A Macroeconomic Simulation Model for Uzbekistan: Technical Guide to Macroeconomic Applications

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A MACROECONOMIC SIMULATION MODEL

FOR

UZBEKISTAN

Technical Guide to Macroeconomic Applications

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CONTENTS

I. INTRODUCTION

A. Overview

The purpose of this guide is to serve as a technical reference to the macroeconomic simulation model for Uzbekistan. It describes the overall model structure and basic economic relationships of the model and provides illustrative basic projections generated by the model.

The objective of the model is to provide the ADB with a theory-consistent and user-friendly representation of the general structure of the Uzbekistan economy to provide basic projections of the economy and to offer a means to quantitatively evaluate the impact of economic reforms on the economy. The modeling procedure has sought to account for the structure of the Uzbekistan economy, the availability of data, and the degree of stability of time-series estimates of parameters. The nature of the ADB's needs over time has motivated the design of a model that can grow and evolve with the economy and the staff's analytical requirements. The present form of the model therefore provides a relatively parsimonious representation of the economy's principal relationships. As such it provides a framework for making rational and consistent forecasts about Uzbekistan's overall economic activities, production and expenditure concepts of the national accounts, and the standard components of the balance of payments, fiscal balance, and monetary survey.

Most models provide flexibility in the determination of different variables in the system of equations that make up the model. For example, the World Bank's (1997) Revised Minimum Standard Model, Extended (RMSM-X) estimates the external financial requirements of a country as the gap between the estimated debits and credits to the balance of payments required to achieve a given growth rate. The present modeling framework provides a similar level of flexibility for the economy of Uzbekistan while incorporating behavioral equations and reducing to a minimum the number of predetermined variables that need to be inputted by the user. It offers a system of equations that describe the interaction of the economy, and it provides for additional extensions to more disaggregated relationships without loss of flexibility.

The major modifications and extensions introduced into the present macroeconomic model for Uzbekistan are the following:

- Estimation of the behavioral equation in real terms;

- Determination of the level of real domestic and foreign economic activity within the system of equations;

- Introduction of monetary, fiscal, and exchange rate policy-determined variables;

- Development of output concepts by sector, and determination of value added for the primary and secondary sector within the system of equations; and

- The simultaneous determination of the overall production and expenditures of Uzbekistan, in both real and nominal terms.

The model uses a spreadsheet framework similar to that used by the World Bank's RMSM-X as a means of facilitating its application and ensuring its general use. It differs from the RMSM-X framework in two important respect: first, it contains a larger number of behavioral equations for the key relationships in standard macroeconomic models; second, it does not rely on spreadsheet macro in order to ensure transparency in the simulation results and an ability of the analyst to view the channels through which the basic projects and policy simulation are obtained.

The study was undertaken by Montague Lord, ADB staff consultant, between November 2004 and January 2005. At the onset, discussions were held with government officials on

macroeconomic policies and data availability, and documents and studies related to macroeconomic issues in Uzbekistan were reviewed. Based on those data and reports, a macroeconomic model was formulated in an Excel spreadsheet format to facilitate its use. The behavioral equations in the model were estimated using Eviews software. This reference guide contains the theoretical and empirical specification of the model, as well as sample forecasts for the baseline projections to be used as stand-alone output or in conjunction with policy simulation exercises.

B. Background

The major characteristics that need to be considered in the design and implementation of a macroeconomic model for Uzbekistan concern the transformation of the economy following the country's independence in 1991. The transition process accompanying such a transformation refers to the introduction of a state-controlled gradual transition strategy in the economy, which has introduced reforms in the former Soviet Union (FSU) socio-economic system that have altered the role of prices in the economy, affected the institutional structures, changed the role of the private sector, and led to the restructuring of industries and establishment of an autonomous banking system. During the 1990's the Government of Uzbekistan introduced a series of gradualism measures to reform the economy in such as way as to stabilize the economy through selective price controls, fiscal deficit reductions and some privatization of large private enterprises. The pace of reforms accelerated at the start of this decade when the Government sought to address fundamental imbalances in the foreign exchange market by the unification of the foreign exchange rates that prevailed under the earlier multiple exchange rate regime. Following an agreement with the International Monetary Fund (IMF) at the end of 2001 to implement economic and fiscal reforms incorporated into a staff-monitored program (SMP), the Government succeeded in implementing tight monetary and fiscal policies, containing the buildup of external debt, and controlling inflation.

The economic stabilization policies, however, led to a slowdown in economic growth until 2004 as a result of the recent export-led expansion in economic activity. Without that external drive, growth will continue to be constrained by the limited expansion in private sector investment, the reliance on traditional, low value added products, and a small amount of foreign direct investment (FDI). Higher and sustained growth over the near and medium term requires further progress toward commitments to the exchange and trade regime, ground-level implementation of announced reforms in the agriculture sector, accelerated enterprise restructuring in the state sector, an improved business environment and facilitation of the entry of new private businesses. Broad-based growth over the medium and long term will require developing a policy framework that is more conducive to private sector development. In response to these needs, the Government also announced a number of structural and sectoral reform measures, including divestment of the Government's minority share holdings in enterprises; further liberalization of agriculture, particularly the cotton and wheat sub-sectors; strengthening regulations for banking supervision; and pursuing further tariff reform and restructuring in the energy sector.

Uzbekistan's adoption of a fixed exchange rate system, while at the same time retaining controls over capital movements, has important implications for the policy instruments that are available to the government and the Central Bank of Uzbekistan (CBU). Capital controls are common to transition economies, and they are usually combined with fixed exchange rate systems. While macroeconomic models often disregard capital controls in their specification, the explicit introduction of those controls in the present model for Uzbekistan changes the mechanism through which interest rate variations affect the economy. Modeling the mechanism through which monetary and fiscal policies affect consumption, investment, and the trade

balance can help to ensure that policy instruments are correctly combined to achieve stability and growth targets for the economy of Uzbekistan.

Modeling these processes in Uzbekistan requires the explicit recognition of how the transmission mechanism affects development on the real and financial sides of the economy. One approach is to incorporate uncertainty in the model and measure its effects on consumption and investment patterns. Another way is to include the propagation mechanism for the adjustment process on the cost side of the model, and use it to determine possible effects of incomes policies on price level increases and the rate of inflation. The inclusion of these transmission mechanisms is particularly important since there is general consensus that macroeconomic stabilization needs to be addressed early on in the reform process of economies in transition towards a market-oriented system.

The movement towards more flexible market-determined prices in Uzbekistan has also brought about fundamental changes in the way businesses and households respond to economic conditions. In modeling economic behavior, these changes imply a greater responsiveness of economic agents to changes in relative prices, and therefore possible parameter changes in the system of equations. If parameter changes occur, then the use of time-invariant parameters can make the system of equations unstable. The alternative approach consists of the introduction of time-varying parameters that capture the transition process in the structure of the economic system. These types of parameters can introduce an element of subjectivity in the operation of the model, and a decision to adopt time-varying parameters therefore should be approached with caution.

Initial developments of macroeconomic modeling of transition economies were often based on the use of a vector autoregressive (VAR) system. More recently, the use of theory-consistent structural models, particularly those based on systems of dynamic time-series equations, has been found to forecast better for long horizons. As a result, a decision was made to develop a medium-size model for Uzbekistan that would provide details as to the overall structure and operation of the economy, and which could be modified and expanded according to the needs of the ADB.

The present macroeconomic model aims to provide a theory-consistent representation of the general structure of the economy of Uzbekistan and, as such, it offers real and financial sector forecasting and policy simulation capabilities targeted to the needs of the ADB. The model serves a dual purpose. First, it provides a framework for making rational and consistent predictions about overall economic activity in Uzbekistan, the standard components of the balance of payments, and the production and expenditure concepts of the national accounts. Secondly, it offers a means of quantitatively evaluating the impact of exchange rate policies and other policy changes on the economy of Uzbekistan, and assessing the feedback effects that changes in key macroeconomic variables of the economy produce in other sectors. These two objectives are, of course, closely related since the capacity to make successful predictions depends on the model's ability to capture the interrelationships between the real and financial sectors of the economy.

The modeling procedure has sought to account for the structure of the economy of Uzbekistan, the availability of data, and the degree of stability of time-series estimates of parameters during the country's transition process. The nature of the transition process of the economy of Uzbekistan has motivated the design of a model that can grow and evolve with the economy. The present model therefore aims to provide a mechanism to link policies and targets while, at the same time, providing an easy and adaptable means of both forecasting key macroeconomic variables and simulating the interrelationships between economic policy initiatives. As such, the model provides a relatively parsimonious representation of the economy of Uzbekistan that

allows for considerable flexibility in its usage for forecasting, selection of the policy mix and instruments for the targets of a program, and determination of the appropriate sequencing of policy changes.

C. Coverage

♦ Chapter 1 provides a general introduction to the macroeconomic simulation model and summarizes the main components of the guide.

♦ Chapter 2 characterizes the Uzbekistan economy from the point of view of macro-modeling building, summarizes the main blocs of the model, and describes the dynamic specification used to characterize economic relationships.

♦ Chapter 3 describes the modeling framework for the real sectors of the economy.

♦ Chapter 4 presents the modeling framework for the money market and fiscal sector.

♦ Chapter 5 sets forth the modeling framework for the balance of payments and the foreign exchange market.

♦ Chapter 6 it describes the major blocks of the system of equations in the model, and it explains the use of macroeconomic policy instruments under the system.

♦ Chapter 7 provides a baseline forecast and illustrates the impact of economic policy reform measures on the economy.

II. MODEL STRUCTURE AND DESIGN

A. Characterization of the Data

There are two important challenges to data in Uzbekistan. The first is the lack of consistent time series over a long period of time that would allow the data to provide estimates of key behavior relationships in the economy; the second is the lack of reliability of the data due to the lack of transparency in the manner in which they were compiled and the general difficulty in obtaining data. Notwithstanding these limitations, the first step in modeling the economy of Uzbekistan inevitably requires a study of the data-generating processes of key variables in the economy. In principle, one would expect that the long-term relationships between consumption and income, between investment and output, between imports of primary and intermediate products and output, between imports of final products and income would be cointegrated. Variables are said to be cointegrated if individually each is nonstationary but there exists a linear combination of the variables that is stationary. An error correction mechanism (ECM) can show how adjustments occur between variables to correct for short-term disequilibrium associated with the long-term equilibrium growth path of the variables.

In the present economic system of Uzbekistan, changes in prices, interest rates and exchange rates are generally not expected to impact on the long-run equilibrium growth path of the economy. Instead, the economy has a transient response to changes in these variables, and it is appropriate to constrain their long-term effects to zero.[1] As such, it is important to differentiate between long-term equilibrium relationships of cointegrated variables, and the transient effects of changes in prices, interest rates, and exchange rates on the key macro variables in the present market-oriented economy.

Table 2.1 presents some descriptive statistics of data series. The statistics on the first four moments (mean, standard deviation, skewness, excess kurtosis) refer to the change in the log of each variable since, if the variables are nonstationary, the statistics themselves will be nonstationary; moreover, the log change is an approximation of the percentage change, so that the minimum and maximums are the minimum and maximum percentage change of each variable, and the standard deviation is expressed as a percentage.

