Board of Governors of the Federal Reserve System

International Finance Discussion Papers

Number 470

May 1994

INTERNATIONAL ECONOMIC IMPLICATIONS OF THE END OF THE SOVIET UNION

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Abstract

This paper quantifies roughly some potential economic developments in the former Soviet Union (FSU), if substantive economic reforms go forward, and assesses the likely implications of these developments for the rest of the world. It is assumed that a move to world prices for energy and other economic reforms result in a significant increase in FSU net oil exports. This paper develops and analyzes several alternative scenarios, including cases in which the FSU is specified to cooperate with OPEC. The simulations reported in this paper indicate that the FSU countries would be major beneficiaries of market reforms, regardless of what happens on the world oil market. However, only in the case in which the world price of oil declines markedly would the countries outside of OPEC notice to any significant extent the macroeconomic consequences of events in the FSU.

International Economic Implications of the End of the Soviet Union

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The most important immediate international implications of the breakup of the Soviet Union into independent states and the abandonment of a centrally planned economic system are political. The international economic consequences in the near term are not likely to be significant, reflecting the relatively closed nature of the old Soviet economic system and the current anemic state of both its supply and demand capacities.[2] However, one cannot avoid the conclusion that in the longer run, developments in the former Soviet Union (FSU) could have substantial implications for the international economy, particularly if meaningful economic liberalization measures are taken in the major former Soviet republics. Much has been written about the issues involved in the transition from a centrally planned economy to a market economy, both on a general level and on the specifics of the economies of the FSU and the rest of Eastern Europe.[3] Less has been written about the international

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1. The authors are staff economists in the Division of International Finance. 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 other members of its staff. We would like to thank David Bowman, Neil Ericsson, Jon Faust, Dale Henderson, Peter Hooper, Catherine Mann, William Melick, Patrice Robitaille, Nathan Sheets, Timothy Wilson, and participants in the International Finance Division's Monday Workshop for their helpful comments and suggestions.

2. A comprehensive overview of the old Soviet economic system is presented in IMF, et al. (1991).

3. See, for example, Calvo and Frenkel (1991), Fischer (1992), Fischer and Frenkel (1992), Lipton and Sachs (1990) and (1992), Nordhaus (1990), Nordhaus, Peck, and Richardson (1991), and such recent collections of papers as Aslund and Layard (1993) and Blanchard, Froot, and Sachs (1994). On the particularly crucial issue of privatization, see, for example, Boycko, Shleifer, and Vishny (1993) and Sachs (1992).

implications of the transition, but these issues have not been neglected in the literature.[4] In this paper, the international implications of the end of the Soviet Union and the adoption of market economies in the FSU are assessed quantitatively, with a focus on the transmission channel represented by the world oil market. For this purpose, a multi-country econometric model, including estimated FSU and oil-market sectors, is employed.

The Soviet Union was a major producer and exporter of fuels, including oil and oil products. The former Soviet republics, taken together, are estimated to have had the seventh largest stock of oil reserves in the world at the end of 1993, and to have controlled 40 percent of the world's gas reserves.[5] Oil production in the former Soviet Union has declined at a fairly rapid rate in recent years, reflecting the depletion of old fields, shortages of equipment, and the general chaos that prevailed in the last years of the Soviet Union and the first years of its successor states. Energy prices in the FSU, including those used for trade between the former Soviet republics, were, as of the end of 1993, generally below world market levels, although the Russian government had started moving toward charging world market prices for energy products in Russia and particularly for energy exports to other former Soviet republics.[6]

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4. See, for example, Collins and Rodrik (1991), Hamilton and Winters (1992), Havrylyshyn and Pritchett (1991), Vavilov and Vjugin (1993), and Williamson (1992).

5. Oil & Gas Journal, December 27, 1993.

6. For an overview of the petroleum industry in the FSU, see Riva (1993).

The adoption of a market economy (with private ownership, profit incentives, and hard budget constraints) along with world market prices for petroleum products in the former Soviet republics, or at least in the major ones, would encourage substantial energy conservation, thereby strengthening the FSU's collective net oil and gas balance. Moreover, such a move to market prices and private market incentives in the energy-producing industry itself, especially if enhanced by foreign direct investment and technology transfers, would, over the medium term, be expected to boost oil and gas production (and reserves) in the FSU substantially. Thus, price reforms and economic liberalization could strengthen FSU oil export potential considerably.

Stronger FSU energy exports could add substantially to world supply. In the first instance, OPEC's swing producers might reduce their own oil exports in order to insulate the world oil price from increases in FSU net exports. However, in the longer run, it is not clear to what extent the swing producers would have the ability or inclination to absorb export losses of sufficient size to counteract fully the downward pressure on oil prices.

In this paper, an attempt is made to quantify roughly some potential economic developments in the former Soviet Union, if substantive economic reforms go forward, and to assess quantitatively the likely implications of these developments for the rest of the world. Simulations using the Federal Reserve Board staff's multi-country model (MCM), are used to analyze the effects of such developments in the FSU on the rest of the world. The country and regional detail of the model enables the analysis to address the differential impacts across countries.

This paper develops and analyzes several alternative scenarios. In the first set of scenarios, the FSU proceeds with general market reforms and its net oil exports strengthen. The simulations indicate that the world price of oil could weaken dramatically, with noticeable consequences for the international economy. However, if OPEC holds the oil price steady, there are few implications for the international economy outside of the FSU and OPEC countries.

In the second set of scenarios, the FSU cooperates with OPEC by not deviating from its baseline path for oil production. Market reforms are, however, implemented, resulting in energy conservation and a consequent boost to net oil exports. The simulations suggest that in the case of cooperation between the FSU and OPEC, the economic implications for the rest of the world are not great. However, in order to obtain FSU cooperation, the OPEC countries probably would have to compensate the FSU countries in addition to cooperating among themselves.

