ABSTRACT

Title of dissertation:	TOWARDS ADEQUATE ANALYSIS AND MODELING OF STRUCTURAL ADJUSTMENT PROGRAMS: AN ANALYTICAL FRAMEWORK WITH APPLICATION TO GHANA
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When a country experiences a balance of payments problem, the typical remedy mix proposed by the International Monetary Fund consists of fiscal austerity, tight monetary policies, devaluation, privatization, elimination of subsidies and trade liberalization, combined with low interest rate loans. Throughout the late 1980s, Ghana has been hailed as a success story for that policy mix. However, Ghana's performance has been increasingly disappointing during the 1990s. This thesis explores the reasons for that slowdown, its distributional implications, and the extent to which the behavior of the Ghanaian economy validates commonly used assumptions in economic models of developing countries.

We compile a complete consistent yearly dataset of financial stocks, nominal money flows (arranged in Social Accounting Matrices) and real product flows for Ghana in 1990-2001. The real-side data, available yearly, are then examined using fit optimization with alternative functional forms, while nominal time series (Consumer Price Index, the broad money supply and the exchange rate), available on a monthly basis, are analyzed using ARIMA-X regressions.

We find that industrial production, as well as investment, has been demand-constrained during our period, while agriculture has hit an aggregate supply constraint around year 1995. The relative price elasticity of substitution between imports and non-traded goods (in volume terms) is around minus one. The government was the only net source of demand during the period. Inflation could be predicted extremely well using only broad money supply, wholesale price of food crops and price of fuel, and formed a weak positive feedback loop with money supply growth. The main channel through which exchange rate depreciation impacted the price level was revaluation of the foreign currency-denominated money supply component. The response of broad money supply to interest rate increases was significant but small. We also formulate a novel matrix formalism for a more compact description and analysis of financial stock dynamics, cleanly separating structural and accounting constraints from behavioral descriptions.

We conclude that the major reasons for the economic slowdown of the 1990s were excessive liberalization of commodity imports and strangulation of industry through lack of demand and volatile real interest rates, and of agriculture through withdrawal of government support programs.

TOWARDS ADEQUATE ANALYSIS AND MODELING OF STRUCTURAL ADJUSTMENT PROGRAMS: AN ANALYTICAL FRAMEWORK WITH APPLICATION TO GHANA

by

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DEDICATION

I would like to dedicate this thesis to 50 Cent and the G-Unit, who have provided the soundtrack for the last and crucial year of its creation.

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I would like to thank all my committee members for being generous with their time, wisdom, and patience throughout the long trip that this thesis has been; the wonderful people at the Integrated Social Development Centre, Ghana, especially Charles, Victoria, Bishop, and Vitus, for their trust and support; Dr. Bawumia of the Bank of Ghana, for many a fascinating chat and many a data table; all of my friends around Washington, DC, especially Deepak, Tim, and Alex, for being there and saving my hide many a time; and last but not least, my wife, for cheerfully enduring me through the whole ordeal.

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Chapter 1

Introduction

When a country experiences a balance of payments problem, the typical remedy mix proposed by the International Monetary Fund consists of fiscal austerity, tight monetary policies, devaluation, privatization, elimination of subsidies and trade liberalization, combined with low interest rate loans.

Throughout the late 1980s, Ghana has been hailed as a success story for that policy mix, known internationally as "neoliberal policies" and in Ghana as the "Economic Recovery Program" or ERP. However, Ghana's performance has been increasingly disappointing during the 1990s, with economic growth slowing down and government deficit surging out of control.

This thesis explores the reasons for that slowdown, its distributional implications, and the extent to which the behavior of the Ghanaian economy conformed to commonly used assumptions in economic models of developing countries.

The following section states the specific research questions of this thesis. Having stated the questions, we proceed to discuss the methods we use in answering these research questions, as well as the intermediate, technical results of these methods, in Section 1.2. Section 1.3 then uses these intermediate results to answer our research questions, and Section 1.4 discusses some limitations of our approach.

1.1 Research Questions

In this dissertation, we address three closely interlinked research questions.

1.1.1 Why Was Macroeconomic Performance Not Sustained?

In the 1990s, what caused

1. Balance of Payments problems
2. Inflation
3. Low GDP growth

1.1.2 What Were the Distributive Impacts?

How did the structural adjustment policies affect the real incomes of different population groups during the 1990s?

1.1.3 Does the behavior of the Ghanaian Economy in 1990s conform to the assumptions of economic models?

Once we understand the key causal mechanisms for the Ghanaian economy in the period under study, we are in a position to evaluate the common assumptions of models and qualitative descriptions that are used to assess impacts of structural adjustment programs.

1.2 Methods and Intermediate Results

Our research for this thesis consists of three steps. First, we compile a stock-flow consistent time series of yearly Social Accounting Matrices and monthly Financial Accounting Matrices for 1990-2001. Then, we use this dataset along with additional monthly macro time series (such as interest rates) to statistically test a series of key relationships, which we have selected based on Computable General Equilibrium (CGE) and macroeconomic theory, so as to achieve a systematic picture of the Ghanaian economy's structure. Finally, the results of these investigations are used in qualitative discussion to address our research questions. The following sections describe each step in more detail.

1.2.1 Compile a Dataset: SAM/FAM time series for 1990-2001

We begin by compiling a yearly time series of Social Accounting Matrices (SAMs), each of which is a complete picture of the money flows in the Ghanaian economy in a given year, at a certain level of aggregation. Then, we augment this by a monthly time series of Financial Accounting Matrices (FAMs) that describe the financial stocks held by the various institutions in the Ghanaian economy (the SAM and FAM methodologies are discussed in detail in Chapter 5). The two datasets are logically connected as the net lending flows of an institution in each SAM have to be consistent with the changes in that institution's net worth (after correcting for revaluation). We achieve that consistency by forcing the SAMs to yield the let lending flows implied by the FAMs, for the following reason.

In developing countries, financial asset stock time series are available and generally more reliable than most flow data. Besides being interesting in its own right, knowledge of financial asset stock time series allows us to get more reliable estimates for net financial savings (net lending) of each institution. In an economy where some important sectors are demand-driven (that is, probably, any economy), knowledge of net lending is important to account for injections and leakages contributing to the aggregate demand. Unfortunately, net lending is normally computed as a residual from flow data, and is thus quite unreliable; using asset stocks for that purpose makes for a much more reliable estimate.

Compiling a SAM/FAM time series dataset such as ours is worthwhile for several reasons: firstly, in the process of compilation one discovers the errors and inconsistencies in the data and can to an extent correct for these, or at least draw conclusions as to which uses of that data are meaningful even in view of the errors and which are not (Chapter 7 discusses several grave errors in official data that we could discover and to an extent correct).

Thirdly, a sufficiently long stock-flow consistent SAM-FAM time series provides a sufficient data base for estimation *and* validation of a multisectoral dynamic model. A complete set of real and nominal flow time series allows us to derive the causal behavior of the model from history, instead of specifying it a priori as the CGE models do, be they neoclassical or structuralist. Further, if we split the SAM-FAM time series into an estimation and a validation segment, we can also gain an idea of how good the chosen causal structure is at predicting future behavior of the economy. Such an approach unites the advantage of a CGE-like ability to handle sectoral disaggregation and a high number of variables with an ability to specify measures of confidence of the model output.

Finally, as the present project demonstrates, such a dataset can be used to understand the overall structure of an economy through statistical testing of specific relationships, even without estimating a complete model. This is an advantage for our approach's potential to be replicated in other developing countries, where technical capacity constraints are often binding.

Summing up, we demonstrate that in spite of low data quality and availability, it is feasible to construct stock-flow consistent SAM/FAM time series for Ghana for more than a decade, providing a strong foundation for further analysis. While that is not a novel approach for industrialized countries with their high data availability, to the best of our knowledge this is the first time such a dataset has been compiled for a developing country.

1.2.2 Statistical Analysis of Selected Variables

The statistical analysis we undertake consists of two parts. On the one hand, macro time series such as the Consumer Price Index (CPI), interest rates, etc. are available monthly, so that we can use reasonably sophisticated statistical techniques. On the other hand, the real side and sectoral data in only available yearly (for a total of 12 data points in our time period), necessitating a different strategy. Let us discuss each in turn.

We use ARIMA-X regressions to explain the behavior of the three variables Consumer Price Index, broad money supply, and the exchange rate, which we denote (in log form) `cpi`, `m2` and `er`. All of these are I(1), and in none of the initial regressions was cointegration observed. Therefore, the regressions are run on the first differences of the logs (corresponding to growth rates of the underlying variables).

We start out by investigating the behavior of the Consumer Price Index, arriving at both expected and unexpected results. On the expected side, money supply is highly significant for price formation, and takes its effect gradually over with a lag of two to nine months. Increases in fuel and wholesale food crop prices are also highly significant, but their impacts happen over a much shorter period (0-2 months). Using just these three variables, we could predict `cpi` surprisingly well four years into the future (1998-2001), with coefficients estimated using pre-1998 data only.

