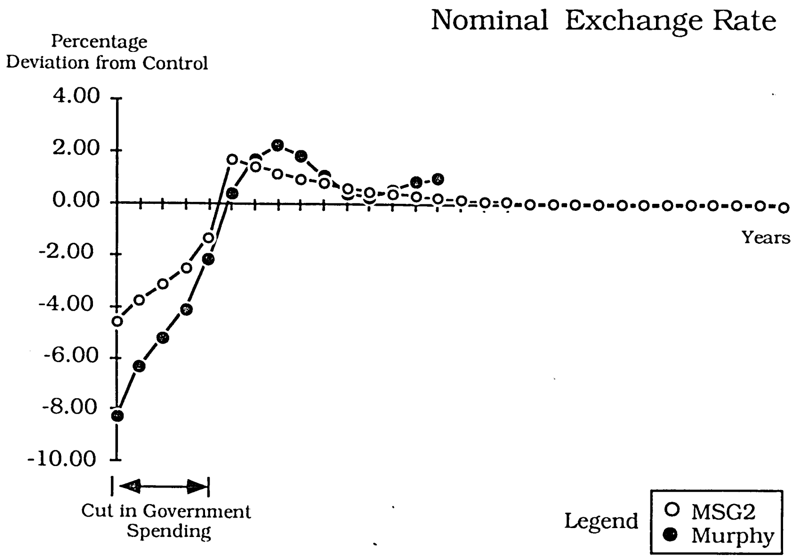


Chart 2: Top panel -- Simulated time path of imports
Bottom panel -- Simulated time path of exports



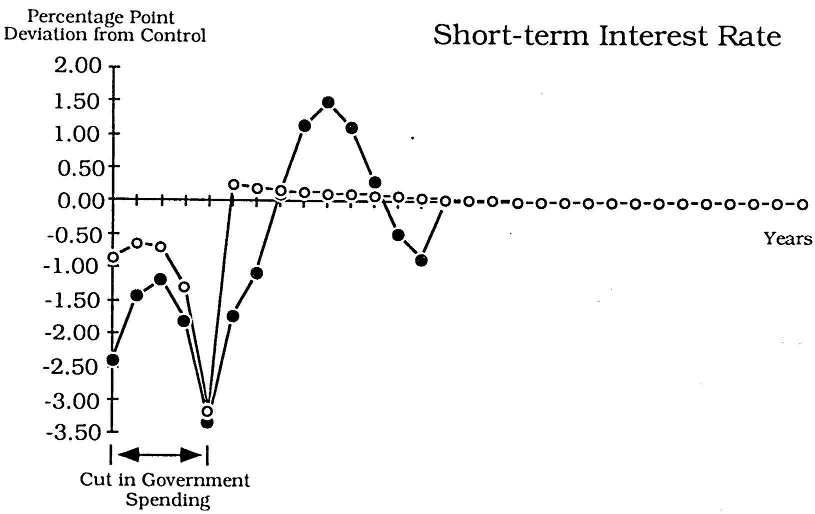


Chart 3: Top panel -- Simulated time path of the nominal exchange rate
Bottom panel -- Simulated time path of the short-term interest rate (3 months for MM, 1 year for MSG2)

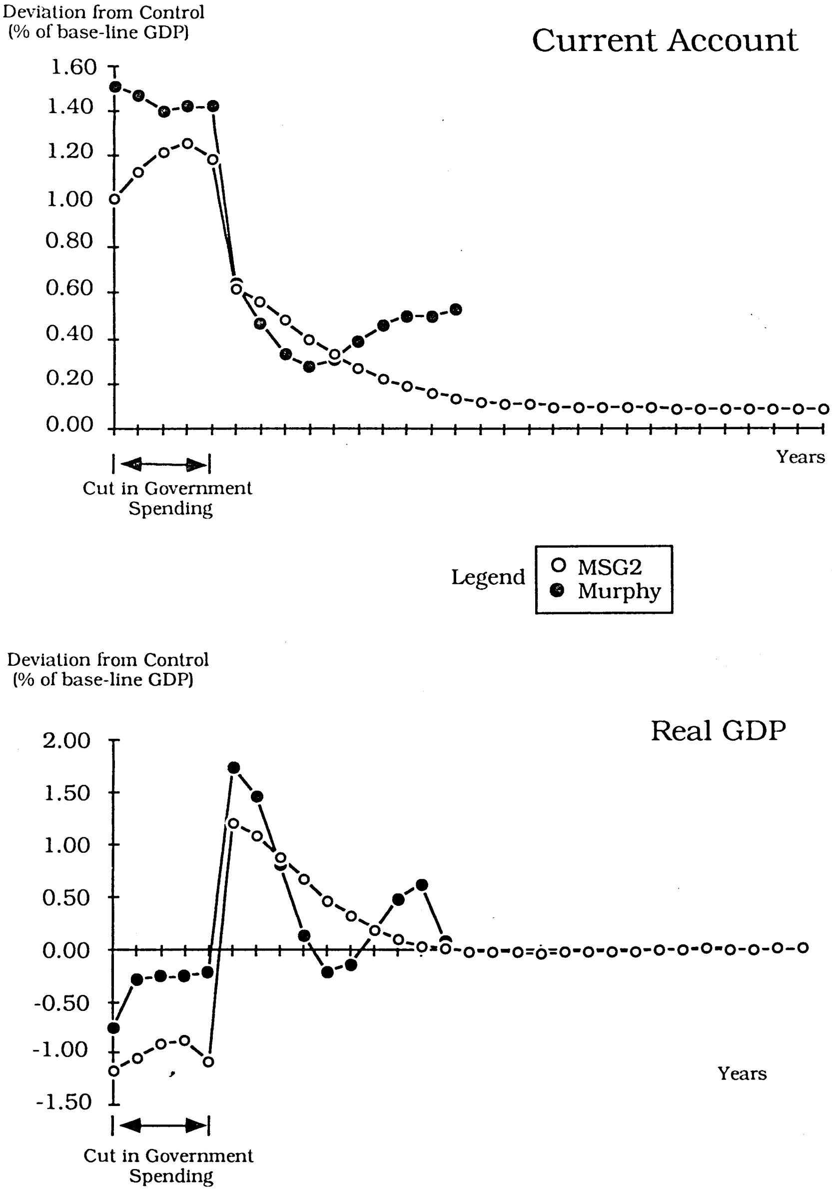


Chart 4: Top panel -- Simulated time path of the Current Account
Bottom panel -- Simulated time path of real GDP

$Aus, per annum) must be equal to the deviation from control of the Australian short-term interest rate (percentage points per annum). In a notation which will be used more extensively in the next section, we can write the UIP condition as:

