# III

# An Extended Scenario and Forecast Adjustment Model for Developing Countries

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The current developing country models, LDCMOD, developed by Adams and Adams (1989), have been used extensively in the *World Economic Outlook* for analyzing the impact on the developing countries of changes in their external environment. In addition, these models have played a key role in the updating of the staff's projections following changes in assumptions regarding the external environment. The models were estimated separately for each of the net debtor developing countries and took the specific characteristics of each of them into account. This paper reports the results of efforts under way to augment these models by incorporating fiscal and monetary sectors, to allow domestic factors to play a role in the determination of imports, and to extend the models to the case of net creditor countries.

## Main Features of the Model

The existing model system includes a detailed set of behavioral equations and identities describing the domestic and external sectors of a prototype net debtor developing economy. An identical structural model is estimated using historic data for each individual country, but differences across countries are captured by the different parameter estimates. Owing to data limitations and problems with outliers, some of the parameters are constrained to be within a range determined by theoretical considerations.

Output is modeled by disaggregating it into internationally tradable and nontradable goods, but no distinction is made between private and public expenditures. Demand for nontradables is determined endogenously as a function of income, the real exchange rate, and external borrowing. Output is then divided into consumption and investment using historical weights. Inflation is determined by excess demand in the goods market, defined as the deviation of actual from potential output, where the latter is a function of capital stock and the real exchange rate.

LDCMOD has a detailed external sector, including separate equations for import and export volumes, official and private transfers, investment income receipts and debits, non-debt-creating capital flows, new borrowing, and change in reserves. A key feature of the model is the assumption that imports are determined residually by the amount of foreign exchange available. This reflects the external constraints faced by most developing countries following the oil shocks of the 1970s and the debt problem of the 1980s.[2]

In this paper, LDCMOD is extended in three main directions. First, to permit the model to analyze the impact of changes in fiscal and monetary policies, government and monetary sectors are introduced and private and public components of aggregate demand are modeled separately. Government revenue is determined endogenously and takes into account the lagged adjustment of revenue to inflation. Government expenditure is divided into current expenditure, which is endogenously determined, and capital expenditure, which is treated as an exogenous policy variable. As regards the monetary sector, the stock of money is endogenously determined (although, for simulation purposes, it is also possible to consider it as a policy variable) and the model incorporates the role of supply side factors in the determination of the money stock. Prices are determined by the interaction of money demand and supply functions. Government policy influences output directly through the effect of changes in expenditures on aggregate demand, and indirectly through changes in the stock of money and prices, which in turn influence domestic absorption and exports. A change in government's capital expenditure also affects the economy's productive capacity and the supply of exports.

Second, the external sector is modified to take account of the effect of domestic factors on imports. This is done by specifying imports to be externally constrained—and thus determined residually—only when the option of using reserves or foreign borrowing is not available to the country. The model

[1]The authors are grateful to Flemming Larsen, David Coe, Tamim Bayoumi, Robert Ford, Steven Symansky, and Charles Adams for very helpful comments and suggestions.

[2]For alternative specifications, see Khan, Montiel, and Haque (1991), Petersen and others (1991), and NIESR (1993).

is, therefore, made more flexible so that, depending on the availability of reserves or new loans, imports may switch from being residually determined by external financial flows and export earnings as in the original version of the model, to being determined in a behavioral manner by a mixture of domestic and external factors. In addition, the nominal exchange rate, rather than being exogenous, now adjusts endogenously to maintain purchasing power parity in the long run. This is important for an analysis of changes in government policies that may involve large changes in domestic prices relative to foreign prices over a number of years.

Finally, the model system is extended to the group of net creditor countries. A key assumption here is that their imports are primarily determined by domestic factors. The equation for private absorption is also modified to take account of the absence of external constraints, and for the oil exporters within this group, a specific equation is developed for oil exports. Both export and import equations for the oil exporters are estimated by pooled cross-section time-series data and imposing cross-country equality restrictions on the slope parameters. Using panel data in this case should improve the reliability of estimates, given the similarities between these countries and homogeneity of their main export.

In the following sections, the extensions to the model system, including parameter estimates for the new or modified equations, are discussed in detail. The model is estimated separately for each of the 95 developing countries (87 net debtor and 8 net creditor).[3] The estimation period is 1973–91 for most countries and equations.[4] Where the modifications are not significant, the specifications are discussed in less detail and the reader is referred to Adams and Adams (1989). Estimation is carried out by ordinary least squares. Owing to data limitations for many countries, more sophisticated estimation techniques—for example, to take account of simultaneity between equations—were not employed. Moreover, in many cases, stringent constraints had to be imposed on the range of permissible parameter values in view of the limited number of observations and to remove the effects of outlying observations and extreme estimates. Particular difficulty was encountered in the case of some high-inflation countries in the Western Hemisphere and Africa, especially in estimating the equations for money and prices. Imposing these constraints ensured stability of the estimated models and increased the usefulness of the simulation exercises.

[3]See Appendix I for a list of countries in the various groups and regions.

[4]In Adams and Adams (1989), estimation period was 1973–88.

## Domestic Sector

A key extension of the model system relates to the separate modeling of the private and public components of aggregate demand, allowing the model to be used for the analysis of fiscal and monetary policies. A second important innovation in modeling the domestic sector is the attention paid to the interaction between fiscal deficits, monetary growth, inflation, and output. Chart 1 illustrates this interaction, abstracting from other parts of the model. An increase in the exogenous component of public expenditure leads to a higher fiscal deficit and monetary growth, and thus higher inflation. In the short run, as public expenditure increases, the effect on aggregate demand is positive despite crowding out of private absorption. In addition, higher public investment expenditure raises the capital stock, increasing potential output as well as enhancing the supply of exports. In the medium run, further crowding out takes place as higher inflation leads to a reduction in private absorption and (by lowering competitiveness) exports. Inflation also leads to a deterioration of fiscal balances, both directly due to the lagged response of nominal government revenue to higher prices, and indirectly through lower revenue from taxes and tariffs as GDP and exports are adversely affected in the medium run. These various interrelationships are discussed in detail in the following sections.[5]

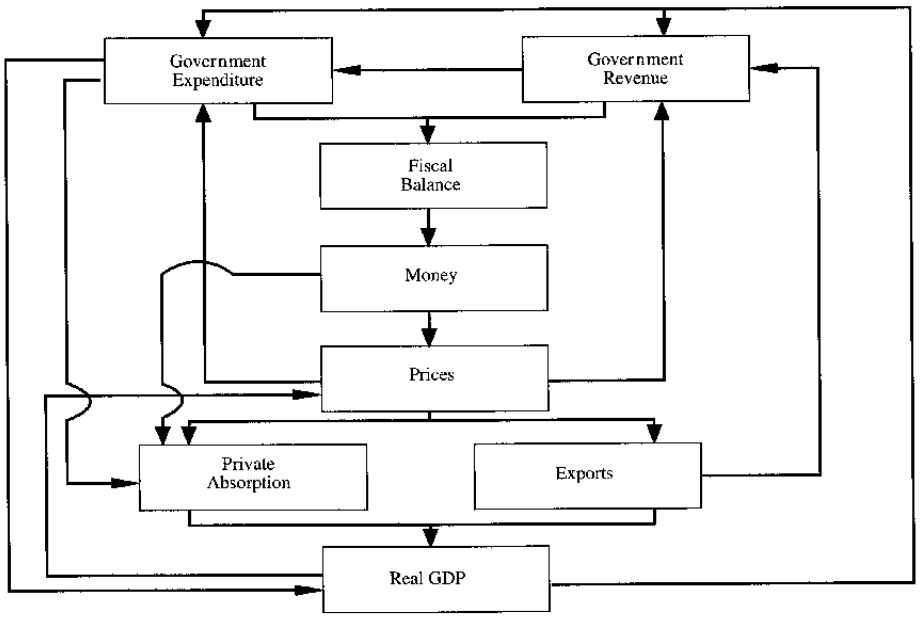
### Private Absorption

Modeling the investment and consumption components of private absorption separately proved impractical because of data problems for a number of countries and the difficulty in identifying a stable investment function, owing in part to the structural differences between the 1970s and the finance-constrained environment of the 1980s. Therefore, private absorption is modeled in its aggregate form. In doing so, both the supply side and the degree of crowding out that may result from government activity are taken into account. In the case of many developing countries, evidence suggests that crowding out may take place directly as resources are claimed by the government, or indirectly, through the price system, in particular through higher interest rates and inflation.[6] Based on this evidence, the formulation adopted here takes account of both the direct and indirect effects of fiscal expenditure on private absorption. Further-

[5]Details of the complete model structure, including all the behavioral equations and identities and definitions of variables, are provided in Appendix II.

[6]See, for example, Haque and Montiel (1991) for a discussion of these issues and evidence in the case of Pakistan.

**Chart 1. Dynamics of Budget Deficits, Money Growth, Inflation, and Real Output**




more, the role of financial wealth and access to external loans in determining private absorption is also taken into account, yielding the following specification:

Real private absorption = $F$(Real income, real fiscal expenditure, real exchange rate, financial wealth, external borrowing). (1)

Fiscal expenditure refers to central government expenditure and is expected to influence private absorption negatively.[7] The real exchange rate (measured by the ratio of export to domestic prices) captures the effect of terms of trade changes on private expenditures and is expected to have a positive coefficient. The real money supply is used as a proxy for financial wealth (or permanent income) in the absence of a more comprehensive measure. Finally, external borrowing is included in order to capture the effect of external constraints on absorption of net debtor countries. It is expected that access to foreign loans would have a positive effect on real absorption. External borrowing is excluded in the case of net creditor developing countries, which are assumed not to face external financial constraints. The equation is estimated in log-linear form. With total private sector absorption determined by equation (1), output is allocated to private consumption and investment spending according to fixed shares, estimated using historical data.

Table 1 presents the parameter estimates—obtained from estimating separately the absorption function for each of the 95 countries—averaged for the four developing country regions (Africa, Asia, Europe and non-oil Middle East, and Western Hemisphere), country groups according to the predominant export of the countries, and for net creditor countries. These estimates suggest that, for net debtors as a whole, the elasticity of private absorption with respect to income is 0.79, and with respect to relative prices, as measured by the real exchange rate, it is 0.24. The average elasticities both for real money and real new borrowing are small and positive, but vary considerably across regions.[8] The elasticity with respect to fiscal expenditure is negative, suggesting a crowding-out of private expenditures resulting from fiscal expansion. Net creditors as a group have a lower income elasticity but a higher price elasticity compared with the net debtors, reflecting the importance of oil prices in

[7]For a more formal representation of the model and the equations in the text, see Kumar, Samiei, and Bassett (1993).

[8]The low coefficient for real money in the case of the Western Hemisphere in part reflects the fact that for countries with very high inflation, constraints had to be imposed on this coefficient to modify the impact of large increases in money and prices.

**Table 1. Average Estimated Coefficients for Real Private Absorption[1]**

| | Real Income | Real Exchange Rate | Real Stock of Money | Government Expenditure | Real New Borrowing |
|---|---|---|---|---|---|
| Net debtor developing countries | 0.79 | 0.24 | 0.17 | −0.42 | 0.11 |
| By region | | | | | |
| Africa | 0.72 | 0.27 | 0.23 | −0.52 | 0.11 |
| Asia | 0.80 | 0.24 | 0.20 | −0.39 | 0.14 |
| Europe and non-oil Middle East | 0.80 | 0.20 | 0.08 | −0.48 | 0.13 |
| Western Hemisphere | 0.80 | 0.23 | 0.09 | −0.42 | 0.04 |
| By predominant export | | | | | |
| Primary products | 0.80 | 0.22 | 0.15 | −0.48 | 0.11 |
| Manufactures | 0.80 | 0.22 | 0.17 | −0.37 | 0.09 |
| Services and remittances | 0.80 | 0.20 | 0.09 | −0.66 | 0.23 |
| Diversified exports | 0.80 | 0.37 | 0.27 | −0.41 | 0.13 |
| Net creditor developing countries | 0.50 | 0.51 | 0.19 | −0.43 | — |

[1]Estimation is undertaken for individual countries using annual data for the period 1973–91. The coefficients are averaged using as weights the share of each country's purchasing power parity (PPP) valuation of GDP in the regional or group GDP.

determining absorption among the oil exporters in this group.

## Government Sector

In developing countries, general government spending, including expenditures by central and state governments, amounts to on average 30 to 40 percent of GDP. While the share of central government spending is lower, it still amounts to 20 to 30 percent of GDP in the net debtor countries (Table 2). The share among net creditors is approximately 10 percentage points higher, reflecting the more important role played by government amongst the major oil exporting countries. Unlike many conventional models which are based on aggregate government expenditure, a distinction is made here between government current and capital expenditure. Because capital expenditure is more likely to be used as a policy instrument by the authorities, it is treated as an exogenous policy variable. This seems consistent with the evidence of the last decade on the behavior of public sector investment.[9]

**Table 2. Government Expenditure in Developing Countries[1]**

*(In percent of GDP)*

| | 1986 | 1989 | 1992 |
|---|---|---|---|
| Net debtor countries | 25.0 | 23.2 | 21.8 |
| By region | | | |
| Africa | 27.1 | 26.9 | 29.7 |
| Asia | 23.8 | 21.2 | 19.9 |
| Europe and non-oil Middle East | 38.1 | 32.9 | 36.0 |
| Western Hemisphere | 23.4 | 23.4 | 19.1 |
| By predominant export | | | |
| Primary products exports | 21.0 | 22.4 | 20.9 |
| Exporters of manufactures | 24.5 | 23.1 | 20.8 |
| Services and remittances | 36.5 | 32.0 | 30.2 |
| Diversified exporters | 24.7 | 23.7 | 27.5 |
| Net creditor countries | 36.4 | 29.2 | 31.2 |

[1]Data are for central government only.

In addition to the distinction between government current and capital expenditures, a second extension is to allow the possibility of inflation-induced deficits, which arise from a differential impact of inflation on real government expenditure and receipts.[10] Existing empirical evidence suggests that in the short run the price elasticity of nominal expenditure tends to be larger than the price elasticity of nominal receipts. That is, a rise in the price level causes a greater short-run increase in nominal government expenditure than in nominal revenue, leading to a widening of the fiscal deficit, which in turn leads to higher prices via an increase in the money supply.[11] As discussed below, this important two-way relationship between budget deficits and inflation is captured by the equations for government expenditure and revenue, and those for inflation and the money supply.

Nominal current government expenditure, $GC$, is therefore modeled as a function of the price level, as well as GDP and lagged government revenue. The last variable is included on the assumption that the government adjusts its expenditure partly in line with its revenue. To capture the short- versus long-run effects of changes in the price level, an error-correction formulation is adopted. The long-run

[9]See Jadhav and Singh (1990) and Kumar (1992) for a detailed discussion and evidence on this issue. For evidence on regional variation in total public sector investment and differences in the productivity of public and private investment see Khan and Kumar (1993).

[10]The adverse effect on government revenues owing to inflation is the so-called Tanzi effect (Tanzi (1978)).

[11]See Aghevli and Khan (1978) for an elaboration of this hypothesis and empirical evidence.

**Table 3. Average Estimated Coefficients for Central Government Current Expenditure[1]**

| | Real GDP | GDP Deflator | Real Government Revenue |
|---|---|---|---|
| Net debtor countries | 0.35 | 0.93 | 0.36 |
| By region | | | |
| Africa | 0.39 | 0.95 | 0.33 |
| Asia | 0.33 | 0.91 | 0.38 |
| Europe and non-oil Middle East | 0.30 | 0.97 | 0.43 |
| Western Hemisphere | 0.39 | 0.94 | 0.33 |
| By predominant export | | | |
| Primary products | 0.32 | 0.94 | 0.36 |
| Manufactures | 0.34 | 0.92 | 0.37 |
| Services and remittances | 0.39 | 0.91 | 0.41 |
| Diversified | 0.40 | 0.93 | 0.36 |
| Net creditor countries | 0.30 | 0.96 | 0.40 |

[1]Estimation is undertaken for individual countries using annual data for the period 1973–91. The coefficients are averaged using as weights the share of each country's purchasing power parity (PPP) valuation of GDP in the regional or group GDP.

elasticity with respect to prices is set equal to unity to ensure the long-run homogeneity of degree 1 of nominal expenditure with respect to prices. The following specification is utilized for estimation purposes:

$$\Delta\log(GC) = F[\Delta\log(GDP), \Delta\log(PGDP), \Delta\log(RGR), \text{error-correction term}], \quad (2)$$

where *PGDP* and *RGR* denote GDP deflator and real government revenue respectively, and the error-correction term is equal to $\log(GC_{-1}) - \alpha_1\log(GDP_{-1}) - \log(PGDP_{-1}) - \alpha_2\log(RGR_{-1})$. The coefficients of the first-difference terms determine the short-run elasticities, while the coefficients in the error-correction term give the long-run elasticities. The difference between the short- and long-run elasticities depends on the speed and extent of adjustment of current government expenditure to each of the explanatory variables.[12]

Nominal government revenues, consisting of tax and nontax receipts, are specified to be a positive function of prices and domestic activity, as well as imports and exports. The rationale for including the latter two variables is provided by the very significant proportion of government revenues derived from trade taxes in many developing countries. Thus, total nominal revenue, *GR*, is modeled as follows:

$$\Delta\log(GR) = F[\Delta\log(GDP), \Delta\log(PGDP), \Delta\log(IM), \Delta\log(X), \text{error-correction term}], \quad (3)$$

where *IM* and *X* are imports and exports in real terms and the error-correction term is defined as $\log(GR_{-1}) - \beta_1\log(GDP_{-1}) - \log(PGDP_{-1}) - \beta_2\log(IM_{-1}) - \beta_3\log(X_{-1})$. As in the case of government expenditure, the long-run elasticity with respect to the price level was set equal to unity to ensure homogeneity. Since data on government accounts for many countries were available only for short periods of time, the error-correction coefficients and the long-run elasticities in equations (2) and (3) were not estimated for each individual country. Based on estimation results for countries with longer data series, and to ensure comparable dynamic properties of the model across countries, the error-correction coefficients in both equations were set equal to 0.30 for all countries. A similar procedure, with appropriate homogeneity conditions, was used to obtain the long-run elasticities. Thus, in the expenditure equation, long-run elasticities with respect to government revenue and GDP were set equal to 0.50, and in the revenue equation, long-run elasticities with respect to GDP, imports, and exports were respectively set equal to 0.50, 0.25, and 0.25. These are generally larger than the short-run elasticities reported below.

Equations (2) and (3) are estimated conditional on the above long-run elasticities and the error-correction coefficients. The estimated parameters for these functions are shown in Tables 3 and 4, and confirm that for all regions, short-run price elas-

[12]Due to lack of available data, the above specification does not take account of the effect of interest payments on expenditure. During the 1980s, in a number of middle-income developing countries, an increasing proportion of the fiscal deficit was financed by domestic borrowing, rather than by monetization (Guidotti and Kumar (1991)). This led to a sharp increase in the ratio of gross domestic debt to GDP and mounting interest payments, which in turn had an adverse effect on other forms of expenditures.

**Table 4. Average Estimated Coefficients for Central Government Revenue[1]**

| | Real GDP | GDP Deflator | Real Exports | Real Imports |
|---|---|---|---|---|
| Net debtor countries | 0.36 | 0.80 | 0.14 | 0.12 |
| By region | | | | |
| Africa | 0.39 | 0.72 | 0.14 | 0.13 |
| Asia | 0.37 | 0.79 | 0.13 | 0.11 |
| Europe and non-oil Middle East | 0.20 | 0.70 | 0.10 | 0.10 |
| Western Hemisphere | 0.35 | 0.89 | 0.15 | 0.15 |
| By predominant export | | | | |
| Primary products | 0.39 | 0.84 | 0.15 | 0.13 |
| Manufactures | 0.30 | 0.83 | 0.14 | 0.13 |
| Services and remittances | 0.38 | 0.64 | 0.11 | 0.12 |
| Diversified | 0.35 | 0.64 | 0.11 | 0.14 |
| Net creditor countries | 0.55 | 0.89 | 0.30 | 0.14 |

[1]Estimation is undertaken for individual countries using annual data for the period 1973–91. The coefficients are averaged using as weights the share of each country's purchasing power parity (PPP) valuation of GDP in the regional or group GDP.

ticities of nominal revenue are smaller than the corresponding elasticities of expenditures. For the net debtors, in the short run, a 1 percent increase in price leads to a 0.93 percent increase in nominal expenditure but a 0.81 percent increase in nominal revenue, indicating that inflation leads directly to a deterioration of fiscal balances. In the long run, as noted above, nominal revenue and expenditure increase in proportion to the price level. Short-run income elasticities average around 0.35 in both equations, except for net creditors where in the revenue function, the elasticity is higher. The coefficients on exports and imports in the revenue equation show some variation across regions, with Africa and the Western Hemisphere having relatively high elasticities, underlining the important role which trade taxes play in several countries in those regions. Net creditors have a significantly higher coefficient on exports than net debtors, reflecting the importance of oil exports for government revenues.

The balance on the government's budget, *GB*, is given by the identity

$$GB = GR - (GC + GK), \qquad (4)$$

where *GK* denotes nominal government capital expenditure.

### Money, Prices, and the Exchange Rate

The common practice of estimating an equation for money as a function of income and the interest rate is justified on the grounds that the stock of money is determined essentially by demand factors. In many low-income developing countries, however, money markets are not well developed; in others, especially in Asia and Latin America, while financial markets have developed and broadened in recent years, supply-side factors remain important in determining the stock of money. The approach adopted here, therefore, is to explicitly take account of the supply-side factors in determining the money stock. This is also necessary in order to capture the effect of fiscal imbalances on monetary growth. Given the supply of money, domestic prices are then determined by the demand for real money.

Two main sources of money supply are domestic credit expansion and changes in official foreign exchange reserves. While reserves are determined primarily by the balance of payments (discussed below), domestic credit is essentially determined by government policy. Credit to the public sector, in particular, depends largely on the magnitude of fiscal deficits, reflecting government expenditure and tax policies. In view of these considerations, the following equation was estimated for the stock of money:

$$\Delta M/NGDP = F[GB/NGDP, \Delta R \cdot e/NGDP, (\Delta M/NGDP)_{-1}], \qquad (5)$$

where $\Delta M$ is the change in the nominal stock of broad money, *NGDP* is nominal GDP, *GB* is the nominal government balance and is used as a measure of credit extended to the public sector, $\Delta R$ is the change in the nominal stock of foreign exchange reserves, and *e* is the nominal exchange rate; dividing by nominal GDP scales the variables appropriately. The estimated coefficients are presented in Table 5. The coefficient on the government balance indicates that a 1 percent increase in deficit for net debtor countries leads to an increase in broad money of 0.58 percent in the short run and 0.78 in

**Table 5. Average Estimated Coefficients for Broad Money[1]**

| | Government Balance | Change in Reserves | Lagged Money |
|---|---|---|---|
| Net debtor countries | −0.58 | 0.08 | 0.26 |
| By region | | | |
| Africa | −0.50 | 0.07 | 0.28 |
| Asia | −0.64 | 0.10 | 0.24 |
| Europe and non-oil Middle East | −0.63 | 0.08 | 0.29 |
| Western Hemisphere | −0.50 | 0.05 | 0.29 |
| By predominant export | | | |
| Primary products | −0.52 | 0.09 | 0.29 |
| Manufactures | −0.64 | 0.09 | 0.25 |
| Services and remittances | −0.56 | 0.08 | 0.20 |
| Diversified | −0.50 | 0.06 | 0.29 |
| Net creditor countries | −0.55 | 0.09 | 0.30 |

[1]Estimation is undertaken for individual countries using annual data for the period 1973–91. The coefficients are averaged using as weights the share of each country's purchasing power parity (PPP) valuation of GDP in the regional or group GDP.

the long run.[13] As expected, the change in foreign reserves has a small positive effect.

The price equation is derived as an inverted demand-for-money function, with an error-correction specification, in the following manner:

$$\Delta\log PGDP = F\,[\Delta\log(M),\ \Delta\log(GDP),\ \text{error-correction term}], \qquad (6)$$

where the error-correction term is equal to $[\log(PGDP_{-1}) - \log(M_{-1}) + \log(GDP_{-1})]$. This is under the assumption that long-run elasticities with respect to money and GDP are equal to 1 and −1, respectively, consistent with the assumption of a constant long-run velocity of money.[14] Based on preliminary estimates and an examination of simulation properties of the model, the error-correction coefficient was set equal to −0.70 for all countries, implying a relatively fast adjustment of prices to changes in the stock of money.[15]

This specification of the price equation captures the inflationary dynamics associated with government policy as discussed earlier; in particular, policy affects prices through monetary growth resulting from the monetization of budget deficits. The estimated parameters for the price equation are shown in Table 6. These short-run elasticities with respect to money and GDP are markedly lower than the long-run elasticities of 1 and −1, respectively. For net debtor countries as a whole, a 1 percent increase in money supply leads to a 0.21 percent increase in prices in the short run. This effect is similar across different regions except for the Western Hemisphere where it is larger, reflecting in part the higher variability of inflation.

With regard to the determination of the exchange rate, the modeling difficulties are well-known. In the case of many developing countries, the modeling problem is aggravated by the fact that the nominal rate is often kept fixed for long periods of time at a level that may not be justified by fundamentals. In view of this, one option would be to assume that

**Table 6. Average Estimated Coefficients for GDP Deflator[1]**

| | Real GDP | Broad Money |
|---|---|---|
| Net debtor Countries | −0.08 | 0.21 |
| By region | | |
| Africa | −0.16 | 0.20 |
| Asia | −0.01 | 0.19 |
| Europe and non-oil Middle East | −0.11 | 0.20 |
| Western Hemisphere | −0.18 | 0.28 |
| By predominant export | | |
| Primary products | −0.14 | 0.20 |
| Manufactures | −0.05 | 0.23 |
| Services and remittances | −0.03 | 0.20 |
| Diversified | −0.15 | 0.19 |
| Net creditor countries | −0.13 | 0.17 |

[1]Estimation is undertaken for individual countries using annual data for the period 1973–91. The coefficients are averaged using as weights the share of each country's purchasing power parity (PPP) valuation of GDP in the regional or group GDP.

[13]The long-run elasticity is obtained by dividing the short-run elasticity by 1 minus the coefficient on lagged money.

[14]This specification does not include interest rates, due to lack of consistent time series and given that, in the past, for many developing countries they were fixed for relatively lengthy periods of time.

[15]Lower values of the error-correction coefficient, by reducing the speed of adjustment of prices to money, caused convergence problems and gave implausible simulation results, in particular, in the case of high inflation countries.

for the duration of any simulation exercise the exchange rate is exogenous. This would, however, be inappropriate when a simulation entails a significantly different inflationary path compared to the baseline. To overcome this problem, it is assumed that purchasing power parity holds in the long run, although in the short run significant deviations from it may occur. Thus, the following error-correction formulation is adopted for estimating the change in the nominal exchange rate:

$$\Delta\log(e) = \alpha\Delta\log(PGDP/PDGP^*) - \delta[\log(e_{-1}) - \log(PGDP_{-1}/PGDP^*_{-1}], \quad (7)$$

where $e$ is the nominal exchange rate and $PGDP^*$ is foreign prices (defined as the GDP deflator for industrial countries in U.S. dollars). Estimating this equation for high-inflation countries, or for countries where the exchange rate is fixed with occasional realignments, was particularly problematic, and the parameter estimates varied considerably across countries. This resulted from the high variability in the response of the exchange rate to prices in different time periods across different countries. To avoid convergence problems, and to ensure that model properties conform to prior expectations, we set the short-run coefficient, $\alpha$, equal to 0.50, and the error-correction coefficient, $\delta$, equal to 0.20 for all countries. These values imply that the nominal exchange rate adjusts to a price shock by 50 percent after one year and by nearly 80 percent after five years.

## External Sector

The current and the capital accounts of the balance of payments are modeled separately. The current account balance is disaggregated into exports and imports of goods and nonfactor services, net transfer receipts, and net investment income flows. For the capital account, separate equations are specified for non-debt-creating capital flows, net external borrowing, and the accumulation of international reserves.

### Exports of Goods and Nonfactor Services

Exports are disaggregated into non-oil, oil, and nonfactor services. The specification for net debtors assumes that non-oil exports are determined by both supply and demand factors. Demand is assumed to depend on export prices relative to world prices and world income, while supply depends on export prices relative to the domestic price of nontradables and the capital stock in the tradable sector:

$$\text{Non-oil export demand} = F(\text{Export price/world export price, world income}); \quad (8)$$

$$\text{Non-oil export supply} = F(\text{Export price/domestic price of nontradables, capital stock}). \quad (9)$$

From these structural equations, the reduced form equations for non-oil export volume and prices are derived. In the case of net creditor oil exporters, which have only negligible non-oil exports, both non-oil exports and their prices are treated as exogenous.

The estimation results are reported in Tables 7 and 8. These indicate that for net debtors, the elasticity of non-oil export volume with respect to world income is, on average, above unity, underlining the high sensitivity of non-oil exports to external demand. The elasticity has the lowest value in the case of Africa, and the highest for Europe and the non-oil Middle East. When China and India, where the adoption of export oriented policies is relatively recent, are excluded, the average income elasticity in Asia increases to 2.47 and for exporters of manufactures, to 2.21. Thus, in general, exporters of manufactures have a much higher foreign income elasticity than primary products exporters. The elasticity of export volumes with respect to relative prices is also broadly as expected with the elasticity for the exporters of manufactures markedly higher than that for primary product exporters. Capital stock influences non-oil export volumes for most groups, with the highest impact on exporters of manufacturers.

The estimation results for the price equation are similar to those in Adams and Adams (1989). They indicate that capital stock and foreign demand have a small impact on export prices in all regions. The elasticity with respect to relative prices, however, is not significantly different from unity in most regions, indicating that changes in world prices are largely transmitted into export prices.

The volume of oil exports by net debtors as a whole is assumed to be exogenous and is allocated across individual countries according to historical shares:

$$\text{Oil export volume (net debtors)} = F(\text{Total oil exports of net debtor countries}). \quad (10)$$

Oil exports by net creditor oil exporters, on the other hand, are assumed to be determined by oil prices relative to world prices (industrial countries) world GDP, and a time trend (which captures the long-run tendency for both a decline in energy

**Table 7. Average Estimated Coefficients for Non-Oil Export Volumes[1]**

| | Real Capital Stock | Relative Price | World Income |
|---|---|---|---|
| Net debtor countries | 0.38 | −0.34 | 1.24 |
| By region | | | |
| Africa | 0.06 | −0.31 | 0.83 |
| Asia | 0.48 | −0.43 | 1.28 |
| Europe and non-oil Middle East | 0.08 | −0.32 | 2.36 |
| Western Hemisphere | 0.40 | −0.17 | 1.10 |
| By predominant export | | | |
| Primary products | 0.31 | −0.17 | 1.28 |
| Manufactures | 0.46 | −0.42 | 1.17 |
| Services and remittances | 0.32 | −0.27 | 0.95 |
| Diversified | 0.18 | −0.21 | 1.31 |

[1]Estimation is undertaken for individual countries using annual data for the period 1973–91. The coefficients are averaged using as weights the share of each country's purchasing power parity (PPP) valuation of GDP in the regional or group GDP.