On the surprising side, exchange rate depreciation, interest rate changes, and GDP growth appear to not have a significant direct effect on inflation.

As we find that growth of broad money supply is the major driver of CPI inflation, we proceed to investigate the dependence of broad money supply growth on the changes in interest rates, inflation, exchange rate depreciation, and base money growth, as well as its own past values. The results show a strong dependence on the exchange rate, monetary base, and Consumer Price Index, as well as a significant but rather small response to interest rates.

From a .37 coefficient of the depreciation rate in the `m2` regression, combined with the fact that exchange rate depreciation was not significant in the `cpi` regression, we could draw the somewhat surprising conclusion that the main channel for the impact of currency depreciation on inflation is not through cost-push such as cost of imports, but through revaluation of the money supply. In contrast to the CPI regression, all impacts on money supply are quite fast, taking at most 3 months for the full impact to be felt; the predictions of post-January 1998 values based on the regressions exhibit realistic behavior and are quite robust with respect to the estimation time period, but not as precise as the CPI predictors, tending to over-estimate broad money supply.

The two regressions we just discussed imply that if we consider broad money supply `m2` to be given in advance (as a function of time), a change of one percent in `m2` would over time lead to a change of about .33 percent in `cpi`; conversely, if we considered the price level to be exogenous, a one percent increase in it would lead over time to about a .67 percent increase in `m2`. In reality, neither of them is given, but rather both evolve (approximately) according to the behavioral equations that we have estimated in the previous section. Therefore, the two variables form a feedback loop - a change in the money supply, happening for whatever reason, will lead to an increase in the price level, which will in turn lead to an increase in money supply, etc., amplifying the initial impact. The total impact of the feedback loop can be computed as $1/(1 - 0.33 * 0.67) \approx 1.3$, so that the feedback loop amplifies by about 30% any effects of other variables on CPI inflation or broad money supply growth.

Following the same model identification strategy that led us to success in explaining the behavior of `cpi` and `m2`, we identify a model of exchange rate behavior. The only two significant variables turn out to be the import price index, each 1% increase in it translating into a 4% depreciation over a year's time; and the interest rate, with interest rate increase by 1% *increasing* depreciation by one third of a percent. Unlike in the cases of `cpi` and `m2`, however, the estimated model proves to be quite bad at predicting values of `er` when used as a recursive equation.

These problems, together with a brief qualitative discussion of exchange rate behavior, lead us to conjecture that better understanding of the exchange rate behavior would require separate study of managed floating and freely falling periods, as well as of the conditions for the change between the two modes.

While we are lucky enough to have monthly time series for the key nominal indicators (such as the Consumer Price Index, the exchange rate, and the money supply), the real-side sectoral data, along with most nominal flow data, is only available on a yearly basis.

As our sample length of 12 years is too short to allow for rigorous econometrics, we use a different method to evaluate hypotheses of real-side behavior. We take the years 1990-1997 as the estimation period and the years 1998-2001 as the validation period. We use the estimation period data to estimate the coefficients of behavioral hypotheses and then use their ability to predict the validation period data as the way to choose between the different hypotheses.

This approach has the potential to increase our confidence in the choice of functional form, as a good fit in the estimation period does not necessarily translate into a good prediction ability in the validation period. On the other hand, if a functional formulation was good at predicting the validation period data when estimated with only estimation period data, we can have some confidence in its predictions for the future (or counterfactuals in the past) when estimated using the data of both periods. After having thus identified the functional form, we use ordinary least squares to produce standard errors for the intercepts and elasticities involved.

The first relationship we test is the venerable constancy of the Incremental Capital Output Ratio, that is the hypothesis that output growth is directly proportional to investment. In line with previous research, this hypothesis is not supported by the data.

We then turn to the productive sectors. In agriculture, we observe a price elasticity of substitution between export and nontraded crops of .42(.15); until 1995, land surface under cultivation is approximately constant, and the wholesale price of food crops relative to CPI moves in the same direction as food crop production, suggesting a demand-driven regime. However, starting in 1995, land surface under cultivation begins to grow substantially, and the relative price of wholesale food crops moves consistently in the opposite direction to food crop output, suggesting a shift to a supply-constrained mode.

In industry, the elasticity of substitution between exports and nontraded output turns out to be negative, equaling -1.00(.23). This is not compatible with a neoclassical productivity-frontier description, but fully compatible with a demand-driven nontraded industrial sector. The hypothesis that nontraded industrial output is demand driven is further supported by the behavior of said elasticity when we change the estimation time period or exclude mining from the estimated ratio, as discussed in Chapter 9. Thus, we conclude that the nontraded industrial sector is demand-driven.

Turning to the demand side, we discover that the government was the major source of demand injections throughout the period under consideration. As nontraded industry is demand-driven, and most likely so is the informal sector, we conclude that government demand was one of the key drivers of the economy.

As far as investment is concerned, we see that investment as a share of GDP has been low (about 15%) and declining; investment demand decreased by about

2% (not percentage points) for each percentage point increase in interest rates.

Finally, turning to import demand, we find a quite large price elasticity of substitution between nontraded and imported manufactures, namely -1.18(.31). This implies that the balance of payments will be quite sensitive to both exchange rate and tariff changes. The corresponding elasticity for services was -0.38(0.11), smaller but still substantial.

1.2.3 Discussion of Quantitative Results' Implications

Having thus reached a number of quantified insights into the structure and behavior of the Ghanaian economy, we proceed to use these to answer our research questions. We do so by means of a verbal discussion, rather than an overall formal model of the Ghanaian economy. The latter decision is defended in Section 1.4.1; let us now proceed to the implications of our data investigations for our research questions.

1.3 Results

1.3.1 Neoclassical/Monetarist vs. Structuralist Theory

The estimates of key macro and sectoral relationships we have discussed above, such as the various elasticities and the determinants of inflation and money supply growth (all of them complete with significance measures), allow a data-driven comparison of the applicability of the two competing schools, neoclassical/monetarist and structuralist, to the Ghanaian economy.

On the macro/nominal side of things, we observe a very strong link from money supply growth to inflation (a monetarist staple assumption) and a weaker but also significant link from inflation to money supply growth (a common structuralist theme). The two variables thus form a feedback loop, which amplifies by about a third all effects of other variables on either inflation or money supply. While broad money supply growth is the dominant determinant of inflation, the price of fuel and the wholesale price of food crops are also important. Additional influences are growth of monetary base and exchange rate depreciation, both of which impact inflation not directly, but through their effects on broad money growth.

Overall, on the nominal side the monetarist hypotheses are better supported by the data than their structuralist counterparts, but with two important caveats. Firstly, certain cost factors were also important, though less so than money supply growth; and secondly, the relevant money supply measure was broad money, and not monetary base that is commonly used for that purpose in monetarist CGE models.

On the real side, agriculture is supply constrained while industry is demand-driven - a setup quite common in structuralist models, as opposed to the neoclassical assumption that all sectors are always at full capacity utilization and therefore supply-constrained. On the other hand, import demand is quite sensitive to the relative price of imports vs. nontraded goods, which is a typical feature of neoclassical models, while structuralist models often assume that quantity effects dominate and relative price effects are of moderate importance.

Summing up, on the side of price formation monetarist theory has the upper hand, while on the real/sectoral side of things structuralist theory is better supported by the data. In both cases, however, the optimal description must include elements of both theories.

1.3.2 Reasons for Poor Macroeconomic Performance

The quantitative understanding of the Ghanaian economy that we have gained also allows us to give a well-founded explanation to the poor macroeconomic performance of the Ghanaian economy in the 1990s. Briefly, the story is as follows.

First of all, import liberalization strangulated domestic manufacturing, as the demand for manufactures was redirected towards imports. At the same time, withdrawal of government support programs for agriculture, combined with population growth, led to an increasing supply problem in nontraded food crops, which led to an increase of food crop imports, especially rice. As the growth in exports was not sufficient to pay for these increases in imports, a persistent balance of payments deficit appeared. As that deficit accumulated in a growing foreign debt, the resulting interest payments further worsened the balance of payments.

The next part of the story are the occasional bursts of government spending, particularly in the years around the first general election of the 1990s, in 1992-1994. While the demand generated thereby did stimulate domestic manufacturing somewhat, it also led to abnormal money supply growth and resultant inflation. Furthermore, a large part of that demand spilled into imports, resulting in even more balance of payments deficits. The inflation combined with balance of payments deficits led to exchange rate depreciation, which in turn boosted money supply growth and inflation in yet another positive feedback loop.

The demand strangulation in industry and the withdrawal of government support programs in agriculture are a part of the explanation for the low GDP growth rate in the 1990s as compared to the 1980s; another reason is that the starting point for GDP in early 1980s was so low that high initial growth rates were easy to realize - and this was no longer the case in 1990s. The final reason for low GDP growth are the high, and volatile, inflation rates. As the result of the the Bank of Ghana's attempts to keep real interest rates positive, nominal interest rates became quite high, and real interest rates quite volatile. That further depressed investment demand, adding to the effects of low demand.