The multi-country model

The MCM is a large econometric model covering 13 countries and regions, including the old Soviet economy.[7] A description of the model is presented in the appendix to this paper. Briefly, the MCM has structural equations to explain all of the components of aggregate

7. The most recent documented version of the MCM appears in Edison, Marquez, and Tryon (1987). Since then, the MCM has been revised and updated to allow more country detail, to extend the estimation sample, and to recognize simultaneity in parameter estimation. The development and implementation of the most recent version of the MCM (in 1992) was a joint effort by William Helkie and Jaime Marquez; details of the changes are available on request. The data used in estimating the MCM are drawn primarily from country sources, supplemented by the OECD's Quarterly National Accounts and the IMF's International Financial Statistics.

spending except government purchases, and a Cobb-Douglas production function to determine potential output and labor requirements. The corresponding spending deflators are modeled as a markup over production costs, which consist of oil, non-oil imports, and labor. For the labor market, the MCM determines labor requirements, the participation rate of the labor force, and the wage rate. Wages are modeled using an expectations-augmented Phillips curve. The short-term interest rate is determined using the equilibrium condition in the money market where the supply of money is set by monetary authorities and the demand for money depends on income and interest rates. Alternatively, short-term interest rates can be specified exogenously, with an endogenous stock of money. Long-term nominal interest rates are determined with a term-structure relation augmented for inflation expectations.

International transmission channels in the MCM operate through international trade, capital flows, and exchange rates. The model uses incomes and relative prices to explain multilateral exports and imports of services and non-oil merchandise. It is specified that: an increase of 100 basis points in the U.S. real, long-term interest-rate differential raises each bilateral, real dollar rate by 8 percent vis-a-vis the currencies of the major foreign industrial countries except those that are pegged to the German mark; the Mexican peso-U.S. dollar rate follows the Mexico-U.S. price differential; the dollar exchange rate for the NIEs follows the open-interest-parity condition; and the currencies of OPEC, the ROW sector, and the Soviet sector are pegged to the U.S. dollar. Finally, changes in claims on foreigners depend on foreign real GDP and differences in rates of return. Changes in liabilities to foreigners depend on domestic economic activity and interest rates.

For the purpose of the present paper, the key sector of the model is the international oil market. In the MCM, oil production is exogenously set for all countries except the members of OPEC. Oil demand in each country consists of changes in oil inventories, modeled as a function of the real interest rate, and oil consumption, treated as a function of real income and relative prices. Oil imports equal the excess of oil demand over the exogenously given level of oil production. Oil exports are exogenous for all countries except Mexico and OPEC. Mexico's oil exports equal the excess of Mexican oil production over its oil demand. OPEC's oil exports equilibrate world demand and supply of oil. Thus, in the MCM, OPEC is the only significant net exporter of oil at the margin, and OPEC sets the price of oil and acts as the residual oil supplier.

The focus of this paper is on the international implications of events in the former Soviet Union rather than on the impact of those events on the former Soviet republics themselves. Nevertheless, the key country/regional group for analysis in this paper is the FSU, both because it is the origin of the shocks affecting the rest of the international economy and because of the modeling challenges presented by trying to specify the old Soviet economy, the (assumed) new FSU emerging market economies, and the transition from one to the other.

The MCM determines income for the Soviet sector using a production function where the productive factors are labor, capital, and oil consumption. In the absence of data for real wages, the supply of labor is modeled as a function of real consumption. Capital accumulation is exogenously set by the government and oil consumption depends on income and the relative price of oil. Given the residual nature of

private consumption in the old Soviet bloc, private consumption is set equal to the excess of income over other aggregate demand activities (government consumption, government investment, and net exports). The MCM does not model the FSU monetary sector and treats both prices and exchange rates as exogenous.

The major modeling challenge of this paper is to specify the transition from the centrally planned socialist economy of the Soviet Union, for which there are data of varying degrees of reliability, to the new market economies of the FSU countries, for which there are virtually no data. The approach taken here is to build on the Soviet sector of the MCM, making judgmental adjustments to the existing equations to reflect the likely impact of market reforms.

Successful market reforms and structural adjustments in the FSU almost certainly would be accompanied by a substantial amount of foreign investment. In this paper, it is assumed that capital inflows are sufficient to finance the deficit implied by the model's unconstrained FSU export supply and import demand functions. Moreover, it is specified that under market reforms, all non-oil imports are of investment goods and that they constitute a net addition to the FSU capital stock. That is, the model's investment equation is supplemented by a term reflecting the level of non-oil imports. The geographic pattern of FSU trade is assumed to adhere to the historical Soviet pattern.[8]

8. The literature on the international implications of the transition of the FSU from a centally planned economy to a collection of market economies has used the so-called gravity model and other techniques to address the question of the prospective FSU geographic trade pattern. See, for example, Collins and Rodrik (1991), Hamilton and Winters (1992), Havrylyshyn and Pritchett (1991), and Vavilov and Vjugin (1993). It seems clear that FSU trade will be re-oriented toward the Western

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There are two important changes in the FSU oil market. It is specified that FSU oil production capacity responds positively to market incentives and benefits from the availability of foreign technology, expertise, and investment. The result is that instead of falling continuously for five years before flattening out at a low level, oil production capacity holds steady during the entire simulation period.[9] (In the actual simulations, the FSU uses this productive capacity fully only in the scenarios in which it does not cooperate with OPEC.) On the demand side, the FSU oil consumption function is altered to reflect the expected effects of market pricing and market incentives. Specifically, the Soviet oil consumption equation is replaced by a weighted average of two distinct oil consumption equations: the equation in the MCM, fitted with Soviet data and embodying Soviet inefficiencies, and a Western-style equation not unlike those fitted for industrial countries in the MCM.

(Footnote continued from previous page)
industrial countries, relative to the old Soviet pattern, and the most reasonable prediction is that Germany's proximity to the bulk of the FSU economies makes Germany likely to gain a large share of the new export markets. The assumption of no change in FSU trade patterns that is employed in the simulations reported in this paper is made for analytical convenience only. The results of a sensitivity analysis, in which it is assumed that eventually all of the FSU's incremental demand for imports is supplied by Germany, are reported later in this paper.

9. Many existing FSU oil fields have huge production potential if the appropriate rehabilitation or enhanced recovery techniques are applied. With economic reforms, at least some of the recent production declines presumably could be reversed in a cost-effective manner. In addition, there are considerable hydrocarbon losses occurring in all sectors of the FSU oil and gas industry. Oil losses, mainly a result of leakages from pipelines, are estimated recently to have been on the order of 1 mbd. Under a regime of market pricing and private enterprise, incentives would be in place to help reduce such losses. See Oil and Gas Journal, September 21, 1992.