**Table 8. Average Estimated Coefficients for Non-Oil Export Price[1]**

| | World Income | Relative Price | Real Capital Stock |
|---|---|---|---|
| Net debtor countries | 0.05 | 0.84 | −0.03 |
| By region | | | |
| Africa | 0.01 | 0.66 | −0.02 |
| Asia | 0.06 | 0.80 | −0.03 |
| Europe and non-oil Middle East | 0.03 | 0.91 | −0.02 |
| Western Hemisphere | 0.04 | 0.97 | −0.05 |
| By commodity | | | |
| Primary products | 0.03 | 0.90 | −0.04 |
| Manufactures | 0.05 | 0.88 | −0.03 |
| Services and remittances | 0.04 | 0.81 | −0.02 |
| Diversified | 0.04 | 0.66 | −0.05 |

[1]Estimation is undertaken for individual countries using annual data for the period 1973–91. The coefficients are averaged using as weights the share of each country's purchasing power parity (PPP) valuation of GDP in the regional or group GDP.

intensity of production and a substitution away from oil). To allow for dynamic adjustment over time, the lagged value of oil exports is also included:

$$\text{Oil export volume (net creditors)} = F(\text{Lagged oil export volume, oil prices/world prices, industrial country GDP, time trend}). \quad (11)$$

Oil export equations for the oil exporting countries are estimated by imposing cross-country equality restrictions on the parameters (except for the intercepts). This gives more reliable estimates than using data on individual countries, given the homogeneity of oil and similarity between net creditor oil exporters. The parameter estimates, presented in Table 9, all have the expected signs and magnitudes, and suggest that holding world income and prices constant, exports of oil exporters fall, on average, by 2 percent a year.[16]

**Table 9. Panel Data Parameter Estimates for Oil Export Volumes: Oil Exporting Net Creditors[1]**

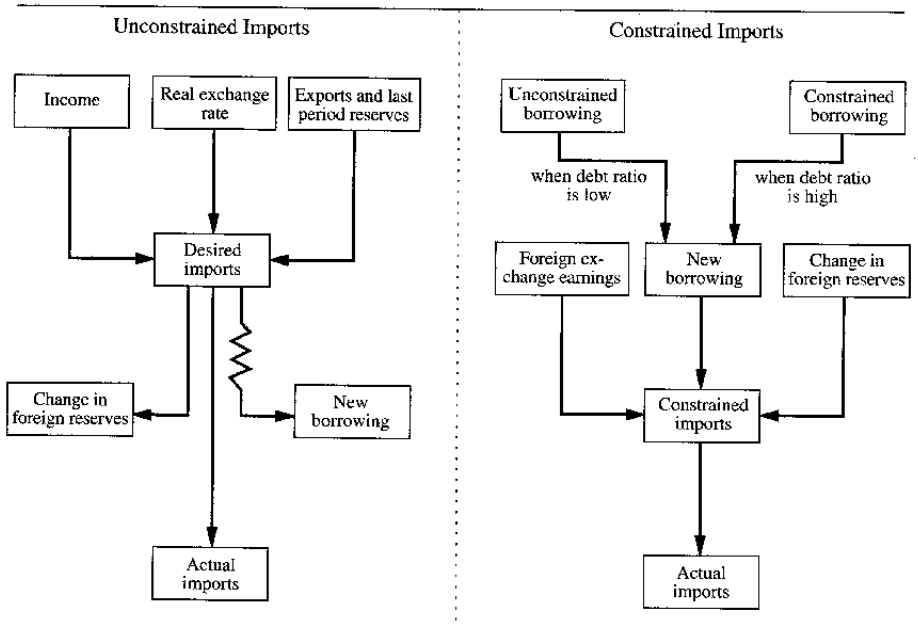
| | |
|---|---|
| Lagged oil exports | 0.82 |
| Relative price | −0.18 |
| Real GDP in industrial countries | 0.63 |
| Trend | −0.02 |

[1]Estimation is undertaken using a panel of cross-section time series data (for the seven oil exporting countries for the period 1973–91).

World oil prices are assumed to be determined exogenously and the dollar export price of oil in

[16]This trend decline counters the otherwise high long-run elasticity of oil export volume with respect to world income.

**Chart 2. Determination of Imports**




each individual net debtor or net creditor country is assumed to follow the world oil price:

$$\text{Oil export price} = F(\text{World oil price}). \quad (12)$$

Exports of nonfactor services comprise receipts from tourism, banking, and other services. For net debtor countries, these exports, in current dollar terms, are assumed to depend on the level of dollar GDP in industrial countries:

$$\text{Exports of nonfactor services} = F(\text{Industrial country current dollar GDP}). \quad (13)$$

In the case of oil exporting net creditors, these exports are relatively small and thus are treated exogenously.

### Imports of Goods and Nonfactor Services

A key feature of the existing model system is the assumption that imports are determined residually by the foreign exchange available in each country. Foreign exchange, in turn, is a function of export earnings, transfer receipts, and net capital flows. The assumption reflects the constraint on a majority of developing countries in the 1980s that resulted primarily from the external debt crisis, and the virtual cessation of new commercial bank lending. This feature of the model is modified in the new version to allow flexibility in financing imports which lets domestic factors play a role.

It is assumed that for each of the net debtor countries, total imports switch between being fully constrained by external financing and being determined by a mixture of domestic and external factors, depending on the size of a country's foreign exchange reserves. Chart 2 illustrates the regime switch and the various factors affecting the determination of imports. When reserves are sufficiently high, the left panel is the relevant one and actual imports are determined by desired imports. When reserves are low, the right panel is the relevant one and imports are constrained. Imports may be further limited in this case when external borrowing is also constrained. These different regimes and constraints are amplified in the equations below.

If the reserves-to-import ratio is low, then imports are constrained by the amount of foreign exchange available:[17]

$$\begin{aligned}\text{Constrained imports} = {} & \text{Total export receipts} \\ & + \text{Net transfer receipts} \\ & + \text{Net investment income receipts} \\ & + \text{Net capital inflows} \\ & - \text{Accumulation of international reserves.}\end{aligned} \quad (14)$$

[17]Reserves are considered low when the average reserves-to-import ratio for the previous three years is below 0.25, or if the

**Table 10. Average Estimated Coefficients for Unconstrained Merchandise Imports[1]**

| | Expenditure on Home Goods | Real Export Earnings | Relative Prices | Reserve-to-Import Ratio |
|---|---|---|---|---|
| Net debtor countries | 0.74 | 0.36 | −0.37 | 0.28 |
| By region | | | | |
| Africa | 0.55 | 0.25 | −0.38 | 0.47 |
| Asia | 0.77 | 0.41 | −0.30 | 0.27 |
| Europe and non-oil Middle East | 0.74 | 0.34 | −0.31 | 0.18 |
| Western Hemisphere | 0.77 | 0.32 | −0.50 | 0.26 |
| By predominant export | | | | |
| Primary products | 0.69 | 0.32 | −0.32 | 0.36 |
| Manufactures | 0.78 | 0.37 | −0.32 | 0.28 |
| Services and remittances | 0.67 | 0.36 | −0.33 | 0.18 |
| Diversified | 0.54 | 0.36 | −0.28 | 0.45 |

[1]Estimation is undertaken for individual countries using annual data for the period 1973–91. The coefficients are averaged using as weights the share of each country's purchasing power parity (PPP) valuation of GDP in the regional or group GDP.

In this case, international reserves are exogenous and assumed not to change relative to the baseline. One of the key items in net capital inflows is new borrowing, which could be constrained depending on the debt/GDP ratio. Therefore, two types of potential constraints, in effect, operate on imports; one results from the availability of reserves and the other from the access to new borrowing from the international capital markets.

In contrast, when the reserves-to-import ratio is sufficiently high, imports are determined by the following behavioral equation:

Unconstrained imports = $F$(Import prices/domestic prices, expenditure on home goods, lagged reserves to import ratio, real export earnings (including factor incomes and transfers)), (15)

where export earnings are included so that external factors are to some extent taken into account, even when the country is not considered to be externally constrained. The presence of the lagged reserves-to-import ratio also generates a response of imports to the change in external environment in the medium term.[18] The results of estimating this unconstrained equation over the historical period are reported in Table 10, and indicate an average elasticity of expenditure on home goods of 0.74 and an average relative price elasticity of −0.37. Both real export earnings and external reserves also have positive effects on imports.

Given total imports, division of imports between oil and non-oil imports for the simulation period is determined by their relative shares computed from historical data.

Non-oil and oil import prices are determined as follows:

Non-oil import price = $F$(World price of manufactures, world price of non-oil primary commodities); (16)

Oil import price = $F$(World oil prices). (17)

When imports are unconstrained, international reserves are residually determined:

Accumulation of international reserves (when imports are unconstrained) = Total exports − total imports + Net transfer receipts + Net investment income receipts + Net capital inflows.[19] (18)

Imports of net creditors in the short run are assumed not to be externally constrained and are determined primarily by domestic factors, while foreign reserves adjust residually.[20] Foreign

current stock of reserves would become negative if the desired imports, given by equation (14) below, were to be realized.

[18]For a comparable specification see Khan and Knight (1988).

[19]Note that this is also the equation for reserves in the case of net creditors, for whom imports are assumed not to be externally constrained.

[20]See Samiei (1989) for a discussion of external constraints in the determination of imports in different developing country regions.

**Table 11. Panel-Data Parameter Estimates for Non-Oil Import Volumes: Oil Exporting Net Creditors[1]**

| | |
|---|---|
| Lagged non-oil imports | 0.37 |
| Relative price | −0.06 |
| Real private absorption | 0.07 |
| Real government spending | 0.33 |
| Reserve-to-import ratio | 0.06 |

[1]Estimation is undertaken using a panel of cross-sectional time-series data (for the seven oil exporting countries for the period 1973–91).

reserves, however, continue to play a role in the determination of imports in the medium term. These assumptions are reflected in the following specification:

Net creditor non-oil import volume = $F$(Non-oil import prices/price of non-tradables, income, lagged reserves-to-imports ratio, lagged non-oil imports).[21] (19)

As in the case of oil exports, slope coefficients were restricted to be equal across all net creditor oil exporting countries. Moreover, the effect of private and government income is separated to allow different absorption elasticities, which could result from the fact that the government is a major importer, and oil revenue is largely taxed (and spent) by it.[22] The estimation results indicate a small price elasticity, a small but positive response to foreign exchange reserves, and a significantly larger absorption elasticity for the government than for the private sector (Table 11).

### Transfers and Net Investment Income

The equations for private and official transfers are as follows:

Private transfers = $F$(Export earnings of Middle East oil exporters, European GNP/GDP).[23] (20)

Official transfers = $F$(Official development assistance). (21)

Equation (20) reflects the fact that a bulk of private transfers in the Asian and African countries have been remittances mainly from the industrial countries in Europe and the high income oil exporters in the Middle East.

Investment income credits are specified to depend on a country's stock of foreign assets and their rate of return, which is proxied by the London interbank offered rate (LIBOR) on six-month dollar deposits. Two categories of investment income debits are considered: direct investment debits, which are modeled as a function of GNP, and other debits, which comprise interest payments on external debt and are modeled as a function of debt-service payments:

Total investment income credits = $F$(LIBOR*international reserves). (22)

Direct investment income debits = $F$(Domestic GNP in dollars). (23)

Other investment income debits = $F$(Debt-service payments). (24)

### Capital Account

The capital account is disaggregated into three components: non-debt-creating capital flows, net external borrowing (defined as new borrowing less amortization), and the accumulation of international reserves. The determination of reserves was noted above, and the other equations, discussed below, are essentially unchanged from the existing version of LDCMOD.

Non-debt-creating capital flows comprise mainly direct foreign investment and portfolio equity flows, but also include new allocation of SDRs, valuation adjustments, and a balancing item necessary to reconcile the discrepancies between the current and capital account of the balance of payments. While in theory there are a large number of factors that affect these flows, in practice, domestic economic performance proxied by the change in domestic GDP appears to be a key determining variable. Thus, the following specification is used:

Non-debt-creating capital flows = $F$(Change in domestic GDP). (25)

New external borrowing is assumed to depend on

[21]The price of nontraded goods is constructed according to the following definition: (nominal GDP − nominal value of exports)/volume of nontradables. This measure was only used in the case of net creditors where GDP deflator (which incorporates movements in oil prices) was deemed inappropriate as a measure of domestic prices.

[22]See, for example, Aghevli and Sassanpour (1991) for a discussion of this issue in the case of the Islamic Republic of Iran.

[23]Note that export earnings of the Middle East oil exporters are not included in the case of net creditor oil exporters.

whether or not a country has access to the international financial markets. If the debt-to-GDP ratio is high (the average of the past three years is above 2), then borrowing is assumed to be constrained and is determined by

Constrained
borrowing = Average amount of dollar financing received over the period 1988–92.[24] (26)

If, on the other hand, external debt is not too large (debt-to-GDP ratio below 2) the following specification is used:

Unconstrained
borrowing = $F$(Real LIBOR, terms of trade changes, domestic GNP, lagged new borrowing). (27)

Amortization payments are assumed to be related to external debt, lagged one year:

Amortization due = $F$(Debt stock at the end of previous year). (28)

Total stock of external debt is then determined by net external borrowing and last period's stock of debt adjusted for valuation effects:

$$\text{Debt} = (1+u)^*(1-v)^*\text{last period's debt} + \text{net external borrowing} + \text{debt-reduction operations}, \quad (29)$$

where $u$ is the proportional change in the dollar multilateral exchange rate (MERM) between $t$-1 and $t$, and $v$ is the share of debt in non-dollar currencies. Debt-reduction operations are treated as exogenous.

Finally, interest payments on outstanding external debt are modeled as a function of current and past LIBOR in order to allow differential interest rates on borrowings of different vintages:

$$\text{Interest payments due} = F(\Sigma\, a_i\, \text{LIBOR}_{t-i}\, \text{debt}_{t-i}), \quad (30)$$

where the $a_i$ are weights that sum to unity.

## Simulation Experiments

The results of four simulation exercises are reported here to illustrate how the new model system may be used to assess the effects of changes in domestic policies and in the external environment. Two of the simulations examine the implications of an increase in government expenditure and excessive monetary expansion. Two other simulations consider the impact on developing countries of a fall in world oil prices and higher growth in industrial countries.

### Increase in Government Expenditure

In this scenario, government capital expenditure in nominal terms is assumed to rise 20 percent above the baseline for the period 1993 to 1998. In the initial year, reflecting this stimulus, real output rises by ¾ of 1 percent above the baseline in the net debtor countries, and by 2 percent in the net creditor countries (Table 12). The increase in capital expenditure also raises potential output and augments the capital stock, which in turn increases export capacity. This short-run beneficial impact on output is smallest in the Western Hemisphere and largest in Africa, reflecting, in part, the differing share of government expenditure in GDP. By 1995, the gain in output is virtually eliminated in all regions, reflecting the adverse effects both on private absorption and exports of higher inflation stemming from faster money growth and the increased burden of government deficit as expenditure adjusts faster than revenue to higher prices. Across regions, this is most notable in the Western Hemisphere and in Africa, where there are a number of large high inflation countries; the Asian and the Middle Eastern and European regions experience a lower increase in prices, reflecting the high weight of countries with low inflation. By 1998, net debtor countries' real GDP falls by ½ of 1 percent below the baseline, as domestic prices and the exchange rate adjust further to higher fiscal deficits.

For net creditors, the output increase, as in the case of the net debtors, has a declining trend. However, the short-run positive impact is larger owing to the higher stimulus reflecting the higher share of government expenditure in GDP. The positive effect, furthermore, lasts longer since exports do not decline (oil prices are exogenously determined) and since imports are not constrained.

### Expansion in the Money Supply

A rise in the money supply has a short-run positive effect on the private sector's real wealth before it is transmitted into higher prices. This positive effect increases private absorption temporarily, leading to higher activity and GDP. In the medium term, however, through the rise in prices, there are negative effects on aggregate demand, similar to those described in the case of fiscal expansion. The effects are manifested in a loss of competitiveness

[24]In Adams and Adams (1989), the period is 1982–88.

**Table 12. Medium-Term Implications of Simulations: Twenty Percent Increase in Government Expenditure**

*(Difference from the reference scenario in percent)*

| | 1993 | 1995 | 1998 |
|---|---|---|---|
| **Net debtor countries** | | | |
| Real GDP | 0.7 | −0.2 | −0.4 |
| GDP deflator | 0.2 | 2.0 | 6.3 |
| Broad money | 1.1 | 3.8 | 8.0 |
| Fiscal balance[1] | −0.8 | −0.8 | −0.7 |
| Export volume | 0.1 | −0.0 | −0.3 |
| Import volume | 0.5 | 0.1 | −0.0 |
| Current account balance[2] | −0.6 | −0.1 | −0.1 |
| Reserve import ratio | −0.8 | −0.3 | −0.5 |
| Debt ratio[2] | −0.1 | −0.2 | −0.4 |
| Debt-service ratio[2] | −0.0 | −0.0 | −0.0 |
| **By region** | | | |
| Africa | | | |
| Real GDP | 1.4 | 0.2 | −0.1 |
| GDP deflator | 0.1 | 2.9 | 8.6 |
| Broad money | 1.9 | 6.1 | 11.2 |
| Fiscal balance[1] | −1.0 | −1.0 | −0.8 |
| Export volume | 0.0 | −0.1 | −0.3 |
| Import volume | 0.2 | 0.1 | 0.3 |
| Current account balance[2] | −0.2 | −0.0 | −0.1 |
| Reserve import ratio | −0.4 | −0.5 | −1.2 |
| Debt ratio[2] | −0.0 | −0.3 | −0.9 |
| Debt-service ratio[2] | −0.0 | −0.0 | −0.1 |
| Asia | | | |
| Real GDP | 0.8 | −0.3 | −0.5 |
| GDP deflator | 0.2 | 1.8 | 5.4 |
| Broad money | 1.0 | 3.1 | 5.7 |
| Fiscal balance[1] | −0.9 | −0.9 | −0.7 |
| Export volume | 0.1 | −0.1 | −0.4 |
| Import volume | 0.7 | −0.0 | −0.2 |
| Current account balance[2] | −0.7 | 0.1 | 0.3 |
| Reserve import ratio | −0.9 | −0.1 | 0.5 |
| Debt ratio[2] | −0.1 | −0.2 | −0.5 |
| Debt-service ratio[2] | −0.0 | −0.0 | −0.1 |
| Europe and non-oil Middle East | | | |
| Real GDP | 1.1 | 0.3 | 0.2 |
| GDP deflator | 0.1 | 1.5 | 4.6 |
| Broad money | 1.4 | 3.7 | 6.9 |
| Fiscal balance[1] | −1.0 | −1.0 | −0.9 |
| Export volume | 0.1 | 0.0 | −0.1 |
| Import volume | 0.8 | 0.4 | 0.2 |
| Current account balance[2] | −0.6 | −0.7 | −0.4 |
| Reserve import ratio | −0.9 | −1.3 | −2.8 |
| Debt ratio[2] | −0.1 | −0.1 | 0.0 |
| Debt-service ratio[2] | −0.0 | −0.0 | 0.0 |
| Western Hemisphere | | | |
| Real GDP | 0.3 | −0.3 | −0.2 |
| GDP deflator | 0.1 | 2.1 | 7.9 |
| Broad money | 1.1 | 4.5 | 12.8 |
| Fiscal balance[1] | −0.5 | −0.5 | −0.5 |
| Export volume | 0.0 | 0.0 | −0.1 |
| Import volume | 0.3 | 0.1 | 0.4 |
| Current account balance[2] | −0.3 | −0.3 | −0.9 |
| Reserve import ratio | −0.6 | −0.5 | −2.2 |
| Debt ratio[2] | −0.1 | −0.0 | 0.2 |
| Debt-service ratio[2] | −0.0 | −0.0 | 0.0 |

| | 1993 | 1995 | 1998 |
|---|---|---|---|
| **By financial criteria** | | | |
| Countries with recent debt-servicing difficulties | | | |
| Real GDP | 0.5 | −0.1 | −0.2 |
| GDP deflator | 0.1 | 2.3 | 7.9 |
| Broad money | 1.2 | 4.8 | 12.1 |
| Fiscal balance[1] | −0.6 | −0.6 | −0.6 |
| Export volume | 0.0 | −0.0 | −0.1 |
| Import volume | 0.4 | 0.2 | 0.3 |
| Current account balance[2] | −0.4 | −0.3 | −0.7 |
| Reserve import ratio | −0.6 | −0.6 | −2.1 |
| Debt ratio[2] | −0.1 | −0.1 | −0.0 |
| Debt-service ratio[2] | −0.0 | −0.0 | −0.0 |
| Countries without recent debt-servicing difficulties | | | |
| Real GDP | 0.8 | −0.3 | −0.5 |
| GDP deflator | 0.2 | 1.9 | 5.5 |
| Broad money | 1.1 | 3.3 | 6.0 |
| Fiscal balance[1] | −1.0 | −0.9 | −0.7 |
| Export volume | 0.1 | −0.1 | −0.4 |
| Import volume | 0.6 | 0.0 | −0.1 |
| Current account balance[2] | −0.7 | 0.0 | 0.2 |
| Reserve import ratio | −0.8 | −0.1 | 0.3 |
| Debt ratio[2] | −0.1 | −0.2 | −0.4 |
| Debt-service ratio[2] | −0.0 | −0.0 | −0.1 |
| **By predominant export** | | | |
| Primary products exporters | | | |
| Real GDP | 0.6 | −0.4 | −0.4 |
| GDP deflator | 0.3 | 3.8 | 12.9 |
| Broad money | 1.7 | 6.4 | 15.8 |
| Fiscal balance[1] | −0.7 | −0.7 | −0.5 |
| Export volume | 0.1 | −0.0 | −0.2 |
| Import volume | 0.3 | 0.1 | 0.2 |
| Current account balance[2] | −0.3 | −0.2 | −0.8 |
| Reserve import ratio | −0.4 | −0.2 | −1.8 |
| Debt ratio[2] | −0.2 | −0.3 | 0.0 |
| Debt-service ratio[2] | −0.0 | −0.0 | 0.0 |
| Exporters of manufactures | | | |
| Real GDP | 0.6 | −0.3 | −0.5 |
| GDP deflator | 0.1 | 1.2 | 4.0 |
| Broad money | 0.8 | 2.5 | 5.3 |
| Fiscal balance[1] | −0.7 | −0.7 | −0.6 |
| Export volume | 0.1 | −0.0 | −0.4 |
| Import volume | 0.4 | −0.1 | −0.2 |
| Current account balance[2] | −0.4 | 0.1 | 0.2 |
| Reserve import ratio | −0.8 | −0.1 | 0.1 |
| Debt ratio[2] | −0.1 | −0.2 | −0.2 |
| Debt-service ratio[2] | −0.0 | −0.0 | −0.0 |
| Service and remittance countries | | | |
| Real GDP | 1.1 | −0.2 | 0.2 |
| GDP deflator | 0.4 | 3.8 | 9.9 |
| Broad money | 2.1 | 6.5 | 14.2 |
| Fiscal balance[1] | −1.5 | −1.4 | −1.3 |
| Export volume | 0.1 | −0.0 | −0.2 |
| Import volume | 1.1 | 0.3 | 0.1 |
| Current account balance[2] | −0.7 | −0.3 | −0.4 |
| Reserve import ratio | −0.9 | −0.8 | −1.2 |
| Debt ratio[2] | −0.3 | −0.3 | −0.3 |
| Debt-service ratio[2] | −0.0 | −0.0 | −0.0 |

**Table 12 (*concluded*)**

*(Difference from the reference scenario in percent)*

| | 1993 | 1995 | 1998 | | 1993 | 1995 | 1998 |
|---|---|---|---|---|---|---|---|
| **By predominant export** | | | | Small low-income countries | | | |
| Diversified exporters | | | | Real GDP | 1.6 | −0.5 | −0.4 |
| Real GDP | 1.2 | 0.0 | −0.3 | GDP deflator | 0.4 | 5.5 | 14.1 |
| GDP deflator | 0.1 | 2.2 | 7.2 | Broad money | 3.0 | 9.2 | 17.4 |
| Broad money | 1.3 | 4.1 | 8.1 | Fiscal balance[1] | −1.6 | −1.4 | −1.1 |
| Fiscal balance[1] | −1.2 | −1.2 | −1.1 | Export volume | 0.2 | −0.1 | −0.3 |
| Export volume | 0.0 | −0.1 | −0.3 | Import volume | 0.6 | 0.2 | 0.1 |
| Import volume | 0.9 | 0.2 | −0.2 | Current account balance[2] | −0.7 | −0.0 | 0.4 |
| Current account balance[2] | −1.2 | −0.6 | 0.1 | Reserve import ratio | −0.7 | 0.0 | 0.2 |
| Reserve import ratio | −0.9 | −0.8 | −0.6 | Debt ratio[2] | −0.8 | −1.6 | −1.5 |
| Debt ratio[2] | 0.0 | −0.0 | −0.5 | Debt-service ratio[2] | −0.1 | −0.1 | −0.1 |
| Debt-service ratio[2] | 0.0 | 0.0 | −0.0 | | | | |
| **By miscellaneous criteria** | | | | **Net creditor countries** | | | |
| Fifteen heavily indebted countries | | | | Real GDP | 2.1 | 1.3 | 1.0 |
| Real GDP | 0.4 | −0.2 | −0.2 | GDP deflator | 0.1 | 1.9 | 7.9 |
| GDP deflator | 0.1 | 2.1 | 7.8 | Broad money | 1.9 | 6.4 | 14.1 |
| Broad money | 1.1 | 4.6 | 12.3 | Fiscal balance[1] | −2.0 | −2.1 | −1.7 |
| Fiscal balance[1] | −0.5 | −0.5 | −0.6 | Export volume | 0.1 | 0.3 | 0.5 |
| Export volume | 0.0 | 0.0 | −0.1 | Import volume | 1.4 | 1.6 | 0.6 |
| Import volume | 0.3 | 0.2 | 0.3 | Current account balance[2] | −1.7 | −1.8 | −1.0 |
| Current account balance[2] | −0.3 | −0.3 | −0.9 | Reserve import ratio | −2.6 | −7.6 | −12.1 |
| Reserve import ratio | −0.6 | −0.6 | −2.3 | Debt ratio [2] | −0.1 | −0.1 | −0.2 |
| Debt ratio[2] | −0.1 | −0.0 | 0.2 | Debt-service ratio[2] | −0.0 | −0.0 | −0.0 |
| Debt-service ratio[2] | −0.0 | −0.0 | 0.0 | | | | |

[1]Ratio to nominal GDP.

[2]Ratios to exports of goods and services.

which leads to a fall in exports, and a decline in private absorption due to the fall in the terms of trade, real income, and wealth. Over time, the effect on GDP diminishes as prices and the exchange rate adjust to the increase in money supply.

The simulated effects of an increase of 10 percent in the stock of money are reported in Table 13. It can be seen that for net debtors as a whole there is a short-run positive effect on GDP of 1¾ percent above the baseline after the first year, but by 1998, the effect is reversed to ½ of 1 percent below the baseline. The GDP deflator rises by about the same amount as monetary expansion by the end of the period. In some regions, depending on the speed of adjustment of prices to money and the nominal exchange rate to prices, small cyclical movements are also observed. In the case of net creditors, the effect on prices is similar to that for net debtors; however, the effect on output is relatively muted in the initial year and is virtually negligible subsequently.

### A Fall in the Nominal Price of Oil

This scenario considers the effect of a fall in the nominal price of oil, below the baseline, sustained over the period 1993–98. Interest in such a scenario stems from the possibility of excess supply developing in the world oil market over the medium term.[25] Countries that are dependent on oil imports and are finance-constrained would benefit from a fall in oil prices as this allows a rise in non-oil imports and a higher level of activity; even countries that are not finance-constrained would benefit from a terms of trade gain. Oil exporting countries, on the other hand, will have lower oil revenue (as long as the price elasticity of world demand for oil is less than unity), lower income and lower imports. However, since the volume of oil exports will rise, the effect on GDP (which by definition does not take account of movements in the terms of trade) would depend on the relative size of the fall in domestic activity and the rise in export volumes. Among oil exporters, the effect of a fall in oil prices is likely to be most noticeable in the case of net creditor oil exporters where oil constitutes a large proportion of GDP.

The simulation results indicate that a 10 percent fall in oil prices has a rather small effect on net debtor countries as a whole (Table 14). Some variation, however, is observed across different regions depending on the presence of major oil exporters. In Africa, for example, primarily because of Nigeria, there is a small negative effect on GDP. In

[25]See, for example, Box 5 in the *World Economic Outlook*, May 1992 (Washington: International Monetary Fund, May 1992), for an examination of the likely developments in the world oil market in the medium term.

