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ASSESSING DYNAMIC PROPERTIES OF THE MCM: A SIMULATION APPROACH

by

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Introduction

This paper reports some simulations with the current version of the Federal Reserve Board's multi-country model (MCM). This exercise was undertaken largely to learn how changes to the MCM made over the last several years have affected its simulation properties and to extend our understanding of the model's policy implications. These changes include the addition of an oil sector, some revisions of trade equations, international accounts in the U.S., revised monetary sectors in Japan and Germany, as well as the way in which exchange rates are modeled.[1/]

The most critical change deals with the behavior of exchange rates. In both the early and most recent versions of the model the exchange rate is viewed largely as an asset market phenomenon. The differences are in the specifications. In the first version of the model there were no explicit exchange rate equations; the exchange rate was solved for implicitly. In the current version we have renormalized a balance of payments capital account behavioral equation for the exchange rate. This has had the effect of substantially moderating exchange rate variability in the model.

After presenting a brief description of the model, we examine the response of the model to a variety fiscal and financial shocks. In these simulations we allow for different sterilization and deficit financing assumptions. In a companion paper, "Assessing Policy Strategies in a Multi-Country Model," we compare alternative financial strategies in an open economy. There we look to see if the model possesses the income stabilization properties that are suggested by the theoretical work of Poole (1970), Bryant (1980), and Henderson (1982).

I. Overview of the Multi-Country Model

The Multi-Country Model is a large scale econometric model developed in the Federal Reserve Board's Division of International Finance. It consists of macro econometric models of five countries -- the U.S., U.K., Canada, Germany, and Japan -- as well as an abbreviated rest-of-the-world sector. Particular attention has been paid to the international aspects of macroeconomic behavior but each country model is sufficiently developed that it can be used individually as well as fully linked with other countries in the model. When the country models are linked together and simulated, as is the case in this paper, economic impulses are transmitted from one country to another by trade flows, capital flows, exchange rates, prices and interest rates.

There are several features of the MCM worth noting at the outset. The first of these is the endogeneity of four exchange rates, specifically the U.S. dollar rates of the Canadian dollar, pound sterling, D-mark and yen. One is tempted to describe the exchange rate determination process in the MCM in terms of the exchange rate that equilibrates the current and capital accounts but this would be a misleading oversimplification. The exchange rate enters equations which do not figure in the balance of payments constraint (such as demand for money functions) and other endogenous variables (such as interest rates) enter into equations that describe components of the balance of payments.

Operationally, in the current version of the MCM, exchange rates are specified as the dependent variable in net private capital account equations. In these equations exchange rates are expressed directly as functions of interest differentials, the net private capital flow (i.e. official intervention and the current account), movements in net worth and

various factors affecting exchange rate expectations, including relative prices, inflation differentials and the cumulative current account. (The details of this specification and the estimated equations are presented in Hooper et.al. (1983).) Thus, for a given current account, exchange rates can be viewed as being directly determined in the asset market. Over time, as the current account responds to exchange rate movements it will effect the level of the exchange rate both by altering exchange rate expectations as well as by changing the size of the international wealth transfers. In other words, in the long run the size of the asset market itself is endogenous to the model.

This endogeneity of the exchange rate induces the capital flows required to offset exogenous shocks either to the current account or to the capital account. Thus a trade surplus (or a private speculative inflow or the sale of foreign currency by the central bank) requires a private capital outflow to equilibrate the system . This is accomplished in the model through a change in the relative rates of return of home and foreign currency assets. With home and foreign currency interest rates determined principally by domestic financial considerations, the spot rate must appreciate relative to the expected spot rate. This impact appreciation of the home currency gives rise to an expected depreciation and thus provides the motivation for the required capital outflow.

A second noteworthy feature of the model is the use of bilateral trade equations. The model is structured so that changes in one country's imports are automatically reflected as changed exports and aggregate demand elsewhere in the model. Thus a rather elaborate set of trade linkages is fully articulated in a manner that transmits commodity demands completely among the MCM countries.

A third feature of the model is the recent addition of an oil sector. Here the model has been enlarged to model explicitly the consumption and trade of oil, as well as the domestic price effects of oil price shocks. Furthermore we have attempted to capture some of the financial effects of oil price shocks by including an OPEC net worth variable in the various exchange rate (capital flow) equations. A full description of each of the country models has been done elsewhere; nevertheless a brief overview of the prototype country model is useful before we begin our examination of the simulation experiments.

The typical model distinguishes four classes of agents: the monetary authority, commercial banks, the government, and private non-bank agents (i.e. firms and households). The actions of these agents are modeled in several markets: the goods market, the labor market, and the asset markets.

The goods market consists of the conventional elements of aggregate demand --consumption, investment, the net trade balance, and government expenditure. The supply side is based on a Cobb-Douglas production function and a labor market which does not clear completely in any given period. This gives rise to a positive output elasticity in the aggregate supply function. In the model inventory changes serve as a short-term buffer.

Prices are determined by a mark-up over average cost. Thus the price equations include as determinants wages, capacity utilization, and foreign export prices adjusted by the exchange rate. The money market focuses on the role of reserves in the system. For a given unborrowed base, the short-term interest rate adjusts to clear the various demands for base. The short-term bond market is the omitted market.[2/] Of course

the various models try to incorporate institutional differences. In particular the U.K. model and, to a lesser degree, the German model differ from the prototype in their specification of domestic financial markets.

The model assumes that neither the composite national goods nor the home currency bonds of the MCM countries are perfect substitutes for one another, even after exchange rate expectations have been taken into account. Consequently, intervention policy has a role to play in the model.

While the model is suitable for forecasting (and is periodically used for that purpose) this paper focuses on the model's capability for policy analysis. The model can be simulated under three alternative exchange rate assumptions -- fixed rates, a pure float or a managed float. Monetary and fiscal policy instruments can be specified in a variety of different fashions. In this paper we present the results of standard monetary and fiscal shocks, including simulations that examine policies coordinated across countries, simulations that alter the degree of openness of the model, and simulations that focus on the role of sterilized intervention.

II. Simulation Results

In this section of the paper we present a variety of simulation results that are designed to show the salient properties of the MCM. We have done this by shocking various exogenous variables in the model.

Before discussing the specific simulation experiment, it is important to specify the overall policy setting. Obviously, the effects of policy will be different in cases in which central banks respond to

exchange market developments and those in which they don't. Similarly, since the nominal budget deficit is endogenous, the method chosen to finance government debt is of key importance. Unless otherwise stated, we simulate under the following two assumptions. First, we assume that central banks offset (i.e. sterilize) any monetary consequences of exchange market intervention. Second, we assume that all budget deficits are bond financed in domestic currency and, furthermore, this debt is an "outside" asset. That is, private wealth holders do not systematically alter their portfolios to fully offset new government bonds but rather view these bonds as a net addition to wealth. We could conceivably have chosen to have kept monetary policy constant by leaving interest rates unchanged instead of the monetary base, but the results would have been less illustrative of the general properties and dynamics of the model. It is, after all, a model in which interest rates play an important role via the investment function and the exchange rate. In some simulations in the fiscal policy section, we relax this assumption and allow for domestic money and foreign currency denominated bond financing of deficits.

Fiscal Policy Shocks

In this section we examine the effects of an autonomous increase in government expenditures. The shock is an increase in real government expenditures equal to 1% the starting period's value of real GNP and held constant throughout the 24 quarters of the simulation. We will present simulation results for three policy assumptions concerning the financing of the debt. Initially, we treat all debt as being sold to the public. As one alternative we treat it as being sold to the central bank (i.e. monetized). The results of these two sets of simulations are presented in

Tables 1-4, which give the impact on each country's GNP, exchange rate, interest rate and price level. In addition, for Canada, we run one simulation where one half the deficit is financed by the sale of bonds denominated in U.S. dollars. These results are given in Tables 5-8. All tables present the shock minus control values; for GNP, exchange rates, and prices. The results are in terms of percentage changes, while the interest rate impacts are given as one hundred basis point deviations. The key at the bottom of Table 1 explains the assumption underlying each of the fiscal simulations.

The first shock discussed is the bond financed increase in real government expenditures. The results are found in the columns marked "ST". The responses of income in each country, shown in Table 1, differ somewhat from one another, but nevertheless some common elements emerge. The income response is higher in the U.S. than in other countries. This is partially due to a short lived U.S. inventory effect and to the fact that the foreign trade sector in the U.S. is not a major source of income-induced leakages. Foreign feedbacks generate an increase in U.S. exports that are comparable to the increase in U.S. imports.[3/] This is not true in the other country models. Secondly, an investment accelerator-multiplier mechanism is strong in the U.S. model, as it is in the German model.

Tables 2 and 3 show the exchange rate and interest rate effects of the fiscal shocks. The very elastic demand for base money in general and free reserves in particular, in most of the models, means that interest rates rise very little in response to a fiscal shock. The capital flow generated by interest rate changes alone are insufficient to provide enough of an offset to the current account. Consequently the

exchange rates depreciate in order to attract enough capital from abroad to equilibrate the system. Thus all of the home currencies weaken with a fiscal shock. Table 4 shows the response of prices to a fiscal shock. As expected the currency depreciation and increase in aggregate demand lead to price increases in all countries, though owing to unique labor market considerations the increase is relatively moderate in the U.K.