(3.1) $$e^{+} = \Delta R,$$

where

(3.2) $$e^{+} = e(1) - e.$$

In these equations, e and $e(1)$ respectively are the percentage deviations from control of the current exchange rate and of the one-period-ahead model forecast of it, while ΔR is the percentage point deviation from control of the domestic short-term interest rate.[1]

What of the exchange rate in the longer term? If the way the shock is imposed (together with the inherent properties of the model) implies that debt servicing in the long term would absorb a lower percentage of GDP than in the situation in which there were no cut in government spending, we would expect a long-term appreciation of the *real* exchange rate. (Because the steady states of both models have differential inflation rates between Australia and the rest of the world which do not change in response to the shock[2], we can equate the long-term deviations from control of the *nominal* and the *real* exchange rates.) The long-term current account projections of the models mirror their long-term exchange rate projections in a way which suggests that, if the cut in government spending takes place, then servicing foreign debt requires a smaller

1 'Short-term' here means the rate applicable to a loan whose term is equal to the period of account of the model; i.e., three months for MM and one year for MSG2.

2 That is, the models are superneutral with respect to the shock.

share of GDP in the long run in both cases (although the long-term MSG2 projections of the deviations from control of these variables are *very* close to zero). We must return to this issue in Section 4.

By way of summary: qualitatively the models give somewhat similar results, not only for the exchange and interest rates (Chart 3), but also for real GDP (Chart 4), and for imports and exports (Chart 2). To the above list one might also append the current account (Chart 4), depending on one's view of how large is a gap of 0.4 or 0.5 percentage points of GDP in the long run. The short-run results for consumption and investment, however, differ substantially.

4. *An Explanation of the Results*

In attempting to come to grips with the mechanisms which are crucial to understanding why each model produces the results described above, we have relied heavily on guidance by the model builders. What follows is an attempt to distill what they told us, and what we found out for ourselves.

With both models we believe it is possible to get a good feel for the important mechanisms by concentrating on end-point projections (i.e., on the first and last periods simulated). Especially in the case of MM it is convenient to focus on the initial four quarters because within such a time span there is little opportunity for oscillations to develop: nevertheless, the projections for the first year seem to encapsulate all important short-run phenomena *other than* cycles. The steady-state (i.e., last period) solutions of both models are informative of where the short-term projections are headed.

4.1 *Short-Run Effects in MM*

We found it helpful to develop a stylized version of MM in our attempts to understand this model's short-run results.[1] Our stylized model, set out in Tables 2, 3 and 4, does *not* pretend to have anything to say about the *level* of the exchange rate (although it does have something to say about its time derivative). Thus, to close SMM (our stylized version of MM) we tell it the value of the exchange rate from the full Murphy Model.[2]

SMM's variables correspond to the simple averages of the first four quarters simulated in MM. Apart from the speed of exchange rate appreciation and the interest rates, all variables are expressed as percentage deviations from control. The treatment of the exceptional variables parallels that set out above in Section 3.

When using SMM to mimic MM, the most important magnitude to get right, other than the exchange rate, is nominal GNE, *GNE$*. This is because the money demand equation in MM (and in SMM) contains a transactions component which is proportional to GNE, and also an interest-rate-responsive component.[3] Consequently, with zero deviation from control in the money supply (see equation (1) of Table 2), any decline in money demand caused by a contraction in GNE must be sterilized by an

1 The equations of SMM were implemented and solved using the GEMPACK general purpose software system for CGE models (Pearson (1988), Codsi and Pearson (1988)). The process of solving the linear equations used the Harwell sparse matrix code (Duff (1977)).

2 We do not see how the initial level of the exchange rate could be endogenized without an intertemporal model; SMM is basically static.

3 The semi-elasticity of money demand with respect to the interest rate in MM is -1/1.282. This value implies that, at a constant level of transactions demand, a one *percentage point* rise in the (short-term) interest rate leads to a fall of 0.78 per cent in money demand.

Table 2
*Equations of A Stylized Murphy Model for Initial Period Simulated**

	Stylized Model Equation(a)	Simulated Value of the Variable(b) Shown in Bold Face from: Stylized Model	Full Murphy Model	Murphy Model Equations Cross Reference(d)
	Money Supply			
(1)	$\mathbf{m} = 0$	0(c)	0(c)	*I39*
	Money Demand			
(2)	$\frac{1}{100}\ m = \frac{1}{100}\ gne\$ + \alpha_1^2\ \Delta\mathbf{RCS}$	-2.018	-2.399	*S13*
	Gross National Expenditure			
(3)	$\mathbf{gne\$} = \alpha_1^3(pyd + yd)$	-1.574	-1.854	*I77*
	Foreign Short-term Interest Rate			
(4)	$\Delta\mathbf{RCSF} = 0$	0(c)	0(c)	
	Uncovered Interest Parity			
(5)	$\mathbf{e^+} = \frac{1}{4}(\Delta RCS - \Delta RCSF)$	-0.504	-0.600	*I27*
	Definition of e^+ (the Differential Speed of Appreciation)			
(6)	$e^+ = \mathbf{e(1)} - e$	-8.436	-7.682	*I27*
	Import Prices in Domestic Currency			
(7)	$\mathbf{pm} = -e$	7.932(e)	7.932(e)	*I25*
	Export Prices in Domestic Currency			
(8)	$\mathbf{px} = \alpha_1^8\ exsr - e$	7.079	8.071	*S01,S02,I24*
	Product Mix			
(9)	$\mathbf{exsr} - yd = -\tau_1\ (px - pyd)$	2.473	2.782	*I15-I25*

... continued overleaf

	Sluggish Response of Exports towards Equilibrium			
(10)	$\mathbf{ex} = \alpha_1^{10}\ exsr$	1.297	1.519	*S09*
	Production Under Constant Returns to Scale			
(11)	$W_1^2\ exsr + W_2^2\ \mathbf{yd} = W_1^3\ ysr + W_2^3\ im$	-2.515	-2.782	*I15-I25*
(12)	$\mathbf{ysr} = W_1^4\ k + W_2^4\ nsr$	0	-0.067	*I15-I25*
	Zero Pure profits			
(13)	$W_1^2\ px + W_2^2\ \mathbf{pyd} = W_1^3\ pysr + W_2^3\ pm$	0.291	0.091	*I15-I25*
	Short-run Stickiness of Factor Employment			
(14)	$\mathbf{nsr} = 0$ *[labour]*	0	-0.027	
(15)	$\mathbf{k} = 0$ *[capital]*	0	0.013	
	Short-run Stickiness of Factor Payments			
(16)	$\mathbf{pysr} = 0$	0	0.026	*S10,S15,I15-I26*
	Input Mix			
(17)	$\mathbf{im} - ysr = \sigma_2\ (pysr - pm)$	-6.106	-5.681	*I15-I25*

* The stylized model presented here is specific to the particular shock. 'Initial period' means the first four quarters simulated.