## Table 13. Medium-Term Implications of Simulations: Ten Percent Increase in Broad Money

*(Difference from the reference scenario in percent)*

| | 1993 | 1995 | 1998 |
|---|---|---|---|
| **Net debtor countries** | | | |
| Real GDP | 1.7 | 0.3 | −0.4 |
| GDP deflator | 1.5 | 7.6 | 9.9 |
| Broad money | 10.0 | 10.0 | 10.0 |
| Fiscal balance[1] | 0.0 | −0.2 | −0.0 |
| Export volume | −0.1 | −0.7 | −0.7 |
| Import volume | 1.2 | −0.1 | −0.4 |
| Current account balance[2] | −1.3 | −0.2 | 0.2 |
| Reserve import ratio | −2.1 | −2.2 | −1.6 |
| Debt ratio[2] | −0.1 | −0.4 | −0.3 |
| Debt-service ratio[2] | −0.0 | −0.0 | −0.1 |
| **By region** | | | |
| Africa | | | |
| Real GDP | 2.2 | −0.2 | −1.3 |
| GDP deflator | 1.4 | 8.0 | 10.4 |
| Broad money | 10.0 | 10.0 | 10.0 |
| Fiscal balance[1] | 0.1 | −0.3 | −0.1 |
| Export volume | −0.1 | −0.4 | −0.3 |
| Import volume | −0.0 | 0.7 | 0.8 |
| Current account balance[2] | −0.0 | 0.0 | −0.0 |
| Reserve import ratio | −0.6 | −1.3 | −1.5 |
| Debt ratio[2] | −0.3 | −1.9 | −1.8 |
| Debt-service ratio[2] | −0.0 | −0.2 | −0.2 |
| Asia | | | |
| Real GDP | 2.3 | 0.7 | −0.5 |
| GDP deflator | 1.7 | 7.9 | 10.8 |
| Broad money | 10.0 | 10.0 | 10.0 |
| Fiscal balance[1] | 0.0 | −0.1 | 0.1 |
| Export volume | −0.2 | −1.0 | −1.0 |
| Import volume | 1.7 | −0.4 | −0.6 |
| Current account balance[2] | −1.9 | 0.2 | 0.5 |
| Reserve import ratio | −3.0 | −2.4 | −1.0 |
| Debt ratio[2] | −0.1 | −0.6 | −0.4 |
| Debt-service ratio[2] | −0.0 | −0.1 | −0.1 |
| Europe and non-oil Middle East | | | |
| Real GDP | 0.3 | −0.4 | 0.1 |
| GDP deflator | 1.5 | 7.7 | 8.2 |
| Broad money | 10.0 | 10.0 | 10.0 |
| Fiscal balance[1] | −0.1 | −0.4 | −0.2 |
| Export volume | −0.1 | −0.7 | −0.5 |
| Import volume | 0.2 | −0.2 | −0.6 |
| Current account balance[2] | −0.3 | −0.5 | −0.1 |
| Reserve import ratio | −0.3 | −0.9 | −2.1 |
| Debt ratio[2] | 0.2 | 0.9 | 0.6 |
| Debt-service ratio[2] | 0.0 | 0.1 | 0.1 |
| Western Hemisphere | | | |
| Real GDP | 0.6 | −0.2 | −0.0 |
| GDP deflator | 1.3 | 6.5 | 7.9 |
| Broad money | 10.0 | 10.0 | 10.0 |
| Fiscal balance[1] | −0.0 | −0.2 | −0.2 |
| Export volume | −0.0 | −0.2 | −0.2 |
| Import volume | 1.0 | 0.4 | −0.4 |
| Current account balance[2] | −1.2 | −1.0 | −0.2 |
| Reserve import ratio | −1.2 | −2.3 | −2.9 |
| Debt ratio[2] | 0.1 | 0.3 | 0.2 |
| Debt-service ratio[2] | 0.0 | 0.1 | 0.0 |

| | 1993 | 1995 | 1998 |
|---|---|---|---|
| **By financial criteria** | | | |
| Countries with recent debt-servicing difficulties | | | |
| Real GDP | 1.3 | −0.2 | −0.5 |
| GDP deflator | 1.3 | 6.9 | 8.8 |
| Broad money | 10.0 | 10.0 | 10.0 |
| Fiscal balance[1] | −0.0 | −0.3 | −0.3 |
| Export volume | −0.1 | −0.3 | −0.2 |
| Import volume | 0.6 | 0.5 | 0.0 |
| Current account balance[2] | −0.8 | −0.7 | −0.1 |
| Reserve import ratio | −1.0 | −2.1 | −2.6 |
| Debt ratio[2] | −0.0 | −0.3 | −0.4 |
| Debt-service ratio[2] | −0.0 | −0.0 | −0.0 |
| Countries without recent debt-servicing difficulties | | | |
| Real GDP | 2.0 | 0.6 | −0.4 |
| GDP deflator | 1.7 | 7.9 | 10.5 |
| Broad money | 10.0 | 10.0 | 10.0 |
| Fiscal balance[1] | 0.0 | −0.1 | 0.1 |
| Export volume | −0.2 | −1.0 | −0.9 |
| Import volume | 1.4 | −0.4 | −0.6 |
| Current account balance[2] | −1.6 | 0.1 | 0.4 |
| Reserve import ratio | −2.8 | −2.3 | −1.1 |
| Debt ratio[2] | −0.1 | −0.5 | −0.3 |
| Debt-service ratio[2] | −0.0 | −0.1 | −0.1 |
| **By predominant export** | | | |
| Primary products exporters | | | |
| Real GDP | 1.3 | −0.1 | −0.6 |
| GDP deflator | 1.6 | 8.9 | 10.6 |
| Broad money | 10.0 | 10.0 | 10.0 |
| Fiscal balance[1] | −0.0 | −0.2 | −0.3 |
| Export volume | −0.1 | −0.4 | −0.3 |
| Import volume | 1.0 | 0.3 | −0.3 |
| Current account balance[2] | −1.2 | −0.8 | −0.1 |
| Reserve import ratio | −1.3 | −2.2 | −2.2 |
| Debt ratio[2] | −0.0 | 0.1 | 0.1 |
| Debt-service ratio[2] | −0.0 | 0.0 | 0.0 |
| Exporters of manufactures | | | |
| Real GDP | 1.9 | 0.7 | −0.4 |
| GDP deflator | 1.6 | 6.8 | 9.6 |
| Broad money | 10.0 | 10.0 | 10.0 |
| Fiscal balance[1] | 0.0 | −0.0 | 0.2 |
| Export volume | −0.2 | −1.0 | −1.0 |
| Import volume | 1.6 | −0.5 | −0.9 |
| Current account balance[2] | −1.9 | −0.2 | 0.3 |
| Reserve import ratio | −2.9 | −2.5 | −1.4 |
| Debt ratio[2] | −0.0 | −0.0 | 0.0 |
| Debt-service ratio[2] | 0.0 | 0.0 | −0.0 |
| Service and remittance countries | | | |
| Real GDP | 0.6 | 0.2 | 0.2 |
| GDP deflator | 1.7 | 8.8 | 8.8 |
| Broad money | 10.0 | 10.0 | 10.0 |
| Fiscal balance[1] | −0.1 | −0.5 | −0.5 |
| Export volume | −0.1 | −0.6 | −0.3 |
| Import volume | 0.3 | −0.1 | 0.0 |
| Current account balance[2] | −0.5 | −0.2 | −0.3 |
| Reserve import ratio | −0.4 | −0.5 | −0.8 |
| Debt ratio[2] | 0.1 | 0.5 | 0.3 |
| Debt-service ratio[2] | 0.0 | 0.0 | 0.0 |

**Table 13 (*concluded*)**

*(Difference from the reference scenario in percent)*

| | 1993 | 1995 | 1998 | | 1993 | 1995 | 1998 |
|---|---|---|---|---|---|---|---|
| **By predominant export** | | | | | | | |
| Diversified exporters | | | | Small low-income countries | | | |
| Real GDP | 3.5 | −0.4 | −1.9 | Real GDP | 1.9 | 0.7 | −0.4 |
| GDP deflator | 1.1 | 8.3 | 12.3 | GDP deflator | 1.5 | 8.1 | 9.4 |
| Broad money | 10.0 | 10.0 | 10.0 | Broad money | 10.0 | 10.0 | 10.0 |
| Fiscal balance[1] | 0.0 | −0.4 | −0.3 | Fiscal balance[1] | −0.0 | −0.4 | −0.5 |
| Export volume | −0.1 | −0.7 | −0.6 | Export volume | −0.1 | −0.7 | −0.3 |
| Import volume | 0.2 | −0.2 | 0.5 | Import volume | 0.8 | −0.0 | −0.3 |
| Current account balance[2] | −0.3 | 1.2 | 0.7 | Current account balance[2] | −1.1 | −0.2 | 0.3 |
| Reserve import ratio | −1.2 | −1.0 | 0.2 | Reserve import ratio | −1.5 | −1.6 | −0.9 |
| Debt ratio[2] | −0.2 | −1.8 | −1.3 | Debt ratio[2] | −0.0 | 0.2 | −0.1 |
| Debt-service ratio[2] | −0.0 | −0.2 | −0.2 | Debt-service ratio[2] | −0.0 | 0.0 | −0.0 |
| **By miscellaneous criteria** | | | | **Net creditor countries** | | | |
| Fifteen heavily indebted countries | | | | Real GDP | 0.6 | 0.0 | 0.1 |
| Real GDP | 0.9 | −0.2 | −0.1 | GDP deflator | 1.4 | 7.2 | 9.2 |
| GDP deflator | 1.3 | 6.6 | 8.1 | Broad money | 10.0 | 10.0 | 10.0 |
| Broad money | 10.0 | 10.0 | 10.0 | Fiscal balance[1] | −0.1 | −0.4 | −0.3 |
| Fiscal balance[1] | −0.0 | −0.2 | −0.3 | Export volume | −0.0 | −0.1 | −0.1 |
| Export volume | −0.0 | −0.2 | −0.2 | Import volume | 0.1 | −0.1 | 0.0 |
| Import volume | 0.8 | 0.4 | −0.4 | Current account balance[2] | −0.2 | −0.3 | −0.3 |
| Current account balance[2] | −1.1 | −1.0 | −0.1 | Reserve import ratio | −0.3 | −1.2 | −2.0 |
| Reserve import ratio | −1.2 | −2.5 | −3.0 | Debt ratio[2] | −0.0 | −0.0 | −0.1 |
| Debt ratio[2] | 0.1 | 0.3 | 0.2 | Debt-service ratio[2] | 0.0 | 0.0 | −0.0 |
| Debt-service ratio[2] | 0.0 | 0.0 | 0.0 | | | | |

[1]Ratio to nominal GDP.
[2]Ratios to exports of goods and services.

the Western Hemisphere, on the other hand, by 1998, the combined positive effects on large oil importers, such as Brazil, offset the negative effects on countries like Venezuela and Mexico. As expected, the effects of an oil price fall is most significant in the case of net creditor oil exporters.[26] To highlight the differential impact on income and GDP in this case, the simulated effects on both of these variables are reported. Real GDP falls below the baseline initially but rises above the baseline as export volumes increase. Income, on the other hand, has a more substantial initial fall and remains below the baseline throughout the period. The current account worsens, and the reserves-to-import ratio falls significantly.

## Faster Industrial Country Growth

In this simulation, GDP growth in the industrial world is assumed to increase by 1 percentage point a year over the period 1993–98. As in Adams and Adams (1989), the rise in industrial country activity leads to higher real exports, imports, and growth in the developing countries (Table 15). Exports rise by 10 percent above the baseline by 1998, contributing to an increase of GDP of 2 percent for the net debtor countries. All regions show a significant increase in real GDP by 1998. Asia, and the Middle East and Europe, post the most noticeable increases in export volume, reflecting the relatively high elasticities of their exports to increases in economic activity. These economies also enjoy a higher increase in real output, reflecting the relatively large share of exports in GDP. Africa shows a more modest increase in output reflecting the importance of fuel and primary product exports, which as noted earlier, are in general relatively less sensitive to changes in economic activity than exports of manufactures. For net creditors, the rise in GDP is higher than that of net debtor countries and reaches 8¾ percent above the baseline by 1988. This is primarily due to the impact of higher foreign demand on exports from Taiwan Province of China.

[26]Table 14 presents only the results for oil exporting net creditors rather than all net creditors.

## Table 14. Medium-Term Implications of Simulations: Ten Percent Fall in Oil Prices

*(Difference from the reference scenario in percent)*

| | 1993 | 1995 | 1998 |
|---|---|---|---|
| **Net debtor countries** | | | |
| Real GDP | −0.1 | −0.1 | 0.0 |
| GDP deflator | 0.0 | 0.1 | 0.2 |
| Broad money | 0.0 | 0.1 | 0.5 |
| Fiscal balance[1] | −0.0 | −0.0 | −0.1 |
| Export volume | 0.5 | 0.4 | 0.3 |
| Import volume | 0.2 | 0.2 | −0.0 |
| Current account balance[2] | −0.2 | −0.2 | 0.2 |
| Reserve import ratio | −0.2 | −0.9 | −0.7 |
| Debt ratio[2] | 1.1 | 0.5 | −0.1 |
| Debt-service ratio[2] | 0.2 | 0.1 | 0.1 |
| **By region** | | | |
| Africa | | | |
| Real GDP | −0.2 | −0.3 | −0.1 |
| GDP deflator | 0.1 | 0.2 | 0.9 |
| Broad money | −0.0 | 0.2 | 1.1 |
| Fiscal balance[1] | −0.1 | −0.1 | −0.1 |
| Export volume | 0.7 | 0.7 | 0.7 |
| Import volume | −0.7 | −0.6 | −1.1 |
| Current account balance[2] | −0.8 | −0.7 | −0.3 |
| Reserve import ratio | −0.9 | −1.5 | −2.1 |
| Debt ratio[2] | 3.7 | 4.1 | 4.8 |
| Debt-service ratio[2] | 0.6 | 0.4 | 1.1 |
| Asia | | | |
| Real GDP | 0.1 | 0.1 | 0.0 |
| GDP deflator | −0.0 | −0.1 | −0.0 |
| Broad money | 0.0 | 0.0 | 0.0 |
| Fiscal balance[1] | −0.0 | −0.0 | −0.0 |
| Export volume | 0.3 | 0.2 | 0.1 |
| Import volume | 0.4 | 0.5 | 0.6 |
| Current account balance[2] | 0.2 | 0.2 | 0.2 |
| Reserve import ratio | −0.1 | −0.3 | −0.3 |
| Debt ratio[2] | 0.0 | −0.2 | −0.2 |
| Debt-service ratio[2] | 0.0 | −0.0 | −0.1 |
| Europe and Middle East | | | |
| Real GDP | −0.4 | −0.2 | −0.3 |
| GDP deflator | 0.0 | 0.3 | 0.5 |
| Broad money | −0.1 | 0.1 | 0.4 |
| Fiscal balance[1] | −0.0 | −0.1 | −0.1 |
| Export volume | 0.2 | 0.2 | 0.2 |
| Import volume | 0.6 | 0.3 | 0.5 |
| Current account balance[2] | 0.1 | 0.4 | 0.4 |
| Reserve import ratio | −0.1 | 0.4 | 1.2 |
| Debt ratio[2] | 0.4 | 0.4 | 0.3 |
| Debt-service ratio[2] | 0.0 | 0.0 | 0.0 |
| Western Hemisphere | | | |
| Real GDP | −0.5 | −0.4 | 0.2 |
| GDP deflator | 0.1 | 0.5 | 0.6 |
| Broad money | 0.0 | 0.2 | 1.3 |
| Fiscal balance[1] | −0.0 | −0.1 | −0.1 |
| Export volume | 0.9 | 0.7 | 0.6 |
| Import volume | −0.0 | −0.4 | −1.6 |
| Current account balance[2] | −1.1 | −1.2 | 0.4 |
| Reserve import ratio | 0.1 | −2.4 | −1.8 |
| Debt ratio[2] | 3.7 | 1.9 | −1.0 |
| Debt-service ratio[2] | 0.5 | 0.5 | 0.1 |
| **By financial criteria** | | | |
| Countries with recent debt-servicing difficulties | | | |
| Real GDP | −0.5 | −0.4 | 0.0 |
| GDP deflator | 0.1 | 0.4 | 0.7 |
| Broad money | 0.0 | 0.2 | 1.2 |
| Fiscal balance[1] | −0.1 | −0.1 | −0.1 |
| Export volume | 0.8 | 0.7 | 0.6 |
| Import volume | −0.0 | −0.5 | −1.1 |
| Current account balance[2] | −1.0 | −0.8 | 0.1 |
| Reserve import ratio | −0.3 | −2.2 | −2.1 |
| Debt ratio[2] | 3.3 | 2.1 | −0.2 |
| Debt-service ratio[2] | 0.4 | 0.4 | 0.1 |
| Countries without recent debt-servicing difficulties | | | |
| Real GDP | 0.1 | 0.1 | 0.0 |
| GDP deflator | 0.0 | −0.1 | 0.0 |
| Broad money | 0.0 | 0.0 | 0.1 |
| Fiscal balance[1] | −0.0 | −0.0 | −0.0 |
| Export volume | 0.3 | 0.3 | 0.2 |
| Import volume | 0.3 | 0.5 | 0.4 |
| Current account balance[2] | 0.2 | 0.1 | 0.2 |
| Reserve import ratio | −0.1 | −0.2 | −0.1 |
| Debt ratio[2] | 0.3 | 0.1 | 0.2 |
| Debt-service ratio[2] | 0.1 | −0.0 | 0.1 |
| **By predominant export** | | | |
| Primary products exporters | | | |
| Real GDP | −0.0 | 0.1 | 0.0 |
| GDP deflator | 0.0 | 0.0 | 0.3 |
| Broad money | 0.0 | 0.1 | 0.5 |
| Fiscal balance[1] | −0.0 | −0.0 | −0.0 |
| Export volume | 0.2 | 0.2 | 0.2 |
| Import volume | 0.3 | 0.4 | 0.3 |
| Current account balance[2] | −0.0 | −0.0 | −0.1 |
| Reserve import ratio | 0.1 | −0.1 | −0.4 |
| Debt ratio[2] | 0.8 | 0.6 | 0.5 |
| Debt-service ratio[2] | 0.1 | 0.1 | 0.1 |
| Exporters of manufactures | | | |
| Real GDP | 0.1 | 0.1 | −0.0 |
| GDP deflator | 0.0 | −0.1 | 0.0 |
| Broad money | 0.0 | 0.0 | 0.1 |
| Fiscal balance[1] | −0.0 | −0.0 | −0.0 |
| Export volume | 0.1 | 0.1 | 0.0 |
| Import volume | 0.5 | 0.6 | 0.8 |
| Current account balance[2] | 0.4 | 0.4 | 0.2 |
| Reserve import ratio | 0.2 | 0.2 | 0.4 |
| Debt ratio[2] | −0.1 | −0.3 | −0.3 |
| Debt-service ratio[2] | 0.0 | −0.1 | −0.1 |
| Service and remittance countries | | | |
| Real GDP | −0.3 | −0.2 | −0.1 |
| GDP deflator | 0.0 | 0.3 | 0.3 |
| Broad money | −0.0 | 0.1 | 0.2 |
| Fiscal balance[1] | −0.0 | −0.1 | −0.1 |
| Export volume | 0.5 | 0.5 | 0.4 |
| Import volume | 0.6 | 0.4 | 0.2 |
| Current account balance[2] | −0.2 | −0.2 | −0.1 |
| Reserve import ratio | −0.1 | −0.4 | −0.6 |
| Debt ratio[2] | 0.8 | 0.8 | 0.6 |
| Debt-service ratio[2] | 0.1 | 0.1 | 0.0 |

**Table 14 (*concluded*)**

*(Difference from the reference scenario in percent)*

| | 1993 | 1995 | 1998 | | 1993 | 1995 | 1998 |
|---|---|---|---|---|---|---|---|
| **By predominant export** | | | | | | | |
| Diversified exporters | | | | Small low-income countries | | | |
| Real GDP | 0.0 | 0.0 | −0.1 | Real GDP | 0.1 | 0.1 | 0.0 |
| GDP deflator | −0.0 | 0.0 | 0.2 | GDP deflator | −0.0 | −0.0 | 0.1 |
| Broad money | 0.0 | 0.1 | 0.2 | Broad money | 0.0 | 0.1 | 0.2 |
| Fiscal balance[1] | −0.0 | −0.0 | −0.0 | Fiscal balance[1] | −0.0 | −0.0 | −0.0 |
| Export volume | 0.2 | 0.1 | 0.1 | Export volume | 0.1 | 0.1 | 0.1 |
| Import volume | 0.1 | 0.2 | 0.3 | Import volume | 0.6 | 0.7 | 0.7 |
| Current account balance[2] | 0.5 | 0.4 | 0.4 | Current account balance[2] | 0.2 | 0.1 | 0.1 |
| Reserve import ratio | 0.3 | 0.8 | 1.2 | Reserve import ratio | 0.2 | 0.4 | 0.6 |
| Debt ratio[2] | 0.0 | −0.1 | −0.2 | Debt ratio[2] | 0.3 | 0.3 | 0.2 |
| Debt-service ratio[2] | 0.0 | −0.0 | −0.0 | Debt-service ratio[2] | 0.0 | 0.0 | 0.0 |
| **By miscellaneous criteria** | | | | **Oil exporting net creditor countries** | | | |
| Fifteen heavily indebted countries | | | | Real GDP | −0.6 | 1.0 | 2.2 |
| Real GDP | −0.5 | −0.4 | 0.1 | Real income | −3.7 | −2.6 | −1.7 |
| GDP deflator | 0.1 | 0.5 | 0.7 | GDP deflator | 0.1 | 0.9 | 1.4 |
| Broad money | −0.0 | 0.2 | 1.3 | Broad money | 0.5 | 1.9 | 4.3 |
| Fiscal balance[1] | −0.1 | −0.1 | −0.1 | Fiscal balance[1] | −0.8 | −0.6 | −0.4 |
| Export volume | 1.0 | 0.8 | 0.7 | Export volume | 1.7 | 4.0 | 5.8 |
| Import volume | −0.2 | −0.9 | −1.5 | Import volume | −0.7 | −1.5 | −2.4 |
| Current account balance[2] | −1.4 | −1.1 | 0.0 | Current account balance[2] | −7.0 | −4.8 | −3.7 |
| Reserve import ratio | −0.3 | −2.7 | −2.6 | Reserve import ratio | −4.6 | −13.3 | −21.5 |
| Debt ratio[2] | 4.5 | 2.8 | −0.1 | Debt ratio[2] | 5.6 | 3.9 | 2.6 |
| Debt-service ratio[2] | 0.6 | 0.6 | 0.2 | Debt-service ratio[2] | 0.6 | 0.7 | 0.4 |

[1]Ratio to nominal GDP.
[2]Ratios to exports of goods and services.

**Table 15. Medium-Term Implications of Simulations: One Percentage Point a Year Increase in Foreign Demand Growth**

*(Difference from the reference scenario in percent)*

| | 1993 | 1995 | 1998 | | 1993 | 1995 | 1998 |
|---|---|---|---|---|---|---|---|
| **Net debtor countries** | | | | **By predominant export** | | | |
| Real GDP | 0.3 | 0.9 | 1.9 | Primary products exporters | | | |
| GDP deflator | −0.0 | −0.4 | −1.6 | Real GDP | 0.3 | 0.7 | 1.3 |
| Broad money | 0.0 | −0.1 | −0.8 | GDP deflator | −0.0 | −0.6 | −1.9 |
| Fiscal balance[1] | 0.0 | 0.1 | 0.3 | Broad money | 0.0 | −0.2 | −1.3 |
| Export volume | 1.3 | 4.2 | 10.1 | Fiscal balance[1] | 0.1 | 0.1 | 0.3 |
| Import volume | 0.8 | 2.7 | 6.9 | Export volume | 1.2 | 3.5 | 7.6 |
| Current account balance[2] | 0.8 | 2.3 | 4.5 | Import volume | 0.8 | 1.8 | 3.9 |
| Reserve import ratio | 0.4 | 2.1 | 7.1 | Current account balance[2] | 0.9 | 2.4 | 4.7 |
| Debt ratio[2] | −2.4 | −6.0 | −10.8 | Reserve import ratio | 0.5 | 2.2 | 6.7 |
| Debt-service ratio[2] | −0.3 | −0.8 | −1.6 | Debt ratio[2] | −3.4 | −7.9 | −14.8 |
| | | | | Debt-service ratio[2] | −0.4 | −0.9 | −1.7 |
| **By region** | | | | | | | |
| Africa | | | | Exporters of manufactures | | | |
| Real GDP | 0.2 | 0.5 | 0.9 | Real GDP | 0.3 | 0.7 | 1.2 |
| GDP deflator | −0.0 | −0.4 | −1.6 | GDP deflator | −0.0 | −0.3 | −1.1 |
| Broad money | −0.0 | −0.4 | −1.4 | Broad money | 0.0 | −0.1 | −0.7 |
| Fiscal balance[1] | 0.0 | 0.1 | 0.3 | Fiscal balance[1] | 0.0 | 0.1 | 0.2 |
| Export volume | 0.6 | 1.9 | 4.2 | Export volume | 1.6 | 5.1 | 11.9 |
| Import volume | 0.6 | 2.0 | 3.8 | Import volume | 1.1 | 3.2 | 8.4 |
| Current account balance[2] | 0.2 | 0.7 | 1.7 | Current account balance[2] | 0.8 | 2.3 | 4.4 |
| Reserve import ratio | 0.2 | 0.5 | 1.2 | Reserve import ratio | 0.4 | 1.6 | 4.8 |
| Debt ratio[2] | −1.5 | −4.5 | −8.9 | Debt ratio[2] | −2.2 | −5.2 | −9.1 |
| Debt-service ratio[2] | −0.3 | −0.6 | −1.1 | Debt-service ratio[2] | −0.3 | −0.8 | −1.3 |

**Table 15 (*concluded*)**

*(Difference from the reference scenario in percent)*

| | 1993 | 1995 | 1998 |
|---|---|---|---|
| **By region (continued)** | | | |
| Asia | | | |
| Real GDP | 0.3 | 1.0 | 2.3 |
| GDP deflator | 0.0 | −0.5 | −1.9 |
| Broad money | 0.0 | −0.0 | −0.5 |
| Fiscal balance[1] | 0.0 | 0.1 | 0.4 |
| Export volume | 1.5 | 5.1 | 12.4 |
| Import volume | 0.9 | 3.2 | 8.2 |
| Current account balance[2] | 0.9 | 2.3 | 4.7 |
| Reserve import ratio | 0.4 | 2.1 | 7.3 |
| Debt ratio[2] | −1.8 | −4.7 | −8.3 |
| Debt-service ratio[2] | −0.2 | −0.6 | −1.1 |
| Europe and non-oil Middle East | | | |
| Real GDP | 0.2 | 2.1 | 4.4 |
| GDP deflator | −0.0 | −0.5 | −2.0 |
| Broad money | −0.0 | 0.3 | 1.0 |
| Fiscal balance[1] | 0.1 | 0.2 | 0.6 |
| Export volume | 2.4 | 7.0 | 16.7 |
| Import volume | 1.7 | 3.0 | 9.4 |
| Current account balance[2] | 0.7 | 4.5 | 9.0 |
| Reserve import ratio | −0.1 | 3.8 | 19.0 |
| Debt ratio[2] | −4.7 | −11.5 | −21.5 |
| Debt-service ratio[2] | −0.5 | −1.3 | −2.6 |
| Western Hemisphere | | | |
| Real GDP | 0.3 | 0.5 | 0.8 |
| GDP deflator | −0.0 | −0.2 | −1.1 |
| Broad money | 0.1 | −0.1 | −1.7 |
| Fiscal balance[1] | 0.0 | 0.1 | 0.2 |
| Export volume | 0.8 | 2.5 | 5.4 |
| Import volume | 0.4 | 1.4 | 3.0 |
| Current account balance[2] | 1.0 | 1.8 | 2.9 |
| Reserve import ratio | 0.8 | 2.6 | 6.3 |
| Debt ratio[2] | −2.8 | −5.4 | −8.7 |
| Debt-service ratio[2] | −0.4 | −0.8 | −1.4 |
| **By financial criteria** | | | |
| Countries with recent debt-servicing difficulties | | | |
| Real GDP | 0.3 | 0.5 | 0.9 |
| GDP deflator | −0.0 | −0.3 | −1.3 |
| Broad money | 0.0 | −0.2 | −1.6 |
| Fiscal balance[1] | 0.0 | 0.1 | 0.3 |
| Export volume | 0.8 | 2.4 | 5.3 |
| Import volume | 0.5 | 1.6 | 3.6 |
| Current account balance[2] | 0.7 | 1.8 | 3.1 |
| Reserve import ratio | 0.6 | 2.1 | 5.8 |
| Debt ratio[2] | −2.3 | −5.7 | −9.9 |
| Debt-service ratio[2] | −0.3 | −0.8 | −1.5 |
| Countries without recent debt-servicing difficulties | | | |
| Real GDP | 0.3 | 1.0 | 2.3 |
| GDP deflator | 0.0 | −0.5 | −1.8 |
| Broad money | 0.0 | −0.0 | −0.4 |
| Fiscal balance[1] | 0.0 | 0.1 | 0.4 |
| Export volume | 1.5 | 5.1 | 12.4 |
| Import volume | 1.0 | 3.2 | 8.3 |
| Current account balance[2] | 0.9 | 2.5 | 5.0 |
| Reserve import ratio | 0.4 | 2.2 | 7.8 |
| Debt ratio[2] | −2.1 | −5.2 | −9.2 |
| Debt-service ratio[2] | −0.3 | −0.7 | −1.3 |
| Service and remittance countries | | | |
| Real GDP | 0.1 | 0.3 | 0.4 |
| GDP deflator | 0.0 | −0.2 | −0.9 |
| Broad money | −0.0 | −0.1 | −1.1 |
| Fiscal balance[1] | 0.0 | 0.1 | 0.3 |
| Export volume | 1.2 | 4.0 | 8.9 |
| Import volume | 0.8 | 3.1 | 7.8 |
| Current account balance[2] | 0.6 | 1.9 | 3.4 |
| Reserve import ratio | 0.2 | 1.2 | 3.9 |
| Debt ratio[2] | −2.8 | −8.6 | −15.3 |
| Debt-service ratio[2] | −0.2 | −0.7 | −1.3 |
| Diversified exporters | | | |
| Real GDP | 0.2 | 1.2 | 2.6 |
| GDP deflator | −0.0 | −0.6 | −2.4 |
| Broad money | 0.0 | −0.1 | −0.8 |
| Fiscal balance[1] | 0.0 | 0.2 | 0.5 |
| Export volume | 0.8 | 3.1 | 6.7 |
| Import volume | 0.6 | 2.4 | 5.4 |
| Current account balance[2] | 0.2 | 1.2 | 2.1 |
| Reserve import ratio | 0.1 | 1.1 | 3.7 |
| Debt ratio[2] | −0.8 | −3.3 | −5.9 |
| Debt-service ratio[2] | −0.1 | −0.4 | −0.6 |
| **By miscellaneous criteria** | | | |
| Fifteen heavily indebted countries | | | |
| Real GDP | 0.3 | 0.5 | 0.9 |
| GDP deflator | −0.0 | −0.3 | −1.1 |
| Broad money | 0.1 | −0.1 | −1.5 |
| Fiscal balance[1] | 0.0 | 0.1 | 0.2 |
| Export volume | 0.7 | 2.2 | 4.9 |
| Import volume | 0.3 | 1.1 | 2.5 |
| Current account balance[2] | 0.9 | 1.9 | 3.1 |
| Reserve import ratio | 0.7 | 2.4 | 6.1 |
| Debt ratio[2] | −2.5 | −5.5 | −9.2 |
| Debt-service ratio[2] | −0.4 | −0.8 | −1.5 |
| Small low-income countries | | | |
| Real GDP | 0.2 | 0.1 | 0.1 |
| GDP deflator | −0.0 | −0.4 | −1.4 |
| Broad money | −0.1 | −0.6 | −2.1 |
| Fiscal balance[1] | 0.1 | 0.1 | 0.3 |
| Export volume | 1.0 | 3.1 | 6.7 |
| Import volume | 0.9 | 2.4 | 4.7 |
| Current account balance[2] | 0.7 | 0.8 | 1.6 |
| Reserve import ratio | 0.2 | 0.5 | 0.9 |
| Debt ratio [2] | −4.1 | −7.7 | −13.9 |
| Debt-service ratio[2] | −0.3 | −0.6 | −1.0 |
| **Net creditor countries** | | | |
| Real GDP | 0.9 | 3.5 | 8.8 |
| GDP deflator | −0.1 | −1.4 | −5.9 |
| Broad money | 0.1 | 0.2 | −0.7 |
| Fiscal balance[1] | 0.1 | 0.5 | 1.3 |
| Export volume | 1.5 | 5.8 | 14.6 |
| Import volume | 0.6 | 2.8 | 8.1 |
| Current account balance[2] | 1.0 | 3.4 | 8.1 |
| Reserve import ratio | 0.2 | 2.8 | 14.2 |
| Debt ratio[2] | −0.6 | −1.7 | −3.7 |
| Debt-service ratio[2] | −0.1 | −0.4 | −0.5 |

[1]Ratio to nominal GDP.