These four tables also present the results of monetizing both the increased debt and the official reserve flows associated with the fiscal shock (except for the U.K. where their financial structure precludes this experiment). These simulation results are found in the columns labeled "MON". As expected this accomodating monetary policy causes interest rates to fall in the face of an expansionary fiscal policy. (Although in both the U.S. and German cases, strong income growth brought on by an investment accelerator gives rise, via the money demand process, to a period of increased interest rates.) The decline in domestic interest rates leads to an even greater domestic currency depreciation supplementing the negative exchange rate effects of the reduced trade balance. Given the additional source of aggregate demand and the currency depreciation, prices are predictably higher when the debt is monetized than when it is not. For similar reasons we would also expect income to be higher and largely this is true, though near the end of the simulation Germany is in a deceleration phase of the cycle.

The results of two other fiscal shocks are presented in the first four tables; a case in which all countries expand together and the results of altering the openness of the model. We begin with the former. One would expect that when all countries are expanding together the effect on any one country's income would be greater than when it expands in

TABLE 1: STERILIZED AND MONETIZED FISCAL SHOCKS — GNP. (PERCENTAGE DEVIATION FROM BASELINE)

	CANADA (ST)	CANADA (OPEN)	CANADA (MON)	CANADA (ALL CTY)	UK (ST)	UK (ALL CTY)	GERMANY (ST)	GERMANY (OPEN)	GERMANY (MON)	GERMANY (ALL CTY)	JAPAN (ST)	JAPAN (MON)	JAPAN (ALL CTY)	US (ST)	US (OPEN)	US (MON)	US (ALL CTY)
Q1	1.014	0.924	1.027	1.31	1.099	1.204	1.129	1.048	1.141	1.239	1.045	1.045	1.233	2.414	2.159	2.153	2.291
Q2	1.066	0.929	1.093	1.405	1.148	1.289	1.365	1.2	1.409	1.534	1.176	1.177	1.336	1.883	1.952	2.012	2.181
Q3	1.049	0.861	1.101	1.441	1.255	1.445	1.605	1.377	1.695	1.835	1.293	1.294	1.468	1.734	1.82	2.069	2.125
Q4	1.05	0.834	1.28	1.579	1.147	1.388	1.759	1.464	1.903	2.068	1.354	1.357	1.596	2.181	2.31	2.821	2.665
Q5	0.989	0.748	1.392	1.608	1.299	1.576	1.829	1.491	2.021	2.185	1.427	1.432	1.74	2.136	2.286	3.059	2.625
Q6	0.981	0.747	1.618	1.599	1.232	1.55	1.915	1.538	2.152	2.312	1.482	1.49	1.788	1.985	2.149	3.097	2.454
Q7	0.981	0.739	1.557	1.62	1.207	1.545	2.04	1.631	2.315	2.477	1.531	1.544	1.865	1.832	1.994	2.95	2.241
Q8	1.023	0.778	1.771	1.728	1.115	1.447	2.123	1.668	2.424	2.573	1.573	1.59	1.897	1.697	1.849	2.618	2.035
Q9	1.007	0.759	1.861	1.75	1.135	1.46	2.125	1.659	2.415	2.569	1.577	1.599	1.949	1.592	1.72	2.192	1.836
Q10	1.011	0.751	1.874	1.734	1.064	1 39	2.185	1.703	2.444	2.633	1.607	1.635	1.947	1.445	1.554	1.69	1.601
Q11	0.988	0.721	1.86	1.684	1.059	1.405	2.242	1.756	2.443	2.683	1.648	1.681	2.012	1.377	1.458	1.373	1.462
Q12	1.025	0.746	1.887	1.753	0.951	1.216	2.26	1.765	2.373	2.683	1.674	1.712	1.99	1.294	1.35	1.197	1.329
Q13	1.011	0.738	1.841	1.706	0.878	1.107	2.163	1.692	2.154	2.553	1.703	1.745	2.036	1.189	1.22	1.191	1.193
Q14	0.998	0.736	1.801	1.64	0.891	1.128	2.077	1.645	1.921	2.43	1.719	1.769	2.033	1.077	1.082	1.346	1.045
Q15	0.95	0.702	1.746	1.515	0.934	1.16	1.951	1.568	1.649	2.269	1.737	1.792	2.023	0.99	0.966	1.609	0.926
Q16	1.005	0.754	1.795	1.551	0.947	1.13	1.816	1.486	1.371	2.068	1.739	1.801	2.	0.901	0.853	1.853	0.834
Q17	0.974	0.728	1.731	1.443	0.966	1.127	1.54	1.295	0.986	1.72	1.735	1.804	1.975	0.823	0.744	1.994	0.729
Q18	0.979	0.738	1.742	1.382	0.977	1.144	1.339	1.189	0.708	1.452	1.746	1.82	1.93	0.737	0.631	1.962	0.641
Q19	0.942	0.71	1.717	1.271	1.073	1.238	1.168	1.097	0.491	1.232	1.764	1.845	1.948	0.669	0.541	1.764	0.578
Q20	0.974	0.746	1.787	1.238	1.083	1.23	1.058	1.06	0.397	1.054	1.755	1.84	1.886	0.607	0.46	1.466	0.538
Q21	0.943	0.73	1.777	1.111	1.063	1.193	0.954	1.019	0.396	0.909	1.783	1.877	1.985	0.563	0.411	1.153	0.518
Q22	0.941	0.739	1.836	1.042	1.102	1.251	0.864	0.994	0.455	0.783	1.836	1.937	1.988	0.574	0.408	1.002	0.542
Q23	0.878	0.702	1.903	0.885	1.159	1.317	0.782	0.969	0.581	0.679	1.872	1.978	2.05	0.552	0.39	0.951	0.574
Q24	0.897	0.732	1.962	0.854	1.154	1.332	0.757	0.998	0.846	0.622	1.912	2.019	2.07	0.52	0.375	1.107	0.616

Key to Fiscal Policy Shocks

ST -- Changes in international reserves are sterilized
OPEN -- All import and export elasticities for all countries are doubled
MON -- Both changes in international reserves and fiscal deficits are monetized
ALL CTY -- All countries increase government spending simulataneously

ALL FISCAL SHOCKS ARE SUSTAINED INCREASES IN GOVERNMENT SPENDING EQUAL TO ONE PERCENT OF GNP IN THE FIRST PERIOD (1975 Q1)

E 2: STERILIZED AND MONETIZED FISCAL SHOCKS -- EXCHANGE RATE (FOREIGN CURRENCY/DOMESTIC CURRENCY) (PERCENTAGE DEVIATION FROM BASELINE)