The latter equation has a long-run income elasticity of 1.4 instead of the 9.3 figure in the Soviet equation, and a long-run price elasticity of 0.6 rather than the Soviet price elasticity of 0.1. The weight given the Western-style equation increases gradually from zero at the beginning of the transition period to unity by the end of eight years.

Three changes are made to the FSU non-oil production function to reflect a move to a market economy. Reflecting the poor quality of the capital stock inherited from the old Soviet bloc, a one-time "depreciation charge" of 25 percent is imposed. That is, the capital stock is reduced by 25 percent at the beginning of the transition to a market economy. On the other hand, the production function is enhanced by adding a 2 percent annual growth trend term to reflect increased total factor productivity growth under market conditions; in the equation estimated with Soviet data there is no trend. At the same time, the share of capital in national production is increased gradually from 20 percent at the beginning of the transition period to 26 percent at the end in order to reflect the presumed effects of market reforms and privatization on the productivity of capital in the FSU. As mentioned earlier in this paper, the investment function is altered so that all non-oil real imports represent an additional increment to the capital stock.

Finally, in order to simulate scenarios in which the world price of oil is determined by market forces rather than by OPEC price-targeting strategies, the MCM's oil sector had to be altered. Specifically, the real price of oil is modeled as a function of the excess world demand for oil (that is, consumption in excess of production) and the lagged value of the real price.

Alternative scenarios

The various alternative scenarios analyzed in this paper are reported as deviations from a baseline model simulation. The general features of this baseline are a constant real oil price of $17 per barrel, in 1987 dollars, real GDP growth in the industrial countries (the entire OECD) of 2-1/2 percent per year, and an annual CPI inflation rate of 3 percent in those same countries.

One important element in the baseline is the assumption that there are no significant economic reforms in the FSU. That is, in the baseline simulation, the Soviet sector of the MCM is retained as estimated using Soviet-era data and Soviet-era behavioral relations. Thus, in general terms, the baseline scenario specifies declining oil production capacity and continued profligate oil consumption in the FSU, as well as continued inefficient production of goods in general. Specifically, it is assumed that FSU oil production capacity declines by 6 percent annually for six years before becoming flat. The FSU real exchange rate is assumed to be constant throughout the simulation period. Investment--an exogenous policy variable under the old Soviet regime--is specified as a fixed percentage of GDP, and depreciation is set at a fixed percentage of the capital stock. FSU exports are endogenous; oil imports remain exogenous.

In this section of the paper, two main alternatives to the baseline scenario are discussed. In each of these alternatives it is assumed that the FSU successfully adopts meaningful market reforms. The tangible effects of these reforms, in terms of the simulation model used in this paper, are as described in the preceding section of the paper.

In brief, FSU oil production capacity stabilizes immediately and oil consumption gradually approaches Western norms; excess oil production is exported and the revenues from exports as well as foreign investment flows are used to purchase imported investment goods. Moreover, the FSU non-oil production function becomes more efficient over time, after a one-time adjustment in the capital stock to reflect the poor quality of the capital stock inherited from the Soviet regime. In the set of alternative scenarios outlined in this section of the paper, the FSU produces oil at full capacity.

The two alternative scenarios differ in how other oil-exporting nations react to the additional supply on the world oil market represented by FSU oil exports. In the first alternative, the OPEC nations keep their own output of oil on the baseline path, and the world market price of oil adjusts to equate the quantity supplied with the quantity demanded. In the second alternative, OPEC adjusts its own production in order to hold the nominal price of oil to its baseline path. Each of these scenarios involves extreme assumptions about OPEC behavior, and the actual response to substantial oil exports emanating from the FSU likely would lie between these two extremes. Nevertheless it is instructive to examine the extremes. An additional set of scenarios, in which the FSU and OPEC countries cooperate, is discussed in the following section of this paper.

Some features of the model simulations of the two alternative scenarios are highlighted in Charts 1 and 2.[10] The top panels of Chart 1 starkly depict the choices confronting OPEC should the FSU seriously

10. Detailed tables of the simulations of each of the alternative scenarios described in this paper are available on request.

Chart 1: Selected Economic Indicators
(deviations from baseline)