1.3.3 Distributional Impacts

As this thesis focuses on analyzing macro and sectoral relationships, it can unfortunately only shed a limited amount of understanding onto the distributional implications of the government policies and external shocks during the 1990s. What we can do is to provide an understanding of how incomes of the various sectors (at our level of aggregation) were affected, which is a necessary first step for a more detailed analysis.

The overall impacts of the government policies certainly benefited export producers, which in Ghana means mainly mining and cocoa. As mining is to a large extent foreign-owned, those profits were not really passed on to the employees (resulting in a profit rate of 50% for mining companies in 1993, far above any other sector), so that the main beneficiaries were the cocoa farmers. These certainly did benefit, with the average cocoa farmer household's income exceeding the average food farmer household's income by about 50%. However, their income was still below that of an average formal sector (industry or government) employee household by another 50%; and geographical reasons limited the expansion of cocoa production.

All agriculture was badly hit by withdrawal of government support programs, and manufacturing was adversely affected by the leakage of demand into imports - thus the net incentives, apart from the benefits to cocoa producers, were towards relocation of labor into the informal sector, comprising a variety of transport, retail, and personal service activities, to a large extent untaxed.

1.4 Limitations

While we believe that this thesis provides significant insight into its research questions, it also was more successful in some areas than in others. This section's purpose is to mark out the main limitations or our work.

1.4.1 No Formal Overall Model

An important limitation of this thesis is that while we compile a dataset sufficient to estimate a complete model of the Ghanaian economy at a certain level of disaggregation (6 sectors, 5 institutions), we do not, in fact, estimate such a model.

In addition to compiling the dataset, we do estimate key relationships that would be useful for building such a model in Chapters 9 and 11, and present accounting frameworks that would form the backbone of such a model in Chapters 8 and 10. However, we stop short of putting all the pieces together and estimating a comprehensive model of the Ghanaian economy in the 1990s. How do we justify this?

There are four major reasons we chose that course of action, namely transparency, management of uncertainty, optimal return to effort, and replicability. Let us discuss each in turn. By management of uncertainty we mean that as the data for different parts of the system is of varying quality, the level of confidence of results derived from that data will also vary. While with monthly data we can test a number of hypotheses involving a variable, yearly data at best allows us to get a reasonable estimate of something like one elasticity per time series; and one or two time series had to be derived as pro-rating from point estimates, making them even less reliable. In a model, all these would appear as numbers with little to indicate their relative reliability - while in a qualitative discussion such as ours, it is possible to distinguish between them.

A similar reasoning applies to higher transparency: in a verbal discussion, it is much more apparent to the reader where the conclusions come from - the reasoning must be stated argument for argument; on the other hand, while model equations are a language in themselves (and arguably a more powerful and versatile one for certain purposes), it is a language that is spoken by a much smaller audience. Therefore, when addressing a non-technical audience, and presenting the results as coming from a model, one risks to be perceived as an oracle for a black box - not an ideal communication strategy.

Neither of these problems is in itself fatal. One could cleanly combine data of varying quality in the same model by specifying model-wide confidence measures that take these quality differences into account. A model-wide optimization, followed by model-wide Monte Carlo experiments, could generate simultaneous confidence intervals for all parameters as well as model output. On the transparency side, nothing prevents a modeler, after having built a model, from also deriving the results in a verbal discussion; the results will stand all the stronger if they come from both a discussion and a modeling exercise.

That brings us to the last two reasons, namely return to effort and replicability. While model-wide estimation and optimization, followed by model-wide Monte Carlo experiments, would in fact allow us to effectively manage uncertainty, and additional discussion would clarify the results to a non-technical audience, the overall effort required would be quite high. That, in turn, would restrict the usefulness of the approach to the institutions that have the appropriate technical capacity and willing to make the extra effort, a fairly high threshold if one is talking of developing countries. Finally, even when the ultimate objective is building a comprehensive model, it is useful to be able to generate analyses like ours beforehand, both to map out the shape of the model-to-be and to generate intermediate output for funding purposes.

Summing up, we don't deny that estimating an overall formal model of Ghana in the 1990s would be very interesting and yield additional insights compared to our approach. However, our approach already surpasses the existing ones in being more systematic than isolated econometric regressions, and in providing measures of confidence in its results based on time series data, which CGE models can't do. It lays the necessary data foundation for building a formal model, and reaches substantial analytical and policy conclusions from study of carefully selected variables; thus, it is well suited for replication in other developing countries, where both varying data quality and limited technical capacity are common.

1.4.2 Limited Analysis of Distributional Impacts

Another important limitation of the present thesis is that it does not provide a deep analysis of distributional impacts of the government policies discussed. The reason for this is twofold, namely the scope of our effort and poor data availability.

The present thesis contains an analysis of the Ghanaian economy in the 1990s on the macro and sectoral levels, based on yearly or monthly time series. The macro/sectoral scope of the effort limited the amount of understanding we could provide of the finer distributional impacts of government policies. A good understanding of the sectoral structure of the economy is a necessary foundation for a sound distributional analysis, as it enables us to see how the incomes of broad occupation groups are affected by macro and sectoral policies and shocks. This is the kind of very broad analysis that we were able to conduct here.

Substantial advances in distributional analysis would require either a further increase in sectoral resolution of the data, or better the use of micro-level data such as household surveys. Finer sectoral price and output data would have been even harder to collect than our present dataset. On the micro data side, there are only two household surveys available for the period under study, and these are in form of raw tables with sparse documentation, requiring much effort to extract useful summary data.

Given the high effort of collecting and processing the necessary data for a deeper distributional analysis, along with an already high workload from the other parts of the research project, we regretfully restrict ourselves to a quite shallow sectoral-level distributional analysis.

1.5 Structure of This Manuscript

The structure of this thesis is designed to address the diverse levels of technical background that its readers will have. The challenge is to make the document interesting to readers with a high level of expertise in economics, while at the same time keeping it accessible to readers with limited economics background.

We aim to achieve it by separating the document into "narrative" and "technical" chapters. Thus, a non-technical reader might want to read Chapters 2 to 6 that provide introduction to all relevant concepts and techniques, skim the technical details of Chapters 7, 8, 9, 10, and 11 and get all the key points from the discussion of these chapters' results in Chapters 12 and 13. Also, at one of the committee members' request, each chapter includes a short summary.

On the other hand, the readers with substantial economic expertise may wish to read Chapters 1 and 6 for a brief summary of the research question and the overall strategy of this thesis, skim or skip Chapters 2 to 5, and turn to Chapters 7, 9, and 11 for the empirical/data-related content and to Chapters 8 and 10 for some modeling technique issues.

Chapters 12 and 13 are meant for all readers as they pull together all the threads from the previous chapters, and Chapter 14 provides some concluding remarks.

Chapter 2

Structural Adjustment: Causes, Content and Assessments

2.1 What is Structural Adjustment?

Structural adjustment can be defined as "an adjustment to some shock that requires not only compositional changes in production, resource allocation, demand, and relative prices, but also changes in macroeconomic aggregates such as income, investment, absorption, consumption, and government expenditure" [Robinson 1989]. While this definition would allow for a wide range of different "structural adjustment programs", historically the term has come to refer to a specific policy package, for reasons described in this section.

During the past two and a half decades, the history of most economies in Asia, Africa and Latin America was characterized by recurring or ongoing economic crises that consisted of some combination of escalating domestic government debt, escalating foreign debt (government or private), and out-of-control inflation. While the debate on the underlying causes of these crises is far from settled, a frequent proximate cause was an acute shortage of foreign exchange, due to some combination of high interest rates, high indebtedness, adverse terms of trade, fluctuating foreign capital inflows, and lack of access to commercial lending. In most cases, countries experiencing such a crisis applied for a loan from the International Monetary Fund (IMF), whose institutional purpose is to assist countries in bridging transient balance of payments imbalances.

If the crisis facing the country was not judged by the IMF to be of a transient nature, an IMF loan was made contingent on the country undertaking a structural adjustment program approved by the IMF and the World Bank. These programs for different countries shared many common features, and are discussed in the next section.

2.2 A Typical Structural Adjustment Policy Package

The last two decades have seen widespread application of the so-called neoliberal policy package as a response to balance of payments difficulties. This package is a combination of fiscal austerity, tight monetary policies, devaluation, privatization, elimination of subsidies, trade and capital account liberalization.

One important reason for the widespread application of these policies is that neoclassical economics is the preferred paradigm of the World Bank and the International Monetary Fund (IMF), which through loans as well as their standing as experts in development and adjustment issues are widely believed to have substantial influence on the policies chosen by the developing country governments. Between the two institutions, it was largely the IMF that determined the specifically macroeconomic content of the policies.

A structural adjustment policy package aims to achieve the two goals of balance of payments (BoP) stabilization and inflation reduction through the two levers of changes in exchange rate and control of the money supply[1].