(a) The variables are defined in Table 3. Combinations of lower case letters refer to the percentage deviation from control in the variable denoted in the Murphy Model by the corresponding upper case letters. The operator $\Delta(\ )$ always means deviation from control. Variables carrying the argument 1 (in parentheses) are the one-period ahead model forecasts.

(b) Values shown for the full Murphy Model are the simple arithmetic averages over the first four quarters simulated.

(c) Exogenously set in both the full and the stylized Murphy models.

(d) Chris Murphy, "Appendix 1", supplied by the author, May 1989.

(e) These values agree exactly because in the stylized model the exchange rate has been set exogenously to the value determined endogenously by the full Murphy Model.

Table 3

List of Variables in the Stylized Murphy Model for Initial Period Simulated

	Symbol	Equations in which Variable Appears	Description*
1.	*e*	6,7,8	Nominal exchange rate
2.	e^{+}	5,6	Differential speed of exchange rate appreciation
3.	*e(1)*	6	Model forecast of exchange rate one quarter ahead
4.	*ex*	10	Exports (quantity basis)
5.	*exsr*	8,9,10,11	Desired level of exports (quantity basis)
6.	*gne$*	3	Nominal gross national expenditure
7.	*im*	11	Imports (quantity basis)
8.	*k*	15	Capital services
9.	*m*	1,2	Money
10.	*nsr*	14	Desired private sector employment
11.	*pm*	7,13	Price of imports (quantity basis))
12.	*px*	8,13	Price of exports in $A
13.	*pyd*	3,9,13	Price of the domestic good in $A
14.	*pysr*	13,16	Price of domestic factors in $A
15.	*ΔRCS*	2,5	Percentage point per annum deviation from control in 3-month interest rate in Australia
16.	*ΔRCSF*	5	Percentage point per annum deviation from control in overseas 3-month interest rate
17.	*yd*	3,9,11	Output of the domestic good
18.	*ysr*	11,17	Real input of composite index of domestic factors

* All variables (except those prefixed by Δ) are percentage deviations from control.

Table 4

List of Coefficients in the Stylized Murphy Model for the Initial Period and Their Values

Coefficient[a]	Description[b]
α_1^2 [2]	Percentage change in money demand per one percentage point change in the three month interest rate; value taken from the Murphy Model: -100/128.2
α_1^3 [3]	Share of domestic commodity in value of gross national expenditure, evaluated as: *PYD.YD/GNE$* = 0.7077
α_1^8 [8]	Reciprocal of export demand elasticity; these reciprocals have values of -0.3665 for non-commodity exports, and -0.320 for commodity exports respectively; the value-weighted average of the corresponding elasticities has reciprocal equal to -0.345, which is the value used in the stylized model.
τ_1 [9]	The elasticity of transformation between exports and the domestic good; the value of -0.7348 is taken from the Murphy Model.
α_1^{10} [10]	The proportion of the gap between their actual and equilibrium values by which exports can be expected to have adjusted after 4 quarters; in the Murphy Model, 27.6 percent of the gap is eliminated per quarter. It can be shown that the temporal aggregation from quarters to an average over 4 quarters suggests that α_1^{10}=0.5244.

.... *continued overleaf*

W_1^2, W_2^2 [11]	The first of these coefficients is the share of equilibrium exports in the sum of their value and the value of output of the domestic good: $$W_1^2 = \frac{EXSR.PX}{EXSR.PX + PYD.YD} = 0.2243;$$ the second is given by: $$W_2^2 = 1 - W_1^2 = 0.7757.$$
W_1^3, W_2^3 [11]	The first of these coefficients is the share of the equilibrium value of payments to domestic factors in the sum of this value and the value of imports; $$W_1^3 = \frac{PYSR.YSR}{PYSR.YSR + PM.IM} = 0.7714;$$ $$W_2^3 = 1 - W_1^3 = 0.2286.$$
W_1^4, W_2^4 [12]	The first of these coefficients is the share of labour in the equilibrium value of total factor payments; the second is the share of capital: $$W_1^4 = \frac{NSR.W}{PYSR.YSR} = 0.7052;$$ $$W_2^4 = 1 - W_1^4 = 0.2948.$$
σ_2 [17]	Elasticity of substitution between domestic factors and imports. The value of 0.7698 is taken from the full Murphy Model.

[a] The entries in square parentheses indicates the equations in which coefficients occur.

[b] The notation for the variables indicated by a string of letters follows Murphy (1989). All coefficients are evaluated at their first quarter values on their control solution paths.

interest rate fall which is large enough to induce an offsetting rise in the interest-responsive component for money demand (see Table 2, equation (2)). Given the value of the interest elasticity of money demand, each one per cent fall in transactions demand must lead to a 0.78 (= 100/128.2) per cent fall in the short-term interest rate. This semi-elasticity (*C1303* in MM notation) is the first critically important parameter noticed by us.

To give a simplified account of how nominal GNE is determined in MM, in SMM we put the percentage change[1] in GNE, *gne$*, equal to the share ($\alpha_1^3$ = 0.71) in GNE of the domestic commodity, times the sum of the percentage changes in the price and output of this commodity (equation (3) of Table 2).[2] This then shifts the burden of explanation to the determination of the latter two percentage changes. To close the system with respect to these variables we end up adding eleven more equations to our model, making a total of seventeen easily interpreted equations in eighteen variables. Apart from the implications of constant returns to scale and the equality of marginal products with factor rewards, equations (7) through (17) of SMM show movements around the CES isoquants and the CET transformation frontier identified in Figure 1 respectively by the junctions annotated with σ_2 and τ_1 values. Also included within this block are equations (14), (15), and (16), which jointly say that within the first year of the simulation period, the changes in factor usage and in rates of reward in MM can be neglected. Finally, equation (10) of Table 2 says that, given the lag

1 From this point on, in this section, unqualified use of the phrase 'percentage change' is shorthand for 'percentage deviation from control'.

2 This treatment abstracts from the effects on (GNE$) of changes in the services of the housing stock, and changes in inventories -- see Figures 3 and 6.

structure governing the behaviour of exports in MM, in the current simulation the response for the four-quarter average of the export flow should be about one half of the corresponding equilibrium response[1]. This brings us to the second critical set of parameter values in MM. The transformation elasticity τ_1 (see Figure 1) measures the ease with which the economy can reconfigure its output mix of domestic good and exportables. Given that its value has variously been set to -0.85 (in AMPS[2]), -0.2 (in an earlier version of MM[3]) and to -0.73 (in the current version of MM[4]), there must be some uncertainty about how far the desired mix responds to changes in relative prices.[5] Excluding the exchange rate -- and, therefore, also import prices -- which are exactly set by MM, and disregarding as well the variables set to zero in SM, the absolute percentage error of SM as a characterization of MM is 12.4 per cent over the nine relevant variables. We conclude that we have captured the important features of MM's short-run response in our stylization of it.