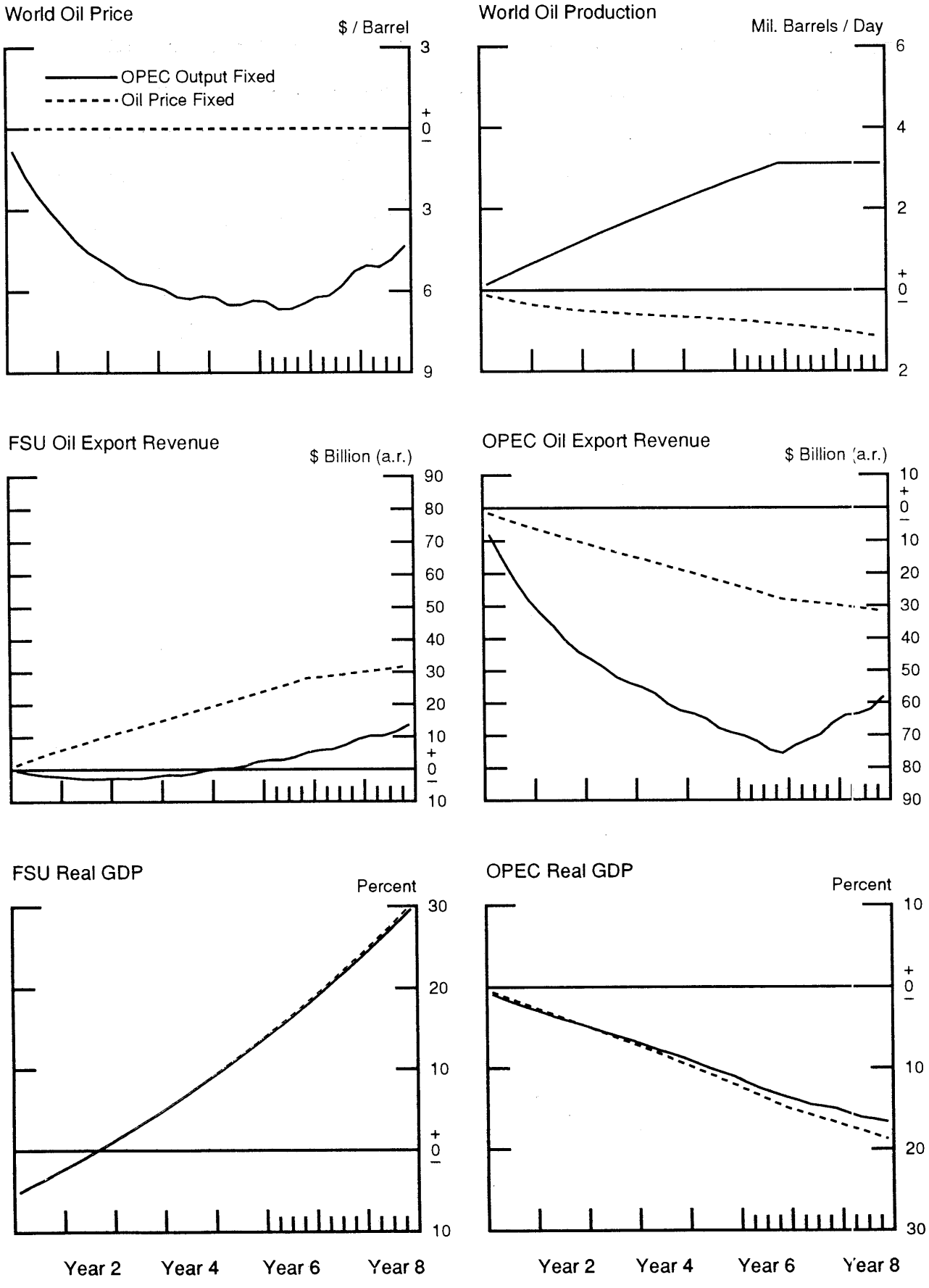
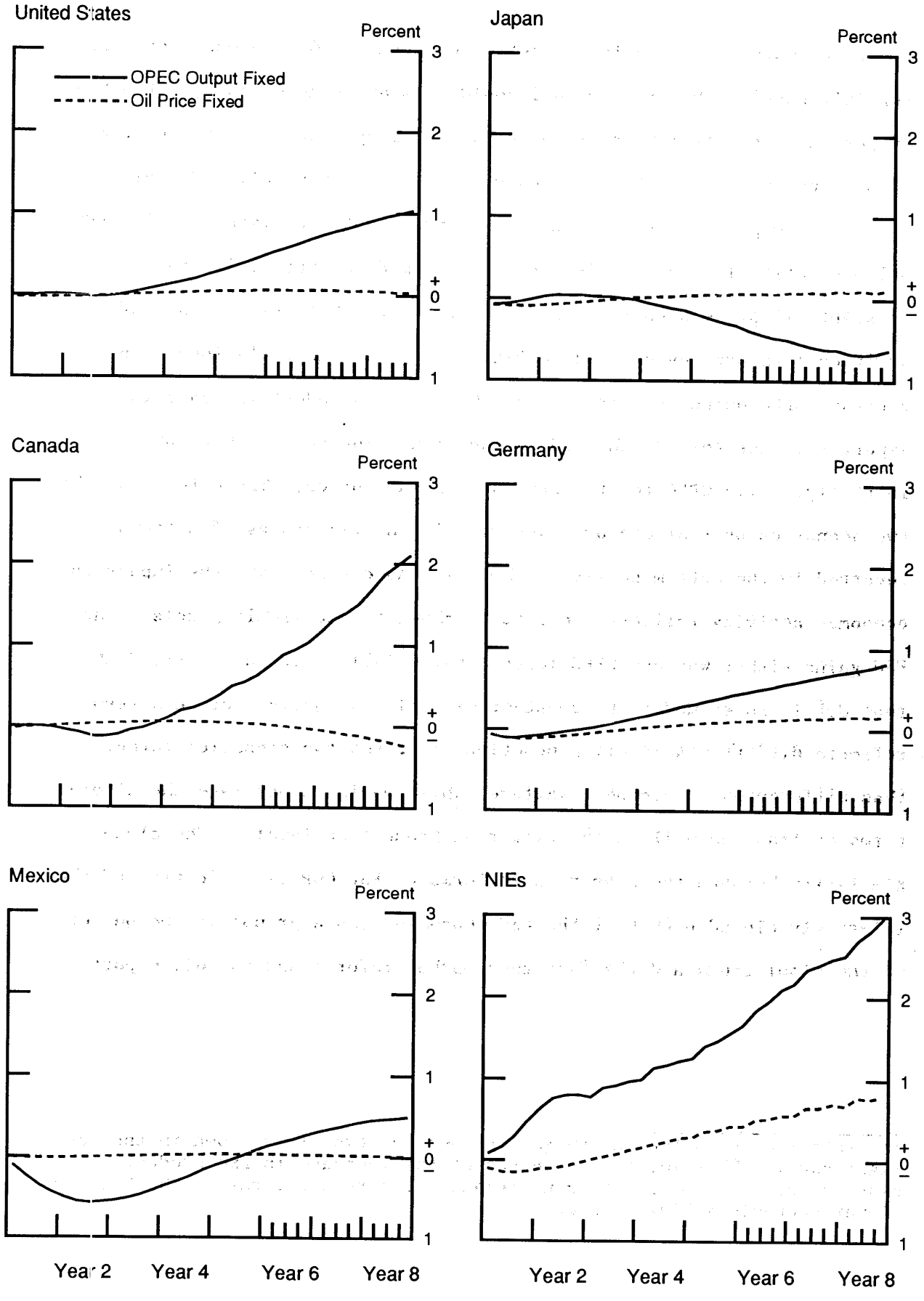