[2]Ratios to exports of goods and services.

# Appendix I

# Countries and Regions in the Developing Country Model

## Net Debtor Countries (87 countries)

### By Region

*Africa* (38 countries)

Algeria, Benin, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo, Côte d'Ivoire, Ethiopia, Gabon, Ghana, Guinea, Guinea-Bissau, Kenya, Liberia, Madagascar, Malawi, Mauritania, Mauritius, Morocco, Mozambique, Niger, Nigeria, Senegal, Sierra Leone, Somalia, South Africa, Sudan, Tanzania, Togo, Tunisia, Uganda, Zaïre, Zambia, Zimbabwe

*Asia* (19 countries)

Afghanistan, Bangladesh, Bhutan, China, Fiji, India, Indonesia, Korea, Lao People's Democratic Republic, Malaysia, Nepal, Pakistan, Papua New Guinea, Philippines, Singapore, Solomon Islands, Sri Lanka, Thailand, Western Samoa

*Europe and Non-Oil Middle East* (8 countries)

Cyprus, Egypt, Israel, Jordan, Malta, Syrian Arab Republic, Turkey, Republic of Yemen

*Western Hemisphere* (22 countries)

Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominica, Dominican Republic, Ecuador, El Salvador, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Paraguay, Peru, Suriname, Uruguay, Venezuela

### By Financial Criteria

*Countries with Debt-Servicing Difficulties* (57 countries)

Defined as those countries that incurred external payments arrears or entered into official or commercial bank debt-rescheduling agreements during 1986–90. Information on these developments is taken from relevant issues of the IMF's *Annual Report on Exchange Arrangements and Exchange Restrictions*.

*Countries Without Debt-Servicing Difficulties* (30 countries)

All other net debtor countries not classified as "Countries with debt-servicing difficulties."

### By Predominant Export

*Exporters of Primary Products* (41 countries)

Afghanistan, Argentina, Bhutan, Bolivia, Burundi, Central African Republic, Chad, Chile, Colombia, Comoros, Costa Rica, Côte d'Ivoire, Dominica, El Salvador, Ghana, Guatemala, Guinea, Guinea-Bissau, Guyana, Honduras, Kenya, Lao People's Democratic Republic, Liberia, Madagascar, Malawi, Mauritania, Mauritius, Niger, Papua New Guinea, Paraguay, Peru, Solomon Islands, Somalia, Sri Lanka, Sudan, Suriname, Togo, Uganda, Uruguay, Zaïre, Zambia

*Exporters of Manufactures* (9 countries)

Brazil, China, India, Israel, Korea, Singapore, Thailand, Tunisia, Turkey

*Services and Private Transfers* (17 countries)

Burkina Faso, Cape Verde, Cyprus, Dominican Republic, Egypt, Ethiopia, Fiji, Grenada, Jamaica, Jordan, Malta, Mozambique, Nepal, Pakistan, Tanzania, Western Samoa, Republic of Yemen

*Diversified Export Base* (11 countries)

Bangladesh, Benin, Haiti, Malaysia, Morocco, Philippines, Senegal, Sierra Leone, South Africa, Syrian Arab Republic, Zimbabwe

### By Miscellaneous Criteria

*Fifteen Heavily Indebted Countries* (excluding the former Socialist Federal Republic of Yugoslavia)

Argentina, Bolivia, Brazil, Chile, Colombia, Côte d'Ivoire, Ecuador, Mexico, Morocco, Nigeria, Peru, Philippines, Uruguay, Venezuela

*Small Low-Income Economies* (34 countries)

Afghanistan, Bangladesh, Benin, Bhutan, Burkina Faso, Burundi, Central African Republic, Chad, Comoros, Ethiopia, Ghana, Guinea, Guinea-Bissau, Guyana, Haiti, Kenya, Lao People's Democratic Republic, Madagascar, Malawi, Mauritania, Mozambique, Nepal, Niger, Pakistan, Senegal, Sierra Leone, Somalia, Sri Lanka, Sudan, Tanzania, Togo, Uganda, Zaïre, Zambia.

## Net Creditors (8)

Islamic Republic of Iran, Kuwait, Libya, Oman, Qatar, Saudi Arabia, Taiwan Province of China, United Arab Emirates

# Appendix II

# Developing Country Model

This appendix presents the structure of the developing country model grouped in the following manner: aggregate demand, the government sector, money, prices and exchange rates, exports of goods and services, imports of goods and services, transfers and net investment income, the capital account, and alternative specifications for net creditors. Regression coefficients are referred to by the letter "*B*" followed by a number. Mnemonics in lowercase refer to model variables, while those in upper case refer to fixed values such as historical shares or values of a variable in a particular year. Model equations are reported using AREMOS software notation: "log" is the natural logarithm, "dlog" is the change in the natural logarithm from the previous year, "pch" denotes the percentage change from the previous year, "diff" denotes the difference from the previous period, "*" denotes multiplication, "**" denotes exponentiation. Lags are indicated by the suffix ".1," where the number "1" indicates that the period for which the variable is lagged. The Boolean operator $(x==a)$ takes the value one if $x = a$ and zero otherwise. $(x>a)$ and $(x<a)$ are similarly defined. Following the list of equations is a list of the endogenous and exogenous variables, as well as the fixed values and shares.

## I. Aggregate Demand

Real private absorption

$$\begin{aligned}\log(nap\_r) = {} & B1 * \log\{(ngdpd + bxsi \\ & - bmsdi - bmsndi + btrp) \\ & /[(1 - SM) * (pgdpd/PGDPD85) \\ & + SM * tmpd]\} \\ & + B2 * \log(txpd/pgdpd) \\ & + B3 * \log(fmb/pgdp) \\ & + B4 * [0.5 * \log(gcenl/pgdp) \\ & + 0.5 * \log(gcenl.1/pgdp.1)] \\ & + B5 * [con\_lend/d - \mathrm{dlog}(pgdpd)] \\ & + B6 \end{aligned} \quad \text{(A1)}$$

Real consumption spending

$$rc = Q\_WT * nap\_r + gcec/pgdp \quad \text{(A2)}$$

Real investment spending

$$ri = (1 - Q\_WT) * nap\_r + gcek/pgdp \quad \text{(A3)}$$

Total real absorption

$$ra = ri + rc \quad \text{(A4)}$$

Total real GDP

$$ngdp\_r = ra + rxgnfs - rmgnfs \quad \text{(A5)}$$

Total capital stock

$$rk = ri + .95 * rk.1 \quad \text{(A6)}$$

Capital stock in tradables

$$rkt = KT\_W * rk \quad \text{(A7)}$$

Capital stock in nontradables

$$rkn = (1 - KT\_W) * rk \quad \text{(A8)}$$

Nominal GDP in local currency

$$ngdp = ngdp\_r * pgdp \quad \text{(A9)}$$

Nominal GDP in U.S. dollars

$$ngdpd = ngdp/ed \quad \text{(A10)}$$

Real GDP in tradables

$$rgdpt = rxgnfs \quad \text{(A11)}$$

Real GDP in nontradables

$$rgdpn = ra - rmgnfs \quad \text{(A12)}$$

Total real GNP

$$\begin{aligned} rgnp = {} & (ngdpd + bxsi - bmsdi \\ & - bmsndi) * ed/pgdp \end{aligned} \quad \text{(A13)}$$

## II. Government Sector

Current expenditure

$$\begin{aligned}\mathrm{dlog}(gcec) = {} & B1 * \mathrm{dlog}(ngdp\_r) \\ & + B2 * \mathrm{dlog}(pgdp) \\ & + B3 * \mathrm{dlog}(gcrg/pgdp) \\ & + B4 * [\log(gcec.1) - 0.5 * \log(ngdp\_r.1) \\ & - \log(pgdp.1) - 0.5 \\ & * \log(gcrg.1/pgdp.1)] \\ & + B5 \end{aligned} \quad \text{(A14)}$$

Current revenue

$$\begin{aligned}\text{dlog}(gcrg) = {} & B1 * \text{dlog}(ngdp\_r) \\ & + B2 * \text{dlog}(pgdp) \\ & + B3 * \text{dlog}(bxt/pgdpd) \\ & + B4 * \text{dlog}(bmt/pgdpd) \\ & + B5 * [\log(gcrg.1) - \log(pgdp.1) \\ & - 0.5 * \log(ngdp\_r.1) \\ & - 0.25 * \log(bxt.1/pgdpd.1) \\ & - 0.25 * \log(bmt.1/pgdpd.1)] \\ & + B6 \end{aligned} \quad \text{(A15)}$$

Capital expenditure

$$gcek = gcek\_r * pgdp \quad \text{(A16)}$$

Total expenditure

$$gcenl = gcec + gcek \quad \text{(A17)}$$

Government balance

$$gcb = gcrg - gcenl \quad \text{(A18)}$$

## III. Money, Prices, and the Exchange Rate

Broad money

$$\begin{aligned}diff(fmb)/ngdp = {} & B1 * gcb/ngdp \\ & + B2 * diff(ifxrd * ed)/ngdp \\ & + B3 * diff(fmb.1)/ngdp.1 \\ & + B4 \end{aligned} \quad \text{(A19)}$$

GDP deflator

$$\begin{aligned}\text{dlog}(pgdp) = {} & B1 * \text{dlog}(ngdp\_r) \\ & + B2 * \text{dlog}(fmb) \\ & + B3 * [\log(pgdp.1) - \log(fmb.1) \\ & + \log(ngdp\_r.1)] \\ & + B4 \end{aligned} \quad \text{(A20)}$$

Nominal exchange rate

$$\begin{aligned}\text{dlog}(ed) = {} & 0.5 * \text{dlog}(pgdp/pgdpd110) \\ & - 0.2 * \log(ed.1/pgdp.1 * pgdpd110.1) \\ & + B1 \end{aligned} \quad \text{(A21)}$$

GDP deflator in U.S. dollars

$$pgdpd = pgdp/ed \quad \text{(A22)}$$

## IV. Exports of Goods and Nonfactor Services

Non-oil export volumes

$$\begin{aligned}\log(txqnoil) = {} & B1 * \log(rkt) \\ & + B2 * \log[(pgdpd/PGDPD85)/txpcpnoild] \\ & + B3 * \log(txrgnp) \\ & + B4 \end{aligned} \quad \text{(A23)}$$

Exports of nonfactor services

$$\log(xs\_nfd) = B1 * \log(ngdpd110) + B2 \quad \text{(A24)}$$

Oil export volumes

$$\text{dlog}(txqoil) = B1 * \text{dlog}(txqoil606) + B2 \quad \text{(A25)}$$

Non-oil export price

$$\begin{aligned}&\log(txpnoild) \\ &- \log(pgdpd/PGDPD85) = B1 * \log(txrgnp) \\ & \qquad + B2 * [\log(txpcpnoild) \\ & \qquad - \log(pgdpd/PGDPD85)] \\ & \qquad + B3 * \log(rkt) \\ & \qquad + B4 \end{aligned} \quad \text{(A26)}$$

Oil export price

$$\begin{aligned}\log(txpoild/txpoild999.1) = {} & B1 * \text{dlog}(txpoild999) \\ & + B2 \end{aligned} \quad \text{(A27)}$$

Total export price

$$\begin{aligned}\log(txpd) = {} & (1 - OILX\_W) \\ & * \log(txpnoild/TXPNOILD85) \\ & + (OILX\_W) * \log(txpoild/TXPOILD85) \end{aligned} \quad \text{(A28)}$$

World income (foreign demand)

$$\begin{aligned}\log(txrgnp) = {} & GEE\_XWT1 * \log(txrgnp111) \\ & + GEE\_XWT2 * \log(txrgnp112) \\ & + GEE\_XWT3 * \log(txrgnp132) \\ & + GEE\_XWT4 * \log(txrgnp134) \\ & + GEE\_XWT5 * \log(txrgnp136) \\ & + GEE\_XWT6 * \log(txrgnp156) \\ & + GEE\_XWT7 * \log(txrgnp158) \\ & + GEE\_XWT8 * \log(txrgnp123) \\ & + GEE\_XWT9 * \log(txrgnp209) \\ & + GEE\_XWT10 * \log(txrgnp606) \end{aligned} \quad \text{(A29)}$$

Total value of non-oil exports

$$txn\_oild = txpnoild * txqnoil \quad \text{(A30)}$$

Total value of oil exports

$$tx33 = txpoild * txqoil \quad \text{(A31)}$$

Total value of exports

$$bxt = txn\_oild + tx33 \quad \text{(A32)}$$

Real exports of nonfactor services

$$rxs\_nfd = xs\_nfd/pgdpd110 \quad \text{(A33)}$$

Real exports of goods and services

$$rxgnfs = [(txqoil * RXPOILD85) + (txqnoil + rxs\_nfd) * RXPN\_OILD85] * xmfactor \quad \text{(A34)}$$

Manufactures and commodity price

$$\log(txpcpnoild) = COMX1 * \log(txpnopc) + COMX2 * \log(txpmf) \quad \text{(A35)}$$

Non-oil primary commodity price

$$\log(txpnopc) = NOPC1 * \log(txpf606) + NOPC2 * \log(txpb606) + NOPC3 * \log(txprm606) + NOPC4 * \log(txpmm606) \quad \text{(A36)}$$

Terms of trade

$$tot = txpd/tmpd \quad \text{(A37)}$$

## V. Imports of Goods and Nonfactor Services

Desired value of merchandise imports

$$\log(bmt\_des/tmpd) = B1 * \log(ra - rmgnfs) + B2 * \log(xcad/txpd) + B3 * \log(tmpd/pgdpd) + B4 * ifxrd.1/bmt.1 + B5 \quad \text{(A38)}$$

Desired imports of nonfactor services

$$ms\_nfd\_des = (1 - BMT\_W)/BMT\_W * bmt\_des \quad \text{(A39)}$$

Control switch for import regime determination

$$bmt\_cntl = [(ifxrd\_bmt3 * 12) < 3] + [(ifxrd.1 - (bmt\_des + ms\_nfd\_des + bmsi - xcad - ndkfd + dsp\_t - con\_lend)] < 0) \quad \text{(A40)}$$

Merchandise imports

$$bmt = (bmt\_cntl == 0) * bmt\_des + (bmt\_cntl > 0) * (ndkfd + con\_lend - dsp\_t + bra + xcad - bmsi) * BMT\_W \quad \text{(A41)}$$

Imports of nonfactor services

$$ms\_nfd = (bmt\_cntl == 0) * ms\_nfd\_des + (bmt\_cntl > 0) * (ndkfd + con\_lend - dsp\_t + bra + xcad - bmsi) * (1 - BMT\_W) \quad \text{(A42)}$$

Non-oil import prices

$$\log(tmpn\_oild) = COMM1 * \log(TXPNOPC606) + COMM2 * \log(txpmf) \quad \text{(A43)}$$

Total volume of non-oil imports

$$\text{dlog}(tmqn\_oil) = \text{dlog}(bmt/tmpd) \quad \text{(A44)}$$

Total volume of oil imports

$$\text{dlog}(tmqoil) = \text{dlog}(bmt/tmpd) \quad \text{(A45)}$$

Oil import price

$$\log(tmpoild) - \log(txpoild999.1) = B1 * \text{dlog}(txpoild999) + B2 \quad \text{(A46)}$$

Total import price

$$\log(tmpd) = (1 - OILM\_W) * \log(tmpn\_oild/TMPNOILD85) + OILM\_W * \log(tmpoild/TMPOILD85) \quad \text{(A47)}$$

Total value of non-oil imports

$$tmn\_oild = tmqn\_oil * tmpn\_oild \quad \text{(A48)}$$

Total value of oil imports

$$tm33 = tmqoil * tmpoild \quad \text{(A49)}$$

Real imports of nonfactor services

$$rms\_nfd = ms\_nfd/pgdpd110 \quad \text{(A50)}$$

Real imports of goods and services

$$rmgnfs = ((tmqoil * RMPOILD85) + (tmqn\_oil + rms\_nfd) * RMPN\_OILD85) - (rxgnfs/xmfactor - rxgnfs) \quad (A51)$$

## VI. Transfers and Net Investment Income

Private transfers, net

$$btrp = B1 * ngdpd120 + B2 * xd209 + B3 \quad (A52)$$

Official transfers, net

$$btrg = B1 * (odad) + B2 \quad (A53)$$

Official development assistance

$$odad = B1 * ngdpd110 + B2 \quad (A54)$$

Investment income credits

$$bxsi = B1 * (ilibor * ifxrd) + B2 \quad (A55)$$

Investment income debits

$$bmsdi = B1 * ngdpd + B2 \quad (A56)$$

Other investment income debits

$$bmsndi = B1 * dsi\_t + B2 \quad (A57)$$

## VII. Capital Account and Reserves

Non-debt-creating capital flows

$$ndkfd = B1 * (ngdpd - ngdpd.1) + B2 \quad (A58)$$

New borrowing

$$nlend = B1 * [ilibor - (pch(txpd)/100)] + B2 * [base\_tmd * \text{dlog}(tot)] + B3 * ngdpd + B4 * nlend.1 + B5 \quad (A59)$$

Debt/export ratio

$$debtr = d/(bxt + xs\_nfd + bxsi) \quad (A60)$$

Debt/export ratio—smoothed

$$drhist = (debtr.1 + debtr.2 + debtr.3)/3 \quad (A61)$$

Constrained borrowing equation

$$con\_lend = MLN85 * (drhist >= 2) + nlend * (drhist < 2) * (drhist.1 < 2) * (drhist.2 < 2) + (2/3 * nlend + 1/3 * MLN85) * (drhist < 2) * (drhist.1 < 2) * (drhist.2 >= 2) + (1/3 * nlend + 2/3 * MLN85) * (drhist < 2) * (drhist.1 >= 2) \quad (A62)$$

Amortization

$$dsp\_t = B1 * d.1 + B2 \quad (A63)$$

Debt

$$d = [1 + (\log(mermus) - \log(mermus.1)) * (1 - D\_CUR\_W)] * d.1 + con\_lend + ddr - dsp\_t \quad (A64)$$

Debt interest payments

$$dsi\_t = \text{D\_VR\_W} * \text{ilibor} * \text{d.1} + (1 - D\_VR\_W) * iliborf * d.1 \quad (A65)$$

Current account receipts

$$xcad = bxt + xs\_nfd + bxsi + btrp + btrg \quad (A66)$$

Current account debits

$$mcad = bmt + ms\_nfd + bmsi \quad (A67)$$

Reserves

$$ifxrd = ifxrd.1 - bra \quad (A68)$$

Reserve-to-import ratio

$$ifxrd\_bmt = ifxrd/(bmt + ms\_nfd) \quad (A69)$$

Three-period-average reserve-to-import ratio

$$ifxrd\_bmt3 = (ifxrd\_bmt.1 + ifxrd\_bmt.2 + ifxrd\_bmt.3)/3 \quad (A70)$$

Change in reserves

$$bra = [(ifxrd\_bmt3 * 12) >= 3] * [(ifxrd.1 - (bmt\_des + ms\_nfd\_des + bmsi - xcad - ndkfd + dsp\_t - con\_lend) >= 0] * (bmt\_des + ms\_nfd\_des$$

$$+ bmsi - xcad - ndkfd + dsp\_t - con\_lend)$$
$$+ [(ifxrd\_bmt3 * 12) < 3] * bra\_base$$
$$+ [(ifxrd\_bmt3 * 12) >= 3] *$$
$$[(ifxrd.1 - (bmt\_des + ms\_nfd\_des$$
$$+ bmsi - xcad$$
$$- ndkfd + dsp\_t - con\_lend) < 0] * bra\_base \quad (A71)$$

Aggregate financing

$$befd = ndkfd + (con\_lend - dsp\_t) + bra \quad (A72)$$

Current account balance

$$bca = - befd \quad (A73)$$

## VIII. Alternative Equations for Net Creditors

Real private absorption

$$\log(nap\_r) = B1 * \log\{(ngdpd + bxsi - bmsdi - bmsndi + btrp)/[(1 - SM)* (pgdpd/pGdpD85) + SM) * tmpd]\} + B2 * \log(txpd/pgdpd) + B3 * \log(fmb/pgdp) + B4 * (0.5 * \log(gcenl/pgdp) + 0.5 * \log(gcenl.1/pgdp.1)) + B5 \quad (A74)$$

Real imports of goods and services taking account of the terms of trade effect

$$rmgnfstt = tmqoil * (tmpoild * ed)/pgdp + (tmqn\_oil + rms\_nfd) * (tmpn\_oild * ed)/pgdp \quad (A75)$$

Real exports of goods and services taking account of the terms of trade effect

$$rxgnfstt = txqoil * (txpoild * ed)/pgdp + (txqn\_oil + rxs\_nfd) * (txpnoild * ed)/pgdp \quad (A76)$$

Price of nontraded goods in dollars

$$pntd = (ngdp\_r - rxgnfstt) * pgdpd/ran \quad (A77)$$

Real income

$$ninc\_r = ra + (rxgnfstt - rmgnfstt) + (bxsi - bmsi)/pgdpd \quad (A78)$$

Oil export volume

$$\log(txqoil) = B1 * \log(txqoil.1) + B2 * \log(txpoild/pgdpd110) + B3 * \log(rgdp110) + B4 * TREND + B5 \quad (A79)$$

Total volume of non-oil imports

$$\log(tmqn\_oil) = B1 * \log(tmqn\_oil.1) + B2 * \log(tmp\_oild/pntd) + B3 * \log(nap\_r) + B4 * \log(gcenl\_r) + B5 * ifxrd.1/bmt.1 + B6 \quad (A80)$$

Imports of nonfactor services

$$\log(ms\_nfd) = B1 * \log(bmt) + B2 \quad (A81)$$

Private transfers, net

$$btrp = B1 * ngdpd120 + B2 * ngdpd + B3 \quad (A82)$$

Total value of imports

$$bmt = tmn\_oild + tm33 \quad (A83)$$

Aggregate financing

$$befd = mcad - xcad \quad (A84)$$

Change in reserves

$$bra = befd - ndkfd - (con\_lend - dsp\_t) \quad (A85)$$

## Endogenous Variables

| | |
|---|---|
| *BCA* | = Current account balance |
| *BEFD* | = Aggregate financing (negative of the current account balance), in billion dollars |
| *BMS* | = Current account, services and income debits |
| *BMSDI* | = Current account, direct investment income |
| *BMSI* | = Current account, factor income debit |
| *BMSNDI* | = Current account, interest income debit |
| *BMSO* | = Current account, other debits |
| *BMT* | = Current account, merchandise imports |
| *BMT_CNTL* | = Control variable for import regime switch |
| *BMT_DES* | = Desired level of merchandise imports |
| *BRA* | = Change (increase = −) in reserves |
| *BT* | = Current account, merchandise balance |
| *BTR* | = Unrequited transfers |

*BTRG* = Current account, official unrequited transfers
*BTRP* = Current account, private unrequited transfers
*BXS* = Current account, services and income credits
*BXSI* = Current account, factor income credit
*BXSO* = Current account, other credits
*BXT* = Current account, merchandise exports
*CON_LEND* = Constrained external borrowing, in billion dollars
*D* = Total debt outstanding at end of current year
*DEBTR* = Debt/export ratio
*DRHIST* = Debt/export ratio (three-year moving average)
*DSI_T* = Total debt interest paid
*DSP_T* = Total amortization paid
*ED* = Exchange rate, national currency per dollar
*FMB* = Broad money
*GCB* = Central government fiscal balance
*GCEC* = Central government current expenditure
*GCEK* = Central government capital expenditure
*GCENL* = Central government expenditure
*GCRG* = Central government revenue
*IFXRD* = Stock of reserves, in billion dollars
*IFXRD_BMT* = Reserve-to-import ratio
*IFXRD_BMT3* = Reserve-to-import ratio, three-year average
*MCAD* = Current account debits, total, in billion dollars
*MS_NFD* = Imports of nonfactor services, in billion dollars
*MS_NFD_DES* = Desired value of imports of nonfactor services
*NAP_R* = Real private absorption
*NDKFD* = Non-debt-creating capital flows in billion dollars
*NGDP* = Nominal GDP, in billion of national currency
*NGDPD* = Nominal GDP, in billion dollars
*NGDP_R* = Gross domestic product, constant prices
*NINC_R* = Real income
*NLEND* = New external borrowing, in billion dollars
*ODAD* = Overseas development assistance
*PGDP* = GDP deflator
*PGDPD* = GDP deflator in dollar terms
*PNTD* = Price of nontraded goods in dollars
*RA* = Real absorption in billions of national currency at constant prices
*RC* = Real consumption (residually defined) in billions of national currency at constant prices
*RGDPN* = Real GDP in nontradables, in billions of national currency at constant prices
*RGDPT* = Real GDP in tradables, in billions of national currency at constant prices
*RGNP* = Real GNP, in billions of national currency at constant prices
*RI* = Real investment, in billions of national currency at constant prices
*RK* = Real capital stock, in billions of national currency at constant prices
*RKN* = Real capital stock in nontradables, in billions of national currency at constant prices
*RKT* = Real capital stock in tradables, in billions of national currency at constant prices
*RMGNFS* = Real imports of goods and nonfactor services
*RMGNFSTT* = Real imports of goods and nonfactor services taking account of the terms of trade effect
*RMS_NFD* = Real imports of nonfactor services, in billions of national currency at constant prices
*RXGNFS* = Real exports of goods and nonfactor services
*RXGNFSTT* = Real exports of goods and nonfactor services taking account of the terms of trade effect
*RXS_NFD* = Real exports of nonfactor services, in billions of national currency at constant prices
*TM33* = Value of oil imports, current prices
*TMN_OILD* = Value of non-oil merchandise imports, in billion dollars
*TMPD* = Import unit value index, 1985 = 1
*TMPN_OILD* = Price index of non-oil imports, 1985 = 1
*TMPOILD* = Price index of oil imports, 1985 = 1
*TMQN_OIL* = Non-oil import volumes, in billion dollars at 1985 prices
*TMQOIL* = Oil import volumes, in billion dollars at 1985 prices
*TOT* = Terms of trade index, 1985 = 1
*TX33* = Value of oil exports, current prices
*TXN_OILD* = Value of non-oil merchandise exports, in billion dollars
*TXPCPNOILD* = Weighted world price of manufactures and non-oil primary commodities, 1985 = 1
*TXPD* = Export unit value index, 1985 = 1
*TXPNOILD* = Price index of non-oil exports, 1985 = 1
*TXPNOPC* = Weighted world price of non-oil primary commodities, 1985 = 1
*TXPOILD* = Price index of oil exports, 1985 = 1
*TXQNOIL* = Non-oil export volumes, in billion dollars at 1985 prices
*TXQOIL* = Oil export volumes, in billion dollars at 1985 prices
*TXRGNP* = Weighted index of world output (demand), 1985 = 1
*XCAD* = Current account credits, total in billion dollars
*XS_NFD* = Export of nonfactor services, in billion dollars

## Exogenous Variables

*BASE_TMD* = Baseline value of imports, in billion dollars
*BRA_BASE* = Baseline value of the change in reserves
*DDR* = Impact of debt-reduction operation, in billion dollars
*GCEK_R* = Real government capital expenditure
*ILIBOR* = London interbank offered rate on six-month U.S. dollar deposits
*ILIBORF* = Moving average of LIBOR interest rate
*MERMUS* = U.S. effective exchange rate, nominal
*NGDPD*110 = GDP in industrial countries, billion dollars
*NGDPD*120 = GDP in Europe, billion dollars
*PGDPD*110 = GDP deflator for industrial countries, dollars
*RGDP*110 = Real GDP in industrial countries
*TREND* = Trend (time) line
*TXPMF* = World export price of manufactures
*TXPNOPC*606 = Price of non-oil primary commodities from developing countries
*TXPOILD*999 = World oil price
*TXQOIL*606 = Volume of oil exports in net debtor developing countries
*TXPB*606 = World commodity price, beverages
*TXPF*606 = World commodity price, food
*TXPMM*606 = World commodity price for metals and minerals
*TXPRM*606 = World commodity price for raw materials
*TXRGNP*111 = Real GDP (United States)
*TXRGNP*112 = Real GDP (United Kingdom)
*TXRGNP*123 = Real GDP (smaller industrial countries)
*TXRGNP*132 = Real GDP (France)
*TXRGNP*134 = Real GDP (Germany)
*TXRGNP*136 = Real GDP (Italy)
*TXRGNP*156 = Real GDP (Canada)
*TXRGNP*158 = Real GDP (Japan)
*TXRGNP*209 = Real GDP (net creditor developing countries)
*TXRGNP*606 = Real GDP (net debtor developing countries)
*XD*209 = Total value of exports from the oil exporting net creditor countries
*XMFACTOR* = Adjustment for re-export trade

## Fixed Values and Shares

*BMT_W* = Share of merchandise imports in imports of goods and nonfactor services
*COMM*1 = Share of non-oil primary commodities in non-oil import prices
*COMM*2 = Share of manufactures in non-oil import prices
*COMX*1 = Share of non-oil primary commodities in non-oil export prices
*COMX*2 = Share of manufactures in non-oil export prices
*D_CUR_W* = Share of non-dollar debt
*D_VR_W* = Share of debt held at variable interest rates
*GEE_XWT*1 = Share of exports to United States
*GEE_XWT*2 = Share of exports to United Kingdom
*GEE_XWT*3 = Share of exports to France
*GEE_XWT*4 = Share of exports to Germany
*GEE_XWT*5 = Share of exports to Italy
*GEE_XWT*6 = Share of exports to Canada
*GEE_XWT*7 = Share of exports to Japan
*GEE_XWT*8 = Share of exports to other industrial countries
*GEE_XWT*9 = Share of exports to net creditor countries
*GEE_XWT*10 = Share of exports to net debtor countries
*KT_W* = Share of trade in real GDP
*MLN*85 = Average level of external financing received 1988–92
*NOPC*1–4 = Average shares of commodities in exports
*OILM_W* = Share of oil imports in total imports
*OILX_W* = Share of oil exports in total exports
*PGDPD*85 = GDP deflator in dollar terms in 1985
*Q_WT* = Share of consumption in real absorption
*RMPOILD*85 = Real import price of oil in 1985
*RMPN_OILD*85 = Real non-oil import price in 1985
*RXPOILD*85 = Real export price of oil in 1985
*RXPN_OILD*85 = Real non-oil export price in 1985
*SM* = Share of imports in total GDP for developing countries
*TMPNOILD*85 = Non-oil import price in 1985 in dollars
*TMPOILD*85 = Oil import price in 1985 in dollars
*TXPNOILD*85 = Non-oil export price in 1985 in dollars
*TXPOILD*85 = Oil export price in 1985 in dollars

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# IV

# Unemployment and Wage Dynamics in MULTIMOD

*Leonardo Bartolini and Steve Symansky*

This study develops an analytical and simulation framework for the analysis of the labor market in the seven major industrial countries.[1] After specifying and estimating a simple model of employment and wage dynamics, the new labor market block is integrated into the current version of MULTIMOD, the International Monetary Fund's macroeconomic simulation model used in policy analysis. The resulting version of the model is intended to replace the version of MULTIMOD that was documented in Masson, Symansky, and Meredith (1990). To this end, several alternative scenarios are considered to illustrate the main differences between the effects of standard policy simulations in the versions of MULTIMOD that include and exclude explicit treatment of the labor market.