1 All of the parameters and coefficients in SM are derived from MM's parameters and steady-state path control solution; see Table 4.

2 Murphy *et al.* (1986), p. 125.

3 Murphy (1988b), p. 183.

4 Murphy (1989), p. 10 shows $q = 2.361$; t_1 is $1/(1+q)$.

5 There are additional uncertainities about the parameter determining the speed of adjustment.

4.2 *Long Run Effects in MM -- by C.W. Murphy*[1]

The long-run effects of this simulation stem from the fact that the public sector has *permanently* reduced the stock of bonds held by the private sector. If the real interest rate equalled the real growth rate this would not have any long-run effect on consumption: equilibrium would be obtained with a reduction in private foreign debt which left desired consumption unaffected. To see that this would be an equilibrium, consider the two places where foreign debt enters the model.

The first is the balance of payments identity. Slightly stylized it states,

(4.1)	*Change between quarters t and t+1 in the \$A value of Australian*[2] *external indebtedness*	=	*-trade surplus + interest payments to foreigners*

We might write (4.1) algebraically as

$$(4.2) \qquad \delta\big(D(t)\big) = -S(t) + R(t),$$

where $\delta(\bullet)$ takes differences through time. In the steady-state, our external indebtedness must grow at the same rate as nominal GDP (and every other nominal variable in the model). Hence

$$(4.3) \qquad \delta\big(D(t)\big)/D(t) \equiv d(t) = \tfrac{1}{100}\hat{m}(t),$$

where $\hat{m}$ is the rate of growth of money (per cent per quarter). Australia's foreign debt is partly denominated in Australian dollars,

1 This section is a slightly edited version of a briefing note prepared by Chris Murphy, for which we are grateful.

2 Aggregate value in \$Aus. of public and private sector indebtness to foreign entities.

and partly in foreign currency. We adopt the following notation and definitions:

	$D_A(t)$	\$Aus. value of Australian overseas debt contracted in \$Aus.
	$D_F^*(t)$	Foreign \$ value of Australian overseas debt contracted in foreign \$
(4.4)	$D_F(t) \equiv D_F^*(t)/E(t)$	\$Aus. value of Australian overseas debt contracted in foreign \$
	$E(t)$	the exchange rate (foreign \$ per \$Aus.)

Dropping time subscripts for the moment, the change in the Australian dollar value of our total external indebtness is

(4.5) $$\delta(D) = \delta(D_A) + \delta(D_F) = \delta(D_A) + \delta(D_F^*/E)$$

$$= \delta(D_A) + \frac{E\delta(D_F^*) - D_F^*\,\delta E}{E^2}$$

$$= \delta(D_A) + \delta(D_F^*)/E - \frac{1}{100}\,\varepsilon^+ D_F$$

where ε^+ is the percentage appreciation per quarter of the exchange rate. For the shares of the two types of debt to remain unchanged in the steady state, we require that their values (in \$Aus.) grow at the rate of $\frac{1}{100}\hat{m}$; that is,

(4.6) $$\delta(D_A)/D_A = \frac{1}{100}\hat{m}$$

$$= \delta(D_F)/D_F$$

[from (4.5)]

$$= \delta(D_F^*)/(E\,D_F) - \frac{1}{100}\,\varepsilon^+ \quad ;$$

so

(4.7) $\delta(D_F^*)/D_F^* = \frac{1}{100} \; (\hat{m} + \varepsilon^+)$.

The last equation says that the foreign currency value of our foreign debt grows, in the steady-state, at the growth rate of money plus the rate of exchange-rate appreciation.

Hence the steady-state version of (4.2) is

(4.8)
$$\frac{1}{100} \hat{m} \, D_A(t) + (\frac{1}{100} \hat{m} + \varepsilon^+) \, D_F^*(t)$$
$$= \frac{1}{100} r_A \, D_A \, (t) + (\frac{1}{100} r_A + \varepsilon^+) \, D_F^*(t) - S(t),$$

where r_A is the long-run domestic interest rate. (Notice that the second last term on the right of (4.8) is obtained via the UIP condition again.) Rearranging (4.8) and using the defininition of total foreign debt D_t, we obtain

(4.9) $\frac{1}{100} \, (r_A - \hat{m}) \, D(t) = S_t;$

that is, in the steady state, our trade surplus is exactly meeting the costs of servicing our indebtedness overseas.

However, $\hat{m}$ can be interpreted as the inflation rate, π, plus the real growth rate, g. Thus

(4.10)
$$\frac{1}{100} \big((r - \pi) - g\big) \; D(t) = S(t).$$

In the special case where the real interest rate equals the real growth rate, we obtain,

(4.11)
$$S(t) = 0.$$

That is, long-run external balance requires balance on the trade account, and the level of foreign debt is irrelevant.

In the baseline the real interest (of 1.125 per cent per quarter) exceeds the real growth rate (of 0.625 per cent per quarter) by 0.5 percentage points (see eqn (4.10)). So the trade surplus in any quarter equals 0.5 per cent of the level of foreign debt.

It follows that the reduction in foreign debt in the core simulation will reduce the required trade surplus, hence making a larger part of domestic output available for domestic use: imports rise and exports fall. This demand switching effect occurs via a real appreciation of the exchange rate (reflected in import competitiveness).

The higher real exchange rate also induces relatively minor supply-side effects. The reduction in the real cost of inputs of imports would potentially increase the desired level of production, but the supply response is limited because of the model's vertical long run labour supply curve. Rather, the real wage is bid up slightly.

The second place where foreign debt appears is in the definition of private sector net worth used in the consumption function.

(4.12) *private sector net worth* = *money + bonds + value of fixed capital + value of inventories - private indebtedness overseas.*

If the real interest rate equals the real growth rate, this is the only place foreign debt enters the steady state model. In that case, the level of foreign debt is wholly determined in the consumption function, and has no effect elsewhere. Even if the real interest rate does not equal the real growth rate, it is still a good approximation to think of foreign debt as being determined in the consumption function. In the core simulation, the government reduces the stock of bonds, and the direct effect of this on consumption is roughly offset by a fall in foreign debt. However, there is also an indirect effect: the reduction in the government's debt-servicing costs (which roughly equals the reduction in foreign debt-servicing costs) leads to a tax cut which raises private consumption. This increase in private consumption roughly equals the fall in net exports (both falls are 0.2 per cent of GDP) so the level of GDP is largely unaffected.