The statistics generally follow the pattern of similar ones for developing and transition economies (see for example, World Bank, 2005 forthcoming). For the national income account components, the standard deviations range from a low of 13 percent for consumption to a high of 43 percent for exports. The standard deviation for interest rates is much larger than that for the exchange rate. All the variables have excess kurtosis, indicating that the distributions have fat tails, and implying that there is a large probability of wide fluctuations, compared with those that would be expected from changes in series having a normal distribution. The tests reject normality for these variables.

For series that tend to grow either positively or negatively over time, it is first necessary to examine whether or not the series are themselves stationary before proceeding to find the long-

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[1]The intuitive explanation for limiting the effects of changes in prices, interest rates, and exchange rates on variables such as consumption and investment is that relative prices for goods cannot continue to deviate from one another since otherwise consumers will eventually purchase only the increasingly cheaper good; similarly, differences between the prices of the same good originating from different countries could not continue indefinitely without consumers eventually only purchasing the good from the country with the decreasing relative price for that product.

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Table 2.1 Descriptive Statistics of Key Macroeconomic Variables (Calculated for percentage changes in real value data of annual periodicity)							
	GDP	Invest- ment	Consu- mption	Exports	Imports	Interest Rate	Real Exch- ange Rate
Mean	14.24	12.60	14.08	11.93	12.40	2.10	4.63
Median	14.24	12.58	14.10	12.02	12.49	2.16	4.63
Maximum	14.47	12.98	14.28	12.49	12.83	2.44	4.71
Minimum	14.01	12.24	13.87	11.21	11.97	1.53	4.57
Std. Dev.	0.15	0.26	0.13	0.43	0.32	0.24	0.05
Skewness	0.07	0.11	-0.10	-0.27	-0.10	-0.95	0.22
Kurtosis	1.83	1.65	1.91	1.80	1.39	3.79	1.59
*Order of Integration * *	I(2)	I(2)	I(2)	I(2)	I(2)	I(2)	I(2)
Augmented Dickey- Fuller (ADF) Test:							
ADF t-statistic	-7.47	-4.74	-4.90	-5.67	-3.70	-4.26	-2.25
Critical value **	1%=-4.89	5%=-4.35	1%=4.88	5%=-4.35	5%=-2.00	1%=3.05	5%=-2.00
Durbin-Watson Statistic	2.52	2.22	1.79	1.76	1.80	2.10	2.04

Note: The sample period is FY90-FY00.
* Order of integration on log levels of corresponding variables.
** MacKinnon critical values. A negative ADF t-statistic that is larger (in absolute terms) than the critical value allows rejection of the hypothesis of a unit root and suggests that the series is stationary.

term equilibrium relationship of two or more economic variables. A brief intuitive description of stationarity and equilibrium relationships shows its importance to the macroeconomic data for Uzbekistan.[2]

In theory, an economic relationship refers to a state where there is no inherent tendency to change. Such a relationship is, for example, described by the consumption function in the log linear form $c = \beta y$. In practice, however, an equilibrium relationship is seldom observed, so that measures of the observed relationship between c and y include both the equilibrium state and the discrepancy between the outcome and postulated equilibrium. The discrepancy, denoted d, cannot have a tendency to grow systematically over time, nor is there any systematic tendency for the discrepancy to diminish in a real economic system since short-term disturbances are a continuous occurrence. The discrepancy is therefore said to be stationary insofar as over a finite period of time it has a mean of zero.

Individual time series that are themselves stationary are statistically related to each other, regardless of whether there exists a true equilibrium relationship. Thus, before estimating the economic relationships in the model for Uzbekistan, it is useful to determine whether the data generating process of each of the series is itself stationary. Since national account variables have a tendency to grow (positively or negatively) over time, the variables themselves cannot be stationary, but changes in those series might be stationary. Series that are integrated of the

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[2]For details of stationarity processes and the specification of dynamic models for equilibrium relationships, see Banerjee, Dolado, Galbraith and Hendry (1993).

same order are said to be cointegrated and to have a long-run equilibrium relationship.[3] For trending variables that are themselves non-stationary, but can be made stationary by being differenced exactly k times, then the linear combination of any two of those series will itself be stationary. It is therefore important to test the order of integration of the key series in the model.

Tests for stationarity are derived from the regression of the changes in a variable against the lagged level of that variable. Consider the following simple levels regression:

$$y_t = a + by_{t-1} + d \tag{2.1}$$

where a and b are constants and d is an error term. If y is non-stationary, then b will be close to unity. By subtracting y_{t-1} from both sides, we obtain

$$\Delta y_t = a + (b\text{-}1)y_{t-1} + d \tag{2.2}$$

The disturbance term d now has a constant distribution and the t-statistic on y_{t-1} provides a means for testing non-stationarity. If the coefficient on y_{t-1} is less than the absolute value of 1, then b must be less than 1, and y is therefore stationary. The Augmented Dickey-Fuller test is a test on the t-statistic of the coefficient on y_{t-1}.

The second test for non-stationarity is the Durbin-Watson (DW) test on the levels regression specified above. Since the DW statistically is given by

$$DW = 2(1\text{-}r) \tag{2.3}$$

where r is the correlation coefficient between y_t and y_{t-1}, then y is white noise when r is zero. The DW is therefore 2 when y is stationary.

In practice, when only a one-period lag of the dependent variable is included in the regression, then a Dickey-Fuller (DF) test is performed to determine whether the series is stationary. When first difference terms are included in the regression, then an Augmented Dickey-Fuller (ADF) test is performed. The number of lagged first difference terms to include in the regression should be sufficient to remove any serial correlation in the residuals, in which case the DW statistic should approximate 2.

A constant and trend variable should be included if the series exhibits a trend and non-zero mean in the descriptive statistics. Alternatively, if the series does not exhibit any trend but has a non-zero mean, only a constant should be included in the test regression. Finally, if the series appears to fluctuate around a zero mean, neither a constant nor a trend should be included in the test regression.

Initially the test is performed on the levels form of the regression. If the test fails to reject the test in levels then a first difference test regression should be performed. If the test fails to reject the test in levels but rejects the test in first differences, then the series is of integrated order one, I(1). If, on the other hand, the test fails to reject the test in levels and first differences but rejects the test in second differences, then the series is of integrated order two, I(2).

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[3]A series is said to be integrated of order k, denoted I(k), if the series needs to be difference k times to form a stationary series. Thus, for example, a trending series that is I(1) needs to be differenced one time to achieve stationarity.

For real GDP of Uzbekistan, for example, the following statistics are reported for the second difference of its log level, with an intercept:

ADF Test Statistic = *-7.49*

The critical values for rejection of hypothesis of non-stationarity are as follows:

1% Critical Value* = -4 88
5% Critical Value = -3.42
10% Critical Value = -2.86

The test therefore failed to reject the test in levels and first differences but rejects the test in second differences, which indicated that the series is of integrated order I(2).

The results of the ADF test and the DW test are presented in the bottom of Table 2.1. As expected, the tests all fail to establish stationarity of the log levels and indicate that all the log levels are integrated processes. In particular, investment, consumption, imports, and GDP are all of integrated order 2, as are exports, interest rates and the real exchange rate.

To facilitate the presentation of the IS-LM framework used for policy analysis in Uzbekistan, the behavioral equations have been presented in the levels form of the variables. However, empirical estimates in the levels form of the behavioral equations would yield parameters whose implied elasticities would vary over the historical and forecast period. In contrast, behavioral equations estimated in their log-linear form yield direct elasticity estimates whose values remain constant over both the historical and the forecast periods. The present estimates of the model for Uzbekistan are therefore based on log-linear relationships.

B. Dynamic Specification

The dynamic processes underlying adjustments of key economic variables to changes in their determinants are described by stochastic difference equations. The general form of the equation for any dependent variable Y and the explanatory variables Z_i is:

$$Y_t = \Sigma^m_{i=1} \alpha_i Y_{t-i} + \Sigma^n_{i=0} \beta_i Z_{it} + \varepsilon_t \qquad (2.4)$$

Like all dynamic equations, the stochastic difference equation imposes an *a priori* structure on the form of the lag to reduce the number of parameters that need to be estimated. Since national income account data of Uzbekistan are limited in terms of their range and annual periodicity, the parsimonious representation of the data generating process afforded by the stochastic difference equation is advantageous to the modeling process.

This class of equations has three other important advantages. First, as pointed out by Harvey (1991: ch. 8), the stochastic difference equation lends itself to a specification procedure that moves from a general unrestricted dynamic model to a specific restricted model. At the outset all the explanatory variables postulated by economic theory and lags of a relatively higher order are deliberately included. Whether or not a particular explanatory variable should be retained and which lags are important are decided by the results obtained. The approach is appropriate

for an economy like that of Uzbekistan where there is uncertainty about the explanatory variables to be included in the behavioral equation.

The second advantage of the use of the stochastic difference equation lies in the estimation procedure. Given sufficient lags in the dependent and explanatory variables, the stochastic difference equation can be so defined as to have a white noise process in the disturbance term. As a result, the ordinary least squares estimator for the coefficients will be fully efficient.

Finally, stochastic difference equations lend themselves to long-run solutions that are consistent with economic theory. This characteristic is useful for the present modeling framework for Uzbekistan, which builds from theory to dynamic specification, and finally to estimation and testing of the theory. When restrictions are imposed by economic theory, the relationships between variables are determined by *co-integration analysis*, and equations known as *error correction models* are used to yield long-run solutions that are consonant with economic theory. Engle and Granger (1987) have demonstrated that a data-generating process of the form known as the error-correction mechanism (ECM) adjusts for any disequilibrium between variables that are cointegrated. The ECM specification thus provides the means by which the short-run observed behavior of variables is associated with their long-run equilibrium growth paths. Davidson *et al.* (1978) established a closely related specification know as the "equilibrium-correcting mechanism" (also having the acronym ECM) that models both the short and long-run relationships between variables.

Rearranging the terms of a first-order stochastic difference equation yields the following ECM:

$$\Delta y_t = \alpha_o + \alpha_1(y - z)_{t-1} + \alpha_2\Delta z_t + \alpha_3 z_{t-1} + v_t \tag{2.5}$$

where $-1 < \alpha_1 < 0$, $\alpha_2 > 0$ and $\alpha_3 > -1$, and where all variables are measured in logarithmic terms.

The second term, $\alpha_1(y - z)_{t-1}$, is the mechanism for adjusting any disequilibrium in the previous period. When the rate of growth of the dependent variable y_t falls below its steady-state path, the value of the ratio of variables in the second term decreases in the subsequent period. That decrease, combined with the negative coefficient of the term, has a positive influence on the growth rate of the dependent variable. Conversely, when the growth rate of the dependent variable increases above its steady-state path, the adjustment mechanism embodied in the second term generates downward pressure on the growth rate of the dependent variable until it reaches that of its steady-state path. The speed with which the system approaches its steady-state path depends on the proximity of the coefficient to minus one. If the coefficient is close to minus one, the system converges to its steady-state path quickly; if it is near to zero, the approach of the system to the steady-state path is slow. Since the variables are measured in logarithms, Δy and Δz can be interpreted as the rate of change of the variables. Thus the third term, $\alpha_2\Delta z_t$, expresses the steady-state growth in *Y* associated with *Z*. Finally, the fourth term, $\alpha_3 z_{t-1}$, shows that the steady-state response of the dependent variable *Y* to the variable *Z* is non-proportional when the coefficient has non-zero significance.