CANADA (ST)	CANADA (OPEN)	CANADA (MON)	CANADA (ALL CTI)	UK (ST)	UK (ALL CTI)	GERMANY (ST)	GERMANY (OPEN)	GERMANY (MON)	GERMANY (ALL CTI)	JAPAN (ST)	JAPAN (MON)	JAPAN (ALL CTI)	US10 (ST)	US10 (OPEN)	US10 (MON)	US10 (ALL CTI)	US4 (ST)	US4 (OPEN)	US4 (MON)	US4 (ALL CTI)
-0.034	-0.068	-0.096	-0.046	-0.06	-0.049	-0.071	-0.1	-0.172	-0.114	-0.058	-0.069	-0.012	-0.248	+0.266	-0.744	-0.118	0.041	0.001	-0.453	0.126
-0.096	-0.179	-0.273	-0.191	-0.108	-0.077	-0.229	-0.309	-0.509	-0.274	-0.187	-0.209	-0.084	-0.452	-0.501	-1.408	-0.116	0.117	0.028	-0.822	0.342
-0.162	-0.284	-0.486	-0.404	-0.154	-0.084	-0.443	-0.576	-0.959	-0.481	-0.314	-0.348	-0.127	-0.653	-0.735	-2.108	-0.089	0.192	0.056	-1.208	0.593
-0.188	-0.282	-1.339	-0.821	-0.206	-0.124	-0.664	-0.893	-1.141	-0.743	-0.471	-0.516	-0.205	-0.949	-1.066	-2.653	-0.165	0.253	0.06	-1.325	0.838
-0.052	-0.27	-2.406	-0.407	-0.263	-0.146	-0.966	-0.204	-1.476	-1.049	-0.627	-0.683	-0.237	-1.325	-1.482	-3.014	-0.286	0.247	-0.009	-1.199	1.069
-0.03	-0.285	-3.446	-0.409	-0.332	-0.175	-1.316	-1.618	-1.813	-1.389	-0.793	-0.86	-0.25	-1.705	-1.902	-3.191	-0.363	0.214	-0.104	-0.883	1.327
-0.224	-0.457	-2.883	-0.808	-0.375	-0.107	-1.698	-2.062	-2.138	-1.631	-0.947	-1.023	-0.211	-2.047	-2.27	-3.246	-0.373	0.172	-0.186	-0.48	1.607
-0.98	-0.705	-2.276	-1.328	-0.426	-0.049	-2.08	-2.507	-2.426	-1.834	-1.106	-1.193	-0.172	-2.333	-2.561	-3.246	-0.28	0.121	-0.266	-0.119	1.917
-0.718	-0.943	-1.926	-1.762	-0.465	0.048	-2.478	-2.964	-2.663	-2.048	-1.261	-1.356	-0.11	-2.595	-2.817	-3.297	-0.166	0.026	-0.379	0.067	2.174
-0.854	-1.074	-1.627	-1.928	-0.504	0.133	-2.861	-3.407	-2.872	-2.304	-1.401	-1.504	-0.053	-2.838	-3.04	-3.485	-0.046	-0.115	-0.531	-0.029	2.355
-0.907	-1.118	-1.502	-1.91	-0.525	0.227	-3.24	-3.838	-3.099	-2.599	-1.518	-1.629	0.028	-3.085	-3.228	-3.87	0.059	-0.262	-0.686	-0.418	2.472
-0.929	-1.141	-1.731	-1.846	-0.55	0.286	-3.602	-4.248	-3.332	-2.886	-1.646	-1.766	0.081	-3.193	-3.348	-4.408	0.215	-0.391	-0.825	-1.038	2.596
-0.965	-1.182	-1.984	-1.813	-0.582	0.358	-3.947	-4.645	-3.547	-3.16	-1.789	-1.918	0.092	-3.287	-3.422	-5.033	0.418	-0.491	-0.94	-1.746	2.74
-1.04	-1.271	-2.312	-1.832	-0.624	0.414	-4.283	-5.035	-3.771	-3.425	-1.841	-1.977	0.169	-3.287	-3.386	-5.552	0.665	-0.573	-1.028	-2.393	2.874
-1.132	-1.377	-2.6	-1.876	-0.645	0.494	-4.598	-5.396	-4.04	-3.665	-1.929	-2.073	0.201	-3.27	-3.341	-5.989	0.913	-0.645	-1.106	-2.644	3.012
-1.252	-1.512	-2.821	-1.984	-0.682	0.536	-4.825	-5.671	-4.292	-3.839	-2.059	-2.214	0.137	-3.153	-3.198	-6.056	1.235	-0.681	-1.148	-3.01	3.199
-1.392	-1.664	-3.031	-2.121	-0.728	0.566	-5.022	-5.917	-4.542	-3.979	-2.174	-2.34	0.102	-3.028	-3.039	-5.934	1.517	-0.721	-1.189	-2.909	3.362
-1.536	-1.822	-3.314	-2.244	-0.792	0.591	-5.197	-6.145	-4.807	-4.108	-2.317	-2.496	0.024	-2.898	-2.881	-5.602	1.815	-0.757	-1.226	-2.571	3.56
-1.665	-1.963	-3.624	-2.328	-0.847	0.52	-5.355	-6.358	-5.126	-4.231	-2.482	-2.678	-0.102	-2.795	-2.762	-5.311	2.077	-0.796	-1.271	-2.266	3.761
-1.641	-1.999	-3.918	-2.132	-0.928	0.44	-5.49	-6.555	-5.472	-4.408	-2.656	-2.867	-0.293	-2.743	-2.701	-5.022	2.295	-0.902	-1.388	-2.058	3.945
-1.602	-2.027	-4.189	-1.902	-1.007	0.375	-5.633	-6.787	-5.905	-4.556	-2.894	-3.125	-0.528	-2.793	-2.749	-4.961	2.491	-1.073	-1.564	-2.123	4.114
-1.621	-2.1	-4.455	-1.771	-1.064	0.342	-5.805	-7.071	-6.118	-4.682	-3.057	-3.911	-0.807	-2.792	-2.761	-5.135	2.59	-1.19	-1.692	-2.51	4.31
-1.674	-2.179	-4.634	-1.704	-1.092	0.342	-6.001	-7.393	-6.958	-4.794	-3.33	-3.601	-1.011	-2.773	-2.78	-5.567	2.652	-1.23	-1.745	-3.082	4.473
-1.782	-2.3	-4.727	-1.748	-1.158	0.268	-6.17	-7.697	-7.463	-4.849	-3.511	-3.799	-1.269	-2.674	-2.699	-6.068	2.73	-1.195	-1.733	-3.696	4.704

us10 - ten-country trade-weighted exchange rate

us4 - exchange rate relative to the other four mcm countries

TABLE 3: STERILIZED AND MONETIZED FISCAL SHOCKS -- INTEREST RATE (100 BASIS POINTS DEVIATION FROM BASELINE)

	CANADA (ST)	CANADA (OPEN)	CANADA (MON)	CANADA (ALL CTY)	UK (ST)	UK (ALL CTY)	GERMANY (ST)	GERMANY (OPEN)	GERMANY (MON)	GERMANY (ALL CTY)	JAPAN (ST)	JAPAN (MON)	JAPAN (ALL CTY)	US (ST)	US (OPEN)	US (MON)	US (ALL CTY)
Q1	0.033	0.032	-0.068	0.025	0.	0.011	0.011	0.01	-0.101	0.010	0.01	-0.033	0.012	0.149	0.152	-0.775	0.161
Q2	0.042	0.037	-0.158	0.018	0.	0.023	0.034	0.029	-0.253	0.051	0.017	-0.067	0.019	0.3	0.308	-0.933	0.334
Q3	0.055	0.048	-0.247	0.016	0.001	0.036	0.057	0.049	-0.331	0.076	0.019	-0.103	0.021	0.447	0.462	-1.074	0.507
Q4	0.274	0.227	-1.366	0.396	0.001	0.051	0.075	0.065	-0.338	0.094	0.025	-0.136	0.028	0.62	0.645	-0.865	0.714
Q5	0.315	0.258	-1.937	0.494	0.001	0.062	0.094	0.079	-0.286	0.12	0.024	-0.175	0.027	0.75	0.785	-0.296	0.872
Q6	0.363	0.294	-2.454	0.588	0.002	0.071	0.106	0.089	-0.211	0.137	0.027	-0.209	0.031	0.856	0.903	0.328	1.002
Q7	0.085	0.089	-0.416	0.037	0.002	0.076	0.114	0.096	-0.115	0.148	0.028	-0.245	0.033	0.928	0.986	0.877	1.09
Q8	-0.003	-0.042	-0.856	-0.223	0.002	0.08	0.13	0.11	0.009	0.168	0.038	-0.271	0.044	0.986	1.053	1.246	1.153
Q9	-0.043	-0.078	-0.764	-0.295	0.002	0.082	0.145	0.123	0.199	0.185	0.035	-0.312	0.04	1.017	1.092	1.346	1.178
Q10	0.019	0.023	-0.392	-0.094	0.002	0.084	0.157	0.135	0.38	0.198	0.039	-0.343	0.044	1.058	1.138	1.147	1.206
Q11	0.082	0.089	-0.522	0.055	0.002	0.086	0.175	0.151	0.519	0.215	0.04	-0.378	0.045	1.103	1.187	0.706	1.233
Q12	0.136	0.144	-0.624	0.159	0.002	0.089	0.195	0.169	0.635	0.235	0.052	-0.399	0.059	1.157	1.243	0.184	1.264
Q13	0.159	0.168	-0.739	0.194	0.001	0.089	0.217	0.191	0.766	0.261	0.047	-0.437	0.054	1.181	1.268	-0.353	1.263
Q14	0.159	0.165	-0.896	0.182	0.001	0.088	0.229	0.204	0.85	0.271	0.051	-0.464	0.058	1.193	1.279	-0.609	1.245
Q15	0.15	0.155	-0.977	0.162	0.001	0.087	0.234	0.21	0.831	0.271	0.053	-0.493	0.06	1.206	1.289	-0.795	1.225
Q16	0.15	0.158	-0.95	0.146	0.001	0.088	0.251	0.227	0.762	0.288	0.072	-0.504	0.08	1.263	1.344	-0.579	1.247
Q17	0.146	0.159	-1.001	0.117	0.001	0.087	0.265	0.242	0.665	0.302	0.063	-0.548	0.07	1.281	1.357	-0.269	1.23
Q18	0.137	0.151	-1.2	0.092	0.001	0.085	0.271	0.251	0.509	0.307	0.067	-0.579	0.074	1.296	1.365	0.092	1.21
Q19	0.141	0.154	-1.356	0.095	0.001	0.084	0.28	0.262	0.256	0.314	0.068	-0.611	0.075	1.315	1.375	0.381	1.192
Q20	0.425	0.362	-1.415	0.59	0.001	0.084	0.286	0.27	-0.033	0.318	0.089	-0.62	0.097	1.332	1.383	0.433	1.175
Q21	0.512	0.429	-1.487	0.727	0.001	0.082	0.304	0.29	-0.384	0.337	0.079	-0.671	0.086	1.336	1.378	0.143	1.149
Q22	0.547	0.458	-1.602	0.762	0.001	0.081	0.317	0.305	-0.752	0.349	0.086	-0.71	0.093	1.347	1.381	-0.368	1.13
Q23	0.574	0.487	-1.654	0.776	0.001	0.079	0.312	0.304	-1.096	0.341	0.088	-0.741	0.096	1.326	1.353	-0.898	1.089
Q24	0.582	0.504	-1.577	0.753	0.001	0.078	0.313	0.31	-1.363	0.341	0.109	-0.759	0.119	1.341	1.366	-1.244	1.086