4.3 *Short-Run Effects in MSG2*

The reduction in government spending has two direct effects. First, because the government consumes both imported and domestically produced goods, the cut in spending reduces the demand for both these commodities. Second, the government's spending cuts reduce the budget deficit.

The Interest Rate and the Exchange Rate

After the initial direct effects, a number of induced changes occur in the economy. First, we discuss the effect on the interest rate and the exchange rate. As a result of the initial reduction in the government's demand for domestically produced goods, output falls relative to the value it would have had in the absence of the shock.

As in MM, the money demand function in MSG2 reflects a transactions motive for holding money. With the reduction in output, there is a decline in the transactions demand for money. Since the money supply is fixed, the interest rate must fall to induce people to hold the same quantity of money as previously. This is reflected in the short-run decline in the real interest rate in the MSG2 results.

The percentage point fall in the interest rate in MSG2 is roughly one-third the fall in MM in year one of the simulation. At first, this seems surprising since, apart from a minor difference of functional form and a slightly higher elasticity of money demand in MM, the money demand functions in the two models are identical. The semi-elasticities of money demand in the two models are -.78 for MM and -.60 for MSG2. Thus, with an identical change in activity levels, we would expect to see a slightly greater change in the interest rate in MSG2 than in MM. Differences in the changes in activity levels are responsible for the differences in the response of the interest rate. The decline in the activity level in MSG2 is slightly less than one-third of the decline in MM. This, combined with the slightly lower interest elasticity of money demand in MSG2, explains the substantially smaller response of the interest rate to the decline in government spending in MSG2 in the first year or two of the simulation.

The decline in the domestic interest rate causes portfolio holders to switch from Australian dollar assets to assets denominated in other currencies. As a result, there is a real devaluation as Australian dollars are exchanged for foreign assets. Not surprisingly there is a substantially smaller effect on the exchange rate in MSG2 than in MM, reflecting the smaller decline in the interest rate in the former model.

Consumption, Investment and the Demand for Intermediate Goods

Consumption and investment behaviour in MSG2 are determined by two types of agents, full optimizers and those agents constrained by liquidity. The reduction in government spending has offsetting influences in both consumption and investment activities. The reduction in demand reduces consumption and investment by those agents that are constrained by liquidity. Countering this contractionary effect in both cases is a positive effect arising as the fully optimizing agents invest more (due to lower interest rates) and consume more (due to higher wealth).

The tax liabilities of households are reduced by the full value of the reduction in the government's outstanding debt. Households' assets, however, are reduced only by the value of the reduction in domestically held debt. Thus, with the reduction in liabilities exceeding the reduction in assets, there is a small net increase in wealth held by households. The negative effect on liquidity-constrained households of the fall in income overwhelms the positive effect of the increase in wealth on intertemporal optimizers, and thus total household consumption falls.

Similarly for investment, the small stimulus to investment resulting from the decline in the interest rate is swamped by the negative effect of the fall in income, resulting in a net decline in investment spending.

The Trade Balance and Current Account

The substantial devaluation of the Australian dollar, combined with the fall in economic activity, results in an improvement in the Australian trade balance. The increase in the domestic price of imports, combined with the reduction in economic activity, results in a substantial drop in imports.

Despite substantial differences in the initial effect on exchange rates, there is a virtually identical fall in imports in the MSG2 and the MM models. Given the smaller change in the exchange rate in MSG2, a relatively small change in imports would also be expected. One factor leading to the relatively large decrease in imports in MSG2 is their greater substitutability against domestic factors: the relevant elasticities of substitution are -1.0 and -0.77 in MSG2 and MM respectively (see Figures 1 and 2). The other difference is the decline in domestic value added. In MM domestic value added remains virtually constant in real terms, while in MSG2, there is a decline of roughly 0.8 per cent. The difference, presumably, is due to stickier factor demands in MM.

As with imports, there is a sharp rise in the Australian dollar price of exports due to the devaluation of the exchange rate. This leads to a surge in exports.

In MM, the change in the price of exports relative to the domestic good accounts for the export surge, with the elasticity of transformation between exports and the domestic good equal to -0.73. In MSG2, however, the elasticity of transformation is infinite, indicating that any increase in the price of exports relative to the domestic good would cause all producers to switch to the export market. To counter this, a supply function for export facilitation is introduced into MSG2. This takes the form of a penalty cost which is incurred whenever the flow rate of exports is changed. This cost varies with the fraction of exports in GDP and increases as the rate of change of exports increases. The cost is symmetric for increases and decreases in exports.

The improved trade balance, combined with the fall in interest payments required to service that part of the debt held by foreigners, accounts for the improvement in the current account.

4.4 *Long-Run Results in MSG2*

In the long run, the temporary fiscal contraction lowers the ratio of government debt to gross domestic product. This occurs because tax rates are unchanged, so the drop in government spending leads to smaller budget deficits and slower accumulation of debt. Interestingly, in the *MSG2* model, a lower level of government debt produces only a few changes in the economy's balanced growth equilibrium. Moreover, all of these are the result of the drop in bonds held by foreigners. To understand why there is so little effect, consider what would happen if all government bonds were held domestically, and there was no long-run growth in the economy.

With all bonds held domestically, a drop in the stock of them has no effect whatsoever. To see why this is so, consider what happens to consumers. Some consumers (30 per cent), choose each period's consumption to solve an intertemporal optimization problem. For them, changes in consumption will be determined by what happens to their wealth. On one hand, fewer government bonds lowers wealth since bonds are one of the assets held by consumers.

On the other hand, individuals deduct from total wealth the present value of the lump sum tax used to finance interest payments on the bonds. Fewer bonds mean lower taxes, so wealth tends to rise. Thus, relative to control, the change in wealth is the following:

$$\Delta W = .3 \left(-\Delta T/r + \Delta B\right) \tag{4.13}$$

where r is the nominal interest rate. Taxes, of course, will fall by $r\Delta B$, so these effects are precisely the same magnitude and leave total wealth unchanged. Since wealth does not change, neither does consumption.

The other 70 per cent of the consumers are liquidity constrained, so for them, consumption is always equal to income. Reducing the stock of government bonds affects their income in two ways. Since they own bonds, income falls because they receive smaller interest payments from the government. At the same time, the lump sum tax also falls. Thus, the change in income will be:

$$\Delta Y = .7 \left(-\Delta T + r\Delta B\right) \tag{4.14}$$

Again, since taxes fall by $r\Delta B$, these two effects leave income unchanged. With no change in income, consumption by the liquidity-constrained group will be unaffected. Thus, when all government debt is held domestically, a reduction in bonds will change the composition of income and wealth, but will have no other effects.