Economies such as that of Uzbekistan have a long-term relationship with one or more series in the global economy after transient effects from all other series have disappeared. That part of the response of real GDP that never decays to zero is the steady-state response, while that part that decays to zero in the long run is the transient response. Examples of relationships in which steady-state responses occur are those between the real domestic private consumption and

real GDP. An example of a transient response is exchange rate movements, since if relative price changes were not transient, the disparity between prices of the home country and the foreign market would continuously widen. In that case, consumers would eventually switch entirely to the supplier with the lower priced products. Hence, it is important to distinguish the short-run adjustment component from the long-run equilibrium component.

The equilibrium solution of equation (2.5) is a constant value if there is convergence. Since the solution is unrelated to time, the rate of change over time of the dependent variable Y (given by Δy_t) and the explanatory variable Z (given by Δz_t) are equal to zero. However, in dynamic equilibrium, equation (2.5) generates a steady-state response in which growth occurs at a constant rate, say g. For the dynamic specification of the relationship in (A.4), if g_1 is defined as the steady-state growth rate of the dependent variable Y, and g_2 corresponds to the steady-state growth rate of the explanatory variable Z, then, since lower-case letters denote the logarithms of variables, $g_1 = \Delta y$ and $g_2 = \Delta z$ in dynamic equilibrium. In equilibrium the systematic dynamics of equation (2.5) are expressed as:

$$g_1 = \alpha_o + \alpha_1(y - z) + \alpha_2 g_2 + \alpha_3 z \qquad (2.6)$$

or, in terms of the original (anti-logarithmic) values of the variables:

$$Y = k_0 Z^\beta \qquad (2.7)$$

where $k_0 = \exp\{(-\alpha_o/\alpha_1) + [(\alpha_1 - \alpha_2\alpha_1 - \alpha_3)/ \alpha_1^2]g_2\}$, and where $\beta = 1 - \alpha_3/\alpha_1$.

The dynamic solution of equation (2.7) therefore shows Y to be influenced by changes in the rate of growth of Z, as well as the long-run elasticity of Y with respect to Z. For example, were the rate of growth of the explanatory variable accelerate, say from g_2 to g'_2, the value of the variable Y would increase. However, it is important to reiterate that the response to each explanatory variable can be either transient or steady-state. When theoretical considerations suggest that an explanatory variable generates a transient, rather than steady-state, response, it is appropriate to constrain its long-run effect to zero.

III. MODELING THE INTERNAL BALANCE

A. Output Determination

The present model represents an application of the conventional Mundell-Fleming model using the IS-LM framework for the open economy of Uzbekistan and, as a forecasting and policy-oriented system, it incorporates key parameters for the formulation of economic decisions. At the onset, the model is designed as a parsimonious representation of the underlying data generating system for key behavior relationships. A similar approach is adopted by the International Monetary Fund (IMF) staff's macroeconomic model-building applications and is used in IMF-sponsored adjustment programs, except that the underlying structure of those models are related to the monetary approach to the balance of payments.[4] The conceptual approach of the present model is instead based on conventional economic theory as described in standard textbooks such as Baumol and Blinder (2004); Romer (2002); Obstfeld and Rogoff (1998), Mankiw (2002), Barro (1997), and Sachs and Larrain (1993).

The empirical specification of the conventional theory, however, is not well established since there are numerous approaches to the specification, estimation and testing procedures in standard macro models. Moreover, no one theory or dynamic specification can provide a complete description of the economy of Uzbekistan. What is essential is that key features of the economic and financial process be represented in the system used to characterize the economy. The resulting system can therefore be viewed as an interpretation of the process by which real and financial transactions in the economy take place, and the way in which economic policies operate to affect those transactions.

To simplify the exposition that follows, Box 1 summarizes the notations used in the model. The present section describes the components for aggregate demand, and the output market in terms of the relationships for consumption, investment, government expenditures, exports and imports. Together these make up the Investment-Savings (IS)-curve. The following section examines factors effecting movements along the curve and those bringing about a shift in the curve.

B. Aggregate Demand and the IS-Curve

1. Aggregate Demand

In an open economy, aggregate demand, *Y*, is the sum of domestic absorption, *A*, and the trade balance, *B*:

$$Y = A + B \tag{3.1}$$

Domestic absorption measures total spending by domestic residents and public and private entities. It is composed of total private consumption, investment, and government expenditures:

$$A = C + I + G \tag{3.2}$$

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[4]A description of the monetary approach to the balance of payments can be found in Krugman and Obstfeld (1997).

Box 3.1
Notations in the Model

A	=	real domestic absorption
B^b	=	overall balance of payments
B^c	=	current account balance
B^k	=	capital account balance
B^t	=	trade balance
C	=	real consumption expenditures
C^g	=	real government consumption expenditures
C^p	=	real private consumption expenditures
D	=	domestic credit from the monetary sector
D^p	=	domestic credit from the monetary sector to the private sector
D^g	=	domestic credit from the monetary sector to the public sector
D^{gs}	=	domestic credit from the monetary sector to the government
E^n	=	nominal exchange rate
E^r	=	real effective exchange rate
F	=	external debt of public sector, denominated in foreign currencies
G	=	government expenditures
G^r	=	government expenditures on other
G^w	=	government expenditures on wages
H	=	nominal debt of government
I	=	real gross domestic investment expenditure
I^f	=	foreign direct investment
i	=	nominal interest rate
i^f	=	nominal interest rate prevailing in world market
K	=	stocks
M	=	broad money
N	=	real non-tax revenue of public sector
P	=	domestic price level
P^f	=	foreign currency price of goods purchased abroad
r	=	real interest rate
R	=	net foreign assets
R^b	=	net foreign assets of commercial banks
R^g	=	net foreign assets of government
R^p	=	net foreign assets of private sector
T^t	=	taxes from trade
T^r	=	taxes from other sources
V	=	velocity of money
X	=	real exports
X^s	=	export value of services
Y	=	real aggregate demand
Y^a	=	real output of primary sector
Y^b	=	real output of secondary sector
Y^c	=	real output of tertiary sector
Y^d	=	real net household income
Y^f	=	real foreign market income
Y^g	=	real government revenue
Z	=	real imports of merchandise
Z^s	=	import value of services

where *C* is real private consumption expenditure, *I* represents real gross domestic investment expenditures, and *G* is real government expenditures.

The trade balance measures the net spending by foreigners on domestic goods. It is defined as:

$$B = X - Z \tag{3.3}$$

where *X* denotes real exports, and *Z* represents real imports. As with domestic absorption, the trade balance is defined in real terms.

2. Output Market

Conventional IS-LM curves offer a useful analytical tool for examining the effects of policy initiatives or shocks on the Uzbekistan economy. These curves, along with that for foreign exchange (FE), provide a framework within which to show the equilibrium output solution of the Uzbekistan economy under different predetermined variables, including those representing policy instruments. We begin with the derivation of the IS curve, and in the next chapter derive the LM curve. After examining the fiscal component of the model, we derive the FE curve, and consider the effect of current account imbalances on capital flows, national savings and investment, and the Government's budget deficit.

There are four steps to the derivation of the IS curve. The first consists of the determination of the long run, or steady state, equilibrium solutions of the individual behavior relationships. The second involves the addition of the government's budget constraint to the system of equations. The third consists of the derivation of the reduced-form equation relating output to the predetermined variables in the economy. The final step consists of the determination of the relationship between interest rates and output to find the slope of the IS curve.

The steady state solution of a variable is a timeless concept. Thus for any variable $Y_t = Y = Y_{t-1}$. Similarly, $\Delta Y_t = \Delta Y = \Delta Y_{t-1}$ is the rate of growth. In what follows, we present the steady-state solution for the behavioral equations that make up the system of equations in the model:

Private Consumption is positively related to real GDP, denoted Y, negatively related to the real interest rates, r.

$$C = k_1 + \beta_{11}Y + \beta_{12}r \tag{3.4}$$

The coefficient β_{11} is the *marginal propensity to consume out of current income (MPC)*.

In Uzbekistan consumption by the private sector depends on income. As real interest rates have been negative in some years of the sample period, the ratio of interest to inflation rather than the difference was used to make all values positive, thereby allowing the logarithm of all values in the series to be calculated.

The final equation using the ECM specification described in equation (2.5) is as follows[5]:

$$\Delta lnC_t = -0.42 - 0.92 \ln(C/Y)_{t-1} \tag{3.5}$$

$$R^2 = 0.76 \qquad DW = 2.2 \qquad \text{Period: 1997-2002}$$

The income elasticity is reasonable in magnitude and has the expected signs. Changes in income produce a strong impact on consumption after one period, and then abate during subsequent years. Despite the relatively simple definition of income, the variable provided a reasonably good explanation of private consumption behavior in Uzbekistan.

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[5] A binary variable (1 in 1997; 0 otherwise) was included in the equation, which effectively eliminated that observation from the estimate.

The long-run, or steady-state solution, of the estimated equation is as follows:

$$C = e^{-0.5} Y \qquad (3.6)$$

Hence the long-run elasticity of consumption with respect to income is 0.92 in the short run (after a one-period lag) and unity in the long run.

Investment is composed of fixed investment and changes in stocks. Given the potential importance of foreign direct investment (FDI), it has been calculated separately from other investment activity and the results are reported under the balance of payments analysis in Chapter 5. For other investment, domestic economic activity in Uzbekistan and the real domestic interest rates (lending rate) were included as explanatory variables. Because real interest rates were negative in some of the early years in the sample, the logarithm of the variable could not be calculated for those years. Instead, the variable used was the logarithm of the ratio of the nominal interest rate to the domestic rate of inflation. This allowed the full sample period to be included in the equation estimate.

Investment is positively related to income and negatively related to interest rates.

$$I = k_2 + \beta_{21}Y + \beta_{22}r \qquad (3.7)$$

The coefficient β_{21} is the *marginal propensity to invest out of current income (MPI)*.

The final equation is as follows:[6]

$$\Delta \ln I_t = -1.36 - 0.85 \ln(I/Y)_{t-1} \qquad (3.8)$$
$$(2.8)$$

$$R^2 = 0.56 \qquad DW = 2.4 \qquad \text{Period: 1996-2003}$$

The elasticity of investment with respect to income is 0.85 in the short run (after a one-period lag) and unity in the long run.

Stock changes are normally inversely related to the general level of economic activity. An increase in economic activity leads to a drawdown of stocks, and conversely, a cutback in economic activity often results in an accumulation of stocks. However, industry studies do not always support this expected negative relationship.[7] We found stocks in Uzbekistan to generally not have a negative relationship to economic activity. We also considered the influence of real interest rates on inventory holdings but did not find a significant relationship or one with the expected sign. Contrary to expectations, stock changes in Uzbekistan were found to be positively related to economic activity:

$$\Delta \ln K_t = -1.8 - 0.82 \ln(K/Y)_{t-1} \qquad (3.9)$$
$$(3.3)$$

$$R^2 = 0.69 \qquad DW = 2.3 \qquad \text{Period: 1998-2003}$$

which yields an elasticity of stock changes with respect to income of 0.82 in the short run and unity in the long run.

Exports are positively related to foreign market income and negatively related to both the price of exports and the real exchange rate.