TABLE 4: STERILIZED AND MONETIZED FISCAL SHOCKS -- PRICE LEVEL (PERCENTAGE DEVIATION FROM BASELINE)

	CANADA (ST)	CANADA (OPEN)	CANADA (MON)	CANADA (ALL CTY)	UK (ST)	UK (ALL CTY)	GERMANY (ST)	GERMANY (OPEN)	GERMANY (MON)	GERMANY (ALL CTY)	JAPAN (ST)	JAPAN (MON)	JAPAN (ALL CTY)	US (ST)	US (OPEN)	US (MON)	US (ALL CTY)
Q1	0.082	0.076	0.086	0.106	0.003	0.003	0.035	0.034	0.042	0.043	0.029	0.029	0.034	-0.054	-0.054	-0.045	-0.06
Q2	0.168	0.153	0.18	0.222	0.008	0.009	0.077	0.075	0.103	0.098	0.063	0.064	0.073	-0.053	-0.05	-0.018	-0.055
Q3	0.259	0.231	0.285	0.354	0.018	0.025	0.136	0.133	0.184	0.173	0.101	0.103	0.122	-0.068	-0.062	-0.005	-0.075
Q4	0.349	0.308	0.436	0.5	0.03	0.049	0.213	0.21	0.286	0.273	0.147	0.15	0.182	-0.081	-0.071	0.006	-0.093
Q5	0.424	0.369	0.621	0.635	0.045	0.084	0.314	0.311	0.408	0.398	0.201	0.206	0.245	-0.074	-0.058	0.02	-0.09
Q6	0.505	0.436	0.855	0.779	0.06	0.126	0.431	0.429	0.542	0.537	0.253	0.259	0.304	-0.035	-0.009	0.054	-0.053
Q7	0.597	0.513	1.046	0.945	0.079	0.175	0.558	0.555	0.678	0.679	0.311	0.318	0.375	0.016	0.052	0.095	-0.004
Q8	0.696	0.595	1.217	1.131	0.098	0.227	0.704	0.702	0.83	0.837	0.371	0.379	0.437	0.095	0.143	0.179	0.074
Q9	0.784	0.667	1.365	1.308	0.12	0.282	0.866	0.865	0.986	1.006	0.432	0.441	0.503	0.204	0.263	0.309	0.184
Q10	0.873	0.74	1.5	1.484	0.145	0.342	1.028	1.028	1.136	1.172	0.489	0.499	0.562	0.29	0.364	0.43	0.269
Q11	0.961	0.811	1.639	1.65	0.172	0.405	1.185	1.181	1.276	1.331	0.543	0.554	0.61	0.375	0.464	0.571	0.351
Q12	1.04	0.872	1.775	1.797	0.199	0.464	1.371	1.368	1.438	1.515	0.616	0.629	0.686	0.46	0.566	0.729	0.431
Q13	1.095	0.913	1.894	1.902	0.224	0.515	1.55	1.549	1.591	1.693	0.682	0.698	0.758	0.537	0.66	0.887	0.496
Q14	1.149	0.956	2.015	2.	0.248	0.559	1.724	1.725	1.735	1.866	0.734	0.75	0.812	0.612	0.75	1.036	0.553
Q15	1.21	1.007	2.143	2.095	0.273	0.603	1.867	1.865	1.853	2.01	0.799	0.818	0.893	0.68	0.833	1.159	0.598
Q16	1.27	1.057	2.264	2.178	0.297	0.646	2.029	2.032	1.988	2.17	0.869	0.89	0.973	0.746	0.912	1.26	0.633
Q17	1.304	1.085	2.352	2.217	0.322	0.686	2.176	2.187	2.113	2.317	0.921	0.944	1.025	0.806	0.982	1.339	0.659
Q18	1.343	1.121	2.441	2.259	0.349	0.729	2.303	2.32	2.224	2.447	0.964	0.989	1.067	0.86	1.046	1.398	0.672
Q19	1.401	1.173	2.552	2.312	0.378	0.776	2.4	2.42	2.313	2.55	1.028	1.056	1.135	0.908	1.102	1.454	0.671
Q20	1.447	1.217	2.656	2.332	0.408	0.825	2.529	2.567	2.444	2.684	1.076	1.106	1.182	0.959	1.159	1.528	0.666
Q21	1.458	1.228	2.724	2.286	0.439	0.879	2.646	2.707	2.581	2.807	1.122	1.154	1.221	1.005	1.209	1.606	0.648
Q22	1.464	1.246	2.8	2.242	0.474	0.944	2.752	2.84	2.724	2.916	1.204	1.241	1.307	1.052	1.258	1.716	0.625
Q23	1.497	1.286	2.907	2.218	0.513	1.016	2.831	2.944	2.848	2.994	1.294	1.337	1.422	1.088	1.298	1.84	0.578
Q24	1.527	1.323	3.004	2.18	0.549	1.085	2.937	3.094	3.027	3.095	1.359	1.404	1.508	1.118	1.326	1.971	0.54

isolation. Generally this is exactly what happens, although the increased amplitudes in the strong U.S. and German income cycles can temporarily cause output to be lower in the coordinated case. This can be seen in Table 1 in the columns labeled "ALL".

Prices have risen more in all countries, except the U.S., when there is coordinated expansionary policy. For all of the foreign countries the increase in aggregate demand has been reinforced by a depreciation of the home currency, which puts additional upward pressure on prices by making foreign produced goods more costly in terms of the home currency. In the U.S. the dollar on a 10-country trade weighted average basis depreciates due to a trade deficit with countries outside the four MCM countries. However the dollar appreciates bilaterally against each of the other MCM countries because of the relatively larger increase in U.S. interest rates. The subsequent effect on U.S. import prices is enough to more than offset the price effects of increased demand; thus U.S. prices are actually lower in the case where all countries increase government expenditures together than where the U.S. expands its economy in isolation. The lower U.S. prices in the coordinated case feed through money demand functions to eventually cause interest rates to be lower in this case than in the single country case.

The penultimate fiscal shock presented in Tables 1-4 is the result of shocking a second model, a model identical to the MCM in all respects save for the fact that all import income elasticities have been doubled.[4/] We did this to see if by altering the degree of openness in the model we would find that there was a corresponding decrease in the effectiveness of policy as defined by a reduction of the conventional income multiplier. Similarly we wanted to see if there were stronger

"spill-over" effects when economic integration is increased. Once again we simulated bond financed fiscal shocks in Germany, Canada, and the U.S.

These results labeled "OPEN" are also presented in the first four tables. In Canada we do in fact find that the income effects of fiscal shocks are muted by increasing the degree of goods market integration. This is not the case throughout the simulation period in Germany however. There the income effect is lower initially for the "more open" system, but eventually is greater. This increase in the amplitude of the cycle is attributable to the role past current account deficits play in the exchange rate determination process. By increasing the MCM import elasticities the marginal leakages in Germany were increased. Thus the same change in income gives rise to substantially larger deficits. As these deficits accumulate, speculators view a depreciation as more likely and restructure their portfolios in a way that does in fact cause the D-Mark to depreciate. This process, which becomes significant with the passage of time, leads to an export led income cycle. Consequently, the German income multiplier is higher in the long run for the case where import elasticites have been increased than in the standard case.

The U.S. income multiplier shows a reversal of this pattern. This happens because U.S. imports are a relatively small fraction of GNP compared to the other MCM countries. Therefore doubling all of the trade equations' elasticities resulted in more of an increase in the marginal propensity to export than the marginal propensity to import for the U.S. once foreign income repercussions have been allowed for.[5/] Over time, the accelerator process drives the income response down.

Not shown in the tables are the effects on foreign income from these fiscal shocks. There are two effects discernible here. First, in increasing trade elasticities, more of a given domestic shock should spill over and appear as increased export demand abroad and thus disturb income there. Second, by increasing leakages, the various income multipliers should be reduced (the U.S. case, described above, is an exception to this) so that the same shock will result in less income change. These two effects work in opposite directions. Examination of the simulation results confirms this; instances of each effect dominating are found. Of course if we had increased only the import coefficients in the home country, the results would not be ambiguous; foreign spill-over effects would increase because nothing has happened to diminish foreign income multipliers.