In the actual MSG2 model, however, some of the government bonds are held by foreigners. This changes the results somewhat, and causes the drop in government debt to have an effect on the economy. The key fact is that domestic residents pay the entire lump sum tax, but receive only a fraction of the interest payments.

When the stock of bonds drops, consumers' tax burden falls more than their income, so they gain by the amount of interest that would have been paid to foreigners. As in the case described above, both the optimizing and liquidity-constrained consumers increase consumption to reflect the rise in income. In algebra, the total drop in bonds is the sum of the drops in bonds held by the domestic and foreign sectors:

(4.15) $$\Delta B = \Delta B_d + \Delta B_f$$

The liquidity-constrained consumers see their income changing as follows:

(4.16) $$\Delta Y = .7\left(-\Delta T + r\Delta B_d\right)$$

Taxes drop by $r(\Delta B_d + \Delta B_f)$, so the consumers will see their income, and hence their consumption, increase by $-r\Delta B_f$ (ΔB_f is negative). The analysis for the unconstrained consumers produces exactly the same result, so total consumption will rise by $-r\Delta B_f$ regardless of the ratio of liquidity-constrained to unconstrained consumers.

At the same time, the trade balance in the steady state must move toward deficit by exactly $-r\Delta B_f$. This must be so to bring the current account back into balance in the long run (causing the foreign debt to GDP ratio to stabilize). For the current account to balance, the following must be true:

(4.17) $$0 = \Delta(TB) - r\Delta B_f$$

where *(TB)* is the trade surplus. Thus, when interest payments drop, there will be an equal fall in the balance of trade.

Since the increase in consumption and the drop in the balance of trade are exactly the same size, there is no change in the demand for domestic output, and hence no change in prices or interest rates. This, in turn, keeps investment at its original share of GDP. Finally, since the fiscal contraction was only temporary, government spending also returns to its original share of GDP. Thus, the only effect of the shock in the long run is to shift output from exports and into consumption.

Introducing long-run GDP growth makes the details slightly more complex, but does not change the basic result at all. When the economy is growing at rate n, and the share of government debt in GDP is stable, then the government can finance part of its interest payments with new debt. Specifically, only $(r-n)B$ must be raised via the lump sum tax. On the other hand, for a growing economy, the long run current account (CA) will not balance, and instead will equal the growth rate times the foreign stock of domestic bonds. This allows the ratio of foreign holdings of bonds to domestic GDP to stabilize. In this situation, the following must be true:

$$(CA) = -nB_f = (TB) - rB_f . \tag{4.18}$$

This means that the trade balance must satisfy:

$$(TB) = (r-n)B_f . \tag{4.19}$$

This, however, is exactly the amount by which consumption will change as the government lowers the lump sum tax on domestic residents. All results discussed above for the no-growth case apply, except that the change in consumption and the trade balance is $(r-n)\Delta B_f$ instead of $r\Delta B_f$, and the current account moves toward surplus by $-n\Delta B_f$. These results are precisely what is shown in Charts 1 to 4.

In summary, the long-run effects of a temporary fiscal contraction all result from the reduction in government bonds held overseas. By reducing its debt, the government can cut taxes on domestic residents by the amount of interest it would have had to pay on the eliminated bonds. Since a portion of the interest formerly went to foreigners, the drop actually increases domestic income, raising wealth and consumption. The extra domestic demand is accommodated by an equal drop in the trade balance, so output remains unchanged.

5. *Postview*

In most respects, the results produced by the two models are fairly similar. The main area of disagreement is in the relative response of investment and exports in the short run. The Murphy model predicts a large rise in investment and a small increase in exports. MSG2, on the other hand, gives precisely the opposite results: investment actually falls, while exports increase sharply. Since both models include q-theoretic investment behaviour, it is surprising to find that short-run investment differs so much between the two.

These results stem from two differences between the two models. First, the short-run interest rate in MM falls further and stays low longer than in MSG2. This reduces the long-run interest rate substantially in early periods, which stimulates investment. The second difference is that investors in MM have myopic expectations about the earnings of capital, while those in MSG2 have perfect foresight.[1] Since the returns on capital rise initially and then decline, investors in MM, who believe the initial increase is permanent, respond more strongly. In MSG2, on the other hand, agents compare the long-run interest rate with the present value of earnings on an additional unit of capital. They realize the increase is temporary, so investment is much weaker.

Returning now to more general issues, we ask which parameters of the two models are particularly influential in generating the overall results? Care is needed in attempting an answer, since normally we are inclined to make judgements from a partial equilibrium viewpoint; the simulation results, on the other hand, reflect the totality of parameter settings. Nevertheless, for the short-run results, the interest elasticity of money demand is crucial in both models. This is because, the fall in the interest rate needed to compensate for a fall in transactions demand for money is (with money held constant) inversely related to (the absolute value of) this parameter. The builders of these particular models use more or less the same value for it; a difference of an order of magnitude would, we believe, have led to quite different short-term results.

Trade parameters are also crucial. We have already noted above some degree of uncertainty surrounding the export parameters in both models. In MM, the relevant parameters are the estimated transformation elasticity between the domestic good and the exportable, and the coefficients of the lag distribution linking actual exports to their equilibrium value; relevant in MSG2 are the adjustment cost parameters associated with the speed at which exports adjust towards long-run equilibrium. Research on

1 That is, investors' expectations are model-consistent.

sharpening up the specification and estimation here would be valuable; this is one area in which we think the MSG2 model could be improved.[1]

As with money demand, the two models treat imports rather similarly. The key common aspects of the specification are:

(i) no domestic intermediate input is recognized;

(ii) substitution against domestic primary factors in production is relatively elastic (σ_2 = 0.77 in MM, σ_4 = 1 in MSG2 -- see Figures 1 and 2, pp. 6 and 7 above).

One approach to assessing the reliability of these and other trade parameters would be to *generate* them by simulations with a more disaggregated model with a stronger econometric base (ORANI[2]). Such an approach would give a systematic way of identifying an important part of the sampling variance of the aggregate parameters; namely, the scope for variations in them due solely to compositional shifts at higher levels of disaggregation.

Above we have focussed on some approaches to improving (or at least, better defining the scope of) the existing models. Other areas where the pay-offs to future research seem high to us are in widening the scope of the models. At present, all paper assets are perfect substitutes. Clients in the finance industry would presumably be keen to know whether the shock analysed here has portfolio implications beyond the simple disaggregation into Australian and foreign bonds. Detailed analysis here undoubtedly would require

---

1 In particular, the Australian version of MSG2 would benefit from having more parameters estimated from Australian data.