The current version of MULTIMOD uses an inflation equation that links expected price changes to capacity utilization and other price-pressure variables (such as changes of the terms of trade), while not explicitly accounting for unemployment and wage developments. This approach limits the usefulness of the model in analyzing issues related to labor markets, such as the effects of wage rigidities, of changes in the natural rate of unemployment, etc. Our strategy to incorporate the labor market in MULTIMOD has been to replace the current reduced form of the price equation with the underlying behavioral equations for unemployment, wages and prices, while assuring consistency with the remaining blocks of the model. To this end, we have chosen to estimate (as a system) an unemployment equation and a wage-setting equation, while relying on a constant markup equation to determine the price of output from unit labor cost. This study only considers changes of the price determination block of MULTIMOD; a general discussion of MULTIMOD is provided in Masson, Symansky, Haas, and Dooley (1988) and Masson, Symansky, and Meredith (1990).

## The Markup Equation

We do not estimate the markup equation. There is a substantial amount of empirical evidence pointing at the unresponsiveness of the markup to demand conditions, and previous attempts aimed at identifying time-varying markups have proven unsuccessful (see, for instance, Masson, Symansky, and Meredith (1990)). Therefore, our price-setting equation sets the (log) price of output, $q$, at a constant markup over unit labor cost:

$$q = w + l - y + \theta, \tag{1}$$

or

$$\Delta q = \Delta w + \Delta l - \Delta y, \tag{2}$$

where $l$ is (log) employed labor services (which equals demanded labor services, $l^d$), $y$ is (log) output, and $w$ is the (log) unit wage.

## The Wage Equation

Following related research by Coe and Krueger (1990), our wage equation combines a standard expectation-augmented Phillips curve with a target real wage model (see Nickell (1988) for a general discussion). The aim is to allow for a relatively general specification by nesting two models that focus—respectively—on the *change* and the *level* of real wages to determine the equilibrium wage rate.[2]

The Phillips curve model specifies that the change in the (log) level of nominal wages, measured with respect to changes of expected consumption prices, should reflect changes in trend productivity and should be negatively related to unemployment (measured with respect to its natural level $u^*$). The target real wage model may be regarded as a version of Sargan's (1964) target-real-wage bargaining model, as well as a reflection of firms' desire to equalize the real product wage to the marginal product of labor.[3] This model suggests

[1] Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States.

[2] For the current exercise, we ignore the effects of taxation on the labor market. See also the discussion in the section below on future research.

[3] If, for instance, firms use a Cobb-Douglas production function, the (log) marginal product of labor is $ln\,(\partial Y/\partial L) = y - l + ln(1-\beta)$. Profit maximization then implies that firms would target $[w-q-(y-l)]$ to $ln(1-\beta) \equiv \tau_0 < 0$.

augmenting the Phillips equation with a catch-up term that reflects the deviation of the real product wage from its target level.

The specification of the wage equation that follows nests the two models and allows a test of the significance of real wage targeting in the form of a test of the hypothesis $\phi = 0$:

$$\Delta w = \Delta p^e_{+1} + \Delta pr^{tr} - \alpha(u - u^*) - \phi(w - q - pr^{tr} - \tau_0)_{-1}. \quad (3)$$

In equation (3), $pr^{tr} \equiv (y - l)^{tr}$ denotes trend average labor productivity,[4] $u$ and $u^*$ are the current and natural rates of unemployment, $\tau_0$ is the target (log) real product wage (measured with respect to average productivity), and $p$ is the (log) consumption-based deflator.

The expected price change term, $\Delta p^e_{+1}$, is to be interpreted as the expectation of the change of prices at time $t+1$ formed on the basis of information available at time $t$. The benchmark assumption is that expectations are formed rationally, that is, that $p^e_{+1}$ equals $Ep_{+1}$, the mathematical expectation taken with respect to all currently available information (which should include the dynamics of the state variables as determined within the whole model). As in Chadha, Masson, and Meredith (1992), however, we nest the rational expectation hypothesis in a more general model that allows for the coexistence of elements of rational and adaptive expectations. We allow, in particular, inflation expectations to be a convex combination of a rational expectation term and the last observed change of prices:[5]

$$\Delta p^e_{+1} = \delta E\Delta p_{+1} + (1-\delta)\Delta p_{-1}. \quad (4)$$

Substituting equation (4) into equation (3), and subsuming the change of trend productivity, $\Delta pr^{tr}$, and the target real wage $\tau_0$ in the constant term, we obtain the following version of the wage equation:

$$\Delta w = \omega + \delta E\Delta p_{+1} + (1 - \delta)\Delta p_{-1} - \alpha(u - u^*) - \phi(w - q - pr^{tr})_{-1}. \quad (5)$$

In the long run, unemployment is at its natural rate (see the unemployment equation below) and the real product wage meets its target (as a result of the markup equation (1)). Thus, the wage equation fixes the long-run growth of real (consumption) wages as a function of average productivity growth and other structural factors that determine the target real wage (all absorbed in the constant term).

## The Unemployment Equation

We assume the technology to be described by the Cobb-Douglas technology:[6]

$$Y = A(t)K^{\beta}L^{(1-\beta)}, \quad (6)$$

where $K$ is the current stock of capital, $L$ is employed labor services (measured by total hours worked), and $A(t)$ is a technology-shift parameter describing technical progress.

For each given $K$, the production function (6) maps changes of output into changes of employed labor services. Now define the "natural" level of (log) employment as $\bar{l} \equiv [\bar{y} - a(t) - \beta k]/(1-\beta)$, where $\bar{y}$ is (log) potential output. The deviation of the demand for labor services from its natural level, $\bar{l}$, can then be written as a function of capacity utilization as:

$$l^d - \bar{l} = \frac{cu}{1 - \beta}, \quad (7)$$

where $cu \equiv y - \bar{y}$ indicates (log) capacity utilization, defined as the deviation of output, $y$, from its potential level $\bar{y}$.

Next, we assume a linearized version of the labor supply equation in which the supply of labor services exceeds its natural level, $\bar{l}$, by a linear function of the (detrended) real consumption wage:[7]

$$l^s - \bar{l} = \zeta + \gamma[w - p - (w - p)^{tr}]. \quad (8)$$

In addition to the econometric need to produce a

[4]Linear and quadratic time trends were used to detrend productivity.

[5]The qualitative features of the model do not change if expected inflation is allowed to depend on a longer distributed lag of prices. The important aspect of equation (4) is that it allows for inflation expectations to be anchored—with an empirically determined weight $\delta$—to past inflation. See Chadha, Masson, and Meredith (1992) for a derivation from an explicit multiperiod wage-setting model.

Note that to introduce sluggish adjustment of real wages to anticipated changes of exogenous variables, it would not be sufficient to assume staggered wage contracts, unless agents' forecast horizon is assumed to be shorter than the contract's length. See Chadha, Masson, and Meredith (1991) for a more complete discussion of price adjustment in a model with overlapping contracts.

[6]A very similar treatment can be given in the case of a more general production function with constant elasticity of substitution. In that case, the time-invariant income share of labor, $1-\beta$, should be replaced by the share of labor at full employment, which may vary in the long run.

[7]Linear and quadratic time trends were used to detrend the real wage.

stationary real wage term on the right-hand side of equation (8), there are economic reasons for detrending the real wage term. Labor supply decisions presumably depend on real wage opportunities, measured with respect to a time-varying (generally *upward*-trending) reservation wage.

Subtracting equation (7) from equation (8), gives the equation describing the rate of unemployed labor services:

$$l^s - l^d = \zeta + \gamma[w - p - (w - p)^{tr}] - cu/1 - \beta. \quad (9)$$

Next, we express the effects of hiring and firing costs on the short-run response of employment to output by assuming that the rate of unemployment $u$ (that measures the rate of people unemployed) is determined as a convex combination of its "desired" rate—given by the rate of unemployed labor services, $l^s - \bar{l}^d$—and its last observed realization, $u_{-1}$:

$$u = \rho u_{-1} + (1 - \rho)(l^s - \bar{l}^d). \quad (10)$$

With this specification, a larger value of $\rho$ implies that the changes of labor services necessary to accommodate short-lived output fluctuations are achieved mainly by changing average per-worker workhours, while the rate of unemployment is more sluggish and responds to output fluctuations over the medium term.

Combining equation (9) and equation (10), we can substitute away employed labor services and obtain an unemployment equation only in terms of real (consumption) wages and capacity utilization:

$$u = \rho u_{-1} + (1-\rho)\{\zeta + \gamma[w - p - (w - p)^{tr}] - cu/1 - \beta\}. \quad (11)$$

In a steady state, (log) capacity utilization is zero and the real wage increases along its trend line. Thus, equation (11) specifies a natural rate of unemployment at $u^* = \zeta$. Our current specification treats the natural rate of unemployment as exogenous, though possibly time-varying. As mentioned in the concluding section of this study, it would be useful to endogenize the link between $\zeta$ and its determinants, such as search costs and the tax structure. For the time being, we treat these factors as exogenous, and follow a simple estimation procedure that accounts for their possible changes over the sample by allowing for a structural break in $\zeta$. The next section provides details to this extent.

## Estimation

Following the previous discussion, the following two-equation system was used to estimate the model for each of the seven major industrial countries. The sample period was 1968–90.[8]

$$\Delta w = \omega + \delta E\Delta p_{+1} + (1 - \delta)\Delta p_{-1} - \alpha(u - u^*) - \phi(w - q - pr^{tr})_{-1}. \quad (5)$$

$$u = \rho u_{-1} + (1-\rho)\{\zeta + \gamma[w - p - (w - p)^{tr}] - cu/1-\beta\}. \quad (11)$$

The role of technology in the simple model outlined above is summarized by the income share of capital, $\beta$. One would not expect estimation of reduced form equations, such as the wage and unemployment equations, to yield an accurate description of technology. Indeed, when the estimation was carried out by leaving $\beta$ unconstrained, this parameter was estimated imprecisely and often implausibly. Leaving a more structural analysis of technology as a topic for further research, the current estimation imposes $\beta$ based on country-specific information on factor shares.

In each country, we allowed for a break point for the natural rate of unemployment, $\zeta$, and for the constant term of the wage equation, $\omega$, by constraining the break point to be the same in both equations and by choosing the structural break by best-fit. Thus,

$$\zeta = \zeta_1 DUM + \zeta_2(1 - DUM), \quad (12)$$

$$\omega = \omega_1 DUM + \omega_2(1 - DUM). \quad (13)$$

With this notation, $\zeta_1$ and $\zeta_2$ provide estimates of the natural rate of unemployment in the first and second subsamples, respectively.

In this formulation, wage-pressure factors, such as measures of union power, minimum-wage legislation, incomes policy, etc., have not been included in the wage equation. These variables are difficult to quantify and their introduction would have made periodic updating of the model from World Eco-

[8]Estimation was cut off at 1990 to allow the use of price data for 1991 as a one-period-ahead term in the wage equation. Estimation for Germany was carried out over the sample 1968–89 because of the problems in data associated with German unification.

**Table 1. Results of Estimation**

| Country | $\gamma$ | $\delta$ | $\alpha$ | $\phi$ | $\rho$ | $\zeta_1$ | $\zeta_2$ | $\omega_1$ | $\omega_2$ | Break Point | $r^2$ eq.1 | $r^2$ eq.2 | $h$ eq.1 | $DW$ eq.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| United States | −.079 | .373 | .229 | .556 | .517 | .026 | .039 | .017 | .019 | 1976/77 | .93 | .88 | .03 | 2.00 |
| | (.301) | (.076) | (.111) | (.102) | (.045) | (.019) | (.016) | (.006) | (.005) | | | | | |
| Germany | .225 | .142 | .465 | .184 | .732 | .024 | .090 | .045 | .006 | 1979/80 | .98 | .78 | .95 | 2.00 |
| | (.062) | (.112) | (.231) | (.054) | (.038) | (.005) | (.006) | (.005) | (.007) | | | | | |
| France | .118 | .402 | .427 | .131 | .801 | .039 | .112 | .043 | .015 | 1978/79 | .99 | .92 | .72 | 2.37 |
| | (.095) | (.110) | (.161) | (.043) | (.038) | (.005) | (.006) | (.004) | (.005) | | | | | |
| Italy | .285 | .649 | .371 | .144 | .857 | .070 | .142 | .033 | .016 | 1979/80 | .90 | .79 | 1.28 | 2.55 |
| | (.626) | (.105) | (.230) | (.099) | (.069) | (.024) | (.027) | (.015) | (.016) | | | | | |
| Canada | .229 | .298 | .402 | .200 | .535 | .031 | .068 | .041 | .027 | 1977/78 | .97 | .79 | .60 | 1.87 |
| | (.130) | (.122) | (.207) | (.105) | (.041) | (.018) | (.022) | (.010) | (.010) | | | | | |
| Japan | .115 | .504 | 2.901 | .083 | .951 | .028 | .031 | .030 | .009 | 1977/78 | .96 | .88 | −.49 | 2.28 |
| | (.067) | (.098) | (1.74) | (.047) | (.011) | (.008) | (.007) | (.033) | (.025) | | | | | |
| United Kingdom | .729 | .448 | .475 | — | .742 | −.006 | .019 | .038 | .057 | 1978/79 | .97 | .70 | .53 | 2.41 |
| | (.388) | (.127) | (.272) | | (.053) | (.025) | (.016) | (.019) | (.025) | | | | | |

Sample: Annual data, 1968–90 (1968–89 for Germany). Figures in parentheses are standard errors.

nomic Outlook data exceedingly laborious. Changes in exogenous factors are partly accounted for by the country-specific structural break of the constant term, $\omega$.

In our preliminary regressions, we have allowed for a role of the wedge between the consumption and output deflators. The estimated coefficient for this variable, however, was almost always insignificant and not robust in sign and magnitude across countries and specifications. This outcome is not surprising, since equation (5) already includes terms describing the dynamics of both the consumption and output deflators. Accordingly, this variable was dropped from our specification.

The two-equation system (5) and (11) was estimated for each individual country by Zellner-efficient three-stage least squares. The results of the estimation are reported in Table 1.[9] Overall, the empirical results were satisfactory for all countries except for the United Kingdom (discussed below). As reported in Table 1, the coefficients $\alpha$, $\rho$, $\phi$, and $\delta$ were always estimated with the correct sign at relatively high marginal significance levels, despite the rather small sample, while the coefficient $\gamma$ was generally less significant. Summary statistics indicate good fit, and there was some evidence of serial correlation of the residuals only for the unemployment equations of the United States, Canada, and the United Kingdom.[10] The estimation results also proved relatively robust across different specifications of the break points and with respect to small modifications of the regression equations (such as the choice of different detrending procedures).

The responsiveness of wages to unemployment, as measured by the coefficient $\alpha$, was estimated to be very similar among the European countries, and generally higher than in the two North American countries. This result likely reflects the similar movement of real wages within the industrial countries, but relatively more stable (at high levels) unemployment rates in Europe. In turn, it is the relatively high estimate of $\rho$ for the European countries that reflects the sluggishness of unemployment in Europe. Similarly, while the very high estimates of $\alpha$ and $\rho$ for Japan indicate both the stability (at low levels) of the Japanese rate of unemployment, as well as the tendency of that country to accommodate output fluctuations through changes of per-worker hours, rather than through changes of employment.

The estimates of $\delta$, the weight of the forward-looking component of price expectations, indicate that both the hypothesis of completely rational and of completely backward-looking expectations can be broadly rejected. Overall, the reported estimates for this parameter appear sensible, although the large estimate for Italy and the small estimate for Germany are somewhat surprising.

For all countries except the United Kingdom, the positive and relatively significant estimates of $\phi$ indicate evidence of real wage rate targeting. In contrast, estimates of the coefficient that capture the response of labor supply to changes in real wages, $\gamma$, were generally small and imprecise, thus confirming the conventional wisdom on the difficulty of capturing the response of labor supply to changes of real wages.

For most countries, the estimates of $\zeta$ proved to be a rough approximation of available estimates of natural rates of unemployment. In the case of the United Kingdom, on the other hand, the estimates

[9]Time and two lags of prices, of capacity utilization, and of the real exchange rate were used as instruments.

[10]Accordingly, the regression results for these three equations have been corrected for first-order serial correlation.

of $\zeta$ were implausibly low. Note the role played by this parameter in our simple model of unemployment: unemployment is expected to converge to $\zeta$ only after all cyclical components of output and wages have been offset and sufficient time has elapsed to eliminate the anchoring effect of lagged unemployment. As a result, one would not expect $\zeta$ to be estimated very precisely, nor to be estimated at a value close to the average rate of unemployment in each sample. We have conducted a simple test of robustness of our regressions to misspecification of $\zeta$ by constraining $\zeta$ to the average level of unemployment for each country's subsample. We found that the constrained estimates of the remaining parameters were almost identical to their unconstrained counterparts, for all countries except the United Kingdom. We also note that the possibly imprecise estimation of $\zeta$ should not be a reason of concern in MULTIMOD simulations, which are independent of the estimates of any constant term such as $\zeta$.

As mentioned above, estimation of the model on U.K. data proved troublesome. Although most estimates of the slope coefficients were plausible, estimates of the natural rate of unemployment were both implausible in their magnitude and statistically significant, while we found no statistical evidence of real wage targeting. Furthermore, estimation proved not very robust to relatively small changes of the model and sample. The following MULTIMOD simulations use our best estimates of the U.K. model, with the wage equation specified as a standard expectation-augmented Phillips curve. We stress however that this estimation should be regarded as preliminary and that further research on modeling the U.K. labor market would be necessary.

## Simulations

To illustrate the properties of the version of MULTIMOD that includes the newly formulated labor market, we have considered several policy simulations. Three newly specified variables appear in the new version of MULTIMOD, namely, "Unemployment rate," "Wages," and "Employed labor services." Note that the shocks discussed in this section were applied only to a country model. While the simulated shocks may have somewhat different effects in the linked version of the model, the comparison between the new and the current versions of the model should not be affected by this consideration.

### Fiscal and Monetary Shocks

The first set of simulations, reported in Tables 2–4, considers the effects of standard fiscal and monetary shocks in the standing version of MULTIMOD and in the version of the model that incorporates the labor market equations. For the six countries that are assumed to have independent monetary policies—the United States, Japan, Germany, the United Kingdom, Italy, and Canada—we simulated both a permanent increase of the fiscal deficit of 5 percent of GDP and a permanent contraction of money supply of 10 percent. Only a fiscal shock was considered for France, since participation in the exchange rate mechanism (ERM) and the consequent need to target the nominal exchange rate with the deutsche mark, make changes of monetary base endogenous. For comparison with the former version of MULTIMOD, we also report simulated fiscal shocks for Italy and the United Kingdom under the assumption of participation in the ERM.

In general, both the fiscal and monetary scenarios described above indicate that the model incorporating the labor market displays virtually identical long-run properties as the standing version of MULTIMOD, as well as very similar short-run properties. There are only two significant differences between the two models. One is the somewhat longer-lived effects of fiscal and monetary shocks over the medium term in the new version of the model (especially for Italy), a feature that expresses the sluggish adjustment of unemployment to its natural rate. The other is a small reduction in the Japanese fiscal multiplier, a feature that can be attributed to the stronger inflation response to demand pressure estimated in the new version of the model.

The simulated behavior of unemployment in the fiscal scenarios (Table 2) illustrates the interaction of our newly formulated labor market block with the rest of MULTIMOD. The fiscal stimulus initially causes a decline in the unemployment rate and raises wages and prices, while the short-run response of employed labor services is substantially stronger than that of the rate of unemployment.[11] Eventually, unemployment converges to its natural rate. The crowding out of private investment and the decline of the capital stock during the period of transition imply that real wages must decline in the long run, in order to accommodate the larger share of labor in total factor employment.

With respect to the monetary contraction scenarios reported in Table 3, we need only note that both the short-run and long-run effects of the reduction of money supply targets are very similar in both versions of the model. In particular, both models display long-run neutrality of nominal shocks.

[11]The impact elasticity of employed labor services to output is equal to the reciprocal of the labor share of income (which is equal to about $^2/_3$ in all countries).

**Table 2. Effect of 5 Percent Deficit Expansion on the Major Industrial Countries**

| | Current Model | | | | | | New Model | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Year 1 | Year 2 | Year 3 | Year 4 | Year 10 | Year 20 | Year 1 | Year 2 | Year 3 | Year 4 | Year 10 | Year 20 |
| United States | | | | | | | | | | | | |
| Real GDP | 3.4 | 0.8 | −0.7 | −1.3 | −0.5 | −0.9 | 3.3 | 0.6 | −0.7 | −1.3 | −1.0 | −0.9 |
| Unemployment rate | — | — | — | — | — | — | −2.3 | −1.8 | −0.7 | 0.2 | 0.4 | 0.0 |
| GDP deflator | 1.5 | 2.8 | 3.2 | 2.8 | 0.6 | 0.6 | 2.2 | 2.9 | 3.0 | 2.5 | 1.2 | 0.6 |
| Wages | — | — | — | — | — | — | 0.8 | 2.4 | 2.7 | 2.3 | 0.4 | −0.3 |
| Employed labor services | — | — | — | — | — | — | 4.8 | 1.2 | −0.5 | −1.1 | −0.3 | 0.0 |
| Japan | | | | | | | | | | | | |
| Real GDP | 3.2 | 0.8 | −0.8 | −1.5 | −0.9 | −1.1 | 2.7 | 0.1 | −1.3 | −2.0 | −0.7 | −1.2 |
| Unemployment rate | — | — | — | — | — | — | −0.2 | −0.3 | −0.2 | −0.1 | 0.1 | 0.0 |
| GDP deflator | 1.5 | 3.1 | 3.7 | 3.4 | 1.6 | 1.3 | 3.3 | 3.6 | 3.8 | 3.9 | 1.6 | 1.5 |
| Wages | — | — | — | — | — | — | 1.0 | 2.9 | 3.7 | 3.9 | 0.1 | 0.4 |
| Employed labor services | — | — | — | — | — | — | 5.0 | 0.8 | −1.2 | −2.0 | 0.8 | −0.2 |
| Germany | | | | | | | | | | | | |
| Real GDP | 2.2 | 0.6 | −0.0 | −0.4 | −0.5 | −0.8 | 2.0 | 0.6 | 0.4 | 0.1 | −0.7 | −0.7 |
| Unemployment rate | — | — | — | — | — | — | −0.7 | −0.8 | −0.8 | −0.7 | 0.1 | 0.0 |
| GDP deflator | 0.5 | 1.0 | 1.2 | 1.1 | 0.5 | 0.8 | 1.2 | 0.8 | 0.6 | 0.6 | 0.6 | 0.8 |
| Wages | — | — | — | — | — | — | 0.3 | 0.4 | 0.2 | 0.2 | 0.2 | 0.0 |
| Employed labor services | — | — | — | — | — | — | 2.9 | 1.1 | 0.7 | 0.4 | −0.3 | −0.0 |
| France | | | | | | | | | | | | |
| Real GDP | 3.4 | 3.3 | 2.1 | 0.3 | −0.6 | −1.1 | 3.4 | 3.6 | 2.7 | 1.4 | −2.7 | −0.5 |
| Unemployment rate | — | — | — | — | — | — | −1.0 | −1.8 | −2.2 | −2.1 | 1.5 | −0.5 |
| GDP deflator | 3.1 | 8.0 | 12.8 | 15.8 | 5.1 | 8.4 | 3.1 | 6.9 | 10.4 | 13.3 | 10.0 | 9.3 |
| Wages | — | — | — | — | — | — | 1.7 | 5.4 | 9.3 | 12.7 | 10.2 | 8.5 |
| Employed labor services | — | — | — | — | — | — | 4.9 | 5.1 | 3.8 | 1.9 | −2.8 | 0.3 |
| United Kingdom | | | | | | | | | | | | |
| Real GDP | 4.0 | 1.8 | 0.0 | −1.0 | 0.1 | −0.5 | 3.9 | 1.9 | 0.6 | −0.2 | −0.7 | −0.6 |
| Unemployment rate | — | — | — | — | — | — | −1.4 | −1.6 | −1.4 | −0.9 | 0.3 | −0.0 |
| GDP deflator | 1.2 | 3.1 | 4.1 | 4.0 | 1.3 | 1.8 | 2.2 | 2.1 | 2.2 | 2.4 | 1.8 | 1.8 |
| Wages | — | — | — | — | — | — | 0.6 | 1.2 | 1.8 | 2.2 | 1.5 | 1.4 |
| Employed labor services | — | — | — | — | — | — | 5.8 | 2.9 | 1.2 | 0.1 | −0.2 | −0.1 |
| Italy | | | | | | | | | | | | |
| Real GDP | 2.2 | 1.3 | 0.3 | −0.6 | −0.2 | −0.7 | 2.2 | 1.6 | 0.9 | 0.3 | −1.0 | −0.6 |
| Unemployment rate | — | — | — | — | — | — | −0.5 | −0.7 | −0.8 | −0.8 | −0.0 | −0.1 |
| GDP deflator | 0.6 | 2.0 | 3.1 | 3.4 | 1.0 | 1.5 | 1.3 | 1.3 | 1.4 | 1.6 | 2.0 | 1.5 |
| Wages | — | — | — | — | — | — | 0.2 | 0.4 | 0.8 | 1.1 | 1.6 | 0.6 |
| Employed labor services | — | — | — | — | — | — | 3.4 | 2.5 | 1.6 | 0.8 | −0.6 | 0.3 |
| Canada | | | | | | | | | | | | |
| Real GDP | 1.4 | 1.1 | 0.5 | 0.0 | −0.5 | −0.7 | 1.3 | 1.1 | 0.8 | 0.4 | −0.6 | −0.5 |
| Unemployment rate | — | — | — | — | — | — | −0.8 | −1.2 | −1.2 | −0.9 | 0.2 | −0.0 |
| GDP deflator | −0.2 | 0.4 | 0.9 | 1.3 | 0.9 | 1.0 | 0.7 | 0.3 | 0.5 | 0.7 | 1.0 | 0.9 |
| Wages | — | — | — | — | — | — | 0.2 | −0.1 | 0.2 | 0.6 | 0.9 | 0.6 |
| Employed labor services | — | — | — | — | — | — | 2.0 | 1.7 | 1.2 | 0.7 | −0.2 | 0.0 |

A noticeable feature of this set of simulations is the large and long cycle in the French fiscal scenario, a property that we largely attribute to the ERM monetary assumption. To aid interpretation of this scenario, we have included fiscal shock scenarios for the United Kingdom and Italy for both non-ERM and ERM participation (Tables 2 and 4). A comparison of the two fiscal scenarios shows substantially greater cycles under the ERM assumption. Because monetary policy in ERM countries is generally targeted to ensure interest parity with Germany, the medium-term effects of a fiscal expansion are magnified by the ensuing monetary expansion. This property of the model is common to the current and new versions of MULTIMOD, but the sluggish response of wages and unemployment leads the new version to predict longer-lasting effects of nominal adjustments.

## Labor Market Shocks

A second set of simulations, which are presented only for the United States, considers specific aspects of the labor market that could not be analyzed with the previous version of the model.