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[6] Binary variables (1 in 1997 and 1999; 0 otherwise) were also included in the equation.
[7] See, for example, the case study on inventories by industries in *Eviews: User's Guide* (Chapter 17).

$$X = k_4 + \beta_{41}Y^f + \beta_{42}P^n + \beta_{43}e^r \qquad (3.10)$$

The coefficient β_{41} is the *marginal propensity to export out of foreign market income (MPX)*. The price effect in equation (3.10) is decomposed into the own-price effect, measured in terms of the domestic currency, and the real effective exchange rate (RER) effect. The RER takes into account changes in the price of domestic goods, P^n, relative to that of foreign goods, P^f, and the nominal exchange rate, R^n. At the bilateral trade level, the real exchange rate is measured by the 'real cross-rate', which takes into account changes in the nominal exchange rate of Uzbekistan with the foreign country and the relative price levels between Uzbekistan and that country. The decomposition allows us to separate the own-price (transmitted through their effect on the domestic-currency-denominated price level) and cross-rate effects to measure the impact of changes in both trade taxes and the exchange rate on the balance of trade and the macro-economy. Estimates of equation (3.10) for Uzbekistan are presented in Chapter 5.

Imports are positively related to domestic income and the real exchange rate, and they are negatively related to the price of imports.

$$Z_t = k_5 + \beta_{51}Y + \beta_{52}P + \beta_{53}e^r \qquad (3.11)$$

The coefficient β_{51} is the *marginal propensity to import out of domestic income (MPM)*. The price effect is decomposed into the foreign currency denominated import price, P, and the real effective exchange rate, e^r.[8] The equation estimates for imports are presented in Chapter 5.

3. Derivation of the IS-Curve

The total demand for a country's output, expressed in terms of its individual components, is derived from the aggregate demand identity in equation (3.1) and the domestic absorption and trade balance identities in equations (3.2) and (3.3):

$$Y = C + I + G + X - Z \qquad (3.12)$$

Substitution of the individual relationships in equations (3.4) through (3.11) into the absorption and trade balance components yields the aggregate demand relationship in its explicit function form:

$$Y = \theta_o + \theta_1 r + \theta_2 P^d + \theta_3 P^f + \theta_4 e^r + \theta_5 G + \theta_6 Y^f \qquad (3.13)$$
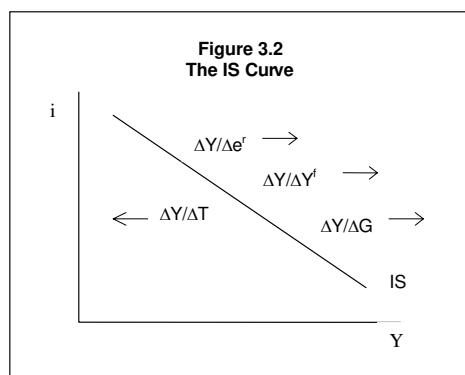
where $\theta_1 < 0$, $\theta_2 < 0$, $\theta_3 < 0$, $\theta_4 > 0$, $\theta_5 > 0$, $\theta_6 > 0$. Aggregate demand is therefore negatively related to the real interest rate and domestic and foreign trade prices, and positively related to, the real exchange rate, government expenditures, and foreign market income.

The total effects of a change in interest rates, government expenditures, the real exchange rate,

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[8] Note that the demand for imports is determined by the local currency price (in sum) of imports. As such, we can decompose the price variable into the US dollar prices and the real effective exchange rate as $P^n = P/e^r$, where P^n is the sum-denominated price of the imported product, P is the US dollar price of the imported product, and e^r is the real effective exchange rate. Since the REER takes into account changes in the price of domestic goods, P^n, relative to foreign goods, P^f, and the nominal exchange rate, e^n, and is defined as $e^r = P^n/(e^n P^f)$, then the demand for imports in Uzbekistan is directly affected by the real exchange rate, as well as the foreign currency denominated import price.

and foreign income are given by the corresponding coefficients of these variables in equation (3.13). An increase in foreign income, Y^f, for example, causes aggregate domestic income, Y, to increase by an amount that is always greater than the original increase in foreign economic activity. The increase in foreign income initially increases exports, which expands domestic aggregate income. The expansion then increases consumption and investment, though there is also some leakage from the accompanying increase in imports. That expansion then leads to a further increase in consumption and investment, thereby leading to a new round of aggregate income increases, until the full impact of the increase in foreign income has been completed. Hence, a unit increase in foreign income always leads to a more than proportional increase in aggregate domestic income. Similar multiplier effects occur with change in interest rates, domestic and foreign trade prices, government expenditures, and the real exchange rate. In each case, the final effect on aggregate demand is more than proportional to the change in these variables.

The effect of a change in the real exchange rate on aggregate demand, however, is less clearly defined. For a relatively small country like Uzbekistan, the Law of One Price will ensure that the demand curve for traded goods is perfectly elastic, so that a devaluation will shift the export demand curve in proportion to the devaluation if there is underutilization of capacity. There is a large literature on possible contractionary effects of a devaluation of output. Edwards has summarized the theoretical reasons for contractionary devaluations (1998). They arise from the effects that a devaluation can have through either price rises that cause a negative real balance effect, the redistribution of demand from a sector having a low marginal propensity to save to one with a high one, low price elasticities of demand for exports and imports, or supply-side rigidities.

Figure 3.2
The IS Curve

The IS (investment-savings) curve relates the level of output of Uzbekistan to its real interest rate. The IS curve is obtained from the relationship between the level of aggregate demand and the level of the interest rate in equation (3.13):

$$\Delta r/\Delta Y = 1/\theta_1 < 0 \qquad (3.14)$$

The curve relating the level of aggregate demand to the level of interest rates is therefore downward sloping.

Shifts in the IS curve result from changes in domestic and foreign trade prices, the real exchange rate, government expenditures, and foreign income. An increase in the real exchange rate causes both foreign and domestic residents to shift their consumption to relatively less expensive Uzbekistan goods, causing aggregate demand to rise and the IS curve shifts to the right for the given level of interest rates. The amount by which the curve shifts is $\Delta Y/\Delta e^r = \theta_2 > 0$. A similar rightward shift in the IS curve occurs when there is an increase in foreign market income, and the amount by which aggregate demand increases equals $\Delta Y/\Delta Y^f = \theta_4 > 0$. For government expenditures, the increase in aggregate demand equals $\Delta Y/\Delta G = \theta_3 > 0$. These shifts are demonstrated in Figure 3.2. If we were to include taxes, an increase in taxes would reduce disposable income, thereby lowering consumption and shifting the IS curve to the left for the given level of interest rates. The amount of the shift would be given by $\Delta Y/\Delta T = \theta_5 < 0$.

C. Aggregate Supply

Having determined aggregate demand, we need to find aggregate supply to determine the output of the economy. Aggregate supply is given by the value added by each sector. The value added of all activities in a sector is the sum of the difference between total revenue from those activities and the cost of their purchases from other industries or firms. In the present model, the output levels of both the primary and secondary sectors are endogenous, while 'other services' in the secondary sector is predetermined.

Table 3.1
Uzbekistan: Value Added by Sector
(percent contribution), 2000-03 average

	2000-03 Avg
Agriculture	34%
Other Services/1	23%
Industry	17%
Trade	11%
Transport and Communication	9%
Construction	6%
GDP at factor costs	100%

In modeling the value added of these six sectors, we determine their output levels by the economy's gross fixed capital formation, I, the general price level, P, and a capacity variable, T:

$$Y^{va}_t = \alpha_{60} + \alpha_{61}I_t + \alpha_{62}P_t + \alpha_{63}T + \mu_6$$

The final equations for the sectors are presented in Table 3.2 and their short and run long elasticities are given in Table 3.3.

Table 3.2
Uzbekistan: Value Added Estimates from Equation (3.15)
Dmt = a60 + a61(m – y)t-1 + a62Dyt + a63yt-1 + a64Dpt + a65pt-1 + u2t

						Summary Statistics		
Description	ln(M)–ln(Y)t-1	Dln(P)t	ln(P)t-1	T	Con	R2	dw	Period
Agriculture	-0.56	0.35	0.11		-0.7	0.82	2.40	1993-2003
	-4.1	2.6	2.9					
Industry	-0.03	0.14		0.02	-0.2	0.99	3.34	1998-2003
	-0.1	2.1		7.7				
Trade	-0.31		0.01		-0.3	0.94	2.27	1993-2003
	-4.6		1.5					
Trans.& Com.	-0.07			0.01	-0.1	0.77	2.74	1993-2003
	-0.6			1.3				
Construction	-0.29	0.08		0.04	-0.7	0.83	2.15	1993-2003
	-1.5	1.3		1.7				

Table 3.3
Uzbekistan: Elasticities from Value Added Estimates from Equation (3.15)

	Activity			Price			Capacity	
Description	Short-Run		Long Run	Short-Run		Long Run	Short-Run	Long Run
Agriculture	0.90	a/	1.00	0.35		0.19		
Industry	0.15	a/	1.00	0.14			0.02	5.97
Trade	0.31	a/	1.00	0.01	a/	0.04		
Trans.& Com.	0.07	a/	1.00				0.01	0.15
Construction	0.37	a/	1.00				0.04	0.14

Note: The elasticities measure the percentage change in Uzbekistan' value added brought about by a 1 percent change in either real investment, the general price level, or the real exchange rate.

a/ One-period lag.

IV. MODELING THE MONETARY AND FISCAL SECTORS

A. Supply and Demand for Money

1. Overview

The banking system of Uzbekistan is composed of the Central Bank of Uzbekistan (CBU) as the central bank and a commercial banking system. The CBU controls the monetary base, or supply of currency in circulation and commercial bank reserves, through a set of policy instruments. In general, the domestic money stock is made up of net foreign assets of the consolidated banking system, plus bank credit to the public and private sector.

In general, money is classified into the following categories:

- *High-powered money* is made up of currency in circulation plus cash reserves of commercial banks in the CBU.
- *M1 money* consists of liquid assets that include currency, demand deposits, traveler's checks, and other types of deposits against which checks can be drawn.
- *M2 money*, or *broad money*, is composed of M1 plus *quasi money* such as savings deposits and money market deposits.

2. The Supply of Money

The supply of money is composed of sum and foreign currency liquidity. The level of this liquidity equals M2, denoted *M*, and is composed of (a) net domestic assets, denoted *D*, and net foreign assets, denoted *R* (in domestic currency terms). Hence:

$$M_t = R_t + D_t \tag{4.1}$$

where net domestic assets is given by:

$$D_t = D^p_t + D^g_t \tag{4.2}$$

and net foreign assets is made up of net foreign assets of the CBU, denoted R^c, net foreign assets of commercial banks, denoted R^b, net foreign assets of the private sector, denoted R^p, and net foreign assets of the government, denoted R^g:

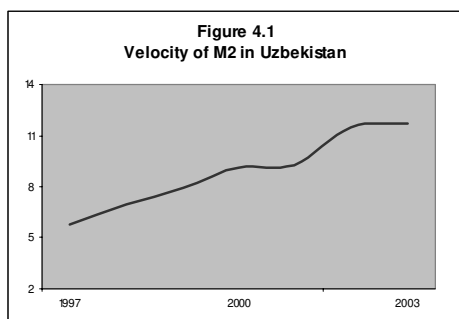$$R_t = R^c_t + R^b_t + R^p_t + R^g_t \tag{4.3}$$

The *velocity of money* defines the number of times that the each unit of money circulates in the economy each year. For M2 money, the velocity of money, denoted V_2, is defined as:

$$V_2 = YP / M_2 \tag{4.4}$$

If V_2 is relatively constant and real output, *Y*, is determined by other factors, then the supply of money, *M*, should grow in a fixed proportion to *Y* to keep prices, *P*, stable, since equation (4.4) implies that P = MV/Y. These circumstances generally describe the monetarist doctrine, under which a stable growth of *M* precludes the use of a proactive monetary policy. In Uzbekistan, however, V_2 has not remained constant but rather increase, and under appropriate conditions.