[1] The causal connection between the targets and the levers is modeled by a simple model known as the Financial Programming Framework (FPF) that was first formulated by Polak [1957] and is discussed in detail by Khan et al. [1990]. FPF assumes constant price elasticities of export supply

In practice, a typical stabilization program has the following components:

Cut government spending and increase taxes Firstly, the resulting decrease in total demand is supposed to improve the balance of payments both through decreasing the demand for imports and freeing up domestic productive capacity to supply more exports (as the IMF analytical approach, the Financial Programming Framework (FPF), implicitly assumes the total production is unaffected by the stabilization program).

Second, as typically the government in question is running a deficit, additional benefits are expected, depending on the previously dominant source of deficit financing: if the deficit was financed by borrowing from the central bank, i.e. by printing money, its reduction is expected to contribute towards inflation control; if the deficit was financed by foreign borrowing, its reduction will improve the balance of payments. The FPF does not really have a way to represent non-monetized borrowing from the domestic private sector (be it commercial banks or households), but the rhetoric is that a reduction in domestic borrowing should free up resources for private investment.

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and import demand (connecting the exchange rate to the current account), and constant velocity of money, with the implication that ceteris paribus increases in the money supply translate in strict proportion into increases in the price level. FPF also assumes that the real output is unaffected by any of the variables in the model. We will discuss the FPF model in more detail alongside the other models in Chapter 4.

Introduce floating exchange rates and depreciate the currency   The corresponding increase in domestic prices of exports and imports is supposed to make exports more competitive and to redirect demand away from imports. The overall reduction in domestic demand from reductions in government spending is supposed to make sure there is nonetheless no excess demand for domestic goods.

This is a common feature of programs that primarily aim at balance of payments stabilization, as common in Africa. The programs primarily aiming at inflation, such as seen in Latin America, often fix the nominal exchange rate instead, aiming to use it as a nominal price anchor through stabilizing the price of imports.

Increase the interest rates and/or reduce the rate of expansion of the monetary base   Increasing the interest rates is supposed to stimulate savings, and thus provide more funds for investment. At the same time, high interest rates are supposed to prevent excessive depreciation of the currency by attracting foreign capital inflows. Reducing the rate of growth of monetary base is meant to decrease the rate of money supply growth and thus reduce inflation under the constant velocity of money assumption. (In the case of market-determined interest rates, these two policies coincide, as increased control of monetary base makes credit more scarce and thus more expensive).

Liberalize the current account   That measure is achieved by abolishing import quotas and reducing import tariffs and is expected to increase efficiency in some not clearly specified way. Sometimes it is also argued that lower prices for imports benefit consumers, but since at the same time higher import consumption means less income for domestic producers, that argument is not tenable without further refinement.

Liberalize the capital account Allowing a higher measure of capital mobility is expected to attract more funds for investment.

2.3 Assessments and Criticisms

It has been a subject of much controversy whether these policies achieved their declared objectives of macroeconomic stabilization (primarily stabilizing the balance of payments and lowering inflation) and sustainable GDP growth, or whether they had no effect at all or worsened the situation (at least in the medium to long term). An equally controversial issue is the impact of these policies on the income distribution.

Haque and Khan [1998] discuss a number of studies using a variety of approaches to analyze the impact of IMF programs on balance of payments, current account, inflation, and growth. The following results stand out:

Firstly, the number of statistically significant results in cross-country studies is quite low, which can be taken as an indicator of a large degree of variation between countries.

Secondly, the impact of IMF programs on the balance of payments and the current account, when significant, is generally found to be positive, while the impacts on inflation and growth rates vary in magnitude and in sign depending on the method chosen as well as between studies using a particular method.

Thirdly, the changes often take time to manifest themselves. Thus, Khan [1990] using the generalized evaluation estimator approach, found that both balance of payments and the current account deficit reductions are strengthened over time, and the initially adverse effects on growth are reversed in the subsequent years. Killick et al. [1995] in an extensive before-after study also find positive balance of payments and current account effects, and find that "[The programme effects] are at their smallest in the twelve months immediately following adoption of a program but larger in the following two years".

Fourthly, the real exchange rate depreciates significantly right at the onset of a program and this depreciation is deepened in the following years. However, the reductions in the rate of credit expansion are small and non-significant, contrary to both expectations and Fund intentions.

Taylor [1988, 2001] discusses a series of case studies, and while finding a wide variety of individual experiences, points out the following similarities between them:

Firstly, when fiscal austerity did result in an improvement in the balance of payments it was not primarily because of relative price effects as postulated by neo-classical theory, but rather, because reduced government spending reduced domestic output and thus demand for imports, and also because the decrease in domestic absorption increased exports. Relative price effects did not appear important in the short run.

Secondly, fiscal austerity was not often successful in fighting inflation, while by reducing both private and public investment it undermined the prospects for long-term prosperity. If it was coupled with high interest rates, investment was undermined even further.

Killick et al. [1995] also find that the brunt of the reduction in domestic absorption, which is the keystone of IMF programs, seems to fall on investment, with overall consumption staying comparatively constant.

The stabilization and structural adjustment programs have also come under extensive criticism from civil society organizations both in developing and developed countries. Kanbur [2001] notes that many of their criticisms were not concerned with the specific research results that claimed to demonstrate positive impacts of structural adjustment, but were instead due to several persistent differences in focus between the civil society groups (referred to by Kanbur as "Group B") and the majority of the development economics profession ("Group A"). Kanbur identifies three such differences in perspective:

The first difference is in the level of aggregation used to evaluate impacts, with academic studies often focusing on the aggregate poverty rates for the population as a whole and their critics highlighting the plight of specific groups. "Quite often a national fall in the poverty incidence can be composed of large movements in opposite directions".

The second difference in perspective is the time horizon over which the consequences of policy are assessed. While development economists tend to think in terms of the "medium term", used to refer to a time horizon of three to ten years, their critics are concerned with both the short term consequences of economic policies ("short run survival trumps medium run benefits every time, if the family is actually on the edge of survival") and a time horizon much longer than a decade, in reference to issues of sustainable development.

The final systematic difference in perspective concerned the perspective of market structure and power. “The implicit framework of Group A in thinking through the consequences of economic policy on distribution and poverty is that of a competitive market structure of a large number of small agents interacting without market power over each other. The instinctive picture that Group B has of market structure is one riddled with market power wielded by agents in the large and in the small.”

These different assumptions lead to very different expected results of policies such as increased openness to trade, and a model that pre-judges any one of these issues will not be helpful for achieving agreement on optimal policy choice.

Summary

When a country experiences balance of payments problem, the typical remedy mix proposed by the International Monetary Fund consists of fiscal austerity, tight monetary policies, devaluation, privatization, elimination of subsidies and trade liberalization, combined with low interest rate loans.

To the extent that these prescriptions are based on economic theory, the theory used is neoclassical, with an explicit or implicit assumption of full employment and thus blind to possible recessionary impacts of the programs. It is these recessionary impacts that are the source of most criticism of structural adjustment.

Chapter 3

Structural Adjustment in Ghana

This chapter sets Ghana into the context of the Sub-Saharan Africa region, narrates the history of structural adjustment in Ghana, and reviews the literature as to the reasons of the poor macroeconomic performance in the 1990s.

3.1 The economies of Sub-Saharan Africa

To create a context for the case study proposed, this section provides an overview of the economic and institutional specifics of the countries of Sub-Saharan Africa.

Probably the most well known characteristic of Sub-Saharan Africa as a region is the extent to which its growth performance during the last three decades has lagged below that of other regions. As a result of the combination of slow GDP growth rates with fast population growth, many African countries that were middle-income, comparable to the South Asian nations in the fifties and sixties have since become low-income countries with average per capita GDP growth below one percent and often negative.

Collier and Gunning [1999] provide a detailed discussion of different explanations advanced to explain that poor performance. On the domestic side, the governments were typically undemocratic and "captured by the educated, urban-resident population, with few agricultural or commercial interests. They expanded the public sector while imposing wide-ranging controls on private activity. [...] Since public sector employment was the main priority, [...] Africa experienced the paradox of poor public services despite relatively high public expenditure". That, in turn, led to increasing transaction costs (for transactions such as transport, telecommunication and contract enforcement) and missing infrastructure, making private manufacturing unattractive. This situation continues to hold to this day, and is quoted as an important reason why private investment in Africa remains significantly below that of other countries with comparable income levels.

Also, "since the political base of the governments was urban, agriculture was heavily taxed and the public agronomic research [...] was neglected". As on the one hand the population was predominantly rural, and on the other hand agricultural exports were for many countries the principal source of foreign exchange (necessary to buy intermediate inputs and capital goods for the domestic industries), that combination of policies typically led to decline in GDP and a balance of payments crisis. These are the major ways in which misguided domestic policies contributed to economic decline.

As a consequence, since the late 1970s the countries of Sub-Saharan Africa increasingly made use of loans from the International Monetary Fund and the World Bank as a solution to their balance of payments crises, and therefore were increasingly led to implement the set of policy measures advocated by these institutions, discussed above.

Sender [1999] critically discusses the consequences of these policy measures. His main criticism is that "Public investment as a share of GDP in Sub-Saharan Africa is now much lower than in any other region of the world. This has had negative effects on both the volume and the productivity of private investment in the region, because of the well-established complementarity between these two categories of investment. [...] Far too little attention has been given to the accumulation of evidence suggesting a causal relationship between the macroeconomic stabilization programs of the International Monetary Fund and declines in investment ratios".