In the final simulation, we reran the initial domestic bond financed fiscal shock for Canada but assumed that half of the increase in the fiscal deficit was financed abroad in U.S. dollar denominated bonds. Tables 5-8 compare income, exchange rates, interest rates, and prices from the original Canadian dollar bond financed fiscal deficit to the results using this new financing assumption. When we assume that the deficit is financed abroad, the capital flow and exchange rate effects are substantially altered. In particular, the official foreign currency inflow serves to offset the worsened current account. Thus when the deficit is partially U.S. dollar financed the exchange rate need not depreciate as much (as happens initially) or actually appreciates (which ultimately occurs). Consequently, aggregate demand and prices are noticeably diminished over the domestic currency bond financed case. What isn't shown is the amount of sterilized intervention. This ran betweeen

TABLE 5: STERILIZED FISCAL SHOCKS FINANCED PARTLY BY FOREIGN CURRENCY BONDS --

GNP (PERCENTAGE DEVIATION FROM BASELINE)

[ALL FISCAL SHOCKS ARE SUSTAINED INCREASES IN GOVERNMENT SPENDING EQUAL TO ONE PERCENT OF GNP IN THE FIRST PERIOD (1975 Q1)]

	All C$ Debt	½ C$/½ US$ Debt
Q1	1.014	1.013
Q2	1.066	1.063
Q3	1.049	1.043
Q4	1.05	1.039
Q5	0.989	0.973
Q6	0.981	0.956
Q7	0.981	0.943
Q8	1.023	0.956
Q9	1.007	0.921
Q10	1.011	0.911
Q11	0.988	0.869
Q12	1.025	0.872
Q13	1.011	0.85
Q14	0.998	0.81
Q15	0.95	0.738
Q16	1.005	0.737
Q17	0.974	0.717
Q18	0.979	0.702
Q19	0.942	0.627
Q20	0.974	0.601
Q21	0.943	0.552
Q22	0.941	0.517
Q23	0.878	0.405
Q24	0.897	0.346

TABLE 6: STERILIZED FISCAL SHOCKS FINANCED PARTLY BY FOREIGN CURRENCY BONDS

EXCHANGE RATE (FOREIGN CURRENCY/DOMESTIC CURRENCY)

(PERCENTAGE DEVIATION FROM BASELINE)

	All C$ Debt	½ C$/ ½ US$ Debt
Q1	-0.034	-0.016
Q2	-0.096	-0.038
Q3	-0.162	-0.045
Q4	-0.108	0.089
Q5	-0.052	0.243
Q6	-0.03	0.383
Q7	-0.224	0.32
Q8	-0.48	0.243
Q9	-0.714	0.214
Q10	-0.854	0.254
Q11	-0.907	0.364
Q12	-0.929	0.504
Q13	-0.965	0.659
Q14	-1.04	0.818
Q15	-1.132	0.996
Q16	-1.252	1.171
Q17	-1.392	1.352
Q18	-1.536	1.548
Q19	-1.665	1.778
Q20	-1.641	2.188
Q21	-1.602	2.636
Q22	-1.621	3.043
Q23	-1.674	3.402
Q24	-1.782	3.709

TABLE 7: STERILIZED FISCAL SHOCKS FINANCED PARTLY BY FOREIGN CURRENCY B

INTEREST RATE

(100 BASIS POINTS DEVIATION FROM BASELINE)

	All C$ Debt	½ C$/ ½ US$ Debt
Q1	0.033	0.034
Q2	0.042	0.044
Q3	0.055	0.052
Q4	0.274	0.263
Q5	0.315	0.298
Q6	0.363	0.345
Q7	0.085	0.067
Q8	-0.003	0.05
Q9	-0.043	0.02
Q10	0.019	0.019
Q11	0.082	0.023
Q12	0.136	0.019
Q13	0.159	0.003
Q14	0.159	-0.014
Q15	0.15	-0.039
Q16	0.15	-0.062
Q17	0.146	-0.101
Q18	0.137	-0.133
Q19	0.141	-0.148
Q20	0.425	0.096
Q21	0.512	0.125
Q22	0.547	0.114
Q23	0.574	0.084
Q24	0.582	0.05

TABLE 8: STERILIZED FISCAL SHOCKS FINANCED PARTLY BY FOREIGN CURRENCY BONDS --

PRICE LEVEL

(PERCENTAGE DEVIATION FROM BASELINE)

	All C$ Debt	½ C$/ ½ US$ Debt
Q1	0.082	0.081
Q2	0.168	0.165
Q3	0.259	0.252
Q4	0.349	0.336
Q5	0.424	0.401
Q6	0.505	0.469
Q7	0.597	0.545
Q8	0.696	0.621
Q9	0.784	0.679
Q10	0.873	0.735
Q11	0.961	0.788
Q12	1.04	0.828
Q13	1.095	0.84
Q14	1.149	0.846
Q15	1.21	0.853
Q16	1.27	0.85
Q17	1.304	0.819
Q18	1.343	0.788
Q19	1.401	0.769
Q20	1.447	0.731
Q21	1.454	0.649
Q22	1.464	0.566
Q23	1.497	0.501
Q24	1.527	0.426

300 and 450 million Canadian dollars a quarter and amounted to 4-1/2 billion Canandian dollars at the end of 6 years. While these results seem to indicate that Canadian and U.S. dollar bonds are imperfect substitutes (a topic discussed in the following section) this would be a misleading characterization. The 4.5 billion of intervention is quite sizeable as it represents almost 12% of the outstanding Canadian bond stock.

Financial Shocks

The financial policy shocks reported here are of two types; changes in central bank discount rates and sterilized intervention. We begin by discussing the interest rate shocks. It is possible to simulate open market operations in all of the models except the U.K; however, comparable monetary simulations across the MCM countries, with their very different monetary institutions, are best achieved by shocking the discount rate. In these simulations, summarized in Tables 9-12, we raised the central bank's discount rate enough to cause short-term interest rates to rise by 100 basis points on impact. The shock was calculated by making use of the known coefficients in the commercial banking system's demand for free reserves, but ignoring any feed-back effects on the supply of free reserves. Consequently the impact effects are not precisely 100 basis points.

The results of this shock applied to each country individually are relatively straightforward. Increased interest rates and the resulting appreciation of the home currencies both work to decrease demand and diminish output. As mentioned earlier, the U.K. model differs in its financial structure from the MCM prototype. In this case alone,

TABLE 9: INTEREST RATE SHOCKS -- GNP (PERCENTAGE DEVIATION FROM BASELINE)

	CANADA	CANADA (ALL CTY)	UK	UK (ALL CTY)	GERMANY	GERMANY (ALL CTY)	JAPAN	JAPAN (ALL CTY)	US	US (ALL CTY)
Q1	-0.118	-0.05	-0.016	-0.009	-0.091	-0.036	0.006	-0.04	-0.04	-0.024
Q2	-0.152	-0.057	-0.033	-0.015	-0.196	-0.107	-0.104	-0.128	-0.116	-0.081
Q3	-0.209	-0.11	-0.093	-0.113	-0.303	-0.201	-0.239	-0.259	-0.282	-0.242
Q4	-0.258	-0.203	-0.102	-0.139	-0.416	-0.309	-0.314	-0.353	-0.491	-0.446
Q5	-0.328	-0.311	-0.109	-0.174	-0.516	-0.406	-0.389	-0.425	-0.644	-0.604
Q6	-0.409	-0.414	-0.12	-0.209	-0.62	-0.503	-0.451	-0.513	-0.714	-0.689
Q7	-0.493	-0.5	-0.128	-0.243	-0.731	-0.6	-0.507	-0.564	-0.706	-0.705
Q8	-0.578	-0.586	-0.112	-0.233	-0.833	-0.675	-0.528	-0.59	-0.641	-0.671
Q9	-0.632	-0.648	-0.089	-0.211	-0.885	-0.708	-0.52	-0.561	-0.56	-0.62
Q10	-0.625	-0.67	-0.075	-0.193	-0.938	-0.745	-0.513	-0.565	-0.48	-0.559
Q11	-0.632	-0.681	-0.077	-0.21	-0.958	-0.757	-0.513	-0.563	-0.429	-0.532
Q12	-0.646	-0.706	-0.061	-0.162	-0.952	-0.744	-0.52	-0.572	-0.388	-0.508
Q13	-0.635	-0.71	-0.04	-0.116	-0.868	-0.666	-0.536	-0.579	-0.354	-0.484
Q14	-0.597	-0.694	-0.04	-0.107	-0.795	-0.604	-0.545	-0.571	-0.324	-0.453
Q15	-0.575	-0.694	-0.038	-0.087	-0.709	-0.537	-0.558	-0.572	-0.3	-0.428
Q16	-0.555	-0.69	-0.026	-0.041	-0.636	-0.473	-0.577	-0.586	-0.263	-0.39
Q17	-0.512	-0.657	-0.014	-0.	-0.509	-0.368	-0.609	-0.613	-0.211	-0.33
Q18	-0.481	-0.625	-0.013	0.023	-0.379	-0.259	-0.618	-0.618	-0.144	-0.255
Q19	-0.445	-0.578	-0.019	0.039	-0.245	-0.143	-0.622	-0.606	-0.073	-0.172
Q20	-0.344	-0.508	-0.011	0.077	-0.14	-0.042	-0.618	-0.61	-0.009	-0.096
Q21	-0.253	-0.436	-0.001	0.097	-0.041	0.054	-0.618	-0.574	0.042	-0.034
Q22	-0.197	-0.393	-0.01	0.095	0.061	0.148	-0.609	-0.558	0.084	0.01
Q23	-0.157	-0.378	-0.005	0.103	0.159	0.234	-0.591	-0.507	0.109	0.038
Q24	-0.124	-0.346	-0.004	0.105	0.206	0.282	-0.563	-0.476	0.11	0.038

ALL INTEREST RATE SHOCKS ARE SUSTAINED CHANGES IN THE DISCOUNT RATE THAT ARE DESIGNED TO BRING ABOUT ON IMPACT A 100 BASIS POINT CHANGE IN THE SHORT TERM INTEREST RATE