3. The Demand for Money

The conventional approach to the demand for money derives from the Baumol-Tobin model (for details, see Boumol and Blinder, 2004; Romer, 2002; Obstfeld and Rogoff, 1998; Farmer, 1998; Hall and Taylor, 1997; Mankiw, 2002; Barro, 1997; and Sachs and Larrain, 1993). It defines the demand for money in an analogous way as the demand for stocks by companies. Money, like stocks, is held by individuals and firms to ensure that they have the necessary liquidity to pay for goods and services. Thus as income expands, the demand for money increases; as income contracts, money demand decreases.

Figure 4.1
Velocity of M2 in Uzbekistan

There is, however, an opportunity cost associated with holding money and associated with foregone earnings from holding interest-bearing financial assets such as bonds. The desire to hold money is therefore negatively related to the interest rate. As interest rates rise, the opportunity cost of holding money increases and the demand for money expands; as interest rates fall, the demand for money contracts due to the lower opportunity cost incurred from holding money. The aforementioned relationships between the demand for money and both income and interest rate are specified in real terms, since the demand for money is generally considered to be absent of any money illusion. Variations in prices therefore lead to proportional changes in nominal income, interest rates, and money demand.

The demand for money, M, is therefore defined in terms of real balances, M/P, and it relates the demand for those balances to the real rate of interest, r, and the level of income, Y:

$$M/P = k_{70} + \beta_{71}r + \beta_{72}Y \tag{4.5}$$

The coefficient β_{71} is used to measure the interest elasticity of money demand, and the coefficient β_{72} serves to measure the real-income elasticity of money demand. In Uzbekistan the final price equation that we derive from equation (4.5) is as follows:

$$\Delta \ln(P_t) = 0.5 - 0.35 \ln(P/M)_{t-1} - 0.75\ln(r_{t-1}) \tag{4.6}$$
$$\quad\quad\quad\quad\quad (12.1) \quad\quad\quad\quad (3.4)$$

$$R^2 = 0.97 \quad\quad\quad DW = 1.2 \quad\quad\quad \text{Period: 1994-2003}$$

B. Derivation of the LM Curve

The LM curve relates the level of aggregate demand to the interest rate for a given level of real money balances. Thus, at each point in the curve, the aggregate demand associated with a given interest rate is consistent with money market equilibrium.

The LM curve is found from the steady-state equilibrium solution of equation (4.1) and equation (4.5) in terms of interest rate:
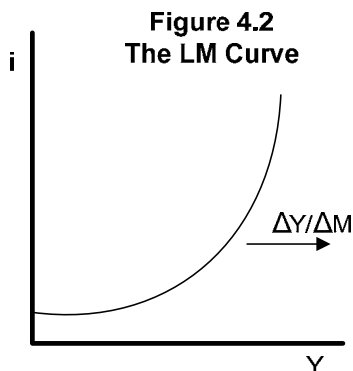
$$r = \kappa_0 - \kappa_1 Y + \kappa_2 (e^n R + D)/P \tag{4.7}$$

where $\kappa_0 = k'_7$, $\kappa_1 = (\beta_{72}/\beta_{71})$, and $\kappa_2 = (1/\beta_{71})$.

The slope of the LM curve is given by:

$$\Delta r/\Delta Y = -\kappa_1 \qquad (4.8)$$

Since $\kappa_1 = \beta_{72}/\beta_{71}$, and $\beta_{71} < 0$ and $\beta_{72} > 0$, the slope of the LM curve is positive. A higher interest rate lowers the demand for money and a higher aggregate demand increases the demand for money. Hence, for a given real money balance, *M/P*, money demand can only be equal to the given money supply if an increase in interest rates is matched by an increase in aggregate demand.

**Figure 4.2
The LM Curve**

i

$\Delta Y/\Delta M$

Y

Increases in the money supply, say from an increase in net foreign assets, *R*, shifts the LM curve to the right. When the money supply expands, it creates an excess supply of money at the prevailing interest rate and level of output. The excess supply causes households to convert their money to bonds and other securities, which drives down the interest rate. The lower interest rate, in turn, increases investment and leads to an overall expansion in aggregate demand.

C. Government Revenue and Expenditures

The Government's revenue collection has been hindered by the large informal sector and dependence on foreign trade taxes. As a result, the real value of tax revenue collections has grown by less than 1 percent on average since 1992. In order to reduce the overall budget deficit, government expenditures have had to be cut, especially on non-wage expenditures. While the burden of the budget deficit as a percentage of GDP has been reduced from 18 percent in 1990/91 to 5 percent in 1998/99, government investment activities, particularly in public infrastructure, have suffered. In addition to public sector wage payments, there has been a drain on government budget from the need to finance public sector programs.

Taxes from trade, denoted T^t, are calculated from the level of imports and the average tariff rate.

Other indirect taxes, denoted T^o, is related to private consumption[9]:

$$\Delta \ln T^o_t = -0.1 - 0.07 \ln(T^o/C^p)_{t-1} \qquad (4.9)$$
$$(1.4)$$

$$R^2 = 0.79 \qquad DW = 2.5 \qquad \text{Period: 1999-2003}$$

And direct taxes, , denoted T^d, is related to private consumption[10]:

$$\Delta \ln T^d_t = -0.3 - 0.08 \ln(T^d/C^p)_{t-1} \qquad (4.10)$$
$$(1.5)$$

$$R^2 = 0.72 \qquad DW = 1.6 \qquad \text{Period: 1999-2003}$$

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[9] A binary variable (1 in 1001; 0 otherwise) was also included in the equation.
[10] A binary variable (1 in 1001; 0 otherwise) was also included in the equation.

D. Monetarization of the Fiscal Deficit

The fiscal deficit, or the change in the government's debt, is the difference between the government's current expenditures and revenue. Government expenditures consist of nominal expenditures on domestic goods, *PG*, interest payments on domestic debt, $i_t\, D^g_{t-1}$, and interest payments on foreign debt, $i_t\, F_{t-1}$. The government revenues derive from tax receipts (in nominal terms), PT, and income from capital and other sources (in nominal terms), PN. The difference between revenue and expenditures represents the change in government debt:

$$\Delta D^g_t = PG + i_t\, D^g_{t-1} + i_t\, F_{t-1} - PT - PN \qquad (4.11)$$

The change in the government debt can be financed through an increase in the money supply, ΔM_t, a decrease in foreign exchange reserves, $e^n_t \Delta R_t$, an increase in the amount borrowed from the private sector, ΔD^p_t, or an increase in the amount transferred from extra-budgetary funds, ΔD^{gr}_t. These sources of deficit financing can be derived from the money supply equation (4.1) and equation (4.3):

$$\Delta D^g_t = \Delta M_t - e^n_t \Delta R_t - \Delta D^p_t - \Delta D^{gr}_t \qquad (4.12)$$

The government budget relates the sources of the deficit in equation (4.12) to the financing of the deficit in equation (4.11):

$$PG + i_t\, D^g_{t-1} + i_t\, F^g_{t-1} - PT - PN = \Delta M_t - e^n_t \Delta R_t - \Delta D^p_t - \Delta D^{gr}_t \qquad (4.13)$$

The *budget constraint* in equation (4.13) states that the government can finance its deficit by increasing the money supply, borrowing from the public sector, or reducing its foreign exchange holdings.

V. MODELING THE EXTERNAL BALANCE

A. The Real Exchange Rate

The international competitiveness of Uzbekistan is generally reflected in the real effective exchange rate (RER), which takes into account both general price movements in Uzbekistan relative to that of each of its trading partners, and the cross exchange rate between Uzbekistan and each of its trading partners. The real exchange rate is a measure of the relative price of non-tradables to tradables and, as such, it measures the cost of producing a good domestically. A relative price rise, for example, reflects an increase in the domestic cost of producing tradable goods, since it makes production of tradables less profitable and induces resources to move to the non-tradables sector. While the concept is straightforward, its empirical measurement is difficult for a country like Uzbekistan where price series for tradable and non-tradable products are not readily available.

Table 5.1
Uzbekistan's Nominal and Real Exchange Rate Indices (1996=100)

	Nominal Exchange Rate	Real Exchange Rates		
		RER1	RER2	RER3
1994	24.8	104.8	319.1	461.4
1995	74.2	108.9	113.6	135.4
1996	100.0	100.0	100.0	100.0
1997	165.4	105.1	70.6	71.4
1998	235.9	97.8	73.0	60.3
1999	311.1	117.2	67.9	55.6
2000	591.0	97.6	59.4	49.7
2001	1,054.5	77.4	47.2	40.1
2002	1,921.2	57.1	43.4	36.5
2003	2,757.4	40.2	43.9	32.9
2004	3,068.0	36.9	43.4	32.3

Note: RER1 is the nominal exchange rate adjusted for inflation of each trading partner; RER2 is the ratio of partner-country and domestic price measured in terms of CPI; and RER3 is the ratio of partner-country and domestic price measured in terms of the GDP deflator.
Source: Country-specific estimates in Uzbekistan macro-model database

Two alternative measures of the real exchange rate can be constructed within the context of Uzbekistan's data limitations. The first uses partner-country and domestic price measured in terms of CPI data to construct a real exchange rate index that represents the ratio between non-tradable and tradable prices. Specifically, the real exchange rate is defined in this case as $e^r_t = P^n_t/P^f_t$, where e^n is the nominal exchange rate, P^f is the foreign currency price of goods purchased abroad, and P is the domestic price level. The second uses purchasing power parity (PPP) definition to correct the nominal exchange rate by the relative price of domestic to foreign prices, as measured b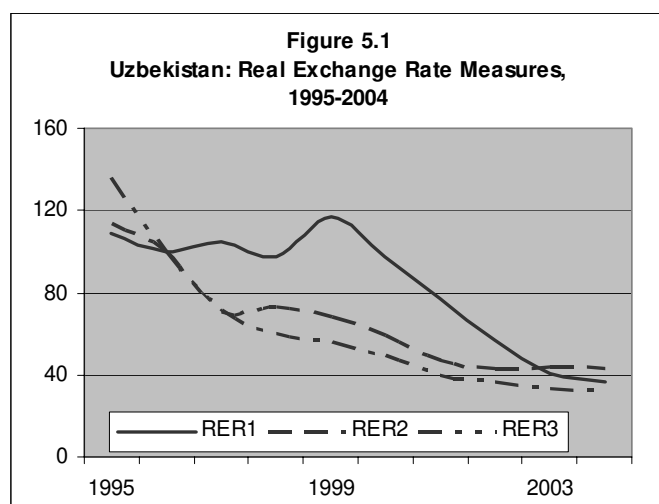y CPI data. Using this approach, the real exchange rate is defined as $e^r_t = (1/e^n)_t P^n_t/P^f_t$, where e^n is the nominal exchange rate, P^f is the foreign currency price of goods purchased abroad, and P is the domestic price level.