As far as the external connections of the economies in question are concerned, African countries' exports were and remain concentrated in a few primary commodities, whose prices are notoriously volatile. (In a classification by Taylor [1988] of countries undergoing structural adjustment, the "externally strangled small primary product (or labor) exporters" category contained all African countries of the sample.) As Deaton [1999] points out, as a result of price-inelastic demand functions for primary commodities the variance of price can equal several times the variance of supply. For the exporting country, an upward spike in prices can then prove as difficult to manage as a downward spike, as the former easily leads to Dutch disease as well as tempting the government to enter commitments that cannot be upheld once the boom is over.

The neoclassical policy advice further encouraged expansion of primary commodity exports for all African countries on the basis of comparative advantage arguments. While neoliberal policies emphasizing export-led growth were often effective in the short term, in the medium term the simultaneous expansion in supply in fairly price-inelastic markets led to a continuous decrease in the terms of trade. Borenszstein et al. [1994] finds a secular downtrend in non-oil commodity prices since the mid-1970s. They further find that the supply expansion explains about 40 percent of the price change in the period 1971-1984, and over 60 percent in the period 1985-88. It is thus indeed primarily the supply expansion and not, say, effi-

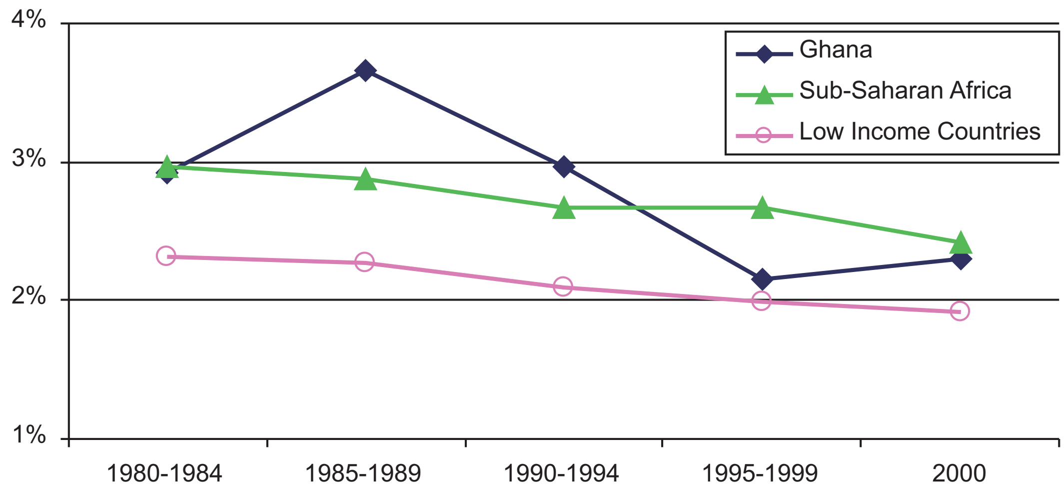


Figure 3.1: Population Growth, Annual (World Development Indicators 2002)

ciency increases or changes in demand by the industrial countries that is the primary cause of the adverse terms of trade trend.

Commodity price shocks also have immediate and far-reaching distributional effects, depending on the identity of the exporters (who can be small cocoa farmers or large mining companies) and the linkages of the export sector to the rest of the economy. Both of these factors are clearly country-specific.

3.2 The case of Ghana

The experience of Ghana during the last decades is largely representative of Sub-Saharan Africa as a whole. Population growth in Ghana was largely in line with the rest of the region, well above the low-income average (Figure 3.1).

Gross economic mismanagement during the 1970s led to an exchange rate that was almost 1000% overvalued and thus "not so much wrong as irrelevant to economic calculation" [Taylor 1988]. As a result, cocoa production, which was the main source of foreign exchange, had dropped drastically; domestic industries were unable to operate due to lack of parts and intermediate inputs.

After a turbulent period in 1978-1981 that saw several regimes come and go, Flt.-Lt. Jerry Rawlings came to power in a military coup on 31. December 1981. The first year of his rule consisted of what Gyimah-Boadi and Jeffries [2000] call "distributionist-cum-populist mobilization", comprising large doses of vigilante justice aiming to root out corruption and restore economic justice. "The goods of hapless traders accused by vigilantes of hoarding and overpricing were confiscated and sold off to the public at reduced prices. In somewhat extreme but certainly dramatic cases, traders' sheds and tables were destroyed and whole markets (tagged as 'dens of corruption' and symbols of the discredited commercial order) were razed to the ground."[Gyimah-Boadi and Jeffries 2000, p.43]

However, after a year of such policies, which also coincided with a severe drought and a huge repatriation of Ghanaians from Nigeria in 1983, the government decided to change course and seek foreign assistance. It first approached the Soviet block, but was advised by them to turn to the IMF and the World Bank, which it did. The standard structural adjustment reform package (known in Ghana as the Economic Recovery Program) was proclaimed by the government, including a maxi-devaluation, fiscal austerity and tight money.

As Aryeetey and Tarp [2000] observe, reforms were designed on the basis of the neo-liberal orthodoxy, with a "particularly optimistic view about the efficacy of the market mechanism as a vehicle for promotion of efficiency and development, including misconceptions about the prevalence of institutional pre-conditions for market efficiency".

According to Aryeetey and Tarp [2000], it was taken for granted that the government had better refrain from intervening in the economy, except from taking care of macroeconomic management and a few other minimalist functions. Not much attention was given to the second-best consideration that trade and market liberalization may not increase efficiency when some markets (such as insurance and credit markets) cannot be made to function properly. Crowding out of the public by the private sector was seen as the critical impediment, and little attention went to exploring what was required to make sure the private sector would indeed respond.

The policy reforms were accompanied by "abnormally high" capital receipts from abroad, mostly from multilateral and bilateral lenders [Killick and Malik 1995], that led to overall balance of payments surpluses in spite of persistent current account deficits as much-needed imports were brought into the country. The more realistic exchange rate, combined with good weather and decreases in smuggling due to better producer prices, increased cocoa export receipts; and thanks to the lifting of the foreign exchange constraint GDP grew by as much as 5% per year (Figure 3.2).

During the 1980s, these reforms were happening in the political context of a military dictatorship. While there were attempts by various groups to resist the reforms and to launch counter-coups, none of these were able to topple the regime or even present any very effective organized opposition to the reforms. Gyimah-Boadi and Jeffries [2000] attribute that to the unusual degree of skill and determination with which the reform process was managed, as well as to the fact that the regime

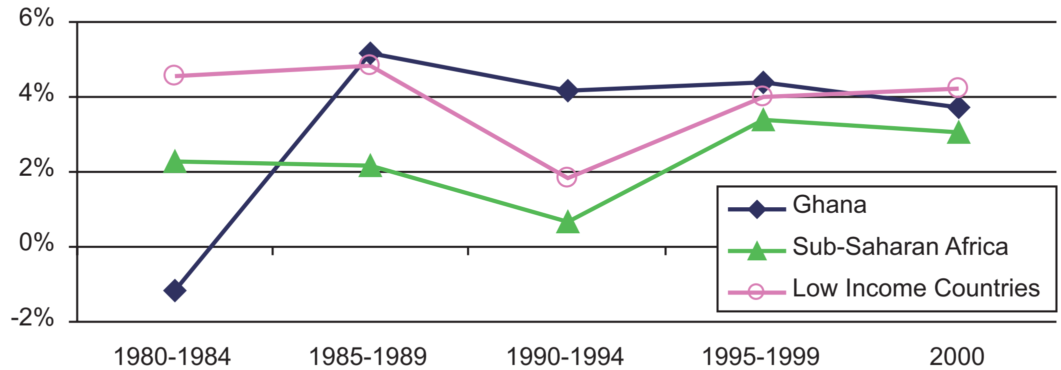


Figure 3.2: GDP growth, Annual (World Development Indicators 2002)

enjoyed a substantial degree of popular support, while also resorting to strong repressive measures to silence any opposition. Overall, Ghana in the 1980s was a relatively strong (for the region), authoritarian state.

During the late 1980s the government has embarked on a series of democratization reforms such as decentralization and the establishment of district assemblies, and the early 1990s saw a return to multi-party politics, with a national election taking place in 1992 (with the party of Jerry Rawlings, the PNDC, coming out as the winner).

Given this combination of a relatively well-functioning (if authoritarian) state, wide economic reforms, rebounding GDP and export growth, and a broad move towards decentralization and democracy, it will come as no surprise that during the late 1980s Ghana was widely touted as the "Front-runner in adjustment" [Husain and Faruquee 1994]. As a result, the behavior of the Ghanaian economy was extensively studied by both proponents and opponents of structural adjustment, resulting in substantial literature on the subject.