ALL CTRY -- ALL COUNTRIES INCREASE THEIR DISCOUNT RATE SIMULTANEOUSLY

TABLE 10: INTEREST RATE SHOCKS -- EXCHANGE RATE (FOREIGN CURRENCY/DOMESTIC CURRENCY)
(PERCENTAGE DEVIATION FROM BASELINE)

	CANADA	CANADA (ALL CTY)	UK	UK (ALL CTY)	GERMANY	GERMANY (ALL CTY)	JAPAN	JAPAN (ALL CTY)	US10	US10 (ALL CTY)	US4	US4 (ALL CTY)
Q1	0.59	-0.076	0.216	0.039	0.824	-0.035	0.249	-0.004	0.515	0.041	0.511	0.04
Q2	1.119	-0.06	0.246	0.068	0.899	-0.048	0.294	0.015	0.756	0.026	0.736	0.02
Q3	1.382	-0.006	0.269	0.064	1.028	-0.025	0.338	0.024	0.96	0.008	0.904	-0.019
Q4	1.383	0.133	0.297	0.083	1.101	-0.01	0.372	0.034	1.039	-0.013	0.925	-0.089
Q5	1.293	0.268	0.31	0.107	1.14	0.028	0.414	0.031	1.053	-0.035	0.855	-0.188
Q6	1.18	0.326	0.325	0.144	1.167	0.098	0.45	0.053	1.055	-0.035	0.762	-0.285
Q7	1.149	0.33	0.331	0.164	1.216	0.184	0.498	0.067	1.088	-0.006	0.693	-0.36
Q8	1.235	0.364	0.337	0.183	1.268	0.263	0.541	0.058	1.14	0.025	0.654	-0.432
Q9	1.303	0.41	0.336	0.176	1.339	0.341	0.587	0.051	1.196	0.052	0.635	-0.496
Q10	1.186	0.417	0.327	0.176	1.421	0.428	0.622	0.025	1.213	0.084	0.597	-0.543
Q11	1.014	0.401	0.33	0.156	1.514	0.513	0.647	-0.01	1.211	0.123	0.56	-0.568
Q12	0.895	0.401	0.338	0.147	1.61	0.598	0.677	-0.049	1.205	0.144	0.536	-0.601
Q13	0.869	0.42	0.348	0.129	1.695	0.662	0.716	-0.088	1.22	0.165	0.543	-0.624
Q14	0.917	0.46	0.355	0.115	1.775	0.711	0.723	-0.13	1.224	0.164	0.566	-0.646
Q15	0.989	0.499	0.357	0.079	1.856	0.765	0.745	-0.154	1.234	0.153	0.599	-0.669
Q16	1.06	0.548	0.362	0.061	1.9	0.794	0.785	-0.163	1.223	0.117	0.632	-0.696
Q17	1.115	0.586	0.366	0.043	1.924	0.797	0.822	-0.155	1.199	0.084	0.664	-0.708
Q18	1.137	0.599	0.36	0.009	1.939	0.798	0.868	-0.138	1.154	0.053	0.681	-0.708
Q19	1.125	0.584	0.358	-0.015	1.937	0.788	0.92	-0.119	1.109	0.025	0.71	-0.694
Q20	0.796	0.448	0.361	-0.018	1.908	0.787	0.974	-0.097	1.012	0.007	0.714	-0.649
Q21	0.48	0.303	0.361	-0.031	1.859	0.745	1.048	-0.059	0.895	0.011	0.709	-0.577
Q22	0.361	0.249	0.354	-0.046	1.797	0.671	1.128	-0.02	0.775	-0.014	0.71	-0.518
Q23	0.432	0.272	0.35	-0.055	1.727	0.583	1.175	0.002	0.691	-0.045	0.728	-0.476
Q24	0.608	0.318	0.351	-0.048	1.616	0.47	1.224	0.016	0.645	-0.068	0.776	-0.429

US10 -- ten-country trade-weighted exchange rate

US4 -- exchange rate relative to the other four mcm countries

TABLE 11: INTEREST RATE SHOCKS -- INTEREST RATE (100 BASIS POINTS DEVIATION FROM BASELINE)

	CANADA	CANADA (ALL CTY)	UK	UK (ALL CTY)	GERMANY	GERMANY (ALL CTY)	JAPAN	JAPAN (ALL CTY)	US	US (ALL CTY)
Q1	0.958	0.878	1.004	1.078	0.9	0.94	0.999	1.016	0.947	0.949
Q2	0.969	0.879	1.004	1.07	0.811	0.879	0.996	1.013	0.829	0.835
Q3	0.901	0.882	1.004	1.069	0.829	0.874	0.994	1.011	0.799	0.812
Q4	0.768	0.994	1.003	1.065	0.82	0.857	0.99	1.005	0.74	0.761
Q5	0.739	0.986	1.003	1.06	0.784	0.808	0.99	1.005	0.658	0.688
Q6	0.699	0.901	1.003	1.055	0.769	0.763	0.988	1.002	0.59	0.627
Q7	0.78	0.842	1.003	1.052	0.762	0.739	0.988	1.001	0.538	0.58
Q8	1.01	0.893	1.003	1.048	0.746	0.724	0.983	0.996	0.484	0.529
Q9	0.958	0.881	1.003	1.046	0.73	0.716	0.985	0.999	0.456	0.501
Q10	0.693	0.809	1.003	1.045	0.712	0.712	0.982	0.996	0.435	0.48
Q11	0.593	0.773	1.004	1.044	0.697	0.715	0.982	0.997	0.425	0.47
Q12	0.58	0.764	1.004	1.043	0.688	0.723	0.976	0.991	0.408	0.452
Q13	0.621	0.772	1.004	1.042	0.667	0.715	0.981	0.996	0.405	0.448
Q14	0.677	0.786	1.003	1.042	0.66	0.716	0.977	0.993	0.398	0.44
Q15	0.724	0.799	1.003	1.042	0.677	0.733	0.977	0.993	0.394	0.436
Q16	0.747	0.805	1.003	1.041	0.685	0.737	0.969	0.984	0.377	0.421
Q17	0.759	0.816	1.003	1.042	0.694	0.741	0.974	0.99	0.389	0.437
Q18	0.758	0.817	1.003	1.043	0.713	0.757	0.974	0.99	0.398	0.45
Q19	0.742	0.8	1.004	1.044	0.734	0.777	0.977	0.993	0.408	0.467
Q20	0.218	0.608	1.004	1.046	0.755	0.797	0.969	0.986	0.425	0.491
Q21	0.153	0.589	1.004	1.049	0.768	0.814	0.975	0.994	0.462	0.537
Q22	0.268	0.668	1.004	1.05	0.785	0.837	0.975	0.995	0.477	0.56
Q23	0.437	0.757	1.004	1.052	0.815	0.864	0.974	0.995	0.495	0.583
Q24	0.589	0.816	1.004	1.055	0.836	0.878	0.966	0.988	0.519	0.614

TABLE 12: INTEREST RATE SHOCKS -- PRICE LEVEL (PERCENTAGE DEVIATION FROM BASELINE)

	CANADA	CANADA (ALL CTY)	UK	UK (ALL CTY)	GERMANY	GERMANY (ALL CTY)	JAPAN	JAPAN (ALL CTY)	US	US (ALL CTY)
Q1	-0.032	-0.003	0.	0.	-0.06	0.002	-0.011	-0.009	-0.009	0.
Q2	-0.081	-0.006	-0.002	-0.	-0.109	0.002	-0.027	-0.022	-0.031	0.
Q3	-0.136	-0.016	-0.012	-0.002	-0.15	-0.004	-0.032	-0.022	-0.046	0.007
Q4	-0.187	-0.037	-0.025	-0.006	-0.196	-0.016	-0.043	-0.028	-0.054	0.015
Q5	-0.236	-0.071	-0.039	-0.012	-0.237	-0.035	-0.056	-0.046	-0.055	0.029
Q6	-0.283	-0.113	-0.047	-0.02	-0.276	-0.06	-0.068	-0.063	-0.054	0.041
Q7	-0.333	-0.161	-0.055	-0.033	-0.311	-0.09	-0.084	-0.075	-0.058	0.048
Q8	-0.392	-0.214	-0.065	-0.051	-0.357	-0.126	-0.1	-0.095	-0.077	0.045
Q9	-0.456	-0.275	-0.074	-0.071	-0.404	-0.164	-0.117	-0.113	-0.103	0.033
Q10	-0.511	-0.336	-0.084	-0.092	-0.45	-0.204	-0.131	-0.125	-0.134	0.019
Q11	-0.559	-0.396	-0.092	-0.112	-0.492	-0.242	-0.142	-0.136	-0.167	-0.001
Q12	-0.603	-0.456	-0.099	-0.132	-0.549	-0.287	-0.161	-0.147	-0.203	-0.027
Q13	-0.644	-0.515	-0.105	-0.149	-0.601	-0.327	-0.177	-0.156	-0.239	-0.053
Q14	-0.681	-0.569	-0.111	-0.163	-0.648	-0.363	-0.187	-0.163	-0.273	-0.077
Q15	-0.716	-0.622	-0.118	-0.177	-0.684	-0.392	-0.201	-0.17	-0.305	-0.1
Q16	-0.748	-0.67	-0.124	-0.189	-0.727	-0.424	-0.218	-0.183	-0.336	-0.122
Q17	-0.774	-0.713	-0.13	-0.199	-0.762	-0.449	-0.23	-0.199	-0.366	-0.144
Q18	-0.793	-0.747	-0.135	-0.207	-0.786	-0.466	-0.238	-0.209	-0.394	-0.164
Q19	-0.806	-0.774	-0.141	-0.215	-0.798	-0.474	-0.254	-0.217	-0.42	-0.182
Q20	-0.794	-0.785	-0.145	-0.22	-0.817	-0.482	-0.264	-0.226	-0.445	-0.203
Q21	-0.764	-0.781	-0.148	-0.222	-0.825	-0.481	-0.273	-0.235	-0.466	-0.222
Q22	-0.725	-0.77	-0.152	-0.222	-0.823	-0.47	-0.293	-0.242	-0.486	-0.24
Q23	-0.688	-0.758	-0.156	-0.22	-0.806	-0.449	-0.315	-0.24	-0.506	-0.253
Q24	-0.657	-0.744	-0.16	-0.216	-0.789	-0.425	-0.327	-0.237	-0.522	-0.263