Chart 2: Real GDP in Selected Countries
(deviations from baseline)



undertake market reforms in the petroleum market. On the one hand (the top left panel), the price of oil could plummet by more than $6 (roughly 40 percent from its 1993 average) before firming toward the end of the simulation period; on the other hand (the top right panel), OPEC oil production might have to be cut by 4.4 mbd (about one sixth of 1993 OPEC oil production levels).[11] As shown in the middle panels, in the constant-oil-price scenario, the FSU obtains a substantial amount of additional export revenue, while OPEC suffers a comparable loss. In the constant-OPEC-output scenario, the FSU records a modest increase in export revenues towards the end of the simulation period, but not initially, while OPEC incurs very substantial losses. The effects of the two scenarios on real economic activity in the two groups of nations are reported in the bottom panels of Chart 1. As can be seen, the impact on economic activity reflects the pattern shown in the middle panels: the FSU gains either way and OPEC loses substantially. In the chart, OPEC real GDP is lower under the constant-oil-price scenario, but this result reflects differences in oil production under the two scenarios rather than differences in economic welfare, which would incorporate the altered terms of trade as well as the different production levels. The close similarity between the scenarios in terms of FSU GDP is reflective of the relatively closed nature of the FSU economies (as a group) at the outset of the simulations and the fact that market reforms and not oil export

11. This figure is the entire gap between the two lines shown in the top right panel. That is, it is the sum of the increase in FSU production plus the oil consumption forgone because of market reforms in the FSU and slower economic activity in OPEC.

revenues are the key to FSU economic growth.[12] Comparing the two scenarios, it would appear that both the FSU and OPEC might be better off with a constant world oil price, even when that price is held constant through unilateral production cutbacks by OPEC.

Chart 2 presents the effects on the level of real economic activity in some key countries of market reforms in the FSU--as modelled in this paper--and the two alternative assumptions about OPEC's response to consequent changes in the supply of and demand for petroleum on world markets. As can be seen in the constant-OPEC-output scenario, there is a noticeable boost to U.S. economic activity which in turn helps to fuel activity in the country's North American trading partners. In the case of Mexico, the extra demand is sufficient ultimately to offset the depressing effect of sagging oil export revenue. Despite the weaker oil price, Japan suffers a slowdown in activity, relative to baseline, largely because a decline in exports to OPEC and an appreciation of the yen offset the stimulative effects of the oil price decline. German gains in real GDP are comparable to those for the United States, as exports to the FSU and the expansionary effects of the lower oil price compensate for the effects of an appreciation of the mark.[13] The NIEs

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12. The general contour of FSU real GDP in Chart 1--an initial sharp dip followed by steady increases--bears a resemblance to the experience of Poland in the early 1990s, where reforms at first produced a severe contraction in economic activity before ushering in a period of expansion.

13. In an attempt to assess the sensitivity of these results to the assumption that FSU trade follows the historical Soviet pattern, the OPEC-output-fixed simulation was run with an alternative, and equally unrealistic, specification in which by the end of the simulation period the entire increment to FSU imports is purchased from Germany. As might be expected, German economic activity is higher in this case, but the difference is relatively modest: about 1 percentage point on the level

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also benefit significantly, primarily because of an expansion of their exports to the United States and elsewhere. It is noteworthy that it is the oil price movement that has by far the largest effect on world economic activity; the combined effects of FSU reforms and OPEC oil production cutbacks have little net impact on any of the countries depicted in Chart 2.

Cooperative strategies involving FSU and OPEC

An increase in FSU oil exports anything like that specified in the preceding section of this paper would exert severe downward pressure on the world oil price. As noted in the earlier discussion, how OPEC would react to such an eventuality is a crucial element of the story. In the preceding section of the paper, two extreme assumptions about OPEC's response are analyzed: OPEC keeps its quantity constant, and the price of oil drops, or OPEC protects its target price by cutting its own production.[14]

There is obvious room for both OPEC and the FSU to gain by cooperating. The export revenue yield to the FSU from increased oil

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of real GDP at the end of the simulation. It is interesting to note that Germany's European partners are adversely affected by the German export boom because the EC currency links incorporated in the MCM elicit an appreciation of those countries' currencies vis-a-vis non-European currencies. This situation is reminiscent of the economic consequences of the unification of Germany in the early 1990s, as analyzed by Adams, Alexander, and Gagnon (1993).

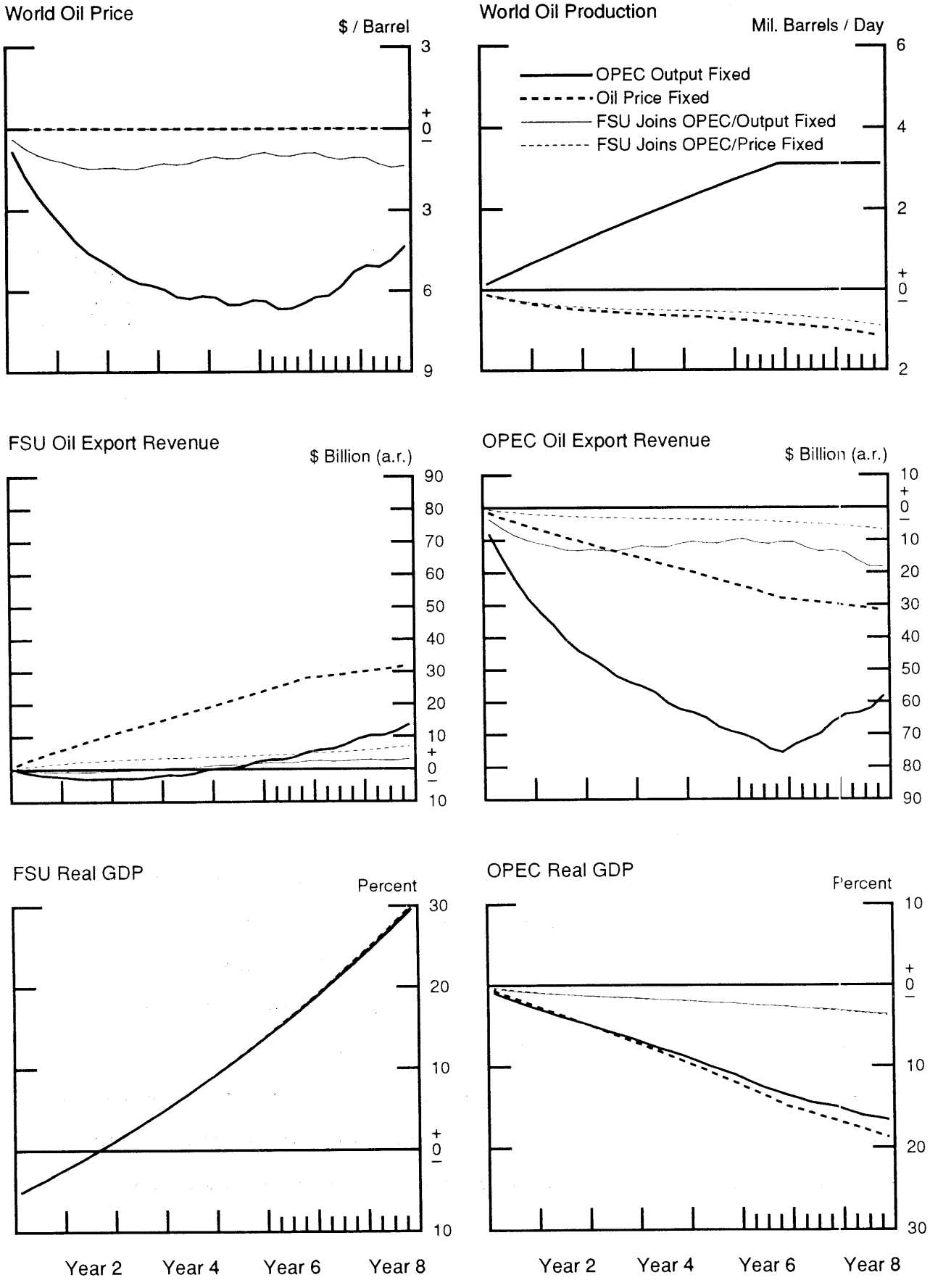
14. For simplicity, it is assumed that the two scenarios presented in Chart 1 are the only non-cooperative paths available for the FSU and OPEC.