Figure 5.1
Uzbekistan: Real Exchange Rate Measures, 1995-2004

Table 5.1 shows the calculations of Uzbekistan's real exchange rate index using these two measures. Series RER1 refers to the purchasing power based definition of the double-deflated nominal exchange rate of Uzbekistan with each of its trading partners, RER2 refers to the ratio of partner-country and domestic price, measured in terms of the CPI, and RER3 refers to the ratio of
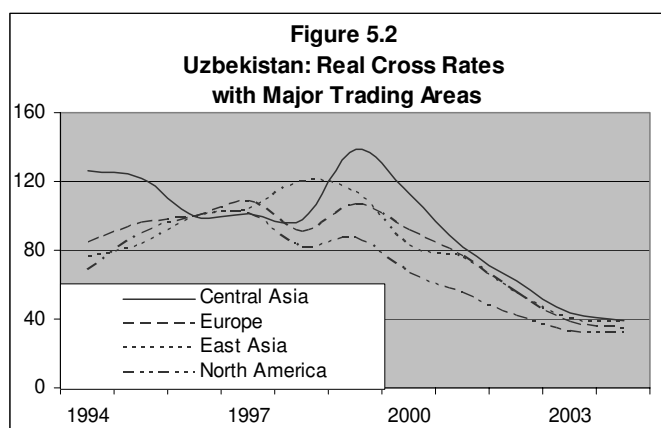
partner-country and domestic price, measured in terms of the GDP deflator. The CPI and GDP deflator for Uzbekistan's trading partners is derived from the trade-weighted average of its trading partners.

Although all measures of the real exchange rate show the same trending direction towards a revaluation of the sum, there are considerable divergences in movements during 1997-2002. As expected, there were relatively similar year-to-year changes in RER2 and RER3, which are variations on the ratio of partner-country and domestic prices using different prices (CPI and the GDP deflator). Year-to-year changes in the purchasing power parity (PPP) based measure, however, differs considerably from the two other measures because movements in the nominal exchange rate did not adequately reflect market conditions.

Table 5.2
Uzbekistan's Real Cross-Rates Indices with Major Trading Partners and the World (1996=100)

		Real Cross-Rates				
	World	Central Asia	Europe	East Asia	North America	Middle East
1992	57.5	-	57.7	58.8	55.0	57.9
1993	55.8	137.9	52.5	44.3	44.0	50.9
1994	104.8	126.2	84.5	76.3	68.3	71.1
1995	108.9	121.9	96.0	83.4	90.1	90.7
1996	100.0	100.0	100.0	100.0	100.0	100.0
1997	105.1	101.8	108.5	104.0	101.0	118.0
1998	97.8	98.2	90.3	119.8	81.8	87.6
1999	117.2	138.7	106.9	113.9	87.5	99.5
2000	97.6	112.9	91.9	82.7	66.9	76.2
2001	77.4	82.1	76.1	75.8	54.7	97.0
2002	57.1	62.0	55.4	55.0	41.9	62.3
2003	40.2	43.7	38.1	40.4	32.6	48.4
2004	36.9	38.7	34.5	38.7	31.8	47.9
Source: Country-specific estimates in Uzbekistan macro-model database						

Table 5.2 presents the real cross-rates of Uzbekistan with its major trading partners and all partners. The real cross-rate for the world is equal to the real effective exchange rate. Figure 5.2 shows the movements of the real cross-rate indices for Uzbekistan's four major trading regions: Central Asia, which in 2001-03 accounted for 37 percent of trade (exports plus imports), Europe (35 percent), East Asia (19 percent) and North America (7 percent). In the late 1990s and early part of this decade there was considerable divergence among the cross-rates for the major trading regions (Figure xx). There was a real devaluation of Uzbekistan's cross-rate with the other Central and East Asian countries in 1996-99, and starting in 2002 the real cross rates for all regions began to converge as a result of efforts by the Central Bank of Uzbekistan (CBU) to devalue the cash and OTC exchange rates to bring it to broadly the same level as that prevailing in the curb market. A number of impediments to the foreign exchange market, however, kept the OTC exchange rate considerably higher than the curb rate. A tightening of monetary and fiscal policy accompanied the liberalization of the foreign exchange market in an effort to control imports. The consolidated government budget deficit and net credit to the government from the CBU were kept well below the program ceilings for 2002, and reserve requirements were increased to slow the growth of broad money. Since that time, the rate of change in the real cross rate has been relatively similar across regions.

Figure 5.2
Uzbekistan: Real Cross Rates with Major Trading Areas

B. Balance of Payments Components

The principal components of Uzbekistan's current account balance are made up of the individual balances on goods and non-factor services[11], income[12] and transfers[13]. Any deficit arising in the current account represents an imbalance between national savings and investment that needs to be financed by a capital inflow or the accumulation of debt.

Offsetting financial cash flows in the capital account arise from foreign direct investment, portfolio investment and other investments, and any imbalance between the current and capital accounts of the balance of payments must be financed through changes in the official foreign reserves of Uzbekistan. Traditionally, interest in the capital account has focused on FDI flows, which comprise capital transactions such as equity capital, earnings reinvestment, and other short and long-term capital that is used to acquire management interest in an enterprise operating in Uzbekistan. Portfolio investments comprising long-term bonds and corporate equities other than direct investment and reserves have become important to Uzbekistan since the mid-1990s. Financing of the current account deficit with portfolio investment tends to be less sustainable than a deficit financed by FDI flows since these so-called hot money flows are more sustainable to reversals when market conditions and sentiments change.

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[11]Non-factor services comprise shipment, passenger and other transport services, and travel, as well as current account transactions not separately reported. These include transactions with nonresidents by government agencies and their personnel abroad, and also transactions by private residents with foreign governments and government personnel stationed in Uzbekistan.

[12]This balance comprises income from (a) factor (labor and capital) services in the form of income from direct investment abroad, interest, dividends, and property and labor income; and (b) long-term interest on the disbursed portion of outstanding public and private loans repayable in foreign currencies, goods or services.

[13]Transfers include (a) private net transfer payments between private persons and nonofficial organizations of the reporting country and the rest of the world that carry no provisions for repayments and that include workers' remittances, transfers by migrants, gifts, dowries, and inheritances, and alimony and other support remittances; and (b) official net transfers in the form of payments between the GOE and governments of the rest of the world.

The Real Exchange Rate and Its Measurement

Two alternative measures of the real exchange rate can be constructed within the context of Uzbekistan's data limitations. The first uses partner-country and domestic price measured in terms of either CPI data or the GDP deflator to construct a real exchange rate index that represents the ratio between non-tradable and tradable prices. Specifically, the real exchange rate is defined in this case as $e^r_t = P^n_t/P^f_t$, where e^n is the nominal exchange rate, P^f is the foreign currency price of goods purchased abroad, and P is the domestic price level. The second uses purchasing power parity (PPP) definition to correct the nominal exchange rate by the relative price of domestic to foreign prices, as measured by CPI data. Using this approach, the real exchange rate is defined as $e^r_t = (1/e^n)_t P^n_t/P^f_t$, where e^n is the nominal exchange rate, P^f is the foreign currency price of goods purchased abroad, and P is the domestic price level. The latter definition is used by the IMF, rather than the conventional inverse relation, i.e., $e^r_t = (e^n_t P^f_t)/P^n_t$. As such, we need to invert the first measure to make it comparable, i.e., $e^r_t = P^f_t/P^n_t$.

Using these definitions, we interpret movements in the real exchange rate as follows: A rise in e^r represents a real devaluation under a fixed exchange rate system, and a depreciation under a flexible exchange rate system. The fall is associated with either a rise in the nominal exchange rate e^n or a rise in relative prices of foreign goods (equivalent to a fall in relative prices of domestic goods). Conversely, a fall in e^r represents a real revaluation in a fixed exchange rate system, and an appreciation in a flexible exchange rate system, which under the purchasing power definition can be brought about by either a fall in the nominal exchange rate e^n, or a rise in the relative price of domestic goods (equivalent to a relative rise in the price of foreign goods).

The real exchange rate, defined in these terms, therefore measures export competitiveness, since variations in e^r influence the quantity of goods demanded in the foreign markets relative to competing foreign and domestic suppliers to those markets.

* For a discussion on measurement issues, see A. Harberger, "The Real Exchange Rate: Issues of Concept and Measure". Paper prepared for a Conference in Honor of Michael Mussa, June 2004.

1. Balance of Payments Equilibrium

Overall equilibrium in the balance of payments is the sum of the trade balance, *B*, and the balance in the capital account, *K*:

$$B^b_t = B_t + K_t \tag{5.1}$$

The capital account is mainly associated with movements in FDI, which in turn depend on interest rates and foreign and domestic incomes. Using equation (3.10) for exports and equation (3.11) for imports in the trade balance component, and the implicit relationship of FDI for the capital account component, we can specify the relationship for the balance of payments as follows:

$$B^b_t = k_8 + \beta_{81}Y^f_t + \beta_{82}Y_t + \beta_{83}e^r_t + \beta_{84}r_t \tag{5.2}$$

2. Derivation of the FE Curve

The foreign exchange (FE) curve relates the level of domestic aggregate demand, *Y*, to the interest rate, *r*, for a given level of the exchange rate, e^r, and foreign aggregate demand, Y^f. Thus, at each point in the curve, the aggregate demand associated with a given interest rate is consistent with equilibrium in the balance of payments such that $B^b = 0$. Hence, the FE curve is found from the steady-state equilibrium solution of equation (5.2) in terms of interest rate:

$$r = \omega_0 + \omega_1 Y + \omega_2 Y^f + \omega_3 e^r \tag{5.3}$$

where $\omega_1 = -(\beta_{82}/\beta_{84})$, $\omega_2 = -(\beta_{81}/\beta_{84})$ and $\omega_3 = -(\beta_{83}/\beta_{84})$.