The two panels of Table 5 report the results of the same fiscal and monetary shocks described above, but under the assumption of exogenous nominal wages. In the fiscal expansion scenario, the weaker inflation response in the sticky-wage case induces a

**Table 3. Effect of 10 Percent Money Supply Reduction on the Major Industrial Countries (Excluding France)**

| | Current Model | | | | | | New Model | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Year 1 | Year 2 | Year 3 | Year 4 | Year 10 | Year 20 | Year 1 | Year 2 | Year 3 | Year 4 | Year 10 | Year 20 |
| United States | | | | | | | | | | | | |
| Real GDP | −1.8 | −2.9 | −1.4 | 0.1 | −0.5 | −0.1 | −2.0 | −3.2 | −1.9 | −0.6 | −0.2 | −0.2 |
| Unemployment rate | — | — | — | — | — | — | 1.3 | 2.7 | 2.5 | 1.5 | −0.0 | 0.1 |
| GDP deflator | −2.4 | −5.8 | −8.4 | −9.7 | −8.8 | −9.1 | −2.1 | −5.7 | −8.0 | −8.8 | −9.0 | −9.1 |
| Wages | — | — | — | — | — | — | −1.5 | −4.9 | −7.8 | −9.0 | −9.2 | −9.3 |
| Employed labor services | — | — | — | — | — | — | −2.6 | −4.1 | −2.2 | −0.4 | −0.0 | −0.1 |
| Japan | | | | | | | | | | | | |
| Real GDP | −2.1 | −2.7 | −1.2 | 0.2 | −0.4 | −0.1 | −1.8 | −2.1 | −0.8 | 0.5 | −0.2 | 0.2 |
| Unemployment rate | — | — | — | — | — | — | 0.1 | 0.3 | 0.3 | 0.2 | −0.1 | −0.0 |
| GDP deflator | −2.4 | −5.7 | −8.3 | −9.6 | −8.9 | −9.0 | −3.2 | −6.7 | −8.5 | −9.5 | −9.3 | −9.2 |
| Wages | — | — | — | — | — | — | −2.1 | −5.6 | −8.5 | −10.1 | −9.1 | −9.3 |
| Employed labor services | — | — | — | — | — | — | −2.9 | −3.2 | −0.8 | 1.3 | −0.4 | 0.3 |
| Germany | | | | | | | | | | | | |
| Real GDP | −2.8 | −2.5 | −0.8 | 0.4 | −0.2 | −0.0 | −3.2 | −2.5 | −0.4 | 1.0 | 0.0 | 0.0 |
| Unemployment rate | — | — | — | — | — | — | 1.4 | 1.9 | 1.3 | 0.4 | −0.5 | 0.0 |
| GDP deflator | −3.4 | −6.8 | −8.8 | −9.6 | −8.9 | −9.1 | −2.4 | −6.9 | −9.3 | −10.0 | −9.2 | −9.1 |
| Wages | — | — | — | — | — | — | −1.1 | −6.0 | −9.4 | −10.6 | −9.2 | −9.1 |
| Employed labor services | — | — | — | — | — | — | −4.5 | −3.4 | −0.3 | 1.7 | 0.0 | 0.0 |
| United Kingdom | | | | | | | | | | | | |
| Real GDP | −0.8 | −2.3 | −1.8 | −0.6 | −0.4 | −0.1 | −0.9 | −2.5 | −1.9 | −0.8 | 0.3 | −0.0 |
| Unemployment rate | — | — | — | — | — | — | 0.6 | 1.3 | 1.5 | 1.1 | −0.4 | 0.1 |
| GDP deflator | −2.5 | −5.4 | −8.0 | −9.5 | −8.4 | −9.0 | −2.0 | −5.7 | −7.8 | −8.7 | −9.1 | −9.0 |
| Wages | — | — | — | — | — | — | −1.6 | −4.9 | −7.4 | −8.7 | −9.3 | −9.0 |
| Employed labor services | — | — | — | — | — | — | −1.1 | −3.3 | −2.3 | −0.8 | 0.4 | 0.0 |
| Italy | | | | | | | | | | | | |
| Real GDP | −1.6 | −2.2 | −1.5 | −0.5 | −0.3 | −0.2 | −1.9 | −2.9 | −2.7 | −2.2 | 1.2 | −0.6 |
| Unemployment rate | — | — | — | — | — | — | 0.4 | 0.9 | 1.3 | 1.4 | −0.0 | 0.0 |
| GDP deflator | −2.4 | −5.4 | −8.0 | −9.7 | −8.4 | −8.8 | −2.1 | −4.4 | −5.7 | −6.5 | −10.2 | −8.4 |
| Wages | — | — | — | — | — | — | −1.4 | −3.6 | −5.0 | −6.2 | −10.8 | −8.2 |
| Employed labor services | — | — | — | — | — | — | −2.5 | −3.8 | −3.4 | −2.5 | 2.0 | −0.7 |
| Canada | | | | | | | | | | | | |
| Real GDP | −1.9 | −2.0 | −1.2 | −0.3 | −0.1 | −0.1 | −2.0 | −1.9 | −0.9 | −0.1 | 0.1 | −0.0 |
| Unemployment rate | — | — | — | — | — | — | 1.5 | 2.0 | 1.4 | 0.6 | −0.3 | −0.0 |
| GDP deflator | −3.1 | −5.8 | −7.8 | −9.0 | −8.9 | −9.0 | −2.5 | −6.4 | −8.5 | −9.2 | −9.1 | −9.0 |
| Wages | — | — | — | — | — | — | −1.5 | −5.7 | −8.3 | −9.5 | −9.2 | −9.0 |
| Employed labor services | — | — | — | — | — | — | −2.8 | −2.5 | −1.1 | 0.1 | 0.2 | 0.0 |

**Table 4. Effect of 5 Percent Deficit Expansion on the United Kingdom and Italy (ERM)**

| | Current Model | | | | | | New Model | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Year 1 | Year 2 | Year 3 | Year 4 | Year 10 | Year 20 | Year 1 | Year 2 | Year 3 | Year 4 | Year 10 | Year 20 |
| United Kingdom | | | | | | | | | | | | |
| Real GDP | 4.7 | 4.2 | 2.3 | 0.4 | −0.4 | −1.0 | 4.7 | 4.3 | 2.8 | 1.3 | −1.6 | −0.8 |
| Unemployment rate | — | — | — | — | — | — | −1.8 | −2.8 | −2.9 | −2.4 | 1.0 | 0.0 |
| GDP deflator | 3.8 | 9.5 | 14.7 | 17.8 | 9.2 | 13.2 | 4.5 | 9.0 | 12.9 | 15.7 | 13.3 | 14.1 |
| Wages | — | — | — | — | — | — | 2.5 | 7.2 | 11.7 | 15.3 | 13.3 | 13.6 |
| Employed labor services | — | — | — | — | — | — | 6.8 | 6.2 | 4.0 | 1.8 | −1.5 | −0.2 |
| Italy | | | | | | | | | | | | |
| Real GDP | 3.8 | 4.0 | 2.9 | 1.2 | −1.4 | −1.2 | 3.7 | 4.0 | 3.6 | 2.9 | −1.0 | −1.5 |
| Unemployment rate | — | — | — | — | — | — | −0.8 | −1.5 | −1.9 | −2.2 | −0.9 | 1.4 |
| GDP deflator | 3.7 | 9.9 | 16.5 | 21.7 | 11.2 | 14.6 | 3.9 | 7.4 | 10.3 | 12.7 | 20.0 | 12.0 |
| Wages | — | — | — | — | — | — | 2.2 | 5.7 | 8.8 | 11.7 | 20.5 | 11.6 |
| Employed labor services | — | — | — | — | — | — | 5.4 | 5.7 | 5.0 | 3.9 | −1.4 | −1.0 |

**Table 5. Effect of Policy Shocks with Sticky Wages on the United States**

| | 5 Percent Deficit Expansion | | | | | | 10 Percent Money Supply Reduction | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Year 1 | Year 2 | Year 3 | Year 4 | Year 10 | Year 20 | Year 1 | Year 2 | Year 3 | Year 4 | Year 10 | Year 20 |
| United States | | | | | | | | | | | | |
| Real GDP | 3.7 | 1.7 | 0.9 | 0.3 | −0.9 | −1.1 | −3.8 | −8.5 | −9.2 | −9.5 | −10.3 | −11.0 |
| Unemployment rate | −2.5 | −2.6 | −2.1 | −1.5 | 0.3 | 0.4 | 2.5 | 7.0 | 9.8 | 11.3 | 13.5 | 14.2 |
| GDP deflator | 1.5 | 0.9 | 0.6 | 0.5 | 0.4 | 0.7 | −1.3 | −3.0 | −3.0 | −2.9 | −2.8 | −2.6 |
| Wages | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Employed labor services | 5.3 | 2.6 | 1.5 | 0.9 | −0.4 | −0.4 | −5.1 | −11.2 | −12.0 | −12.2 | −12.8 | −13.3 |

**Table 6. Effect of Labor Market Shocks on the United States**

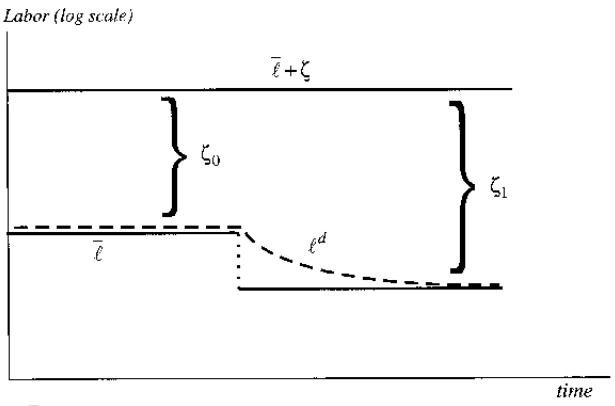
| | 2 Percent Shock to Employment and to Natural Rate of Employment | | | | | | 2 Percent Shock to Employment and Labor Force | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Year 1 | Year 2 | Year 3 | Year 4 | Year 10 | Year 20 | Year 1 | Year 2 | Year 3 | Year 4 | Year 10 | Year 20 |
| United States | | | | | | | | | | | | |
| Real GDP | −0.4 | −1.0 | −1.2 | −1.3 | −1.9 | −2.0 | −0.3 | −0.7 | −0.9 | −1.0 | −1.8 | −2.0 |
| Unemployment rate | 0.3 | 0.8 | 1.2 | 1.4 | 2.2 | 2.2 | −0.8 | −0.9 | −0.9 | −0.8 | 0.1 | 0.2 |
| GDP deflator | 0.3 | 0.3 | 0.4 | 0.5 | 1.0 | 1.2 | 0.0 | −0.1 | −0.0 | 0.2 | 0.8 | 1.1 |
| Wages | 0.4 | 0.6 | 0.7 | 0.9 | 1.3 | 1.3 | 0.1 | 0.2 | 0.3 | 0.5 | 1.2 | 1.3 |
| Employed labor services | −0.6 | −1.3 | −1.5 | −1.7 | −2.2 | −2.2 | −0.4 | −1.0 | −1.1 | −1.3 | −2.2 | −2.2 |

stronger short-run increase in output. In the long run, however, the sticky-wage economy settles at a similar level as the flex-wage economy. In contrast, the sticky-wage model produces substantially different results with respect to the flex-wage model when implementing a monetary contraction: when nominal wages are fixed, long-run neutrality of nominal shocks no longer holds and the output costs of deflation are substantial, both in the short and in the long run.

The left panel of Table 6 reports the effects of a permanent increase of the natural rate of unemployment $\zeta$ for a given level of "natural" labor supply $\bar{l} + \zeta$. This type of shock is intended to capture exogenous changes in a variety of determinants of the natural rate of unemployment, such as increasing job-search costs or higher labor income taxes. The unemployment rate responds to this type of shock by converging slowly toward its new natural level, following the pattern illustrated in Figure 1. As labor employed declines toward its new steady-state level $\bar{l}$, output falls correspondingly.

Finally, the right panel of Table 6 describes the effects of a simultaneous decline of the steady-state demand and supply of labor, $\bar{l}$ and $\bar{l} + \zeta$, while keeping the natural rate of unemployment, $\zeta$, fixed. The effects of this negative shock to labor supply, which is summarized in Figure 2, are very similar to the previous case, except that the unemployment rate will be unaffected in the long run. Simultaneous shifts of the labor force and of the natural rate of unemployment (the difference between this and the previous scenario) are broadly neutral: they would produce no long-run effect on GDP, wages, etc., only an increase in the unemployment rate.

**Figure 1. Effects of an Increase in the Natural Rate of Unemployment**

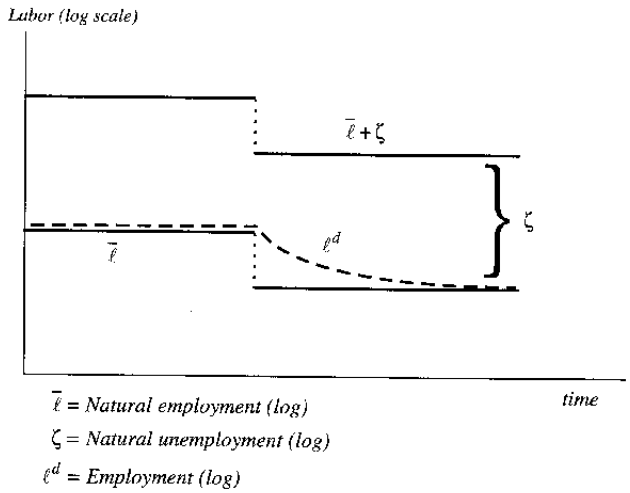



$\bar{\ell}$ = *Natural employment (log)*

$\zeta$ = *Natural unemployment (log)*

$\ell^d$ = *Employment (log)*

**Figure 2. Effects of a Decline in Labor Supply**




## Future Research

The analysis of the previous sections features a rather stylized treatment of technology. The current specification is only a first attempt to tackle the problem. In the future, it would be useful to consider a multilevel multi-input production technology to account more precisely for developments in primary goods markets. Following standard treatment, GNP would be produced with an intermediate input and a primary input (e.g., oil). The intermediate input, in turn, would be produced with capital and labor. Assuming a Cobb-Douglas or constant elasticity of substitution technology at each level of production should allow a rather simple and flexible treatment.

A natural extension would be to endogenize some of the determinants of the natural rate of unemployment. For instance, there is theoretical support and some empirical evidence of a positive correlation between taxes and the natural rate of unemployment.[12] It would be necessary to respecify some of the behavioral equations and to redefine data to account for taxation. Estimation of the model would provide a test of the cross-country evidence on the theoretical links between taxes and unemployment.

[12]See Pissarides (1985) for a reference model, and Adams and Coe (1990) and Coe and Krueger (1990) for empirical applications.

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# V

# An International Comparison of Tax Systems in Industrial Countries

*Enrique G. Mendoza, Assaf Razin, and Linda L. Tesar*[1]

The precise measurement of tax rates that affect economic decisions at the aggregate level is critical to the design of economic models that simulate the effects of fiscal policies. The extensive analytical work on the macroeconomic implications of different tax systems produced during the last decade, as reviewed in Frenkel and Razin (1987), emphasized the importance of modeling explicitly the structure of incentives and constraints under which households and firms formulate optimal plans in order to produce reliable assessments of the effects of policies. This is particularly true in an environment of increasing international economic integration.[2] The literature established that the models designed to simulate the effects of changes in fiscal policy must consider a realistic description of the rates of taxation prevailing in different countries before experimenting with alternative policies. The issue is particularly relevant in the context of current discussions on the implications of the convergence of fiscal policies envisaged for the European Community under the Maastricht Agreement and the agreements to harmonize indirect taxes, and on the effects of significant changes in the tax regime announced in the recent deficit-reduction plan for the United States.

Unfortunately, it is difficult to measure tax rates that are relevant for macroeconomic modeling. Many studies have been written on the measurement of effective *marginal* tax rates on labor and capital income.[3] Each constructs estimates of marginal tax rates by combining information on statutory tax rates, tax returns, and tax codes with data on income distribution, household surveys, and projections of real present values for investment projects in specific industries. However, as Frenkel, Razin, and Sadka (1991) argue, the complexity of tax credits and tax exemptions, as well as the numerous equivalences that link broad categories of taxes, makes constructing effective marginal tax rates that affect actual economic decisions at the aggregate level extremely difficult. It is also difficult to show that marginal tax rates that apply to particular individuals in a household survey, or a specific aggregation of incomes based on tax-bracket weights, are equivalent to the aggregate tax rates that affect macroeconomic variables as measured in conventional national accounts systems. Moreover, detailed time series and international cross-sectional applications of methods for computing effective marginal tax rates are seriously limited by the available data.

Lucas (1990) and (1991) and Razin and Sadka (forthcoming) have opted for an approach that produces effective *average* tax rates, for the taxes that generate the majority of the government's tax revenue, based on data on actual tax payments and national accounts. Their analysis suggests that these tax rates are useful approximations of the taxes that distort decisions by representative agents in macroeconomic models. Their method focuses on the information that national accounts data provide regarding post- and pre-tax prices and incomes, combined with figures that aggregate tax revenues by allocating them to taxes on consumption and factor incomes. This method, although less rigorous in the treatment of the tax laws, produces measures of the tax rates that are consistent with the representative agent assumption and, by looking at the aggregate data, it also takes into account the effective, overall tax burden resulting from each of the major tax categories (i.e., taxes on capital and labor income and taxes on consumption). In addition, this method is easier to implement in multi-country research projects because it exploits the international consistency of available data sources on national accounts and revenue statistics.

This paper describes an application of this method to compute time series of the effective average tax rates on consumption, capital income, and labor income for the group of seven largest indus-

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[2]See Frenkel, Razin, and Sadka (1991).

[3]For the United States, see Auerbach (1987), Barro and Sahasakul (1986), Joines (1981), and Seater (1985) and for other countries, King and Fullerton (1984), McKee, Visser, and Saunders (1986), OECD (1991b), and Carey, Chouraqui, and Hagemann (1993).

trial countries, using information publicly available from the Organization for Economic Cooperation and Development (OECD). Comparing these tax rates with some of the available estimates of effective marginal tax rates, we find that, despite differences, the tax rates reported here are within the ranges of marginal tax rate estimates and display similar trends. We also show that our estimates of the tax rates are generally consistent with some key predictions of macroeconomic models. In particular, in most countries, the savings rate is inversely related to the tax rate on capital income, the average number of hours worked is negatively correlated to the sum of the labor and consumption taxes, and the rate of unemployment is positively correlated with the labor income tax. The first two results are consistent with the intertemporal equilibrium model of savings in an open economy, as explained in Frenkel, Razin, and Sadka (1991); the second is consistent with models of equilibrium unemployment, or the "natural rate," as in Pissarides (1985) and Adams and Coe (1990). The investment rate is also inversely related to the capital income tax, reflecting the well-known positive correlation between savings and investment, and suggesting that the rates of taxation affecting the returns on foreign and domestic capital tend not to offset each other.

Comparing the data across countries, we find that when tax rates on capital income are above average, savings and investment rates tend to be below average, and when labor income taxes are relatively high, the rate of unemployment tends to be higher and the number of hours worked tends to be lower. The international cross-sectional and time-series information is combined in panel data tests to formalize the evidence obtained from the inspection of correlation coefficients. Finally, the cross-country analysis highlights important differences in the distribution of the tax burden on consumption, labor income, and capital income between North America, Japan, and Europe, which indicate the magnitude of adjustment that policies of tax harmonization may require. The analysis indicates that consumption taxes in the United States are significantly lower than in Canada and the European Community, but that increasing the U.S. consumption tax could result in a higher natural rate of unemployment and a reduction in the number of hours worked.

Our analysis of the interaction between computed tax rates and macroeconomic variables is only a rough first approximation that illustrates the empirical relevance of the method proposed. Mendoza and Tesar (1992) examine some of the implications of current policies of fiscal convergence in a model of business cycles for integrated economies using the tax rates reported in this study. Razin and Yuen (1992) study the extent to which these tax rates can explain the international convergence or divergence of growth patterns. Finally, the proposed tax rates are also being incorporated into the multi-country macroeconometric model of the International Monetary Fund (MULTIMOD) with the aim of producing policy simulations in which the short-run and long-run interactions of the tax rates with other macro-aggregates of interest are taken into account.

## A Methodology for Computing Effective Average Tax Rates

While the concept of the marginal tax rate that affects the decisions of economic agents is simple in theory, and quite easy to quantify at a microeconomic level, computing effective marginal tax rates that apply at a national or international level is quite difficult. Within one country, computing these tax rates is problematic (1) because tax revenue data and the tax system itself do not conform to the aggregate concepts of a macroeconomic model; (2) because the many exemptions and credits make it difficult to extrapolate the information from the statutory tax rates written in the law; (3) because equivalent effects may result from different types of taxes; and (4) because of the need to have available data on the distribution of income be consistent with systems of income tax and social security contributions. At an international level, differences in the structure of the tax systems and the limitations of the information available on tax revenues and income distribution further complicate the computation. Following Frenkel, Razin, and Sadka (1991) and Razin and Sadka (1993), we look at effective average tax rates based on actual tax payments and national accounts as a useful approach.

This section of the paper describes our method for computing effective average rates of taxation on consumption and the income derived from capital and labor services for the group of seven largest industrial countries. Using data from two publications by the Organization for Economic Cooperation and Development—*Revenue Statistics of OECD Member Countries*, OECD (1990) and *National Accounts: Volume II, Detailed Tables*, OECD (1991a)—we compute time series of the effective average tax rates for each country covering the period 1965–88. We use the same method as did Razin and Sadka (1993) to examine the structure of taxation in Israel,[4] which was based on guidelines suggested by Lucas (1990) and (1991).

[4]These authors start their analysis by examining the details of the Israeli tax laws, including credits and exemptions, and the effects of the inflation tax on measures of effective marginal tax rates on capital income similar to those of King and Fullerton (1984) and Auerbach (1987).

Razin and Sadka (1993) undertake a quantitative analysis of static and dynamic inefficiencies of taxation using a general equilibrium model of an economy inhabited by representative agents. Firms produce an aggregate consumption good using capital and labor services provided by households, and government levies ad valorem taxes on consumption, capital income, and labor income. Ad valorem tax rates are then derived as the ratio of *specific* tax rates (i.e., the difference between household and producer prices of each) to the producer prices. Calibration of the model using Israeli national accounts data on pre- and post-tax income and prices produces aggregate effective tax rates that correspond to realized average tax rates. Thus, the effective average tax rates aggregate the information on statutory taxes, credits, and exemptions implicit in national accounts in a manner that maintains consistency with the representative agent framework.

### Description of the Data

The four-digit codes listed below identify different measures of tax revenue and correspond to the codes used in the OECD's *Revenue Statistics*. The publication is extremely useful because it collects information on tax revenues from country sources and organizes it under a uniform format at the general government level and on a cash basis. Abbreviations in capitalized letters correspond to variables obtained from the OECD's *National Accounts: Volume II, Detailed Tables*. This publication also takes information from country sources and attempts to organize it under a common format. Of particular importance for computing tax rates are the data at the disaggregated level that it provides on the detailed accounts for households, corporate enterprises, and government. The data from both sources cover the period 1965–88. The key to the variables is as follows:

*Revenue Statistics Data*

1100 Taxes on income, profits, and capital gains of individuals
1200 Taxes on income, profits, and capital gains of corporations
2000 Total social security contributions
2200 Employer's contribution to social security
3000 Taxes on payroll and workforce
4100 Recurrent taxes on immovable property
4400 Taxes on financial and capital transactions
5110 General taxes on goods and services
5121 Excise taxes

*National Accounts Data*

$C$ = Private final consumption expenditure
$G$ = Government final consumption expenditure
$GW$ = Compensation of employees paid by producers of government services
$OSPUE$ = Operating surplus of private unincorporated enterprises
$PEI$ = Household's property and entrepreneurial income
$W$ = Wages and salaries
$OS$ = Total operating surplus

### Effective Average Consumption Tax Rate

In a simple equilibrium model of fiscal policy, where representative households purchase an aggregate consumption good and pay an ad valorem tax on their purchases, the consumption tax rate should correspond to the percentage difference between the post-tax price they pay and the pre-tax price at which firms supply the good. Thus, if we use the data collected from the OECD sources, the effective average tax rate on sales of consumption goods ($t_c$) can be computed as follows:

$$t_c = [(5110 + 5121)/(C + G - GW - 5110 - 5121)]*100. \quad (1)$$

The numerator is the revenue from indirect taxation (general taxes on goods and services plus excise taxes), which is equal, by definition, to the difference between the nominal value of aggregate consumption at pre-tax and post-tax prices. The denominator is the base of the tax, which is the pre-tax value of consumption—measured as post-tax consumption expenditures minus the revenue from indirect taxation. The formula takes advantage of the fact that nominal consumption expenditures in national accounts are at post-tax prices. Government consumption of goods must be included in the denominator because *Revenue Statistics* reports data on indirect tax revenue that includes taxes paid by government; however, this applies only to purchases of goods and nonfactor services. Hence, the compensation of government employees must be deducted from $G$. This formula is identical to the one used by McKee, Visser, and Saunders (1986) to compute the consumption tax that they incorporated in their calculations of effective marginal tax rates on labor income for OECD countries.

### Effective Average Labor Income Tax Rate

The effective average tax on labor income corresponds to the percentage difference between post- and pre-tax labor income. In practice, however, computing this average tax rate is difficult because of the manner in which data on income taxes and

other taxes based on labor income are reported. One common problem, which also affects most computations of effective marginal labor income tax rates,[5] is that tax revenue sources typically do not provide a breakdown of individual income tax revenue in terms of labor and capital income. We address this problem by assuming that all sources of the households' income are taxed at the same rate—an assumption which according to 1991 tax laws in OECD member countries is a good approximation.[6] Another concern is that, in addition to the individual income tax on wages, there are other important taxes based on labor income, such as social security contributions and payroll taxes. These are taken into account in the computations that follow.

We begin by computing the households' average tax rate on total income ($t_h$) as

$$t_h = [1100/(OSPUE + PEI + W)]*100. \quad (2)$$

Thus, the representative agent's income tax rate is the ratio of individual income tax revenue—which represents the difference between post-tax and pre-tax individual income—to pre-tax household income. The latter is defined as the sum of wage and nonwage individual income (i.e., the sum of wages and salaries, property and entrepreneurial income, and the operating surplus of private unincorporated enterprises).

Then we estimate the revenue from the income tax on wages and salaries as $t_h*W$ and we compute the effective average tax rate on labor income ($t_l$) as

$$t_l = [(t_h*W + 2000 + 3000)/(W + 2200)]*100. \quad (3)$$

In addition to the tax on wages and salaries, the calculation incorporates all social security contributions and payroll taxes, as part of the revenue derived from labor income taxes. It also makes a correction to expand the tax base to include the employers' contribution to social security—since households are not taxed on the portion of compensation to employees that represents social security contributions by firms.

### Effective Average Capital Income Tax Rate

Continuing under the assumption that all sources of the households' income are taxed uniformly, we estimate first the revenue from the capital income tax on individuals as $t_h*(OSPUE + PEI)$, and then we define the effective average capital income tax rate ($t_k$) as

$$t_k = t_h*(OSPUE + PEI) + 1200 + 4100 + 4400/OS*100. \quad (4)$$

This formula represents the difference between post-tax and pre-tax capital income divided over pre-tax capital income. The difference between post- and pre-tax capital income includes, in addition to the households' payments of capital income taxes, the payments of capital income taxes made by corporations,[7] all recurrent taxes on immovable property paid by households and others, and the revenue from specific taxes on financial and capital transactions. The pre-tax capital income, which serves as the base of the tax, is the operating surplus of the economy as a whole (gross output at producers' values less the sum of intermediate consumption, compensation of employees—which is wages and salaries plus employers' contributions to social security—consumption of fixed capital, and indirect taxes reduced by subsidies).

Charts 1–4 show the time series of the effective average tax rates on consumption, labor income, capital income, and corporate capital income for each of the seven largest industrial countries.

## A Comparison with Previous Work

The analytical framework from which the method for computing effective average tax rates was derived indicates that these tax rates are an accurate characterization of the wedge between pre-tax and post-tax prices in a representative agent, equilibrium model. Nevertheless, the method we presented does not consider explicitly the statutory tax rates and the peculiarities of the tax laws of each country, nor does it incorporate information on the income distribution according to income tax brackets and the schedule of social security taxes. These issues are examined thoroughly in the existing literature on the computation of effective marginal tax rates.

Consider first some of the studies that have focused on the computation of marginal labor income tax rates for the United States, as in Joines (1981), Seater (1985), and Barro and Sahasakul (1986).[8] These studies compute effective marginal tax rates by calculating weighted averages of tax rates, or tax bills, per tax bracket, using as weights

[5]As in McKee, Visser, and Saunders (1986); and Barro and Sahasakul (1986).

[6]See OECD (1991b).

[7]The average income tax rate on corporate capital can be computed in a similar manner by dividing the income tax bill of all corporate enterprises by the operating surplus of the corporate sector.

[8]For earlier studies of this issue see Seater (1982), Barro and Sahasakul (1983), and Wright (1969).

**Chart 1. Consumption Sales Tax**
*(In percent)*

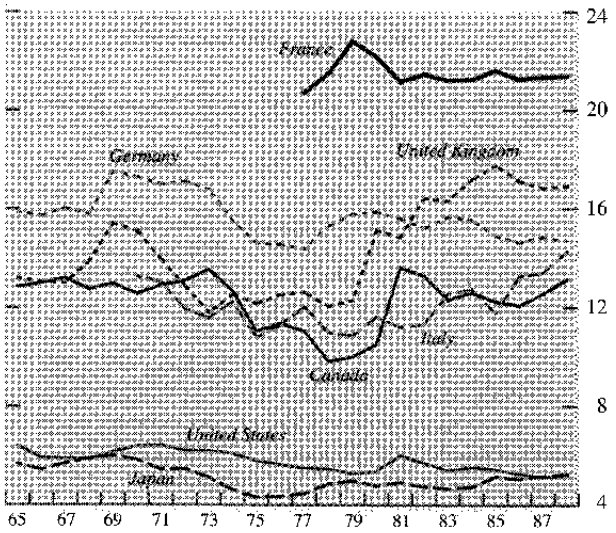



**Chart 2. Labor Income Tax**
*(In percent)*

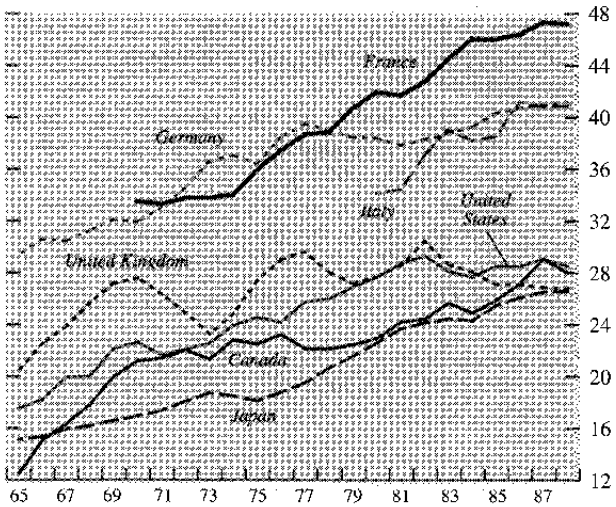
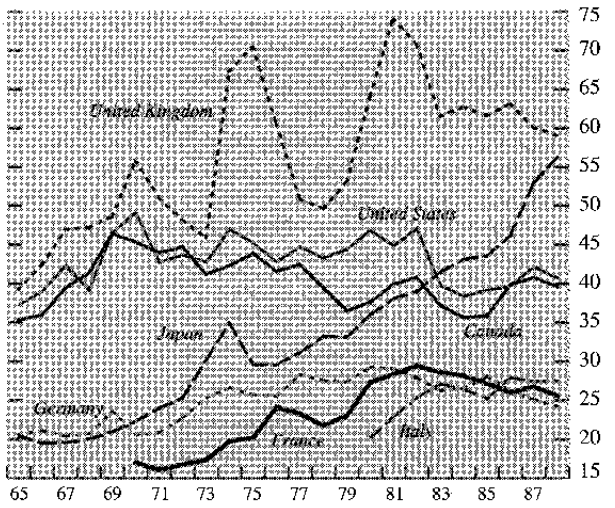



**Chart 3. Capital Income Tax**
*(In percent)*




average of the statutory tax rates listed in income tax schedules. All three authors face the problem of individual income tax revenue data not providing detail on the revenue derived from labor income and capital income separately. Seater and Barro and Sahasakul set aside this problem by focusing on tax rates for individuals, without distinguishing between capital and labor income; while Joines takes a similar approach to the one adopted here, by assuming that personal income tax rates apply uniformly to capital and labor income.