diminished output and lower prices do not feed directly back on financial markets to moderate the initial interest rate increase. In the U.K. short-term interest rates do not rapidly or fully feed through into long rates and hence investment. Thus the output effect is very weak. The persistence of high interest rates in Japan is due to another reason. Extremely interest rate elastic demands by the banking system result in a very flat "LM" curve. Consequently, interest rates decline very little in Japan as income falls. Given the strong multiplier-accelerator properties of the U.S. and German models, the income effects in those countries are not terribly surprising.

Perhaps of more interest is the case where all of the central banks simultaneously raise their discount rates. Table 11 shows that a coordinated interest rate change results in larger and longer interest rate effects. (The failure of Canadian rates to rise initially as much in the coordinated case as in the single country case reflects the unique role that U.S. interest rates play in commercial bank asset demand functions. Higher U.S. dollar interest rates cause a once and for all shift out of Canadian dollar assets.) Of course not all countries currencies can appreciate in this case -- indeed only the trade weighted dollar and sterling are up initially. Consequently less restrictions in aggregate demand come about from exchange rate changes in this case than in the single country cases. Offsetting this effect however is foreign demand. Table 9 shows that on balance these foreign demand effects more than offset the exchange rate effect for Canada, the U.K. and, to a lesser degree, Japan. On the other hand German and U.S. income seem to be more strongly affected when they raise their rates in isolation because the

influence of the exchange rate on aggregate demand outweighs the foreign income response.

Exchange rate effects are particularly important when examining price behavior. In the MCM an exchange rate appreciation feeds through into domestic prices via a fall in the home currency price of imported goods. Since there is less of an appreciation when all interest rates move together than when a country changes its rate in isolation, it is not surprising to find the effects of generally weaker exchange rates and lower foreign prices outweighing the effects of decreased aggregate demand. It may seem counter intuitive that price effects are smaller for a given country when all countries contract rather than just a single country. However, the key price variable for this comparison should be the world price level. We find (although not shown in the table) that the world price level, as an aggregate, is lower when all of the MCM countries tighten up together than when a single country pursues the same policy in isolation.

The final financial policy to be discussed is central bank intervention in the foreign exchange market. We want to focus exclusively on that aspect of financial policy that is unique to intervention, the changing of the currency composition of assets in the hands of the public. To that end we will define our simulation experiment solely in terms of sterilized intervention. That is, we hold the monetary base to the control solution throughout the simulation. Thus any economic effects that occur come about because of the change in the composition of the currency of assets backing base money, and not from any changes in the size of the monetary base that would normally be associated with intervention. For intervention so defined to have an effect, there must

TABLE 13: INTERVENTION SHOCKS -- GNP

(PERCENTAGE DEVIATION FROM BASELINE)

	CANADA	UK	GERMANY	JAPAN
Q1	0.012	-0.029	0.001	-0.013
Q2	0.03	-0.04	0.004	-0.012
Q3	0.031	-0.06	0.002	0.015
Q4	0.031	-0.024	0.002	0.015
Q5	0.024	-0.015	0.002	0.02
Q6	0.022	-0.	0.002	0.009
Q7	0.018	-0.007	0.003	0.012
Q8	0.022	0.003	0.003	0.006
Q9	0.018	0.008	0.001	0.012
Q10	0.019	0.014	0.	0.002
Q11	0.016	0.012	-0.001	0.006
Q12	0.021	0.014	-0.002	0.
Q13	0.017	0.015	-0.003	0.008
Q14	0.014	0.016	-0.003	0.002
Q15	0.01	0.015	-0.003	0.005
Q16	0.016	0.013	-0.003	0.002
Q17	0.012	0.011	-0.003	0.012
Q18	0.011	0.01	-0.003	0.005
Q19	0.01	0.009	-0.003	0.011
Q20	0.017	0.008	-0.003	0.003
Q21	0.016	0.006	-0.002	0.021
Q22	0.011	0.003	-0.002	0.011
Q23	0.006	0.003	-0.002	0.015
Q24	0.015	0.003	-0.001	0.004

INTERVENTION SHOCKS ARE THE STERILIZED PURCHASE OF ONE BILLION DOLLARS WORTH OF U.S. SECURITIES

TABLE 14: INTERVENTION SHOCKS --

EXCHANGE RATE (FOREIGN CURRENCY/DOMESTIC CURRENCY)

(PERCENTAGE DEVIATION FROM BASELINE)

	CANADA	UK	GERMANY	JAPAN
Q1	-0.261	-0.457	-0.185	-0.355
Q2	-0.225	0.028	-0.023	-0.062
Q3	-0.119	-0.004	-0.017	-0.027
Q4	-0.028	-0.034	-0.011	0.019
Q5	0.025	-0.039	0.007	0.009
Q6	0.048	-0.027	0.015	0.018
Q7	0.048	0.003	0.014	-0.01
Q8	0.042	0.003	0.015	0.003
Q9	0.035	0.005	0.013	-0.003
Q10	0.032	-0.009	0.011	0.001
Q11	0.029	-0.018	0.01	-0.002
Q12	0.029	-0.007	0.009	-0.005
Q13	0.028	-0.005	0.008	-0.011
Q14	0.027	-0.004	0.008	-0.013
Q15	0.027	-0.008	0.007	-0.014
Q16	0.028	-0.007	0.008	-0.017
Q17	0.029	-0.005	0.009	-0.017
Q18	0.031	-0.002	0.009	-0.017
Q19	0.033	-0.002	0.01	-0.017
Q20	0.039	-0.	0.01	-0.022
Q21	0.047	0.001	0.012	-0.023
Q22	0.052	0.004	0.013	-0.025
Q23	0.054	0.005	0.013	-0.028
Q24	0.057	0.008	0.014	-0.038

TABLE 15: INTERVENTION SHOCKS -- INTEREST RATE

(100 BASIS POINTS DEVIATION FROM BASELINE)

	CANADA	UK	GERMANY	JAPAN
Q1	-0.	-0.	0.001	0.
Q2	0.001	-0.	0.006	0.
Q3	0.002	-0.	0.007	0.
Q4	0.008	-0.	0.004	0.
Q5	0.01	-0.	0.004	0.
Q6	0.012	-0.	0.004	0.
Q7	0.003	-0.	0.003	0.
Q8	0.003	-0.	0.003	0.
Q9	0.002	-0.	0.003	0.
Q10	0.002	-0.	0.003	0.
Q11	0.002	-0.	0.003	0.
Q12	0.002	0.	0.002	0.
Q13	0.001	0.	0.003	0.
Q14	0.001	0.	0.002	0.
Q15	0.001	0.	0.002	0.
Q16	0.001	0.	0.002	0.
Q17	0.	0.	0.001	0.
Q18	0.	0.	0.002	0.
Q19	0.	0.	0.002	0.
Q20	0.005	0.	0.002	0.
Q21	0.007	0.	0.002	0.
Q22	0.007	0.	0.002	0.
Q23	0.006	0.	0.002	0.
Q24	0.006	0.	0.002	0.