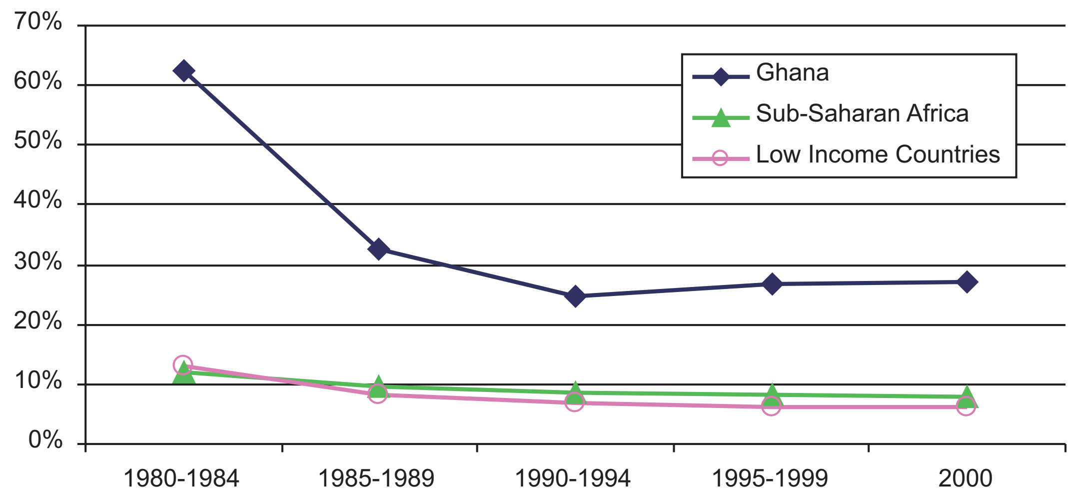


Figure 3.3: GDP Deflator, Annual Inflation (World Development Indicators 2002)

The democratization process continued unabated through the 1990s. The elections of 1992 were followed by the next round in 1996 (PNDC winning again), and another in 2000, when PNDC lost and peacefully transferred power to the winning party. Overall, Ghana enjoyed remarkable political stability throughout the period, with occasional protests (for example, opposing the introduction of the Value Added Tax in 1995) but no civil unrest and no systematic opposition to the economic reforms.

Given the positive political developments, it is all the more disappointing that they were not matched by economic success. Inflation remained persistently high, averaging 30% per annum in 1986-89 (Figure 3.3). In order to boost its popularity prior to the 1992 elections, the government made excessive commitments that led to egregious budget deficits during 1992-1994, further fueling inflation during that period (fortunately, that was not as strongly the case for the subsequent elections). Capital formation remained depressed, with a total investment ratio estimated to be

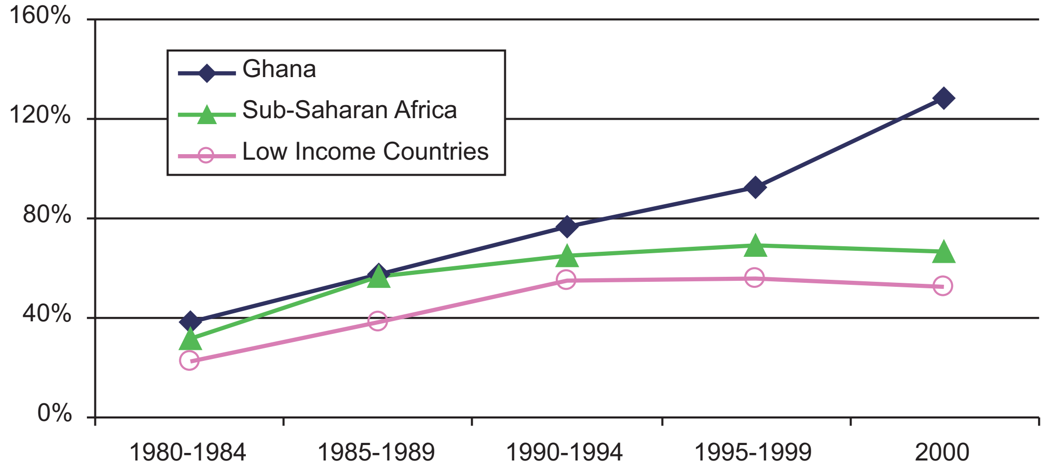


Figure 3.4: Debt to GDP ratio (World Development Indicators 2002)

6-12% in 1988 [Killick and Malik 1995], and even exhibited a slight downward trend in the 1990s (Figure 7.4, p. 115). The continuing capital inflows led to debt buildup and mounting interest payments. The medium-term benefits of liberalization didn't set in; growth turned from high in the late 80s to lagging in early to mid-90s[1] (Figure 3.2), and external debt has increased to an extent that Ghana qualified for the Heavily Indebted Poor Countries (HIPC) initiative (Figure 3.4).

Let us discuss the key aspects of the Ghanaian economy in some more detail.

3.2.1 Fiscal Policy

Let us begin with a brief discussion of fiscal policy. As we have seen in Chapter 2, fiscal austerity is one of the pillars of structural adjustment. The average deficit values for the last four five-year periods can be seen in Table 3.1; however, it might

[1] As we will see in Chapter 7, the official GDP numbers for Ghana for the 1990s are somewhat suspect. However, we use them here as part of the accepted version of events.

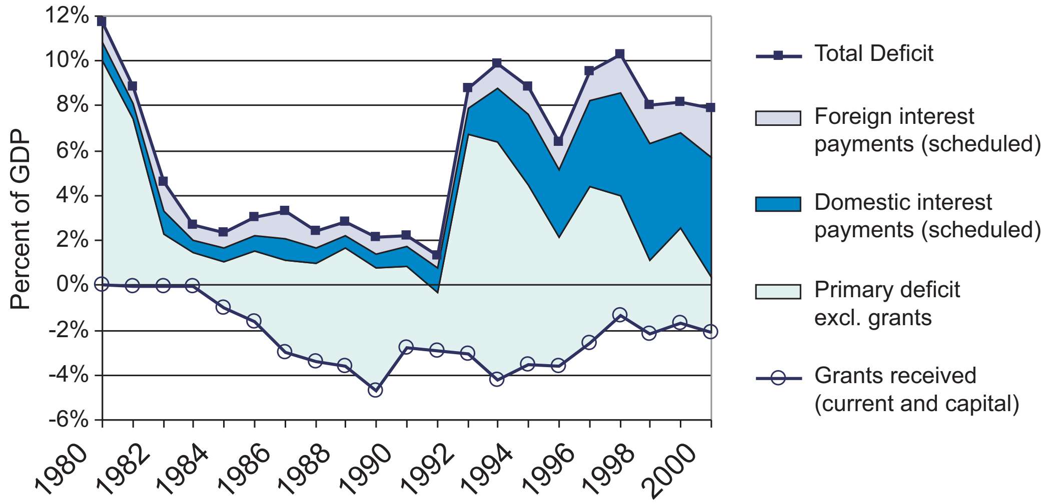


Figure 3.5: Composition of the Fiscal Deficit (International Monetary Fund)

be more informative to look at a decomposition of the deficit over time in Figure 3.5.

As the figure packs quite a bit of information, let us go quickly over its contents. All values in Figure 3.5 are plotted as shares of GDP. The lowermost line (empty circles) represents the total grants received. As they *reduce* the deficit, they are plotted with a minus sign. The large area on top of that represents the primary

	1980-1984	1985-1989	1990-1994	1995-1999	2000
Primary deficit as % of GDP	4.5%	1.2%	3.6%	2.8%	0.4%
Total deficit as % of GDP	6.0%	2.7%	5.9%	8.5%	9.7%
Broad money growth rate	32%	42%	33%	28%	35%
Nominal TB interest rate	13%	20%	27%	36%	35%
Real TB interest rate	-40%	-6%	9%	14%	17%
Effective import tariff	25%	16%	15%	14%	13%
Effective cocoa duty	51%	35%	28%	35%	14%
Exchange rate overvaluation	1279%	50%	4%	1%	0%

Table 3.1: Indicators of Ghana's adherence to Structural Adjustment policies.

deficit (that is, without taking into account the expenditure on interest payments) excluding grants; by stacking it onto the grants graph, its upper border represents the primary deficit including grants. Stacked on top of that there are the two areas representing interest payments on domestic and foreign debt, respectively. The topmost line (filled-in squares) is merely there to emphasize that all the areas together stack up to the total deficit.

Looking at Figure 3.5, we see several distinct periods. First, there is the period of turmoil in 1980-1982 with large deficits and no grants; then from 1984 until 1989 we see growing pre-grant primary deficits compensated by an even larger growth in grants, with the interest payments remaining comparatively small. In 1990 and 1991, grants fell, but so did the primary deficit, actually resulting in a tiny primary surplus.

Unfortunately, this fairly rosy picture unravels immediately after that. In 1992 (election year, bad cocoa harvest) revenues fell, expenditures rose, and foreign grants stayed low, leading to a huge primary deficit. The primary deficit remained high for the next couple of years, at the same time as grants were shrinking. While the primary deficit was brought under control from 1997 onwards, the interest payments on the debt accumulated during earlier excesses make sure the broad deficit never again fell under 6% of GDP, and generally stayed around 8%.