Chart 5 plots the available time series for the effective marginal tax rates on labor or individual income from the studies mentioned above, together

**Chart 4. Corporate Capital Income Tax**
*(In percent)*

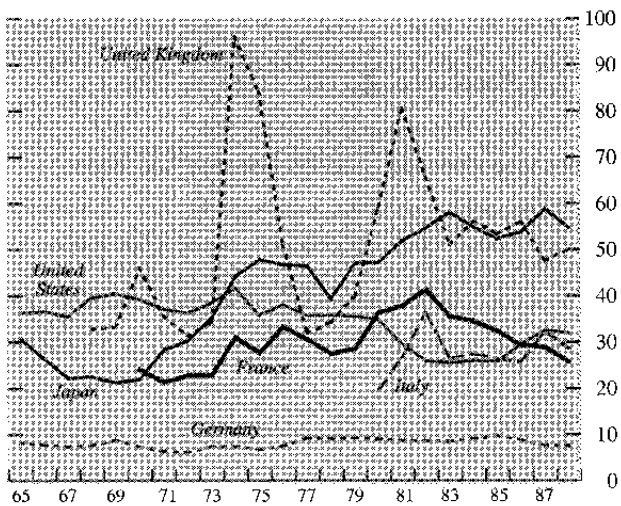
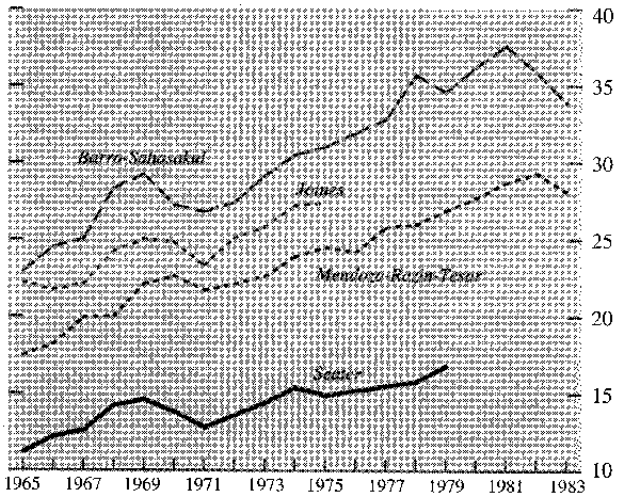


**Chart 5. Average and Marginal Labor Income Tax Rates**
*(In percent)*




with the effective average tax rate estimates reported earlier in the paper. The chart illustrates clearly that despite methodological differences, which result in noticeable differences in the level of the tax rates, the general trend of the four series listed is very similar. Nevertheless, it is important to try to account for the factors that explain the differences in levels because theory predicts that the level of the tax rates has important implications on economic behavior. The Barro-Sahasakul rates are the highest because, by focusing on statutory tax rates, they abstract from the information on tax credits and exemptions that estimates based on actual tax returns can capture. The tax rates that Seater estimated using actual tax returns are the lowest, but considering Joines's adjustments to take into account the number of returns per tax bracket and taxes that tend to be proportional to income—such as consumption taxes—the outcome is a series on labor income tax rates that is not very different from the effective average tax rates presented here. If the effective average consumption tax is added to the effective average labor income tax, the difference in Joines's marginal labor income tax is negligible.[9]

We focus now on international studies of effective marginal tax rates, in particular the study on capital and labor income taxes in OECD countries by McKee, Visser, and Saunders (1986), and the studies on effective tax rates on marginal investments by King and Fullerton (1984) and OECD (1991b). The tax rates on labor income constructed by McKee, Visser, and Saunders differ from those discussed above in that they do not represent weighted averages of tax-bracket data. Instead, their calculations are based on statutory taxes, tax returns, and post- and pre-tax labor income that apply at the level of the "Average Production Worker" (APW) as a reference for international comparisons.[10] Their estimates incorporate payroll taxes, social security contributions, income taxes, and consumption taxes, assuming that individuals do not collect capital income—so that statutory taxes on individual income and individual income tax returns can be treated as corresponding to labor income taxes. Two sets of tax rates are produced, corresponding to APWs that are single workers and APWs that are single-earner married couples with children, for the years 1979, 1981, and 1983. The limitations of the sample are due to restrictions imposed by data availability. As Table 1 shows, on a country-by-country basis, changes in the labor income tax rates computed by McKee, Visser, and Saunders coincide with the changes in the effective average tax rates computed here. Nevertheless, these authors' estimates are generally higher than those computed here. The bias reflects in part the addition of individual capital income tax as part of the labor income tax, and is also an indication of the relative position of the hypothetical APW in each country's tax schedule and income distribution.

The international studies on capital income taxation by McKee, Visser, and Saunders (1986) and OECD (1991b) are based on a methodology originally developed in the work of King and Fullerton (1984). This method computes rates of taxation on marginal investments as the percentage difference between post- and pre-tax net rates of return on specific investment projects. The pre-tax real rate of return is defined as the value of the marginal rate of return that equates the expected discounted present value of the future stream of after-tax profits of the project with its cost, net of grants and allowances, and after deducting the rate of depreciation. The procedure requires, therefore, that researchers obtain information on the statutory taxes on corporate and individual capital income according to ownership institutions, industries, and form of income (i.e., interest, dividends, or retained earn-

[9]Joines (1981) also constructed estimates of the effective marginal tax rate on capital income by computing a weighted average of proportional and nonproportional capital income taxes. The nonproportional tax is assumed to be identical to the federal personal income tax, and the proportional taxes include sales taxes, property taxes, corporate income taxes, and state and local income taxes. Joines's estimates are slightly higher than those reported in the paper for the effective average tax rate on capital income, but the two series display similar trends. The difference between the two estimates is minimal if the average sales tax is added to the average capital income tax.

[10]The APW income is the average of earnings of production workers in the manufacturing sector.

**Table 1. Comparison of Average Tax Rates on Labor Income**

| | Mendoza-Razin-Tesar[1] | | | McKee-Visser-Saunders[2] | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Single worker APW | | | Married couple APW | | |
| Country | 1979 | 1981 | 1983 | 1979 | 1981 | 1983 | 1979 | 1981 | 1983 |
| Canada | 32.4 | 37.8 | 38.0 | 43.3 | 45.1 | 42.7 | 41.1 | 43.0 | 42.7 |
| France | 63.5 | 62.9 | 65.7 | 66.9 | 66.7 | 68.8 | 57.5 | 57.2 | 59.7 |
| Germany | 54.3 | 53.5 | 54.5 | 61.1 | 60.5 | 60.4 | 56.8 | 56.4 | 57.0 |
| Italy | 45.4 | 45.7 | 51.7 | 56.3 | 59.5 | 62.7 | 56.3 | 59.5 | 62.7 |
| Japan | 26.6 | 28.6 | 29.2 | 40.5 | 43.9 | 43.7 | 35.9 | 39.4 | 39.9 |
| United Kingdom | 39.5 | 43.2 | 45.0 | 51.5 | 53.4 | 54.5 | 51.5 | 53.4 | 54.5 |
| United States | 32.2 | 34.7 | 33.5 | 47.1 | 52.9 | 48.6 | 40.2 | 45.2 | 42.6 |

[1]Including effective average sales tax.
[2]McKee, Visser, Saunders (1986).

ings), as well as information on application of taxes, credits, and exemptions according to form of financing and accounting of depreciation. Moreover, the computation of real internal rates of return also requires assumptions regarding the expected path of the rate of inflation and the market discount factor.

The tax rates computed in the three studies just mentioned illustrate strengths and weaknesses of the King-Fullerton approach. The tax rates differ very significantly depending on the sector to which investment is going, on whether, within each sector, it is oriented toward equipment, structures, or inventories, on whether it is financed by debt, new share issues, or retained earnings, on whether it is undertaken by firms owned by households subject to personal income taxes or by tax-exempt institutions, and on the assumed inflation and market discount rates. For instance, McKee, Visser, and Saunders show that for the United States in 1983, the tax rate on investments in manufacturing, assuming inflation fixed at 8.3 percent, varies from −137.8 percent, for equipment investments by tax-exempt institutions incurring debt, to 97.1 percent for investments in structures financed by household-owned firms issuing new shares.

While this methodology provides accurate measures of the effective marginal tax on specific investments, which can be compared across industries and across countries, it is nonetheless difficult to introduce into a macroeconomic model for explaining aggregate investment and saving decisions. Moreover, the assumptions of perfect foresight regarding the future paths of profits and prices seem difficult to integrate with the uncertain environment that modern macroeconomic models emphasize.

## Stylized Facts of Effective Average Tax Rates

In this section, the empirical regularities that characterize the effective average tax rates and their co-movements with other key macroeconomic aggregates are examined. The analysis serves two purposes. First, it provides some informal evidence on the empirical regularities that distinguish the tax systems across large industrial countries. Second, it gives some insight into the potential empirical relevance of effective average tax rates for macroeconomic modelling. The second goal is accomplished by contrasting the co-movements we find between our estimates of the tax rates and data on macroeconomic variables with basic implications derived from theory. However, the results of this analysis must be interpreted carefully because they are intended only to establish whether effective average tax rates "make sense," in the sense that they do not produce empirical puzzles, without providing substantial evidence for or against any particular model.

There are three basic theoretical implications regarding the connection between taxes and macroeconomic variables that we examine here. The first two follow from intertemporal equilibrium models of the open economy. In these models, as Frenkel, Razin, and Sadka (1991) explain, the capital income tax distorts savings decisions by taxing the benefits obtained from postponing consumption. An increase in the rate of the capital income tax lowers the intertemporal relative price of consumption, inducing agents to increase current consumption and reduce savings. In contrast, investment should not be significantly affected by capital income taxation to the extent that financial capital is mobile across countries, physical capital is not costly to adjust, and the returns on domestic and foreign investments are taxed uniformly. If there are capital-adjustment costs, capital income taxes affect investment depending on whether it is equity- or debt-financed.[11] Hence, we examine whether the

[11]In general, assuming taxes are constant over time, it is only when firms retain profits and issue equity that investment would be independent of the tax structure (see Frenkel, Razin, and Sadka (1991), Chapter 5).

capital income tax rate and the savings rate are negatively correlated, and we also study the co-movement between investment and the capital income tax.

The second implication of the neoclassical framework that we examine is that taxes on consumption and labor reduce the price of leisure time relative to consumption. As these two tax rates rise, households substitute consumption for leisure and devote less time to work. Thus, we study whether the sum of the labor and consumption tax rates is negatively correlated with the number of hours worked per worker.[12] Finally, we also examine a prediction of equilibrium models of unemployment as that of Pissarides (1985), which has also been examined in the empirical literature on the natural rate of unemployment.[13] In Pissarides' search framework, given tax-free unemployment compensation, firms cannot pass the effect of an increase in the rate of labor income tax entirely to workers, and hence wage costs to firms increase with the tax and result in a decline in profits and vacancies and higher equilibrium unemployment. We examine, then, whether the rate of unemployment is positively related to the labor income tax, particularly in the absence of cyclical effects.

Charts 1–4 illustrate some important stylized facts of taxation in industrial countries. First, effective average tax rates have fluctuated markedly since 1965 mainly in response to both long-term fiscal reforms and short-term policy changes in statutory taxes, tax credits, and exemptions, and also to some extent in response to cyclical effects affecting the data on tax revenues and the measures of tax bases described earlier.[14] While tax rates on consumption and capital income appear to be stationary (except for the tax rate on capital income in Japan), the effective average tax rate on labor income has followed an increasing trend in all countries. Second, cross-country differences in tax rates, particularly labor income tax rates, have narrowed considerably in recent years relative to the late 1960s.

Nevertheless, as of 1988 one can still identify clear differences in the various tax systems, and, in general, it is observed that countries that tax more (less) consumption and labor income tend to tax less (more) capital income. The rate of taxation on consumption is significantly lower in Japan and the United States than in the rest of the countries examined. The tax rates on labor income can be divided into three groups—four countries with a rate between 26 and 28 percent (Canada, Japan, the United Kingdom, and the United States), two with a rate of about 41 percent (Germany and Italy), and one with a rate of nearly 47 percent (France). Similarly, taxes on capital income can also be broken down in three groups. The capital income tax rate is significantly higher, at about 57 percent, in the United Kingdom and Japan than in the other countries.[15] In Canada and the United States capital income is taxed at about 40 percent, while in France, Germany, and Italy, that tax rate is around 25–28 percent. A comparison of Charts 3 and 4 suggests also that the mix between corporate and individual capital income taxes has shifted over time in most countries.

Tables 2 and 3 report the arithmetic means of the effective average tax rates in each country and their co-movement with savings, investment, net exports, unemployment, trend unemployment—as a proxy for the natural rate of unemployment—and hours worked.[16] These statistics only provide a general idea of how taxes and other macroeconomic variables differ across countries on average, and how they move within each country over time; they must be interpreted with caution because some of the series, in particular the labor income tax rates, do not appear to be stationary in the sample under study. An examination of the co-movement of the tax rates and macroeconomic variables at business cycle frequencies, using filters to separate trend and cyclical components, is undertaken later in this section.

With regard to time-series co-movements within each country, Table 2 shows that the tax rate on

[12]Note that the two co-movements identified in this paragraph emphasize only substitution effects resulting from a specific tax adjustment. The equilibrium co-movements observed in the data, however, reflect the outcome of income and substitution effects that result not only from changes in one tax rate, but also from other exogenous variables—such as other tax changes, productivity disturbances or terms of trade shocks. For a formal analysis of this issue see Mendoza and Tesar (1992).

[13]See, for example, Adams and Coe (1990).

[14]Fluctuations in the corporate income tax rate of the United Kingdom are particularly notorious. The sharp increases following the oil price shocks reflect increases in tax revenue from the petroleum revenue tax and the supplementary petroleum duty (see OECD (1990), p. 136), as well as declines in the aggregate operating surplus of corporations due to the recession induced by those shocks. Nevertheless, the corporate income tax during the period 1973–82 was centered around 52 percent, which was in line with the statutory General Corporate Tax prevailing at that time.

[15]The striking pattern of the average capital income tax rate in Japan, which unlike in the other countries has increased in a sustained manner since 1965, is an interesting fact to examine by itself in light of the impressive growth performance of the country over the same period.

[16]Data on national accounts aggregates were obtained from OECD (1991a) and data on hours worked, which correspond to an index of hours worked per employee in the manufacturing sector, were obtained from Bureau of Labor Statistics (United States (1992b)).

**Table 2. Savings, Investment, Net Exports, and Capital Income Tax Rates**

| Country | Savings/GDP Ratio | | Investment/GDP Ratio | | Net Exports/ GDP Ratio | | Capital Tax Rate |
|---|---|---|---|---|---|---|---|
| | Mean | Corr. ($tk$)[1] | Mean | Corr. ($tk$)[1] | Mean | Corr. ($tk$) | Mean |
| United States | 0.17 | 0.32 | 0.18 | 0.11 | −0.01 | 0.34 | 0.43 |
| United Kingdom | 0.18 | −0.23 | 0.18 | −0.37 | — | 0.09 | 0.56 |
| Germany | 0.25 | −0.85 | 0.22 | −0.69 | 0.03 | −0.11 | 0.25 |
| Italy | 0.21 | −0.43 | 0.21 | −0.93 | — | 0.95 | 0.26 |
| France | 0.23 | −0.95 | 0.22 | −0.81 | 0.01 | −0.53 | 0.24 |
| Japan | 0.33 | −0.45 | 0.31 | −0.58 | 0.02 | 0.36 | 0.33 |
| Canada | 0.24 | −0.12 | 0.22 | 0.11 | 0.02 | −0.24 | 0.40 |

Note: Data are for the period 1965–88, except for Italy (1980–88) and France (1970–88).
[1]Contemporaneous correlation with the capital income tax rate.

**Table 3. Unemployment, Hours Worked, Consumption Tax, and Labor Income Tax**

| Country | Unemployment Rate | | Trend Unemployment[2] | | Hours[4] | | Consumption Tax | Labor Income Tax |
|---|---|---|---|---|---|---|---|---|
| | Mean | Corr. ($tl$)[1] | Mean | Corr. ($tl$)[3] | Mean | Corr. ($tc+tl$)[5] | Mean | Mean |
| United States | 6.20 | 0.74 | 6.30 | 0.93 | 104.7 | −0.76 | 5.77 | 24.77 |
| United Kingdom | 5.26 | 0.56 | 5.03 | 0.60 | 104.8 | −0.71 | 14.37 | 26.63 |
| Germany | 3.73 | 0.83 | 3.65 | 0.90 | 105.1 | −0.92 | 15.68 | 36.45 |
| Italy | 10.09 | 0.95 | 9.97 | 0.95 | 101.3 | 0.66 | 12.47 | 38.27 |
| France | 8.07 | 0.98 | 7.83 | 0.99 | 102.2 | −0.86 | 21.49 | 43.49 |
| Japan | 1.90 | 0.94 | 1.86 | 0.97 | 102.6 | −0.49 | 5.12 | 20.47 |
| Canada | 7.18 | 0.80 | 7.14 | 0.91 | 104.0 | −0.73 | 12.30 | 22.30 |

Note: Data are for the period 1965–88, except for Italy (1980–88) and France (1977–88).
[1]Correlation between the unemployment rate and the labor income tax rate.
[2]Trend defined as the trend component of data filtered using the Hodrick-Prescott filter with the smoothing parameter set at 100.
[3]Correlation between trend unemployment and the labor income tax rate.
[4]Average annual hours in manufacturing (index, 1982 = 100).
[5]Correlation between hours and the sum of the labor income and consumption tax rates.

capital income is generally negatively correlated with savings and investment rates, while the correlation between the capital income tax and the net exports-output ratio is positive or negative, depending on the size of the correlations of the tax with investment and savings. Table 3 indicates that the tax rate on labor income moves closely with actual and trend unemployment rates, and hours worked are negatively correlated with the sum of labor and consumption tax rates in all countries except Italy. The time-series correlations between capital income tax and savings, between labor-plus-consumption tax and hours worked, and between labor income tax and unemployment are in line with the theoretical predictions mentioned earlier. The observed negative co-movement between investment and the capital income tax rate is more difficult to interpret. It reflects in part the well-known positive correlation between savings and investment (see Obstfeld (1986)), but it may also be an indication of the degree to which rates of taxation on domestic corporate income and foreign capital income differ, or, assuming capital is costly to adjust, the extent to which the structures of taxation and investment financing vary across countries.

Cross-country comparisons of the mean tax rates in Tables 2 and 3 confirm most of the differences in the structure of the tax systems identified earlier in Charts 1–4. Cross-country comparisons also suggest that higher savings and investment rates tend to be associated with lower capital income tax rates, higher rates of taxation on labor income tend to coexist with higher unemployment rates, and higher consumption and labor income taxes coincide with less hours worked—with the notable exception of Germany.

Tables 4 and 5 list cyclical co-movements between the tax rates, net exports, savings, investment, hours worked, and unemployment. Cyclical components for the correlations in Table 4 have been obtained using the Hodrick-Prescott filter with the smoothing parameter set at 100, while the correlations in Table 5 correspond to first-differenced data. These cyclical correlations are qualitatively similar to the correlations obtained from the original data, but quantitatively are much weaker. Using

the Hodrick-Prescott filter, savings and investment rates, as well as the ratio of net exports to output, are weakly negatively correlated, or uncorrelated, with the capital income tax rate in most countries. Unemployment rates are weakly positively correlated with the labor income tax in three countries (Italy, the United Kingdom, and the United States), while the other countries—except Japan—display almost no cyclical correlation between the two variables. Hours worked are significantly negatively correlated with the consumption-labor tax in the United States and Canada, almost uncorrelated in the United Kingdom, Italy, and France, and positively correlated in Germany and Japan. Table 5 reports similar results using first-differenced data, although the magnitude of some correlation coefficients is noticeably different. Overall, these cyclical co-movement indicators suggest that, while there are no obvious anomalies in the co-movement of tax rates and macroeconomic aggregates during business cycles, the link between the two sets of variables seems stronger at frequencies lower than business cycle frequencies. This is a reasonable result in view of the fact that changes in tax policy need approval of legislative bodies in most countries, and hence tax rates are not likely to fluctuate significantly at business cycle frequencies.

The stylized facts documented above provide some crude evidence on the extent to which effective average tax rates help explain the behavior of savings, investment, unemployment, hours worked, and the balance of trade. We try to formalize this evidence by applying panel data econometric techniques that combine the time-series and cross-sectional information on tax rates and macroeconomic variables. The data is pooled by stacking the time series of each of the seven countries in the sample, and then we estimate basic pooled (total), between means, fixed effects, random effects, and country independent models. The regressions for which each model is estimated are (1) the savings rate on the capital income tax rate; (2) the invest-

**Table 4. Cyclical Correlations of Savings, Investment, Net Exports, Hours Worked, and Unemployment with Effective Average Tax Rates[1]**

*(Based on Hodrick-Prescott filter)*

| Country | Savings–Capital Tax | Investment–Capital Tax | Net Export–Capital Tax | Hours Worked–Labor Consumption Tax | Unemployment–Labor Tax |
|---|---|---|---|---|---|
| United States | 0.09 | −0.19 | 0.37 | −0.74 | 0.11 |
| United Kingdom | −0.19 | −0.01 | −0.13 | −0.01 | 0.32 |
| Germany | −0.30 | −0.19 | −0.04 | 0.45 | 0.01 |
| Italy | 0.55 | −0.60 | 0.64 | 0.05 | 0.15 |
| France | −0.80 | 0.03 | −0.73 | −0.01 | 0.07 |
| Japan | 0.05 | 0.36 | −0.39 | 0.67 | −0.46 |
| Canada | −0.17 | −0.07 | −0.08 | −0.27 | −0.02 |

[1]Savings, investment, and net exports as a share of GDP. Savings equals GDP minus private and public consumption. All data are detrended using the Hodrick-Prescott filter with the smoothing parameter set at 100. Hours worked are logged prior to detrending. Data cover the period 1965–88, except for Italy (1980–88) and for France (1970–88 for savings, investment, and capital tax rate, and 1977–88 for unemployment, hours worked, and labor and consumption tax rates).

**Table 5. Cyclical Correlations of Savings, Investment, Net Exports, Hours Worked, and Unemployment with Effective Average Tax Rates[1]**

*(Based on first-differenced data)*

| Country | Savings–Capital Tax | Investment–Capital Tax | Net Export–Capital Tax | Hours Worked–Labor Consumption Tax | Unemployment–Labor Tax |
|---|---|---|---|---|---|
| United States | −0.12 | −0.24 | 0.17 | −0.62 | 0.16 |
| United Kingdom | −0.10 | 0.05 | −0.10 | −0.14 | 0.34 |
| Germany | −0.18 | −0.17 | 0.02 | 0.47 | −0.30 |
| Italy | 0.71 | −0.71 | 0.85 | 0.25 | 0.63 |
| France | −0.81 | 0.26 | −0.79 | −0.03 | 0.28 |
| Japan | 0.09 | 0.33 | −0.28 | 0.48 | −0.22 |
| Canada | −0.23 | 0.08 | −0.27 | −0.21 | −0.07 |

[1]Savings, investment, and net exports as a share of GDP. Savings equals GDP minus private and public consumption. All data are detrended by first differencing. Hours worked are logged prior to detrending. Data cover the period 1965–88, except for Italy (1980–88) and for France (1970–88 for savings, investment, and capital tax rate, and 1977–88 for unemployment, hours worked, and labor and consumption tax rates).

**Table 6. Panel Data Tests: Regression of Savings Rate on Capital Income Tax Rate**
*(Time trend excluded)*[1]

| Model | Intercept | Slope | *F*-Test Against | | Hausman Test | $\bar{R}^2$ | *SSR* |
|---|---|---|---|---|---|---|---|
| | | | Total | Independent | | | |
| Total | 0.301 | −0.192 | — | 129.52* | — | 0.211 | 0.325 |
| | (25.670)* | (−6.345)* | | **12,134** | | | |
| Means | 0.292 | −0.180 | — | — | — | 0.016 | 0.013 |
| | (4.613)* | (−1.048) | | | | | |
| Fixed Effects | — | −0.102 | 169.85* | 11.653* | — | 0.089 | 0.039 |
| | | (−4.619)* | **6,140** | **6,134** | | | |
| Random Effects | 0.265 | −0.103 | — | — | 0.0 | 0.101 | 0.041 |
| | (14.159)* | (−4.634)* | | | **1** | | |
| Independent | | | | | | | |
| United States | 0.101 | 0.170 | — | — | — | 0.061 | 0.006 |
| | (2.183) | (1.578) | | | | | |
| United Kingdom | 0.200 | −0.032 | — | — | — | 0.011 | 0.004 |
| | (12.097)* | (−1.121) | | | | | |
| France | 0.344 | −0.503 | — | — | — | 0.893 | 0.001 |
| | (35.100)* | (−12.283)* | | | | | |
| Germany | 0.393 | −0.585 | — | — | — | 0.704 | 0.003 |
| | (19.910)* | (−7.468)* | | | | | |
| Italy | 0.240 | 0.116 | — | — | — | 0.073 | 0.003 |
| | (10.29)* | (−1.276) | | | | | |
| Canada | 0.252 | −0.040 | — | — | — | 0.013 | 0.003 |
| | (8.532)* | (−0.549) | | | | | |
| Japan | 0.359 | −0.094 | — | — | — | 0.168 | 0.009 |
| | (26.240)* | (−2.379)* | | | | | |

[1]Numbers in parentheses are *t*-statistics. Numbers in bold are degrees of freedom for numerator and denominator of *F*-tests or for the Hausman test of the fixed versus random effects models. An asterisk denotes statistical significance at the 5 percent level.

ment rate on the capital income tax rate; (3) the ratio of net exports to output on the capital income tax rate; (4) the rate of unemployment on the labor income tax rate; and (5) the index of hours worked on the sum of the labor income tax and the consumption tax. The models were also estimated using a time trend to account for the problem of non-stationarity in some of the variables involved—particularly in the case of the labor income tax rates. The basic statistics describing the results of these tests are presented in Tables 6–15. Table 16 reports additional information combining cross-sectional and time-series data by computing co-movements of some of the time series in terms of deviations from the average for the group of seven in each year.

The results of the panel tests indicate that there is statistically significant evidence of a negative relationship between the savings rate, or the investment rate, and the capital income tax rate, and between hours worked and the consumption-labor tax, as well as a positive link between unemployment and the labor income tax. These effects are estimated with more precision in the total regressions involving the time series of the seven countries, while regressions based on country means generally produce slope coefficients that are not significantly different from zero. Both fixed effects (common slope coefficients, fixed intercepts) and random effects (common slopes, random intercepts) models generally produce statistically significant coefficients with the expected signs when the time trend is ignored, but in the regressions with time trends the standard errors are too large to reject the hypothesis that the slope coefficients are not zero. Thus, the panel tests also support the view that the link between macroeconomic variables and tax rates is stronger at low frequencies. Moreover, given the differences in tax structures discussed above, it is not surprising that most of the hypothesis tests that evaluate whether the slope coefficients, the intercepts, or all parameter estimates are equal across countries produce negative results. Hence, while the pooled data indicate that increases in the capital tax rate have adverse effects on savings and investment, increases in the consumption or labor income tax reduce hours worked, and increases in the labor income tax result in an increase in unemployment, the magnitude of these effects seems to differ across countries.

The results of the independent model regressions reported in Tables 6–15 give support to the argument that the effects of changes in taxes on macroeconomic variables differ significantly across countries. Note that in each of these regressions, the slope coefficients are statistically different from

**Table 7. Panel Data Tests: Regression of Investment Rate on Capital Income Tax Rate**
*(Time trend excluded)*[1]

| Model | Intercept | Slope | *F*-Test Against | | Hausman Test | $\bar{R}^2$ | *SSR* |
|---|---|---|---|---|---|---|---|
| | | | Total | Independent | | | |
| Total | 0.282 | −0.159 | — | 87.32* | — | 0.184 | 0.262 |
| | (26.810)* | (−5.848)* | | **12,134** | | | |
| Means | 0.274 | −0.142 | — | — | — | — | 0.097 |
| | (4.959)* | (−0.957) | | | | | |
| Fixed Effects | — | −0.126 | 131.57* | 7.339* | — | 0.148 | 0.040 |
| | | (−5.708)* | **6,140** | **6,134** | | | |
| Random Effects | 0.268 | 0.126 | — | — | 0.0 | 0.163 | 0.041 |
| | (15.830)* | (−5.675)* | | | **1** | | |
| Independent | | | | | | | |
| United States | 0.170 | 0.031 | — | — | — | — | 0.002 |
| | (6.858)* | (0.536) | | | | | |
| United Kingdom | 0.212 | −0.050 | — | — | — | 0.095 | 0.003 |
| | (13.787)* | (−1.849) | | | | | |
| France | 0.316 | −0.393 | — | — | — | 0.630 | 0.003 |
| | (18.921)* | (−5.629)* | | | | | |
| Germany | 0.353 | −0.528 | — | — | — | 0.453 | 0.006 |
| | (11.890)* | (−4.480)* | | | | | |
| Italy | 0.374 | −0.622 | — | — | — | 0.837 | 0.007 |
| | (15.155)* | (−6.483)* | | | | | |
| Canada | 0.203 | 0.054 | — | — | — | — | 0.005 |
| | (4.973) | (0.539) | | | | | |
| Japan | 0.360 | −0.140 | — | — | — | 0.312 | 0.010 |
| | (25.155)* | (−3.379)* | | | | | |

[1]Numbers in parentheses are *t*-statistics. Numbers in bold are degrees of freedom for numerator and denominator of *F*-tests or for the Hausman Test of the fixed versus random effects models. An asterisk denotes statistical significance at the 5 percent level.