TABLE 16: INTERVENTION SHOCKS -- PRICE LEVEL
(PERCENTAGE DEVIATION FROM BASELINE)

	CANADA	UK	GERMANY	JAPAN
Q1	0.01	-0.	0.013	0.023
Q2	0.019	0.007	0.011	0.025
Q3	0.022	0.029	0.009	-0.004
Q4	0.023	0.038	0.007	0.003
Q5	0.021	0.033	0.004	0.
Q6	0.019	0.014	0.003	0.
Q7	0.018	0.018	0.002	0.001
Q8	0.018	0.021	0.001	0.002
Q9	0.018	0.019	0.	0.001
Q10	0.018	0.016	-0.	0.001
Q11	0.017	0.013	-0.001	0.
Q12	0.018	0.012	-0.001	0.002
Q13	0.018	0.012	-0.001	0.003
Q14	0.018	0.011	-0.001	0.004
Q15	0.016	0.01	-0.001	0.005
Q16	0.016	0.008	-0.001	0.006
Q17	0.016	0.008	-0.001	0.005
Q18	0.015	0.007	-0.001	0.004
Q19	0.014	0.006	-0.002	0.004
Q20	0.014	0.005	-0.002	0.003
Q21	0.014	0.004	-0.002	0.002
Q22	0.012	0.003	-0.003	0.003
Q23	0.01	0.002	-0.003	0.006
Q24	0.01	0.001	-0.003	0.007

be some difference in the foreign and domestic currency bonds held by the central bank. If, allowing for expected exchange movements, they are perfect substitutes, sterilized intervention would be an empty exercise and one would not logically expect any financial or real effect to result. Of course, in this, case unsterilized intervention would still be an effective policy, but it would rely entirely on monetary effects for its potency. In the case where bonds are perfect substitutes, there is no difference between unsterilized intervention and open market operations. Similarly, the presence of imperfect substitutability in asset markets allows us to view intervention as a policy tool separate and distinct from open market policy. In this case sterilized and unsterilized intervention have qualitatively similar properties but quantitatively different effects.

The important empirical issue then centers on the imperfections in asset substitutability. We have experimented with a variety of specifications in the MCM concerning exactly this issue. It is important to point out that our research in this area is still ongoing and consequently all of the results of our intervention shocks are very provisional. (In fact, in some preliminary unpublished empirical work by members of Federal Reserve Board Staff, we find that assets are even closer substitutes than are indicated by the current version of the MCM).

We simulated four instances of sterilized intervention by having each of the non-U.S. MCM countries buy 1 billion dollars worth of U.S. securities while sterilizing all monetary effects of the purchase. Tables 13 to 16 summarize the results of the shock for incomes, exchange rates, interest rates, and prices. The country results differ among themselves somewhat owing largely to differences in the coefficients that describe

asset substitutability. While there is a currency depreciation, in no case are the effects particularly strong or long lasting. Germany is closest to the perfect substitutes case with a one quarter depreciation of about .2 percent that has no substantial effect on any real side variables. The exchange rate effects in the U.K. and Japan are stronger, but still result in little price or income effect.[6/] In Canada the effect on the exchange rate is the strongest, and owing to the exchange rate expectations process, the longest lasting. Nevertheless, the quantitative effect is still rather weak.

To say that the quantitative effects are weak may be somewhat misleading because it depends on the scale of the shock. The fiscal shock comparison in Tables 5-8 indicate that sterilized intervention can be effective in Canada. However, that shock represented large and sustained intervention rather than just a once and for all change in the currency composition of the central banks portfolio. We ran domestic open market shocks (unreported here) in Canada and Germany in order gauge the relative strength of sterilized intervention. The open market shocks demonstrate that intervention has relatively weak effects. For example in Canada an equivalent amount of open market operation has almost 10 times the impact on the exchange rate as the sterilized intervention and, furthermore, the effect is sustained. The German results are roughly similar; the open market operation is about 5 times as powerful as an equivalent intervention shock.[7/]

In the simplest of models we would expect an exchange of home currency assets for U.S. dollar assets by the central bank, ceteris paribus, to raise home currency interest rates and lower the U.S. interest rates. This is by and large what happens. The effect on U.S.

interest rates, not shown on the tables, is negative, as expected, but extremely small. The effect on home interest rates is straightforward in Japan and Germany. In Canada interest rates fall very slightly on impact owing to a momentary decrease in money demand that can be ultimately traced to the J-curve phenomenon. In the U.K. the interest rate determination process is heavily influenced by the developments in the Eurodollar markets which in turn reflect U.S. money market conditions. Thus lower U.K. rates in the short-run reflect the slight fall in U.S. rates. In all countries interest rates are ultimately pushed slightly above their control solutions by money demand considerations.

Conclusions

In this paper we have presented some results of a recent simulation exercise with the MCM to get some idea of the current dynamic properties of the model. This has been accomplished through numerous financial and real side shocks simulated under a variety of financial policy assumptions. Because of the wide range of simulation experiments, no one result or conclusion emerges; rather, these policy shocks have enhanced our understanding of the model, pointed out areas where our priors are not always justified because of model dynamics or special institutional characteristics, and suggested areas where the model needs additional work. Furthermore, this analysis provides a foundation for investigating policy questions which we consider in a separate paper, "Assessing Policy Strategies in a Multi-Country Model". In that paper we extend our anlaysis to include an examination of the MCM's response to different unanticipated foreign and domestic disturbances under

alternative finacial policy regimes. The paper examines the simulation properties of the MCM in light of the theoretical work of Poole (1970), Henderson (1982) and Bryant (1980). In that paper we extend their work by analyzing to what extent the conclusions are dependent upon the specific monetary aggregate that is targeted.

Footnotes

* The authors have benefitted from comments by Peter Clark, Michael Dooley, Dale Henderson, Peter Hooper, Caryl McNeilly, Ralph Bryant, and Chuck Freedman on an earlier draft as well as discussions with Ralph Tryon and Tom Glaessner on several aspects of the U.K. and Japenese models. Nevertheless, this paper represents the views of the authors and should not be interpreted as reflecting the views of the Board of Governors of the Federal Reserve System or members of its staff.

1/ The original version of the MCM is documented in Howe et. al. (1981) and in The U.S. Economy in an Interdependent World; a Multicountry Model, Federal Reserve Board, Washington, D.C. (forthcoming). The oil sector is found in Tryon (1982); the capital account (exchange rate) in Hooper et. al. (1983); the Japanese monetary sector in Glaessner (1982); the German monetary sector in Symansky (1981); and the U.S. international accounts in Hooper and Stekler (1983).

2/ In some ongoing research in the Federal Reserve System we have modeled the bond market for Canada, Japan, and Germany. The empirical results regarding asset substitutability by and large conform to the current version of the MCM.

3/ This result is straightforward. Given a simple linear version of a model where m and c are marginal propensity to import and consume, Y is real income, G is government spending, and * represent foreign variables we get

(3-1) $Y = cY + m^*Y^* - mY + G$

(3-2) $Y^* = c^*Y^* + mY - m^*Y^* + G^*.$

Letting $G^* = 0$, solving (3-2) for Y^*, and substituting into (3-1) gives

(3-3) $$Y = cY + \left(\frac{m^*}{1 - c + m^*} - 1 \right) mY + G$$

and solving for the reduced form of Y gives

(3-4) $$Y = \frac{G}{1 - c - \frac{m^*m}{1 - c^* + m^*} + m} .$$

From the second term on the right hand of (3-3) we can see that if m is small (as in the U.S.) and m* is large (as in the European countries), trade leakages can be small and this term can almost cancel out. Similarly taking the third and fourth terms in the denominator of (3-4) yields

(3-5) $$\frac{-m^*m + m - mc^* + mm^*}{1 - c^* + m^*} = \frac{m\,(1 - c^*)}{1 - c^* + m^*} .$$

While this term is unambiguously >0, it again shows that a small m and a large m* can produce a small value (i.e. very little foreign trade leakage).

4/ See Bryant (1980), chapter 12, for a discussion of the issues involved here.

5/ This result can be motivated using the simple model given in footnote 3. If we differentiate (3-3) with respect to m and m* we get

$$(5\text{-}1)\quad \frac{dY}{dm^*} = \frac{G[m[1 - c^* + m^*] - m^*m]}{(1 - c^* + m^*)^2} = \frac{m(1 - c^*)G}{(1 - c^* + m^*)^2}$$

$$(5\text{-}2)\quad \frac{dY}{dm} = G\left[\frac{m^* (1 - c^* + m^*)}{(1 - c^* + m^*)^2} - 1\right] = \frac{-(1 - c^*) [1 - c^* + m^*]G}{(1 - c^* + m^*)^2} .$$

Subtracting 5-2 from 5-1 we get

(5-3) $m - [1 - c^* + m^*]$.

For reasonable values of these parameters, 5-3 will be < 0 which implies that equal (and small) changes in m and m* will reduce the government spending multiplier. However, in our experiments we doubled elasticities and not marginal propensities to import. Because imports are a small fraction of GNP in the U.S. relative to the U.S trading partners, we effectively increase (dY/dm*) significantly more than (dY/dm). Thus from the U.S. point of view, the first term in 5-3 is increased by a factor greater than one and it is quite possible that 5-3 could > 0.

6/ There are two items worth mentioning here. They both concern the fall on impact of British and Japanese real income following a depreciation of sterling and the yen. This comes about in Japan because of a large deficit on service account. In the U.K. this is the result of a relatively strong consumption function effect. A depreciation causes personal disposable income via a J-curve, to fall. This effect on consumption more than outweighs the expansionary effects of the real trade balance for several quarters.

7/ The effect of the intervention shock is not long lasting, mainly because the specifications of the exchange rate (net capital flow) equations. The flow rather than the stock of net private capital enters the behavioral equations. This framework is consistent with the hypothesis that assets are almost perfect substitutes and there are long adjustment lags (see Hooper et. al. (1983).)

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