Summing up, fiscal policy during both the 1980s and the 1990s cannot really be characterized as particularly austere, with the worst excesses happening between 1992 and 1997, during the transition to democracy. As the next step in our investigation, let us see whether monetary policy was as tight as fiscal policy was austere.

3.2.2 Monetary Policy

To get a picture of monetary policy, let us look at three variables: growth rate in broad money supply, nominal interest rates (treasury bills) and real interest rates, as pictured in Figure 3.6. To compute real interest rates, we subtracted year-on-year CPI inflation from the nominal interest rates. CPI was chosen because it is the most readily available deflator, and year-on-year inflation was computed to avoid interference from the (quite strong) seasonal effects in inflation. Likewise, money supply growth is year-on-year. The averages of the same three variables over five-year periods are also reproduced in Table 3.1.

What Figure 3.6 tells us is that monetary policy since 1980 has been anything but tight. During the the 1980s, real interest rates were more often than not negative, and money supply growth rates of over 40% were quite common. Money supply has grown in the 1980s mainly because of the high foreign exchange inflows that were monetized by the Bank of Ghana, and in the 1990s primarily because of government deficits. In the 1990s, likely in reaction to the fiscal excesses, interest rates were raised somewhat, but were still occasionally negative for extended periods; and money supply growth likewise slowed down, but not by much.

High interest rate spreads between lending and deposit rates meant that real rates on deposits were even more likely to be negative than treasury bill rates, giving no incentive to save with the banks. Instead of savings accounts, holding foreign exchange was widely used as way of storing wealth, so that from 1997 BoG included

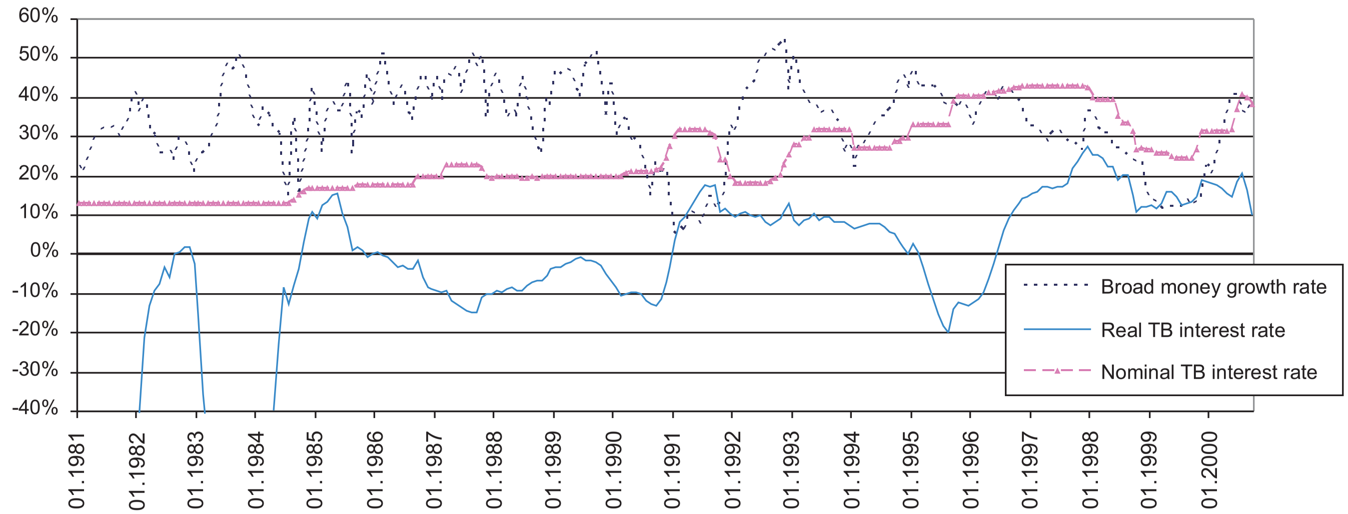


Figure 3.6: Monetary Policy Indicators

forex holdings in the definition of money. [Brownbridge et al. 2000]

Stimulating credit to the private sector was one of the goals of the Economic Recovery Program. However, that was hard to achieve because of extremely high government borrowing. On the one hand, the government borrowed from the Bank of Ghana, thus increasing the money supply; on the other hand, it also borrowed from the domestic commercial banks, making commercial credit scarce. As raising interest rates on treasury bills did not increase savings much, tight restrictions on bank lending to the private sector were necessary to avoid even more money supply growth.

The Bank of Ghana had very little room for manoeuvre: If it accommodated government borrowing demand, it could only control money supply growth by constraining private sector borrowing; however the latter is only 30% of the broad money supply [Aryeetey and Harrigan 2000].

The result was a crowding out of the private sector from the credit market (although reserve requirements of commercial banks e.g. in 1993 were 52% of Bank of Ghana bills plus 5% cash, actual rates were over 70% [Aryeetey and Harrigan 2000]) and strangulation of investment. Bank credit to the private sector averaged less than 5% of GDP, and if we adjust it for the increased cost of capital goods (mostly imported), it hardly grew at all in real terms [Brownbridge et al. 2000].

What little bank lending went to the private sector financed working capital rather than investment, especially as the need for working capital went up with constant inflation and depreciation [Aryeetey and Harrigan 2000]. Discussions with private investors and executives of the Private Enterprises Foundation suggested that high nominal interest rates made firms reluctant to use loans for investment purposes, and also increased cost of operation, thus pushing up prices [Brownbridge et al. 2000]. Even though real interest rates were not that high, even in the 1990s, high nominal interest rates combined with very volatile inflation made real rates hard to predict, making borrowing to invest too risky.

From this discussion we extract two hypotheses: firstly, that interest rates had little impact on the money supply and secondly, that interest rates were a cost-push factor, and thus increasing interest rates increased inflation. We will test these hypotheses in Chapter 11.

3.2.3 Inflation

One of the persistent problems of the Ghanaian economy has been out-of-control inflation - as Figure 3.3 shows, it was almost triple the average value for either Sub-Saharan Africa or the low-income countries. Given the huge growth in money supply throughout the 1980s and 1990s, it is not surprising that this growth is usually taken as the main explanation for the high inflation rates. However, there are also dissenting opinions.

The view that money supply was the primary driver of inflation is critiqued by Sowa et al. [Sowa and Kwakye 1991, Sowa 1994, CEPA 1996], who argue that real-side factors matter more in the inflationary spiral. Their econometric regressions are used to suggest that elasticity of inflation with respect to output is almost unity, so output volatility (especially in food production, which has a weight of 50% of CPI) rather than monetary factors drive inflation.

Another supply-side explanation for the persistent inflation is the low growth rate and capacity utilization of the industrial sector. However, as Aryeetey and Harrigan [2000] remarks, that seems unlikely to be a major influence as the industrial sector is so small (less than 10% of GDP).

Upon reviewing the above supply-side arguments, Aryeetey and Harrigan [2000] concludes that they might explain the short-term jumps in inflation (for instance during a drought, such as the 60% inflation rate in 1995) but not persistent high inflation, unless there are continued high rates of monetary growth. A structuralist explanation would only be useful if it could show that the huge money supply growth rates since the start of ERP were caused by inflation rather than vice versa.

This debate is clearly central to one of our research questions, namely understanding of inflation, and thus we expect to provide substantial evidence allowing us to evaluate the above debates. To be precise, in Chapter 11 we will address the question of the relative importance of money supply, cost factors, and inertia in determining the level of inflation.

3.2.4 Labor Market

The availability of data on labor market is much lower than that on macroeconomic indicators. No yearly data for overall employment composition are being collected in Ghana to the best of the author's knowledge. The only source of employment composition data are various surveys happening at irregular intervals. The most detailed of these is the Ghana Living Standards Survey (GLSS), of which a total of four rounds have been conducted, in 1987, 1988, 1991 and 1998.

Figure 3.7 shows the composition of the labor force in absolute and percentage terms.