exports is not great when the effects of a weakening oil price are taken into account, and the export revenue losses to OPEC, while substantial in either non-cooperative scenario, are considerably worse when the oil price is allowed to decline.

In this section of the paper, the FSU and OPEC are assumed to cooperate. In particular, it is specified that the FSU joins OPEC, with production quotas corresponding to the path of FSU oil production that is embodied in this study's baseline simulation. Thus, the boost to the supply of oil on the world market attributable to events in the FSU is confined to what is made available for export as a result of the energy conservation stemming from FSU market reforms. Even with this substantial degree of cooperation from FSU oil producers, OPEC must decide how to respond to those extra oil exports. The two extreme assumptions employed in the earlier section of this paper--OPEC maintains its baseline production path and lets the oil price decline, or OPEC adjusts its own production so as to keep the price of oil on its baseline path--are utilized in the analysis of the cooperative scenarios discussed in the present section as well. The implications of these assumptions are reported in Chart 3.

In the chart, the non-cooperative scenarios discussed in the preceding section of the paper are shown as the darker solid and dashed lines, as they were on Chart 1. The two cooperative scenarios are denoted in Chart 3 by the lighter solid and dashed lines. The effects on the international economy of either of the cooperative scenarios are minimal and are not reported in this paper. Turning first to the case in which the FSU joins OPEC and world oil production follows its baseline path--the light solid lines in the chart--the simulation indicates a

Chart 3: Selected Economic Indicators
(deviations from baseline)



drop of about $1 per barrel in the world price of oil. Of more significance is the result that FSU oil export revenue (the middle left panel) essentially follows the baseline path in this scenario: the FSU gains little from its cooperation with OPEC. Considering the non-cooperative alternatives, in which the FSU does derive revenue enhancements--to varying degrees--from oil exports, it would seem that in order for OPEC to obtain FSU cooperation, some form of compensation would have to be offered. The gaps between the light solid line and the darker lines in the middle right panel of Chart 3 suggest that OPEC could indeed afford to offer the FSU countries side payments in return for their cooperation on oil production restraint. Moreover, the substantial differences in the paths of real GDP in the OPEC countries in the two sets of simulations indicate that OPEC would have a strong incentive to seek the FSU's cooperation in restraining oil production.

A more attractive cooperative scenario for both the FSU and OPEC is that shown by the lighter dashed lines in Chart 3. In this scenario, OPEC adjusts its own production so that the world price of oil adheres to the baseline path. The result is that FSU oil export revenue is stronger than in the other cooperative simulation, as is OPEC oil revenue. To be sure, the FSU might still prefer a non-cooperative strategy, especially in the out years, but presumably it would take a smaller side payment to obtain FSU cooperation than in the case in which OPEC does not adjust its own oil production. Moreover, OPEC would be in a better financial position to provide such a compensatory payment.

Comparison of the four scenarios depicted on Chart 3 indicates that while the FSU would prefer the darker dashed line, OPEC would prefer the lighter dashed line. In both of these scenarios, OPEC adjusts

production to keep the price of oil constant; the difference in the scenarios is that in the former, OPEC does all of the necessary adjustment, in the latter, the FSU joins in the effort. Which scenario is the more likely outcome depends on the degree to which OPEC is willing and able to compensate the FSU.

The discussion of these cooperative scenarios raises a fundamental question: how credible and/or sustainable is any cooperative strategy involving the various FSU oil producing countries and the various members of OPEC? The free-rider incentives would be enormous and difficult to resist, especially taking into consideration the financial situation that some FSU countries might face at least early in the transition to a market economy. Full cooperation might not be forthcoming from important FSU oil producers. Similarly, there are questions about the ability of the OPEC countries to cooperate even among themselves in any strategy chosen to offset FSU oil exports. The oil production cutbacks needed would be substantial, especially in the case where the FSU boosts its production relative to the baseline path, and would constitute a hardship for many OPEC members. Again, the free-rider incentives would be a powerful inducement to cheat on any production agreement. Finally, the financial burden of compensating the FSU might be difficult to bear, economically and politically, and probably would be even harder to share among the OPEC membership than would production cutbacks.

The failure of the FSU and OPEC countries to work out a sustainable cooperative strategy would result in an outcome similar to that shown in Chart 3 as the darker solid line. The FSU would gain little from its oil exports until late in the simulation period, but the

FSU countries, as a whole, would start reaping the benefits of market reforms within a very few years. The OPEC countries would be hit hard by this outcome, with oil export revenue and economic activity plummeting along with the price of oil. Economic activity in the rest of the world would, on balance, be strengthened somewhat.