The slope of the FE curve is given by:

$$\Delta r / \Delta Y = \omega_1 \tag{5.4}$$

Since $\omega_1 = -\beta_{82}/\beta_{84}$, and $\beta_{82} > 0$ and $\beta_{84} < 0$, the slope of the FE curve is positive. When capital is highly immobile, the curve is vertical. Shifts in the FE curve result from changes in the real exchange rate and foreign income. A devaluation of the real exchange rate causes the curve to shift to the right. The amount by which the curve shifts is $\Delta Y / \Delta e^r = \omega_3 > 0$. A rightward shift in the FE curve also occurs when there is an increase in foreign market income, and the amount by which aggregate demand increases equals $\Delta Y / \Delta Y^f = \omega_2 > 0$. Figure 5.1 demonstrates the effects.
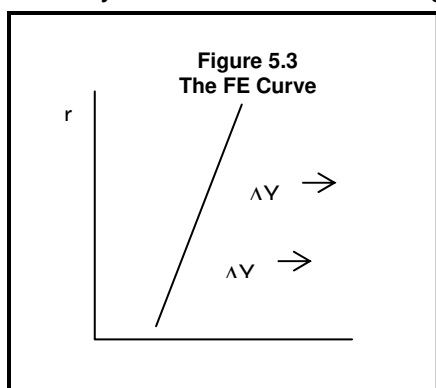
3. Balance of Payments Relation to Money Market Equilibrium

The link between money and the balance of payments is through the change in foreign exchange reserves, ΔR. The balance on the current account can run down foreign exchange reserves in a deficit, or it can increase them with a surplus. Hence, the relationship between the current account, B^c, and the change in foreign exchange reserves, ΔR_t, is given by:

$$\Delta R_t = B^c = \Delta R^c_t + \Delta R^b_t + \Delta R^p_t + \Delta R^g_t \tag{5.5}$$

In the same way, capital inflows from direct or portfolio investments and borrowing from banks, foreign governments and international organization such as the World Bank and International Monetary Fund can increase foreign exchange reserves. In this case the relationship between the capital account, B^k, and the change in foreign exchange reserves, ΔR_t, excludes changes in foreign exchange reserves of the CBU. Hence,

$$B^k = \Delta R^b_t + \Delta R^p_t + \Delta R^g_t$$

Figure 5.3
The FE Curve

Finally, the overall balance of payments is the sum of the current and capital accounts. That difference equals the change in foreign exchange reserves of the CBU:

$$B^b = \Delta R^c_t$$

4. Balance of Payments Relation to Savings and Investment

Capital inflows allow domestic investment to exceed national savings when they finance a current account deficit. As such, capital inflows that finance the current account deficit can increase investment and the rate of economic growth of a country like Uzbekistan. The relationship between the current account balance and domestic savings and investment can be demonstrated in the following manner. From equation (3.1) suggests that the balance on trade in goods and non-factor services (B) is the difference between total GDP (Y) and domestic absorption (A):

$$B_t = Y_t - A_t \tag{5.8}$$

Since consumption is composed of private (C) and public sector (G), and since domestic investment (I) is equal to national savings (S) plus the current account deficit (B) or foreign savings, then the following identity holds:

$$S_t = Y_t - C_t - G_t \qquad\qquad (5.9)$$

Substituting equation (5.9) into equation (5.8) gives the expression for the trade balance in terms of savings and investment:

$$B_t = S_t - I_t \qquad\qquad (5.10)$$

Hence the balance on trade in goods and non-factor services is the difference between savings and investment.[14] If Uzbekistan invests more than its saves, then the country is producing an amount of output Y that is smaller than the total spending on goods for consumption and investment purposes (C+G+I). The excess absorption over GDP, or the excess of investment over savings, implies that Uzbekistan has a trade deficit.

To finance the deficit and pay for the excess of consumption (C+G) over income/output (Y), Uzbekistan needs to reduce its assets or borrow from abroad. Whether assets are run down or new foreign borrowing is undertaken, Uzbekistan's net foreign assets (R) will be reduced by the amount of the current account deficit:

$$B_t = \Delta R_t \qquad\qquad (5.11)$$

Hence, the change in the net foreign assets (R), a stock concept, will be equal to the current account, a flow concept.

C. Demand for Imports and Exports

1. Imports of Goods and Nonfactor Services

The demand for imports of Uzbekistan is postulated to have a steady-state response to domestic economic activity, and a transient response to the constant local currency price of imports. The life-cycle approach to consumption emphasizes income as a determinant of intertemporal consumption planning and provides theoretical justification for the existence of the dynamic effect on import demand of changes in the rate of growth of domestic income. In contrast, there is no logical explanation for any dynamic effects of the price of imports. Were the import price of a product to change continually relative to the general price deflator, consumers would soon cease to purchase the product as the spread between the product price and the general price level widened.

An important characteristic of the import demand for any one product is that its long-term response to the growth of domestic income is not necessarily proportional, and in fact has historically exceeded unity. Moreover, among individual countries the marginal propensity to import has varied greatly. This characterization suggests that the dynamic specification of the import demand equation should not introduce any restrictions that would impose long-run unitary elasticity with respect to income. Nevertheless, the model should encompass long-term proportionality responses when they exist.

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[14]Although the term B has been used to represent the balance on trade in goods and non-factor services, in practice, B should be treated as the current account balance, excluding official transfers, when calculating gross national savings.

A second feature of the present modeling approach is that the dynamics for import demand relationships can be restricted to one period since the adjustment of imports to price and income changes tends to decline exponentially over time. Accordingly, in terms of the general stochastic difference specification, the expression for imports, M, in terms of income, Y, the price of the product, P, in foreign currency terms, and the real effective exchange rate, R, can be expressed as:

$$\ln(M)_t = \alpha_{10} + \alpha_{11}\ln(M)_{t-1} + \alpha_{12}\ln(Y)_t + \alpha_{13}\ln(Y)_{t-1} + \alpha_{14}\ln(e^r)_t + \alpha_{15}\ln(e^r)_{t-1} + u_{1t} \qquad (5.12)$$

where the expected signs of the coefficients are $0 < \alpha_{11} < 1$; α_{12} and $\alpha_{13} > 0$; α_{14} and $\alpha_{15} < 0$. Income is treated as (weakly) exogenous for the parameters of interest. The use of the logarithmic specification in equation (5.12) provides a means by which the elasticity can be calculated directly from the estimated equation; the results are consistent when the elasticities remain constant over time. Tests of parameter constancy provide a means of validating that hypothesis.

The third characteristic is that the observed price for the Uzbekistan importer incorporates the tariff of the product. Expenditure-switch policies in the form of tariffs create a 'price wedge' between the domestic price to the consumer and the world market price of the product. This measure effectively imposes a tax on the consumer. The effective tax rate, denoted t, raises the price of the product to $(1+t)P^b$, where P^b is the border price of the product. The observed price of the domestic good, P^n, is therefore defined as:

$$P^n = (1 + t)P^b \qquad (5.13)$$

Changes in the tariff rate will be fully passed on to the importer when the foreign market export supply to small markets like that of Uzbekistan is perfectly price elastic.[15]

The fourth important characteristic is that the demand for imports is determined by the local currency price (in sum) of imports. As such, we can decompose the price variable into the US dollar prices and the real effective exchange rate in equation (5.13) as follows:

$$P^n = P/e^r \qquad (5.14)$$

where P^n is the sum-denominated price of the imported product, P is the US dollar price of the imported product, and e^r is the real effective exchange rate.

The real effective exchange rate takes into account changes in the price of domestic goods, P^n, relative to foreign goods, P^f, and the nominal exchange rate, e^n. It is defined as follows:

$$e^r = P^e/(e^n P^f) \qquad (5.15)$$

As mentioned earlier, the demand for imports in Uzbekistan is directly affected by the real

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[15]The 'small market' assumption is important for the calculations that follow. In calculating the effects of a tariff reduction, the Uzbekistan market is assumed to represent a fairly small proportion of its trading partners' total exports and, hence, that the import supply schedule is infinite with respect to prices. Prices of each of Uzbekistan's imported products are therefore changed by the full amount of any tariff reduction on the products. Were the import supply schedule to be less than perfectly elastic with respect to prices, a change in tariffs would lead to less than proportional changes in prices and smaller increases in the volume of imports than would otherwise occur under a perfectly price elastic import supply schedule.

exchange rate. A fall in e^r represents a real *revaluation* in a fixed exchange rate system, and an *appreciation* in a flexible exchange rate system, which can be brought about by either a fall in the nominal exchange rate e^n, or a rise in the relative price of domestic goods (equivalent to a relative rise in the price of foreign goods). Conversely, a rise in e^r represents a real *devaluation* under a fixed exchange rate system, and an *depreciation* under a flexible exchange rate system. The fall is associated with either a rise in the nominal exchange rate e^n or a rise in relative prices of foreign goods (equivalent to a fall in relative prices of domestic goods).

The final characteristic is that if the import supply elasticity were to be less than infinite, then the pass-through of exchange rate changes from import price changes in foreign currency terms to import prices in local currency terms would be less than complete (see the summary by Goldstein and Khan, 1985). Consequently, the estimated price and exchange rate coefficients in equation (5.12) could differ from one another.[16]

The estimated import demand equation for Uzbekistan did not suggest any lagged response to the income and price variables:[17]

$$\Delta \ln M_t = -0.3 - 0.94 \ln(M/Y)_{t-1} - 0.18 (e^r)_{t-1} \qquad (5.16)$$
$$\qquad\qquad\quad (3.2) \qquad\qquad (1.2)$$

$$R^2 = 0.83 \qquad DW = 2.2 \qquad \text{Period: 1997-2003}$$

2. Exports of Goods and Nonfactor Services

The demand for exports of Uzbekistan has a steady-state response to the import demand of its geographic markets, and a transient response to its relative export price. The justification for these long-run dynamic properties is similar to that for the import demand of Uzbekistan discussed in the previous section. The demand for exports of a product from all foreign suppliers is equivalent to the import demand for the product from that market. Thus the life-cycle model of consumption provides the same theoretical justification for the existence of a long-run dynamic effect associated with import demand in foreign markets as it did for the import demand function of Uzbekistan. In contrast, unless relative-price movements generate only transient responses, a continuous change in the price of exports from one country relative to that of exports from competing suppliers would eventually cause importers to purchase the product from the lower-priced supplier(s). Thus it is appropriate to constrain the long-run effect from relative prices to zero.

Consider the general first-order stochastic difference expression for export demand, X, of a geographic market j of Uzbekistan's products as a function of real GDP of the geographic market, Y^f, and the price of Uzbekistan's exports measured in US dollar terms that has been double deflated, P:

$$\ln(X)_t = \beta_{40} + \beta_{41}\ln(X)_{t-1} + \beta_{42}\ln(Y^f)_t + \beta_{43}\ln(Y^f)_{t-1} + \beta_{44}\ln(e^r)_t + \beta_{45}\Delta\ln(e^r)_{t-1} + v_{1t} \qquad (5.17)$$

where the expected signs of the coefficients are $0 < \beta_{41} < 1$; β_{42} and $\beta_{43} > 0$; β_{44} and $\beta_{45} > 0$.

The estimated export demand equation for Uzbekistan

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[16]For a derivation of the import supply schedule, see Lord (1991: Annex D).
[17] Binary variable was included for 1993-94.

$$\Delta \ln(X)_t = 7.8 - 0.78 \ln(X/Y^f)_{t-1} - 0.45 \, (e^r)_{t-1} \tag{5.18}$$
$$\quad\quad\quad (1.9) \quad\quad\quad (1.6)$$

$$R^2 = 0.52 \quad\quad DW = 1.8 \quad\quad \text{Period: 1997-2003}$$

D. Foreign Direct Investment

The effects of real exchange rate movements on FDI depend on the sourcing of inputs and market distribution. If cross-border production activities are directed towards exports and they rely on domestic inputs, then a rise in the real effective exchange rate (an effective devaluation of the sum) will increased FDI inflows will improve the current account. In contrast, if cross-border production activities are oriented to the domestic market and they use foreign inputs, then FDI will be positively related to a fall in the real effective exchange rate and the current account balance will be negatively related to FDI inflows.

The specification for FDI inflows, denoted F, with an ECM driven by foreign real income, Y^f, and with a 'differences' formulation of the real effective exchange rate, E, term nested in the levels form of the equation is:

$$\Delta f_t = \beta_{70} + \beta_{71}(f - y^f)_{t-1} + \beta_{72}\Delta y^f_t + \beta_{73}y^f_{t-1} + \beta_{74}\Delta E_t + \beta_{75}E_{t-1} + v_{3t} \tag{5.19}$$

where $-1 < \beta_{71} < 0$; $\beta_{72} > 0$; $\beta_{73} > \beta_{71}$; β_{74} and $\beta_{75} < 0$; and where all variables are measured in logarithmic terms.