2 Dixon, P.B., *et al.* (1982).

disaggregation also on the real side of the economy: both, it seems, are possible.[1] There may also be some pay-off at the existing level of disaggregation to incorporating some *direct* feedback on the exchange rate from the level of foreign debt relative to GDP (how *do* Moodys determine Australia's credit rating?).[2]

The last item on our list of suggestions for future research is related more to *explaining* models than to building them. In Section 4 we made use of a miniature (or stylized) model to aid interpretation of short-run results in MM: using it we are not able, however, to explain the initial 'jump' in the exchange rate. If forward-looking models based on essentially control-theoretic aproaches are to be explained successfully to policy makers, some relatively simple, stylized miniature models will be needed, at least by those charged with advising policy makers. We hope to extend our work in this direction.

---

1 Higgs (1988) shows how Australian equities can be mapped to input-output industries such as those used in the ORANI model.

2 While the parameters associated with any such feedback rule could only be conjectural, it would allow some account to be taken of imperfect asset substitutability without major respecification of the models.

REFERENCES

Codsi, G., and Pearson, K. R. (1988) "GEMPACK: General-Purpose Software Suite for Applied General Equilibrium and Other Economic Modellers", *Computer Science in Economics and Management*, Vol. 1, pp. 189-207.

Dixon, P.B., Parmenter, B.R., Sutton, J., and Vincent D.P. (1982) *ORANI: A Multisectoral Model of the Australian Economy* (Amsterdam: North-Holland).

Duff, I.S. (1977) "MA28 - A Set of Fortran Subroutines for Sparse Unsymmetric Systems of Linear Equations", *Report* R.8730, Atomic Energy Research Establishment, Harwell, England (London: Her Majesty's Stationery Office).

Higgs, Peter, J. (1988) "A Mapping of Selected Australian Corporations Across Input-Output Industries", IMPACT Project *Preliminary Working Paper* No. IP-40, December.

McKibbin, W. (1988) "An Overview of the MSG Model and its Applications", Research Department, Reserve Bank of Australia (mimeo).

McKibbin, W., and Elliott, G. (1989) "Fiscal Policy in the MSG2 Model of the Australian Economy", Research Department, Reserve Bank of Australia (mimeo).

McKibbin, W., Sachs, J. (1989) "The McKibbin-Sachs Global (MSG2) Model of the World Economy", draft Chapters 4 and 5 from the forthcoming monograph *Macroeconomic Interdependence and Cooperation in the World Economy* (mimeo).

McKibbin, W., Siegloff, E. (1988a) "The Australian Economy from a Global Perspective", paper presented to the Bicentennial Economics Congress, Canberra, 30 August 1988 (mimeo).

McKibbin, W., Siegloff, E. (1988b) "A Note on Aggregate Investment in Australia", *The Economic Record*, December.

Murphy, C.W. (1988a) "Rational Expectations in Financial Markets and the Murphy Model", *Australian Economic Papers*, Vol. 27 (Supplement), pp. 61-88, June.

Murphy, C.W. (1988b) "An Overview of the Murphy Model", *Australian Economic Papers*, Vol. 27 (Supplement), pp. 175-199, June.

Murphy, C.W. (1989) "Appendix A", update of Appendix A in Murphy (1988b), Department of Statistics, The Faculties, The Australian National University (mimeo).

Murphy, C.W., Bright, I.A., Brooker, R.J., Geeves, W.D., and Taplin, B.K. (1986) "A Macroeconometric Model of the Australian Economy for Medium-Term Policy Analysis", *Technical Paper* No. 2, Canberra, Economic Planning and Advisory Council, June.

Pearson, K.R. (1988) "Automating the Computation of Solutions of Large Economic Models", *Economic Modelling*, Vol. 5, pp. 385-395.

Appendix Table A1

Annual Summary of the Effects of the Contraction in Government Spending Projected by the Murphy Model

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	long run
NATIONAL ACCOUNTS (constant 1984-85 prices) (deviations from baseline as a percentage of baseline gross domestic product)															
private consumption	0.07	0.16	0.23	0.31	0.40	0.56	0.76	0.71	0.45	0.18	0.07	0.13	0.27	0.39	0.21
dwelling investment	0.10	0.30	0.32	0.29	0.28	0.26	0.19	0.06	-0.02	-0.03	-0.01	0.02	0.04	0.04	0.02
business fixed investment	0.11	0.26	0.30	0.33	0.35	0.36	0.31	0.22	0.10	0.04	0.04	0.09	0.13	0.14	0.00
general government expenditure	-2.17	-2.17	-2.17	-2.17	-2.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
gross national expenditure	-2.08	-1.53	-1.34	-1.24	-1.13	1.44	1.42	1.03	0.50	0.13	0.06	0.23	0.47	0.61	0.23
exports of goods and services	0.30	0.38	0.33	0.29	0.25	0.37	0.32	0.11	-0.09	-0.18	-0.14	-0.04	0.05	0.10	-0.05
- imports of goods and services	1.03	0.88	0.76	0.71	0.65	-0.08	-0.28	-0.34	-0.28	-0.17	-0.07	-0.04	-0.06	-0.09	-0.11
gross domestic product	-0.75	-0.28	-0.26	-0.25	-0.22	1.74	1.46	0.80	0.13	-0.22	-0.15	0.16	0.47	0.62	0.07

continued overleaf

Murphy Results Summary (ctd)

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	long run
CAPITAL AND LABOUR (deviations from baseline)															
stock of dwellings (%)	0.05	0.35	0.69	0.97	1.23	1.47	1.63	1.65	1.56	1.45	1.36	1.30	1.27	1.26	0.35
business fixed capital (%)	0.04	0.20	0.37	0.55	0.73	0.90	1.04	1.10	1.07	1.00	0.92	0.88	0.87	0.88	0.02
employment (%)	-0.03	-0.09	-0.14	-0.16	-0.16	0.47	0.79	0.58	0.13	-0.25	-0.36	-0.23	-0.00	0.16	0.00
participation rate (% points)	-0.01	-0.02	-0.04	-0.04	-0.04	0.12	0.20	0.15	0.03	-0.06	-0.09	-0.06	-0.00	0.04	0.00
unemployment rate (% points)	0.01	0.05	0.08	0.09	0.09	-0.26	-0.43	-0.32	-0.07	0.14	0.20	0.13	0.00	-0.09	0.00
WAGES AND PRICES (% deviations from baseline)															
wage rate	0.07	0.21	0.16	-0.46	-1.81	-2.83	-1.84	-0.25	1.09	1.57	1.13	0.23	-0.58	-0.90	-0.21
consumer price index	0.09	0.32	0.32	-0.25	-1.58	-2.81	-2.42	-1.14	0.23	0.94	0.72	-0.10	-0.97	-1.41	-0.25
g.d.p. deflator	0.42	0.52	0.48	-0.11	-1.45	-2.85	-2.37	-1.03	0.36	1.06	0.84	0.01	-0.86	-1.31	-0.25

continued overleaf

Murphy Results Summary (ctd)