**Table 8. Panel Data Tests: Regression of Net Exports-Output Ratio on Capital Income Tax Rate**
*(Time trend excluded)*[1]

| Model | Intercept | Slope | *F*-Test Against | | Hausman Test | $\bar{R}^2$ | *SSR* |
|---|---|---|---|---|---|---|---|
| | | | Total | Independent | | | |
| Total | 0.019 | −0.033 | — | 8.692* | — | 0.051 | 0.044 |
| | (4.324)* | (−2.974)* | | **12,134** | | | |
| Means | 0.018 | −0.037 | — | — | — | — | 0.001 |
| | (1.221) | (−0.900) | | | | | |
| Fixed Effects | — | −0.024 | 13.982* | 2.502* | — | — | 0.027 |
| | | (1.318) | **6,140** | **6,134** | | | |
| Random Effects | 0.002 | 0.011 | — | — | 3.240 | — | 0.029 |
| | (0.243) | (0.650) | | | **1** | | |
| Independent | | | | | | | |
| United States | −0.068 | 0.139 | — | — | — | 0.074 | 0.004 |
| | (−1.919) | (1.687) | | | | | |
| United Kingdom | −0.011 | 0.017 | — | — | — | — | 0.007 |
| | (−0.497) | (0.430) | | | | | |
| France | 0.028 | −0.110 | — | — | — | 0.233 | 0.001 |
| | (2.671)* | (−2.543)* | | | | | |
| Germany | 0.039 | −0.057 | — | — | — | — | 0.005 |
| | (1.456) | (−0.524) | | | | | |
| Italy | −0.133 | 0.506 | — | — | — | 0.890 | 0.000 |
| | (−8.304)* | (8.109)* | | | | | |
| Canada | 0.049 | −0.095 | — | — | — | 0.012 | 0.004 |
| | (1.466) | (−1.137) | | | | | |
| Japan | −0.001 | 0.046 | — | — | — | 0.092 | 0.004 |
| | (−0.159) | (1.832) | | | | | |

[1]Numbers in parentheses are *t*-statistics. Numbers in bold are degrees of freedom for numerator and denominator of *F*-tests or for the Hausman Test of the fixed versus random effects models. An asterisk denotes statistical significance at the 5 percent level.

**Table 9. Panel Data Tests: Regression of Unemployment Rate on Labor Tax Rate**
*(Time trend excluded)*[1]

| Model | Intercept | Slope | *F*-Test Against | | Hausman Test | $\bar{R}^2$ | *SSR* |
|---|---|---|---|---|---|---|---|
| | | | Total | Independent | | | |
| Total | 0.756 | 0.160 | — | 30.753* | — | 0.160 | 1275.4 |
| | (0.851) | (5.380)* | | **12,134** | | | |
| Means | 1.870 | 0.132 | — | — | — | 0.010 | 33.6 |
| | (0.470) | (1.019) | | | | | |
| Fixed Effects | — | 0.476 | 29.231* | 4.623* | — | 0.501 | 410.1 |
| | | (12.440)* | **6,140** | **6,134** | | | |
| Random Effects | −7.479 | 0.445 | — | — | 120.61* | 0.474 | 448.9 |
| | (−5.032)* | (11.643)* | | | **1** | | |
| Independent | | | | | | | |
| United States | −2.602 | 0.355 | — | — | — | 0.525 | 32.5 |
| | (−1.505) | (5.143)* | | | | | |
| United Kingdom | −17.154 | 0.842 | — | — | — | 0.284 | 195.0 |
| | (−2.427)* | (3.184)* | | | | | |
| France | −16.849 | 0.575 | — | — | — | 0.978 | 3.3 |
| | (−20.69)* | (28.577)* | | | | | |
| Germany | −18.891 | 0.620 | — | — | — | 0.674 | 56.8 |
| | (−5.795)* | (6.974)* | | | | | |
| Italy | −9.757 | 0.519 | — | — | — | 0.893 | 1.6 |
| | (−4.035)* | (8.223)* | | | | | |
| Canada | −3.943 | 0.499 | — | — | — | 0.625 | 49.6 |
| | (−2.190)* | (6.268)* | | | | | |
| Japan | −1.125 | 0.148 | — | — | — | 0.874 | 1.0 |
| | (−4.634)* | (12.654)* | | | | | |

[1]Numbers in parentheses are *t*-statistics. Numbers in bold are degrees of freedom for numerator and denominator of *F*-tests or for the Hausman Test of the fixed versus random effects models. An asterisk denotes statistical significance at the 5 percent level.

**Table 10. Panel Data Tests: Regression of Hours Worked on the Sum of the Consumption and Labor Tax Rates**
*(Time trend included)*[1]

| Model | Intercept | Slope | *F*-Test Against | | Hausman Test | $\bar{R}^2$ | *SSR* |
|---|---|---|---|---|---|---|---|
| | | | Total | Independent | | | |
| Total | 106.2 | −0.059 | — | 19.661* | — | 0.027 | 2122.1 |
| | (95.29)* | (−2.218)* | | **12,127** | | | |
| Means | 104.9 | −0.032 | — | — | — | — | 12.1 |
| | (51.27)* | (−0.692) | | | | | |
| Fixed Effects | — | −0.685 | 17.005* | 13.063* | — | 0.365 | 1200.9 |
| | | (−9.350)* | **6,133** | **6,127** | | | |
| Random Effects | 119.1 | −0.366 | — | — | 57.521* | 0.610 | 1568.8 |
| | (42.86)* | (−6.103)* | | | **1** | | |
| Independent | | | | | | | |
| United States | 119.7 | −0.492 | — | — | — | 0.560 | 46.2 |
| | (43.61)* | (−5.512)* | | | | | |
| United Kingdom | 138.4 | −0.821 | — | — | — | 0.485 | 192.3 |
| | (19.50)* | (−4.759)* | | | | | |
| France | 160.8 | −0.903 | — | — | — | 0.719 | 30.0 |
| | (14.79)* | (−5.401)* | | | | | |
| Germany | 195.4 | −1.731 | — | — | — | 0.837 | 135.5 |
| | (23.58)* | (−10.913)* | | | | | |
| Italy | 77.8 | 0.463 | — | — | — | 0.353 | 28.5 |
| | (7.66)* | (2.317)* | | | | | |
| Canada | 118.3 | −0.414 | — | — | — | 0.514 | 53.4 |
| | (41.32)* | (−5.033)* | | | | | |
| Japan | 115.7 | −0.511 | — | — | — | 0.207 | 256.7 |
| | (23.17)* | (−2.645)* | | | | | |

[1]Numbers in parentheses are *t*-statistics. Numbers in bold are degrees of freedom for numerator and denominator of *F*-tests or for the Hausman Test of the fixed versus random effects models. An asterisk denotes statistical significance at the 5 percent level.

**Table 11. Panel Data Tests: Regression of Savings Rate on Capital Income Tax Rate**
*(Time trend included)*[1]

| Model | Intercept | Slope | Trend | *F*-Test Against | | Hausman Test | $\bar{R}^2$ | *SSR* |
|---|---|---|---|---|---|---|---|---|
| | | | | Total | Independent | | | |
| Total | 0.389 | −0.182 | −0.001 | — | 108.84* | — | 0.228 | 0.316 |
| | (8.890)* | (−6.031)* | (−2.084 | | **18,127** | | | |
| Means | 1.030 | −0.284 | −0.009 | — | — | — | 0.053 | 0.010 |
| | (1.519) | (−1.470) | (−1.093) | | | | | |
| Fixed Effects | — | −0.015 | −0.002 | 228.18* | 5.439* | — | 0.320 | 0.029 |
| | | (−0.676) | (−6.972)* | **6,139** | **12,127** | | | |
| Random Effects | 0.352 | −0.019 | −0.001 | — | — | 0.0 | 0.314 | 0.031 |
| | (15.653)* | (−0.840) | (−6.739)* | | | **2** | | |
| Independent | | | | | | | | |
| United States | 0.262 | 0.139 | −0.002 | — | — | — | 0.692 | 0.002 |
| | (7.356)* | (2.237) | (−6.783)* | | | | | |
| United Kingdom | 0.244 | 0.013 | −0.001 | — | — | — | 0.103 | 0.003 |
| | (8.419)* | (0.355) | (−1.805) | | | | | |
| France | 0.442 | −0.306 | −0.002 | — | — | — | 0.939 | 0.001 |
| | (16.269)* | (−5.016)* | (−3.749)* | | | | | |
| Germany | 0.404 | −0.527 | 0.000 | — | — | — | 0.697 | 0.003 |
| | (15.773)* | (−4.643)* | (−0.780) | | | | | |
| Italy | 0.442 | 0.177 | −0.003 | — | — | — | 0.680 | 0.000 |
| | (8.034)* | (1.884) | (−3.782)* | | | | | |
| Canada | 0.313 | −0.077 | −0.001 | — | — | — | 0.067 | 0.002 |
| | (7.162)* | (−1.067) | (−1.823) | | | | | |
| Japan | 0.527 | 0.101 | −0.003 | — | — | — | 0.199 | 0.008 |
| | (4.207)* | (0.677) | (−1.352) | | | | | |

[1]Numbers in parentheses are *t*-statistics. Numbers in bold are degrees of freedom for numerator and denominator of *F*-tests or for the Hausman Test of the fixed versus random effects models. An asterisk denotes statistical significance at the 5 percent level.

**Table 12. Panel Data Tests: Regression of Investment Rate on Capital Income Tax Rate**
*(Time trend included)*[1]

| Model | Intercept | Slope | Trend | *F*-Test Against | | Hausman Test | $\bar{R}^2$ | *SSR* |
|---|---|---|---|---|---|---|---|---|
| | | | | Total | Independent | | | |
| Total | 0.375 | −0.149 | −0.001 | — | 72.82* | — | 0.211 | 0.252 |
| | (9.603)* | (−5.510)* | (−2.466)* | | **18,127** | | | |
| Means | 0.752 | −0.211 | −0.006 | — | — | — | — | 0.009 |
| | (1.193) | (−1.173) | (−0.762) | | | | | |
| Fixed Effects | — | −0.041 | −0.001 | 174.04* | 3.491* | — | 0.358 | 0.029 |
| | | (−1.773) | (−6.834)* | **6,139** | **12,127** | | | |
| Random Effects | 0.354 | −0.044 | −0.001 | — | — | 0.0 | 0.357 | 0.031 |
| | (16.857)* | (−1.910) | (−6.640)* | | | **2** | | |
| Independent | | | | | | | | |
| United States | 0.195 | 0.026 | −0.000 | — | — | — | — | 0.002 |
| | (5.937)* | (0.452) | (−1.161) | | | | | |
| United Kingdom | 0.261 | 0.002 | −0.001 | — | — | — | 0.240 | 0.003 |
| | (10.087)* | (0.056) | (−2.278)* | | | | | |
| France | 0.506 | −0.012 | −0.004 | — | — | — | 0.843 | 0.001 |
| | (12.589)* | (−0.135) | (−4.890)* | | | | | |
| Germany | 0.423 | −0.173 | −0.002 | — | — | — | 0.652 | 0.004 |
| | (13.903)* | (−1.282) | (−3.676)* | | | | | |
| Italy | 0.585 | −0.314 | −0.003 | — | — | — | 0.942 | 0.000 |
| | (9.890)* | (−3.113)* | (−3.687)* | | | | | |
| Canada | 0.325 | −0.020 | −0.001 | — | — | — | 0.229 | 0.004 |
| | (5.922)* | (−0.218) | (−2.904)* | | | | | |
| Japan | 0.532 | 0.059 | −0.003 | — | — | — | 0.334 | 0.009 |
| | (4.044)* | (0.378) | (−1.313) | | | | | |

[1]Numbers in parentheses are *t*-statistics. Numbers in bold are degrees of freedom for numerator and denominator of *F*-tests or for the Hausman Test of the fixed versus random effects models. An asterisk denotes statistical significance at the 5 percent level.

**Table 13. Panel Data Tests: Regression of Net Exports-Output Ratio on Capital Income Tax Rate**
*(Time trend included)*[1]

| Model | Intercept | Slope | Trend | *F*-Test Against | | Hausman Test | $\bar{R}^2$ | *SSR* |
|---|---|---|---|---|---|---|---|---|
| | | | | Total | Independent | | | |
| Total | 0.014 | −0.034 | 0.000 | — | 9.082* | — | 0.048 | 0.044 |
| | (0.837) | (−2.978)* | (0.316) | | **18,127** | | | |
| Means | 0.279 | −0.074 | −0.003 | — | — | — | 0.360 | 0.001 |
| | (2.151) | (−1.992) | (−2.012) | | | | | |
| Fixed Effects | — | 0.025 | 0.000 | 13.859* | 4.562* | — | — | 0.027 |
| | | (1.146) | (−0.083) | **6,139** | **12,127** | | | |
| Random Effects | −0.001 | 0.882 | 0.000 | — | — | 2.169 | — | 0.029 |
| | (−0.090) | (0.464) | (0.243) | | | **2** | | |
| Independent | | | | | | | | |
| United States | 0.067 | 0.113 | −0.002 | — | — | — | 0.834 | 0.001 |
| | (3.324)* | (3.221)* | (−10.107)* | | | | | |
| United Kingdom | −0.017 | 0.011 | 0.000 | — | — | — | — | 0.007 |
| | (−0.393) | (0.205) | (0.153) | | | | | |
| France | −0.064 | −0.293 | 0.002 | — | — | — | 0.484 | 0.001 |
| | (−2.052) | (−4.200)* | (3.051)* | | | | | |
| Germany | −0.019 | −0.354 | 0.001 | — | — | — | 0.270 | 0.003 |
| | (−0.649) | (−2.716)* | (3.183)* | | | | | |
| Italy | −0.143 | 0.492 | 0.000 | — | — | — | 0.872 | 0.001 |
| | (−2.057) | (4.147)* | (0.142) | | | | | |
| Canada | −0.012 | −0.057 | 0.001 | — | — | — | 0.074 | 0.003 |
| | (−0.232) | (−0.685) | (1.572) | | | | | |
| Japan | −0.005 | 0.042 | 0.000 | — | — | — | 0.049 | 0.004 |
| | (−0.056) | (0.425) | (0.040) | | | | | |

[1]Numbers in parentheses are *t*-statistics. Numbers in bold are degrees of freedom for numerator and denominator of *F*-tests or for the Hausman Test of the fixed versus random effects models. An asterisk denotes statistical significance at the 5 percent level.

**Table 14. Panel Data Tests: Regression of Net Unemployment Rate on Labor Tax Rate**
*(Time trend included)*[1]

| Model | Intercept | Slope | Trend | *F*-Test Against | | Hausman Test | $\bar{R}^2$ | *SSR* |
|---|---|---|---|---|---|---|---|---|
| | | | | Total | Independent | | | |
| Total | −19.581 | 0.021 | 0.315 | — | 31.793* | — | 0.481 | 781.4 |
| | (−8.758)* | (0.746)* | (9.573)* | | **18,127** | | | |
| Means | −52.044 | −0.035 | 0.756 | — | — | — | 0.362 | 17.2 |
| | (−1.870) | (−0.263) | (1.950) | | | | | |
| Fixed Effects | — | 0.010 | 0.294 | 38.345* | 11.363* | — | 0.639 | 294.3 |
| | | (0.143) | (7.396)* | **6,139** | **12,127** | | | |
| Random Effects | −17.412 | 0.023 | 0.288 | — | — | 0.119 | 0.657 | 309.9 |
| | (−10.188)* | (0.395) | (8.178)* | | | **2** | | |
| Independent | | | | | | | | |
| United States | −1.538 | 0.606 | −0.135 | — | — | — | 0.527 | 30.9 |
| | (0.356) | (2.427)* | (−1.045) | | | | | |
| United Kingdom | −29.021 | −0.001 | 0.449 | — | — | — | 0.794 | 53.6 |
| | (−7.052)* | (−0.008) | (7.440)* | | | | | |
| France | −19.922 | 0.482 | 0.086 | — | — | — | 0.978 | 3.2 |
| | (−4.514)* | (3.638)* | (0.709)* | | | | | |
| Germany | −25.246 | −0.313 | 0.528 | — | — | — | 0.876 | 20.7 |
| | (−11.127)* | (−1.916) | (6.061)* | | | | | |
| Italy | −28.576 | 0.130 | 0.401 | — | — | — | 0.981 | 0.2 |
| | (−8.369)* | (1.798) | (5.776)* | | | | | |
| Canada | −16.804 | −0.046 | 0.327 | — | — | — | 0.742 | 32.5 |
| | (−4.053)* | (−0.260) | (3.324)* | | | | | |
| Japan | −4.145 | 0.011 | 0.076 | — | — | — | 0.894 | 0.8 |
| | (−3.071)* | (0.174) | (2.269)* | | | | | |

[1]Numbers in parentheses are *t*-statistics. Numbers in bold are degrees of freedom for numerator and denominator of *F*-tests or for the Hausman Test of the fixed versus random effects models. An asterisk denotes statistical significance at the 5 percent level.

**Table 15. Panel Data Tests: Regression of Hours Worked on the Sum of the Consumption and Labor Tax Rates**
*(Time trend included)*[1]

| Model | Intercept | Slope | Trend | *F*-Test Against | | Hausman Test | $\bar{R}^2$ | *SSR* |
|---|---|---|---|---|---|---|---|---|
| | | | | Total | Independent | | | |
| Total | 138.3 | 0.058 | −0.475 | — | 18,053* | — | 0.587 | 894.4 |
| | (56.62)* | (2.986)* | (−13.763)* | | **18,120** | | | |
| Means | 143.7 | 0.059 | −0.544 | — | — | — | 0.771 | 2.0 |
| | (16.42)* | (2.014)* | (−4.458)* | | | | | |
| Fixed Effects | — | 0.180 | −0.522 | 1.453 | 24.782* | — | 0.553 | 838.9 |
| | | (1.381) | (−7.555)* | **6,132** | **12,120** | | | |
| Random Effects | 138.3 | 0.057 | −0.474 | — | — | 3.995 | 0.546 | 890.2 |
| | (55.3)* | (2.799)* | (−13.389)* | | | **2** | | |
| Independent | | | | | | | | |
| United States | 111.8 | −1.469 | 0.493 | — | — | — | 0.826 | 17.5 |
| | (51.09)* | (−8.372)* | (5.875)* | | | | | |
| United Kingdom | 145.6 | −0.043 | −0.510 | — | — | — | 0.800 | 71.1 |
| | (31.82)* | (−0.258)* | (−5.990)* | | | | | |
| France | 166.8 | −0.282 | −0.561 | — | — | — | 0.726 | 26.3 |
| | (13.93)* | (−0.490) | (−1.125) | | | | | |
| Germany | 172.8 | −0.120 | −0.803 | — | — | — | 0.964 | 28.9 |
| | (36.96)* | (−0.604) | (−8.810)* | | | | | |
| Italy | 39.8 | −0.120 | 0.806 | — | — | — | 0.357 | 24.3 |
| | (1.03) | (−0.200) | (1.022) | | | | | |
| Canada | 125.0 | 0.047 | −0.296 | — | — | — | 0.723 | 29.0 |
| | (46.61)* | (0.374) | (−4.199)* | | | | | |
| Japan | 161.9 | 2.403 | −1.580 | — | — | — | 0.857 | 44.22 |
| | (31.94)* | (7.971)* | (−10.045)* | | | | | |

[1]Numbers in parentheses are *t*-statistics. Numbers in bold are degrees of freedom for numerator and denominator of *F*-tests or for the Hausman Test of the fixed versus random effects models. An asterisk denotes statistical significance at the 5 percent level.

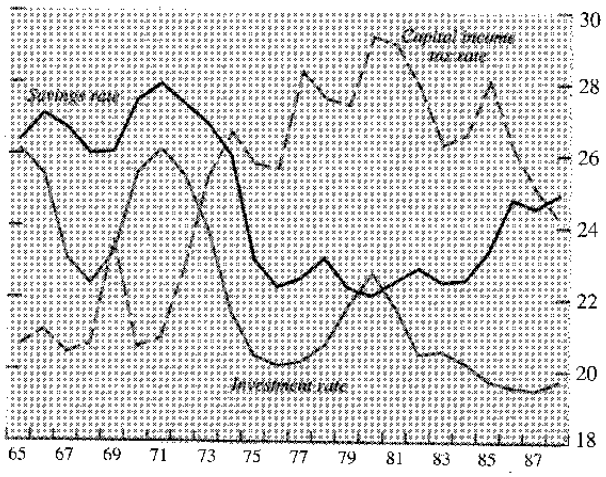
zero only when the sign of the coefficient is as predicted by theory—except in the cases of Italy in Table 6 and Japan in Table 15. Thus, effective average tax rates produce statistically significant co-movements with savings, hours worked, and unemployment that are consistent with basic theoretical principles. Moreover, in some countries the tax rates alone are sufficient to explain a large fraction of the observed movements in savings, hours worked, and unemployment. This is particularly the case of the capital income tax rate as an explanatory variable of savings in France, Germany, and Italy, and the labor income tax as an explanatory variable of unemployment in the United Kingdom and the United States, and the sum of the labor and consumption taxes as an explanatory variable of hours worked in the United States.

**Table 16. Co-Movement Between Macroeconomic Variables and Tax Rates**
*(Based on deviations from cross-sectional means)*

| Country | Savings–Capital Tax | Investment–Capital Tax | Net Exports–Capital Tax |
|---|---|---|---|
| United States | 0.233 | −0.619 | 0.664 |
| United Kingdom | 0.383 | 0.047 | 0.259 |
| Germany | −0.514 | 0.053 | −0.547 |
| Italy | 0.508 | −0.604 | 0.874 |
| France | −0.630 | −0.208 | −0.458 |
| Japan | 0.092 | −0.319 | 0.591 |
| Canada | −0.810 | −0.550 | −0.417 |

The results of the independent regressions for the United States are of particular interest in view of the current discussion on the possibility of increasing tax rates on consumption or labor income in order to reduce the fiscal deficit. The international comparison of tax rates discussed earlier in this section indicated that consumption and labor taxes are significantly lower in the United States than in the rest of the large industrial countries (except Japan), so that potential tax increases would tend to harmonize the U.S. tax rates with those of other countries. The econometric analysis provides insight into some of the implications that would follow from these tax increases. In particular, we find that an increase of 1 percentage point in the labor income tax may result in an increase in the unemployment rate of about 1/3 of 1 percentage point (see Table 9), and that an increase of 1 percentage point in either consumption or labor income taxes may induce a reduction in the index of hours worked of between 1/2 to 1 1/2 points (see Tables 10 and 15). All the coefficient estimates that link the tax rates to unemployment and hours worked in the United States are statistically significant, the explanatory power of the regressions ranges from 53 percent to 83 percent, and the Durbin-Watson statistics reject the hypothesis of first-order serial autocorrelation of the resid-

**Chart 6. Germany: Savings, Investment, and Capital Income Tax**
*(In percent)*




uals when the time trend is included. It must be noted, however, that these results are not an indication of the welfare effects of the tax increases examined, but merely a rough estimate of their partial effects on some of the elements that affect the behavior of labor markets.

The clear relationship between the tax rates and savings, hours worked, and unemployment, and the fact that the relationship seems stronger at lower frequencies is clearly illustrated in Charts 6–8 for the case of Germany. Chart 6 shows how, over the period 1965–88, the savings and investment rates in

**Chart 7. Unemployment and Labor Income Tax**
*(In percent)*

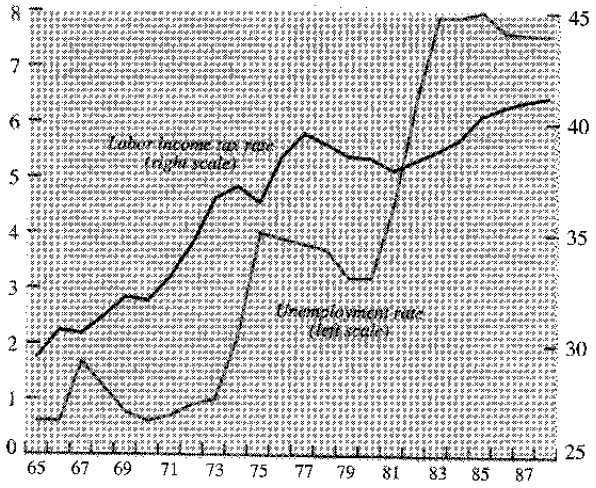
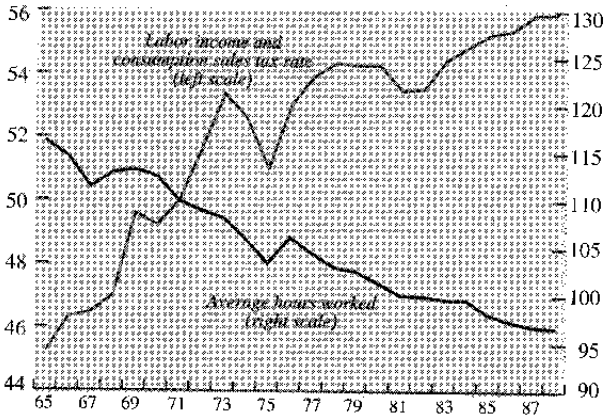



**Chart 8. Average Hours Worked and Consumption-Labor Income Tax Rate[1]**




[1]Average hours worked is an index number; the tax rate is in percent.

Germany fell in conjunction with an increase in the capital income tax rate. On a yearly basis, however, there are episodes during which the capital income tax increased and savings also increased. Chart 7 illustrates a similar point for the rate of unemployment and the labor income tax and Chart 8 for the index of hours worked and the sum of the labor and consumption tax rates.

To conclude, Table 17 reports some of the cyclical properties of tax revenues based on Hodrick-Prescott filtered data. We observe that the revenue of all three taxes is more variable than output in each country, and that capital income tax revenue tends to fluctuate more than the revenue from labor income tax and the consumption tax. Revenues are generally procyclical and uncorrelated, or weakly negatively correlated, with net exports. These results suggest that, while our measures of effective average tax rates may be affected by cyclical noise, as explained before, the fact that tax revenues and tax bases tend to move together over the business cycle contributes to minimize that noise.

## Conclusion

This paper presented a method for computing effective average rates of taxation on consumption and the income derived from capital and labor based on aggregate data from revenue statistics and national income accounts. Following recent work by Lucas (1990) and (1991) and Razin and Sadka (1993), we constructed estimates of the tax rates that represent the wedges distorting optimal plans in a representative agent framework by calculating percentage differences in measures of aggregate

**Table 17. Variability and Co-Movement of Tax Revenues in Industrial Countries[1]**

| Country | Sales Tax Revenue | | | Labor Income Tax Revenue | | | Capital Income Tax Revenue | | | Output |
|---|---|---|---|---|---|---|---|---|---|---|
| | Standard dev. | Output corr. | Trade balance corr. | Standard dev. | Output corr. | Trade balance corr. | Standard dev. | Output corr. | Trade balance corr. | Standard dev. |
| United States | 3.04 | 0.11 | −0.06 | 3.74 | 0.35 | −0.07 | 5.83 | 0.74 | −0.19 | 2.30 |
| United Kingdom | 4.86 | −0.38 | 0.35 | 4.71 | −0.24 | 0.18 | 4.71 | −0.38 | −0.12 | 2.03 |
| Germany | 4.49 | 0.75 | −0.57 | 4.53 | 0.84 | −0.11 | 5.92 | 0.51 | −0.02 | 3.08 |
| France | 2.66 | 0.59 | −0.08 | 2.54 | 0.17 | −0.06 | 3.94 | 0.37 | −0.60 | 1.93 |
| Italy | 4.09 | 0.54 | −0.01 | 2.45 | 0.13 | 0.36 | 3.97 | −0.34 | 0.60 | 2.33 |
| Japan | 6.49 | 0.81 | 0.04 | 3.52 | 0.75 | −0.16 | 9.09 | 0.83 | −0.28 | 3.98 |
| Canada | 5.71 | 0.08 | 0.09 | 5.22 | 0.12 | −0.23 | 4.95 | 0.69 | −0.68 | 2.85 |

[1]Data are annual observations for the period 1965–88 (except 1970–88 for France and 1980–88 for Italy), expressed in per capita terms, logged, and detrended using the Hodrick-Prescott filter with the smoothing parameter set at 100. Measures of tax revenue were computed using revenue figures from OECD (1990). Output and revenue figures were deflated using the private consumption deflator. The detrended trade balance is equal to the detrended ratio of net exports to output.

post- and pre-tax incomes and prices. The method was used to compute time series of the three tax rates for the group of seven largest industrial countries covering the period 1965–88. The potential applicability of the resulting tax rates in the design of macroeconomic models of fiscal policy was examined by contrasting the results of this study with existing estimates of effective marginal tax rates, as well as by exploring the relationship between the tax rates and savings, investment, net exports, hours worked, and unemployment.

The comparison between the effective average tax rates computed here and available estimates of effective marginal tax rates showed that, while the levels of the taxes differ, the trends are very similar. Moreover, average tax rates are within the range of existing estimates of marginal tax rates, and a large fraction of the difference between the two can be attributed to the treatment of tax credits and exemptions and the treatment of consumption taxes. The differences between the two sets of estimates are minimal when the effective average labor income tax is adjusted to incorporate sales taxes, and the resulting effective tax is compared with estimates of marginal tax rates based on tax returns data.

The empirical analysis undertaken here illustrates important trends and differences in the structure of the tax systems among industrial countries. While labor, capital, and consumption taxes have fluctuated noticeably in response to changes in statutory tax schedules and policies regarding credits and exemptions, capital and consumption taxes have not exhibited a noticeable trend in general; the rate of taxation on labor income has increased over time in all of the countries studied. The rates of indirect taxation and labor income tax tend to be higher in European countries relative to Japan and the United States, while the effective average tax rates on capital income in the United States have been higher than in other large industrial countries—except the United Kingdom and, in recent years, Japan. Notwithstanding significant differences in tax systems, tax rates have tended to converge over the last twenty years for groups of countries in the sample—particularly in the case of consumption taxes in European countries (except France), labor income taxes in North America, Japan, and the United Kingdom, and capital income taxes in Germany, Italy, and France, and in the United States and Canada.

The statistical analysis relating effective average tax rates to macroeconomic variables provided evidence suggesting that these measures of tax rates may be useful for macroeconomic modeling. In particular, the effective average tax rate on capital income is negatively related to savings rates, and the consumption and labor income tax rates are negatively correlated with the number of hours worked, as predicted by neoclassical equilibrium models. Moreover, the level and trend of the rate of unemployment are positively correlated with the tax on labor income, as predicted by models of equilibrium unemployment or the "natural rate." These relationships are stronger in panel data tests that combine time-series and cross-sectional information, but they remain strong even for time series of several individual countries. These empirical regularities were also documented using data that were adjusted and unadjusted for time trends. The relationships between macroeconomic variables and the tax rates were found to be generally stronger at low frequencies relative to business cycle frequencies.

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