Conclusion

This paper has developed and analyzed several alternative scenarios. The simulations reported in this paper indicate that in the absence of cooperation between the FSU and OPEC, the price of oil could weaken dramatically, with noticeable consequences for the international economy if OPEC keeps to its baseline production path. However, in the case in which OPEC adjusts its own production and holds the oil price steady, there are few significant macroeconomic implications for the international economy outside of the FSU and OPEC countries. The simulations suggest also that in the case of cooperation between the FSU and OPEC, the macroeconomic implications for the rest of the world are quite modest.

In order to obtain FSU cooperation, the OPEC countries probably would have to compensate the FSU countries, in addition to cooperating among themselves. Since there is some reason to question whether the requisite amount of cooperation among the various FSU and OPEC countries would be forthcoming, events in the former republics of the Soviet Union could end up weakening the oil market significantly. As a consequence, economic activity in most of the rest of the world, including in some of the major industrial countries, could receive a boost.

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Appendix: Description of the MCM

The MCM has in excess of 1250 equations grouped into thirteen countries and regions: Canada, France, Germany, Italy, Japan, the United Kingdom, the United States, the Rest of the OECD (ROECD), Mexico, four Asian Newly Industrialized countries (NIEs: Hong Kong, Singapore, South Korea, and Taiwan), OPEC, the Soviet Union, and the Rest of the World (ROW). Table 1 shows a compact representation of the typical country model. The equations are grouped into eight sectors: domestic expenditure, government finance, international trade, monetary sector, aggregate supply, labor supply, prices, and international finance.

The domestic expenditures sector explains real consumption and real investment. Consumption expenditures (eq. 1) (durable and nondurable) depend on real, personal disposable income and the real interest rate; inflationary expectations are formed adaptively. Personal disposable income (eq. 2) equals labor income, net interest receipts, and government transfers in excess of personal taxes.[15] Investment expenditures (eq. 4) (residential and nonresidential) depend on gross output and real interest rates. Real government purchases are treated as exogenous; real net exports are determined in the international trade sector.

The government finance sector determines nominal government expenditure, tax receipts, the government deficit, and government debt. Nominal government expenditures (eq. 10) equal the value of government

15. Data constraints for developing countries limit the degree of disaggregation in the components of domestic expenditures and preclude explaining both personal disposable income and its components. For example, the model explains Mexico's aggregate consumption with real, per capita GDP instead of disposable income.

consumption plus net transfer payments and interest payments on government debt. Government revenues (eq. 9) recognize differentials in tax rates across personal income, corporate profits, and oil consumption.[16]

The international trade sector explains multilateral merchandise trade, non-factor services, and factor services. Merchandise exports are disaggregated into non-oil and oil; non-oil exports (eq. 13) depend on foreign real income and relative prices. Oil exports are exogenous for all countries and regions except Mexico and OPEC. Mexico's oil exports equal the excess of oil production over oil demand. OPEC's oil exports equilibrate world demands and supplies of oil which implies that (1) OPEC is the only significant net exporter of oil at the margin and (2) OPEC sets the price of oil and acts as the residual oil supplier.

Merchandise imports are also disaggregated into non-oil and oil. Non-oil imports (eq. 16) depend on real income and relative prices. Oil imports (eq. 17) equal the excess of oil requirements over the exogenously given level of oil production. Oil requirements consist of changes in oil inventories and oil consumption (eq. 29); the latter depends on real income and relative prices. Non-factor services are explained in a manner analogous to non-oil merchandise trade. Exports of non-factor services (eq. 14) depend on foreign real income and relative prices; imports of non-factor services (eq. 18) depend on domestic real income and relative prices.

Finally, factor services are disaggregated, whenever possible, according to their source -- portfolio or direct investment. Factor

16. Again, data limitations for developing countries preclude such a differentiation of taxes.

receipts (eq. 19) depend on the stock of claims on foreigners, interest rates, and foreign income. Factor payments (eq. 20) depend on the stock of liabilities to foreigners, the interest rate of those liabilities, and domestic income.

The monetary sector explains real money holdings and interest rates. The nominal money supply in G-7 countries, France excluded, and the NIEs is taken as given. For France and the ROECD, the money supply adjusts to peg their currencies to the DM. For Mexico, changes in the money supply depend on the balance of payments and the government deficit. The model does not have monetary sectors for OPEC, the Soviets, and the ROW.

Assuming that real money holdings depend on real income and the nominal short-term interest rate, the model determines the nominal, short-term interest rate using the equilibrium condition in the money market (eq. 21). Short-term interest rates for France and the ROECD obey an open interest-parity condition vis a vis Germany. Finally, long-term nominal interest rates (eq. 22) are determined with a term-structure relation augmented for inflationary expectations; for non-U.S. countries, the term-structure also includes the U.S. long-term interest rate.

The aggregate supply sector determines labor requirements and potential output. To determine labor requirements, the model uses a Cobb-Douglas production function (eq. 24) where gross output (eq. 23) depends on employment, oil, and capital adjusted for capacity utilization; for some countries, the model includes a time trend to capture neutral technological change. For given levels of capital, oil, and real GDP, the production function is normalized on labor to yield labor requirements. Potential output is determined by substituting the

full-employment levels of labor and capital into the production function (eq. 25). Thus developments affecting investment or the labor force influence potential output in the MCM. For developing countries, the production function is also Cobb-Douglas but with oil and capital as the sole productive factors. Thus this function only determines potential output.

For industrial countries, the supply of labor (eq. 30) depends on the after-tax real wage. Given the rate of inflation, the growth in productivity, and the level of unemployment, the model uses a Phillips curve to determine the growth rate of nominal wages (eq. 32). For developing countries, nominal wages depend on consumer prices and the gap between actual and potential GDP.

The price sector explains the price of gross output, the non-oil export price, and the deflators for domestic spending. The price of gross output (eq. 35) depends on wages, the price of oil, growth in labor productivity, and the gap between actual and potential output. The price of non-oil exports (eq. 38) depends on the price of gross output and the foreign non-oil export price expressed in local currency. Finally, the expenditure deflators (eq. 33) depend on the prices of gross output and non-oil imports to recognize that domestic and foreign products vary in importance across expenditure categories.