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	long run
EXCHANGE RATE AND COMPETITIVENESS (% deviations from baseline)															
exchange rate	-8.27	-6.33	-5.20	-4.09	-2.14	0.42	1.68	2.22	1.87	1.06	0.39	0.23	0.50	0.84	1.02
import competitiveness	8.24	6.23	5.28	4.89	4.38	1.76	-0.09	-1.69	-2.29	-1.84	-0.89	-0.08	0.25	0.17	-0.81
INTEREST RATES (deviations from baseline as percentage points p.a.)															
90 day bill rate	-2.40	-1.44	-1.19	-1.80	-3.33	-1.73	-1.08	0.12	1.14	1.51	1.12	0.30	-0.48	-0.85	0.00
10 year bond rate	-1.14	-0.94	-0.90	-0.86	-0.62	-0.18	0.06	0.19	0.16	0.03	-0.10	-0.14	-0.10	-0.03	0.00
10 year expected inflation rate	-0.07	-0.15	-0.22	-0.20	-0.01	0.31	0.33	0.18	-0.00	-0.12	-0.12	-0.04	0.06	0.09	0.00
TWIN DEFICITS (deviations from baseline as a percentage of gross domestic product)															
public sector deficit	-1.97	-1.98	-1.99	-1.99	-1.99	-0.74	-0.75	-0.77	-0.78	-0.78	-0.78	-0.76	-0.75	-0.75	-0.76
lump sum tax	0.00	-0.29	-0.48	-0.66	-0.84	-0.75	-0.54	-0.23	0.04	0.13	0.06	-0.08	-0.20	-0.24	-0.19
trade a/c in goods & services	1.55	1.36	1.16	1.06	0.96	0.18	-0.10	-0.31	-0.39	-0.32	-0.18	-0.07	-0.02	-0.03	-0.17
current a/c	1.51	1.47	1.40	1.42	1.42	0.64	0.47	0.33	0.28	0.31	0.39	0.46	0.50	0.50	0.53

continued overleaf

Murphy Results Summary (ctd)

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	long run
BALANCE SHEETS (deviations from baseline as a percentage of gross domestic product)															
private sector net worth	-0.38	-0.95	-1.09	-1.32	-1.54	-2.17	-0.33	0.81	1.09	0.65	-0.11	-0.73	-0.95	-0.76	0.45
public sector net worth	1.07	3.12	4.85	6.29	7.49	7.92	8.20	8.50	8.69	8.70	8.56	8.36	8.22	8.17	8.20
liabilities to foreign sector	0.55	-1.46	-2.95	-4.28	-5.58	-6.57	-6.78	-6.79	-6.63	-6.43	-6.30	-6.28	-6.33	-6.41	-8.51

Appendix Table A2

Summary of the Effects of the Contraction in Government Spending Projected by the MSG2 Model

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	long run
NATIONAL ACCOUNTS (constant 1984-85 prices) (deviations from baseline as a percentage of baseline gross domestic product)															
private consumption	-0.19	-0.23	-0.19	-0.16	-0.25	0.63	0.66	0.60	0.54	0.46	0.39	0.34	0.30	0.26	0.21
business fixed investment	-0.11	-0.11	-0.10	-0.09	-0.14	0.27	0.25	0.21	0.15	0.11	0.07	0.04	0.01	0.00	0.00
general government expenditure	-2.06	-2.06	-2.06	-2.06	-2.05	-0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00
exports of goods and services-	0.36	0.57	0.68	0.69	0.63	0.47	0.35	0.25	0.15	0.06	0.00	-0.06	-0.11	-0.14	-0.19
- imports of goods and services	0.83	0.80	0.76	0.73	0.73	-0.16	-0.19	-0.20	-0.19	-0.18	-0.16	-0.14	-0.12	-0.10	-0.02
gross domestic product	-1.16	-1.04	-0.91	-0.88	-1.08	1.20	1.08	0.87	0.66	0.45	0.32	0.19	0.09	0.03	0.00
CAPITAL AND LABOUR (deviations from baseline)															
business fixed capital (%)	0.00	-0.01	-0.02	-0.02	-0.02	-0.04	0.06	0.14	0.18	0.21	0.21	0.20	0.18	0.16	0.00
employment (%)	-0.51	-0.59	-0.52	-0.55	-0.96	1.77	1.53	1.15	0.78	0.46	0.21	0.03	-0.07	-0.13	0.00

continued overleaf

MSG2 Results Summary (ctd)

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	long run
WAGES AND PRICES (% deviations from baseline)															
wages	0.00	0.20	0.10	-0.23	-0.94	-1.63	-1.42	-1.07	-0.70	-0.39	-0.15	0.02	0.12	0.18	0.00
consumer price index	0.10	-0.12	-0.37	-0.89	-0.19	0.06	0.17	0.20	0.19	0.15	0.11	0.08	0.05	0.03	0.00
EXCHANGE RATE AND COMPETITIVENESS (% deviations from baseline)															
exchange rate	-4.59	-3.77	-3.17	-2.54	-1.33	1.73	1.41	1.16	0.95	0.77	0.62	0.48	0.37	0.28	0.00
import competitiveness	4.48	3.52	3.01	2.71	2.36	-0.77	-0.53	-0.46	-0.46	-0.47	-0.46	-0.43	-0.38	-0.33	-0.02
INTEREST RATES (deviations from baseline as percentage points p.a.)															
Short-run rate	-0.85	-0.64	-0.70	-1.30	-3.17	0.26	0.19	0.16	0.15	0.13	0.12	0.10	0.08	0.07	0.00
TWIN DEFICITS (deviations from baseline as a percentage of gross domestic product)															
public sector deficit	-1.81	-1.81	-1.83	-1.83	-1.76	-0.37	-0.33	-0.26	-0.19	-0.13	-0.08	-0.04	-0.01	0.00	0.00
lump sum tax	-0.26	-0.23	-0.27	-0.38	-1.23	-0.38	-0.43	-0.45	-0.45	-0.44	-0.42	-0.41	-0.39	-0.38	-0.24
trade a/c in goods & services	0.97	1.05	1.08	1.06	0.95	0.34	0.26	0.16	0.07	-0.01	-0.07	-0.12	-0.16	-0.19	-0.19
current a/c	1.01	1.13	1.22	1.26	1.19	0.62	0.56	0.48	0.40	0.33	0.27	0.22	0.19	0.16	0.09