The following are the results of the equation estimate:

$$\Delta f_t = 1.4 - 0.51(f - y^f)_{t-1} - 1.17\Delta E_t - 0.67E_{t-1} \tag{5.20}$$
$$\quad\quad (4.6) \quad\quad\quad (1.6) \quad\quad (1.9)$$

$$R^2 = 0.96 \quad\quad dw = 3.2 \quad\quad\quad \text{Period: 1994-2003}$$

where figures in parenthesis are t-statistics.

Table 5.3 Income and Exchange Rate Elasticities of FDI Inflows		
	Elasticity with respect to:	
	Exch. Rate	Income
Short-term	-1.71	0.51
Long-term	-1.30	1.00

Table 5.3 summarized the results of the equation estimate in stead-state growth. The most interesting observation of the estimate is that FDI growth is negatively related to changes in the real effective exchange rate. This response reflects the domestic orientation of FDI in Uzbekistan, and its reliance on foreign inputs. An appreciation of the real effective exchange rate, for example, reduces the cost of inputs to transnationals in Uzbekistan and has a positive effect on cross-border production. That effect is relatively strong, both in the short and long run. It is important to note, however, that the present elasticities estimates are based on existing levels of protection on production and trade in Uzbekistan. It does not take into account new production activities from an efficient import substitution and export expansion that would be expected under a concurrent exchange rate depreciation and trade liberalization.

E. Output Equilibrium

The equilibrium values for the interest rates and aggregate demand are determined by the intersection of the IS and LM curves. At that point, the real output demand and the money market are in equilibrium for a given levels of domestic prices, P, for a given level of foreign income, Y^f, and for given levels of the policy instruments (taxes, T, government expenditures, G,, and the real exchange rate, e^r). To derive aggregate demand, substitute equation (4.7) of the LM-curve into equation (3.14) for the IS-curve, and solve for aggregate demand:

$$Y = \lambda_0 + \lambda_1(M/P) + \lambda_2 e^r + \lambda_3 G + \lambda_4 T + \lambda_5 Y^f \tag{5.21}$$

where $\lambda_1 = \theta_1\kappa_2/(1+\theta_1\kappa_1)$, $\lambda_2 = \theta_2/(1+\theta_1\kappa_1)$, $\lambda_3 = \theta_3/(1+\theta_1\kappa_1)$, $\lambda_4 = \theta_4/(1+\theta_1\kappa_1)$, and $\lambda_5 = \theta_5/(1+\theta_1\kappa_1)$. Thus aggregate demand, Y, is positively related to the real money balance, M/P, since λ_1 is positive. However, since $0 < \lambda_1 < 1$, a change in real money balances always leads to a less than proportional change in aggregate demand, since the resulting change in interest rates also affects aggregate demand. An increase in real money balances, for example, leads to an excess supply and a shift from money to bond purchases. The resulting increase in bond prices lowers their interest rate, which in turn stimulates investment and consumption, and leads to an overall increase in aggregate demand.

The effect on aggregate demand from changes in fiscal and exchange rate policy instruments, as well as exogenous foreign market demand are also shown in the final aggregate demand equation. Aggregate demand is negatively related to taxes since $\lambda_4 < 0$; it is positively related to the real exchange rate, e^r, since $\lambda_2 > 0$; it is positively related to government expenditures, G, since $\lambda_3 > 0$; and it is positively related to aggregate demand in foreign markets, Y^f, since $\lambda_4 > 0$.

As Figure 5.4 shows, the equilibrium level of output and prices is determined by the intersection of aggregate demand and aggregate supply. For supply of the secondary sector, the steady-state solution for the total aggregate supply is given by:

$$Y = Y^a + \phi_0 + \phi_1 I + \phi_2 P^b + Y^c \tag{5.22}$$

The price index of the secondary sector, P^b, is related to the general price level, P, according to the following relationship:
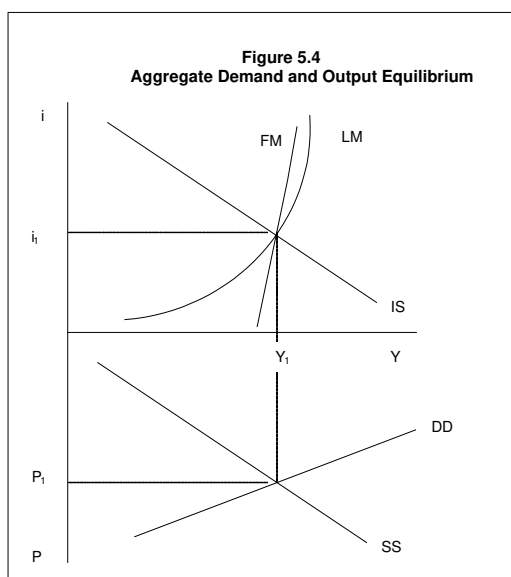
$$P^b = \gamma_0 + \gamma_1 P + \mu_7 \tag{5.23}$$

Overall equilibrium of the Uzbekistan economy is achieved when aggregate demand in equation (6.1) is equal to aggregate supply in equation (6.2). The solution for the general price level is given by:[18]

$$P = \zeta_0 + \zeta_1 M + \zeta_2 e^r + \zeta_3 G + \zeta_4 T + \zeta_5 Y^f + \zeta_6(Y^a + Y^b) \tag{5.24}$$

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[18]For ease of computation, it is useful to approximate M/P by M-P.

where $\zeta_1 = \lambda_1/(\tau_1+\theta_2) > 0$, $\zeta_2 = \lambda_2/(\tau_1+\theta_2) > 0$, $\zeta_3 = \lambda_3/(\tau_1+\theta_2) > 0$, $\zeta_4 = \lambda_4/(\tau_1+\theta_2) < 0$, $\zeta_5 = \lambda_5/(\tau_1+\theta_2) > 0$, and $\zeta_6 = -1/(\tau_1+\theta_2) < 0$. Prices are positively related to the monetary, fiscal, and exchange rate policy instruments, M, G, and e^r, and they are negatively related to the fiscal policy instrument, T. However, since $0 < \zeta_1 < 1$, the price rise associated with a monetary expansion is always less than proportional to the increase in the supply of money. Prices are positively related to foreign market demand, since an increase in demand with capacity unchanged leads to a price rise. In contrast, prices are negatively related to a real output expansion in the primary and tertiary sectors since the increase in productive capacity, with demand unchanged, drives down prices.

Figure 5.4
Aggregate Demand and Output Equilibrium

Equilibrium output is found from the substitution of the price equation (6.4) into the aggregate demand equation (6.1):[19]

$$Y = \omega_0 + \omega_1 M + \omega_2 e^r + \omega_3 G + \omega_4 T + \omega_5 Y^f + \omega_6(Y^a + Y^b)$$

where $\omega_1 = \lambda_1 - \lambda_1\zeta_1 > 0$, $\omega_2 = \lambda_2 - \lambda_1\zeta_2 > 0$, $\omega_3 = \lambda_3 - \lambda_1\zeta_3 > 0$, $\omega_4 = \lambda_4 - \lambda_1\zeta_4 < 0$, $\omega_5 = \lambda_5 - \lambda_1\zeta_5 > 0$, and $\omega_6 = -\lambda_1\zeta_6 > 0$. Output is positively related to the monetary, fiscal, and exchange rate policy instruments, M, G, and e^r, and it is negatively related to the fiscal policy instrument, T. However, since $0 < \omega_1 < 1$, the final effect on output is always smaller than the initial rise in aggregate demand associated with the policy change, the reason being that the associated price change dampens the initial shift in the demand schedule. A similar situation occurs with a change in foreign market income. The resulting rise in prices dampens the initial increase and causes a lower expansion in output. Finally, as expected, output is positively associated with a change in output from the primary and tertiary sectors.

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[19]Again, for ease of computation, it is useful to approximate M/P by M-P.

VI. BASELINE PROJECTIONS AND POLICY SIMULATIONS

The macroeconomic model incorporates key assumptions about exogenous and policy-related variables. The principal policy variables for the Uzbekistan economy are the nominal exchange rate, the tariff structure, government expenditures, including those on the Annual Development Program, and changes in the net domestic assets component of the money supply. The principal exogenous variables are the economic growth rates, inflation and exchange rates of Uzbekistan's foreign markets and investors, and world prices of traded goods. The model can be used for basic projections and policy simulations. To illustrate its use, two sets of simulations have been performed with the model. The first provides the benchmark against which policy impact assessments are measured; the second set assesses the impact of trade liberalization on the economy.

The forecasts generated by the model are indicative of the direction of the economy and should be interpreted with caution since the model results depend on key assumptions and interpretations about the data-generation process of the economy of Uzbekistan. The results provide a parsimonious representation of that economy that nevertheless yield an internally consistent set of estimates about the likely outcome of events over the next few years.

Table 7.1

Major Baseline Assumptions, 2005-2010

(Average annual growth rates)

	2003-2010
GDP of major trading partners, real	2.0
Inflation in foreign markets	11.0
Government expenditures, real	3.0
Nominal exchange rate	6.0
Money supply (M2)	5.0

The baseline assumptions for Uzbekistan's major export markets and foreign investors are that the global economy will grow by around 2 percent a year in real terms in 2005-2010 (see Table 7.1). Inflation in Uzbekistan's major trading partners will continue at the prevailing levels of 2004. In the key policy variables, it is assumed that the CBU will continue to expand the supply of money at a moderate rate (5 percent a year) and, in line with past experience, allow the nominal exchange rate to rise by around 6 percent a year. Finally, overall government expenditures, measured in real terms will continue to expand gradually at a rate of 3 percent a year.

Table 7.2
Baseline Projections of Key Macroeconomic Variables, 2005-2010
(Annual percentage changes)

GDP (constant sum)	
Exports of Goods and NFS	4.6%
Imports of Goods and NFS	4.3%
Gross Fixed Capital Formation	3.7%
Total Consumption	3.8%
Government Consumption	3.0%
Private Consumption	4.1%
Gross Domestic Product	4.4%
Money, Prices and the Exch. Rate	
Broad Money (M2)	5.0%
Inflation	3.6%
Nominal Exchange Rate	6.0%
Real Exchange Rate	-4.0%

The results for the baseline forecasts are presented in Table 7.2. Uzbekistan's economic growth is expected to accelerate moderately from just under 4 percent to 4.5 percent over the forecast period. Exports of goods and non-factor services are expected to outpace imports of goods and non-factor services at the beginning and end of the forecast period, but lag behind those imports at the end of the decade. As is to be expected, the forecast is for the growth of private consumption to equal that of government consumption during the initial years, and surpass it in the latter years. Investment is expected to accelerate gradually. Inflation is projected to accelerate during the period, in line with the growth rate of M2.

In the balance of payments, the merchandise trade balance is projected to improve as a result of the larger volume of exports, relative to those of imports at the beginning of the forecast period. Net service receipts, however, are expected to contract during the period. With trade taxes representing only a small proportion of total government revenue, the growth in imports is unlikely to influence the fiscal deficit, which is expected to move from a fiscal surplus in 2003/04 to a large fiscal deficit by the end of the decade. Moreover, it is questionable whether, in reality, Uzbekistan will be able to maintain its currently high average tariff rate, in light of its interest in accession to the WTO.

Past differences in growth among the three productive sectors is expected to continue over the medium term. Growth of the industrial sector is expected to outpace that of agriculture, and that of trade is expected to outpace all other sectors. The contributions of other sectors (transport and communications, construction, and other services) are expected to remain relatively stable over the forecast period.

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