The international finance sector explains exchange rates and changes in the external asset position. Based on Edison and Pauls (1993), the model assumes that an increase of 100 basis points in the U.S. real, long-term interest-rate differential raises each bilateral, real dollar rate by five percent vis-a-vis the currencies of the G-7 except France (eq. 41). The currencies of France and the ROECD are

pegged to the DM; the Mexican peso-U.S. dollar rate follows the Mexico-U.S. price differential; the dollar exchange rate for the NICs follows the open-interest-parity condition vis-a-vis the United States; and the currencies of OPEC, the ROW, and Soviets are pegged to the U.S. dollar. Finally, changes in claims on foreigners depend on foreign real GDP and differences in rates of return (eq. 43). Changes in liabilities to foreigners depend on domestic economic activity and interest rates (eq. 45).

Table 1
Prototype Country Model in the MCM:
Compact Representation

Domestic Expenditures	$C = C(YD/PC,\ is - E\%\Delta PQ)$	(1)
	$YD = L\cdot W\cdot(1-\tau) + CAPRET\cdot(1-\tau') + TR$	(2)
	$CAPRET = f(is,\ il,\ YV,\ K)$	(3)
	$I = I(Q,\ is - E\%\Delta PQ)$	(4)
	$\Delta INV = F[C(-1) + I(-1) + G(-1),\ \ is - E\%\Delta PQ]$	(5)
	$Y = C + I + G + \Delta INV + X - M$	(6)
	$YV = PC\cdot C + PI\cdot I + PG\cdot G + PINV\cdot\Delta INV + PX\cdot X - PM\cdot M$	(7)
Government Finance	$GDEF = EXP - T$	(8)
	$T = L\cdot W\cdot\tau + CAPRET\cdot\tau' + CO\cdot\tau''$	(9)
	$EXP = PG\cdot G + TR + is\cdot GDEBT(-1)$	(10)
	$GDEBT = GDEBT(-1) + GDEF$	(11)
International Trade	$X = XNO + XO + XS$	(12)
	$XNO = X(Y^*,\ PXNO/P^*)$	(13)
	$XS = XS(Y^*,\ PXS/P^*)$	(14)
	$M = MNO + MO + MS$	(15)
	$MNO = M(Y,\ PMNO/P)$	(16)
	$MO = CO + XO - QO$	(17)
	$MS = MS(Y,\ PMS/P)$	(18)
	$XSF/FA = XSF(is,\ is^*,\ Y^*)$	(19)
	$MSF/FL = MSF(is,\ is^*,\ Y)$	(20)
Monetary Sector	$MA/PC = MA(Y,\ is)$	(21)
	$il = i(is,\ E\%\Delta PQ,\ il_{us})$	(22)
Aggregate Supply	$Q = Y + MO$	(23)
	$Q = Q(K\cdot CU,\ L,\ CO)$	(24)
	$QPOT = Q(K,\ LF,\ CO)$	(25)
	$QPOT = YPOT + MO$	(26)
	$K = K(-1) + I$	(27)
	$CU = CU(Q/QPOT,\ L/LF)$	(28)
	$CO = CO(Q,\ PO/PQ)$	(29)
Labor Supply	$LF/POP = LF[W(1-\tau)/PC]$	(30)
	$U = (LF - L)/LF$	(31)
	$\%\Delta W = W(U,\ E\%\Delta PQ,\ Q/L)$	(32)
Prices	$Pj = Pj(PQ,PMNO),\ j=C,I,G,INV,\ XS,\ MS$	(33)
	$PMNO = S\cdot PXNO^*$	(34)
	$PQ = P(PO,\ W,\ QPOT/Q,\ Q/L)$	(35)
	$PO = S\cdot PO^* + \tau''$	(36)
	$P = YV\ /\ Y$	(37)
	$PXNO = PXNO(PQ,\ S\cdot PXNO^*)$	(38)
	$PX = (PO\cdot XO + PXNO\cdot XNO + PXS\cdot XS)\ /\ X$	(39)
	$PM = (PO\cdot MO + PMNO\cdot MNO + PMS\cdot MS)\ /\ M$	(40)
International Finance	$S\cdot PQ_{us}/PQ = S[(il-E\%\Delta PQ)-(il_{us} - E\%\Delta PQ_{us})]$	(41)
	$FA = FA(-1) + CAPOUT$	(42)
	$CAPOUT = CAO(Y^*,\ is,\ is^*)$	(43)
	$FL = FL(-1) + CAPIN$	(44)
	$CAPIN = CAI(I,\ is,\ is^*)$	(45)

mnemonics

C = Personal consumption
CAPOUT = Capital outflow
CAPIN = Capital inflows
CAPRET = Return to capital
CO = Consumption of oil
CU = Capacity utilization
EXP = Government expenditures, nominal
FA = Foreign assets
FL = Foreign liabilities
G = Government purchases
GDEF = Government deficit
GDEBT = Government debt, nominal
is = Short-term interest rate
il = Long-term interest rate
I = Private fixed, gross investment
INV = Inventories
K = Capital stock
L = Employment
LF = Labor force
M = Imports of merchandise and non-factor services
MA = Monetary aggregate
MNO = Merchandise, non-oil imports, real
MO = Oil imports, real
MS = Non-factor service imports, real
MSF = Factor income payments
P = GDP deflator
PC = Deflator for consumption
PG = Deflator for government purchases
PI = Deflator for investment
PINV = Deflator for inventory investment
PM = Deflator for imports of merchandise and non-factor services
PMNO = Deflator for non-oil imports
PMS = Deflator for non-factor service imports
POP = Population
PX = Deflator for exports of merchandise and non-factor services
PXNO = Deflator for non-oil exports
PXS = Deflator for non-factor service exports
PO = Price of oil, domestic
PQ = Deflator for gross output
Q = Gross output
QO = Domestic production of oil
QPOT = Potential gross output
S = Exchange rate, local/U.S. dollar, nominal
T = Government revenue
TR = Government transfers
τ, τ', τ'' = Tax rates
U = Unemployment rate
W = Wage rate
X = Exports of merchandise and non-factor services
XNO = Merchandise, non-oil exports, real
XO = Oil exports, real
XS = Non-factor service exports, real
XSF = Factor income receipts
Y = Real GDP
YD = Disposable income, nominal
YPOT = Potential real GDP
YV = Nominal GDP
*, us = Foreign country, United States

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