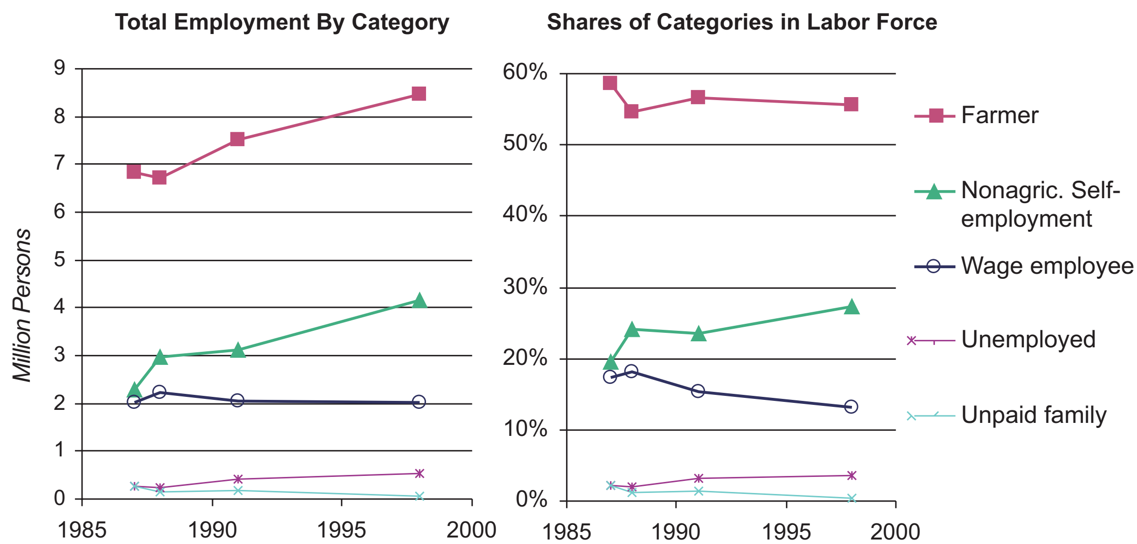


Figure 3.7: Employment composition (GLSS1-4 and author's estimates)

We see that the majority of the population are farmers, followed by non-agricultural self employment (transport, personal services, etc. - most of these activities fall into the informal sector) and wage employees.

To get an idea of the relative attractiveness of the different occupations, consider Figure 3.8, showing the composition of an average household's income across different occupations in 1998, derived by the author from GLSS4 data. For a sense of proportion, note that the poverty line at that time was 0.7 million cedis *per person*. Seeing that the income of an average food farmer *household* is barely twice that, and that of an average informal sector or cocoa farmer household about three times that, it will come as no surprise that the vast majority of the rural population is

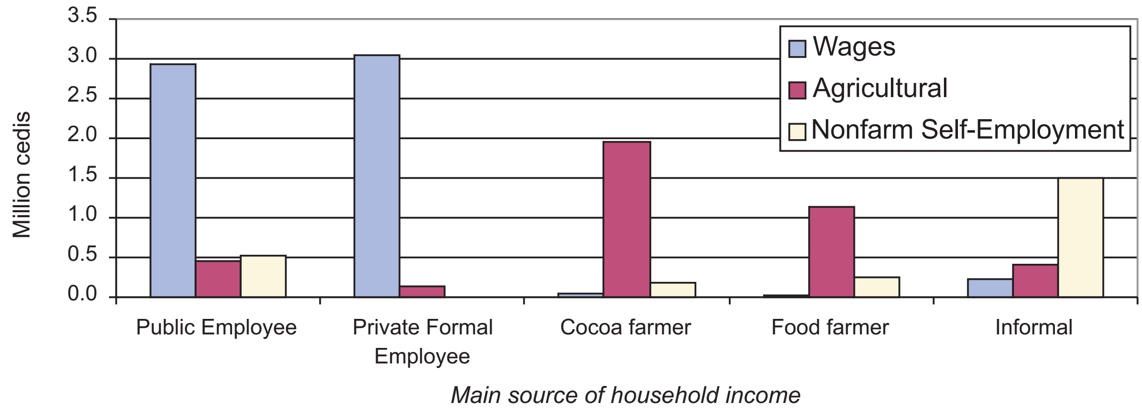


Figure 3.8: Average Households' Income Composition in 1993 by Main Occupation (author's estimates from GLSS4 data)

poor, and that employment in the informal sector presents only a marginally better alternative.

From Figure 3.7 we see that the share of population in agriculture is sinking, but very slowly. Unfortunately, that decrease goes not go towards the lucrative wage employment in the modern sector, but towards the informal sector which serves as a catch-all. The share of wage employees in the labor force has been stagnating in absolute terms, and thus decreasing in relative terms.

Disaggregating wage employment between government, state enterprises, and private firms (data not shown here) we see that the labor force employed by government has been fairly stable, the labor force employed by the state enterprises has sunk drastically (due to extensive divestiture programs) and increases in employment by private firms have just about made up for that decrease, with no overall growth in absolute terms.

According to Aryeetey and Tarp [2000], the least addressed aspect of fiscal adjustment is its effect on employment, both directly on public employment and through demand effects. Reductions in import duties also had negative impact on domestic employment, and displaced workers mostly landed in the informal sector, further depressing its productivity.

This appears to be a fairly disturbing picture in terms of poverty alleviation prospects. To gain a better understanding for its reasons, let us take a look at the behavior of the different productive sectors.

We do not formulate specific hypotheses concerning the employment composition and income structure of the households. The GLSS surveys are quite rich and fascinating datasets, but unfortunately the detailed investigation thereof is beyond the scope of the present thesis.

3.2.5 Sectoral Behavior

A major goal of most structural adjustment programs is eliminating or reducing what is perceived as price distortions, in particular government subsidies and tariffs. That was also the case in Ghana. This section discusses the sectoral implications.

The sectoral structure of the Ghanaian economy is dominated by agriculture (primarily food for domestic consumption and cocoa for export) followed by a large services sector (some 40% of GDP). The industrial sector is dominated by mining, which is largely foreign owned and has few linkages to the rest of the economy.

The agricultural sector in Ghana is crucial for any poverty reduction strategy, containing as it does over half of the country's working population and having by far the highest poverty incidence. Thus, impacts on the agricultural sector are an important gauge of distributional impacts of a policy.

The impacts of the ERP on the agricultural sector appear to have been mixed. On the one hand, the initial opening up to foreign trade and the flood of foreign assistance to finance it led to increased availability of capital goods and inputs such as fertilizer; furthermore, the cocoa producers profited from increased producer prices of cocoa and from liberalization of cocoa marketing. On the other hand, the food subsector appears to be weakened by the switch to price incentives for cash crops and by increased cost of fertilizer and labor.

According to Nyanteng and Seini [2000], the level of productivity is generally low due to poor farming practices and very low use of fertilizer, the latter additionally depressed by fertilizer subsidy cuts. Likewise, removal of subsidies on insecticides and fungicides almost tripled their real prices. As government pulled out of procurement, supply and distribution of inputs, private sector did not jump in to fill the gap, resulting in decreased availability.

A major constraint on the marketing of foodstuffs is the poor infrastructure; transportation alone is said to contribute as much as 70% to marketing costs, and storage losses are estimated at between 15% and 30%.

Let us now consider the policies of the ERP that affected the industrial sector. A major component of the program was a package of investment incentives, including unlimited repatriation of profits, a reduction in corporate tax rates, and a shift in price incentives for investment favoring export industries and disadvantageous to formerly protected manufacturing industries.

The main components of the industrial sector are mining, manufacturing (largely for the domestic market), and utilities (largely government-owned). As we have mentioned, mining is mostly foreign-owned and its products are mostly exported. Investment in mining is largely foreign-financed, and thus apart from providing some employment, tax revenue, and modest intermediate input demand, the mining sector appears to be largely insulated from the rest of the economy.

In response to the investment incentives listed above together with generous tax concessions, the mining sector did indeed grow substantially. However, the impacts on domestic manufacturing were largely negative.

Real depreciation and real interest rate raises led to almost a doubling of the cost of capital goods relative to the GDP deflator from 1983 to 1991 [Brownbridge et al. 2000, Table 4.2]. That did not affect mining as it was largely indifferent to domestic price levels, but it combined with the competition from increased imports to depress manufacturing. Average capacity utilization for medium and large factories was between 40% and 46% during 1990-1993 [IMF 1998, Table 12] Apparently, capacity utilization data was no longer collected after 1993.

From this discussion we extract the following testable hypotheses. Firstly, we would expect an increased scarcity of domestic food production, expressed in the increase of its relative price. Secondly, this increase may or may not have been a major driver of overall inflation, as the producer price of crops at the farm gate appears to be a small percentage of retail price of food, due among other things to high transport costs. Thirdly, it would be interesting to know how strongly the composition of output in agriculture and industry (export vs. nontraded) responds to relative price – relative price adjustments being the mainstay of mainstream theory and policy design. Finally, we would like to ask whether industry and manufacturing are primarily demand-driven or supply-constrained. This is important in terms of policy design, as a supply-constrained sector would primarily need capital investment (private or public) to expand its output, regardless of the fiscal policy stance, while a demand-driven sector would be harmed by austerity and benefited by a loose fiscal policy. Note that the answers to the above questions can be different for agriculture and industry.

3.2.6 External Trade and Balance of Payments

Another major component of the ERP was to liberalize the trade and payments regime. According to Aryeetey and Harrigan [2000], that had the following goals: narrow the gap between official and parallel exchange rate, provide foreign exchange to ease import strangulation, achieve a viable balance of payments position, clear up arrears, and introduce current account convertibility.

The means to that were devaluations in 1983-86, a foreign exchange auction from 1986, and a free interbank market from 1992 onwards. This was accompanied by a gradual liberalization of imports, with import licenses abolished in 1989 and import tariff rate lowered to between 10% and 30%. Export policies were also gradually liberalized, allowing exporters to retain an increasing share of earnings, reaching 100% in 1991 for all exports except gold and cocoa. The import liberalization programme and the forex auction could only be maintained with the help of foreign transfers [Aryeetey and Harrigan 2000].

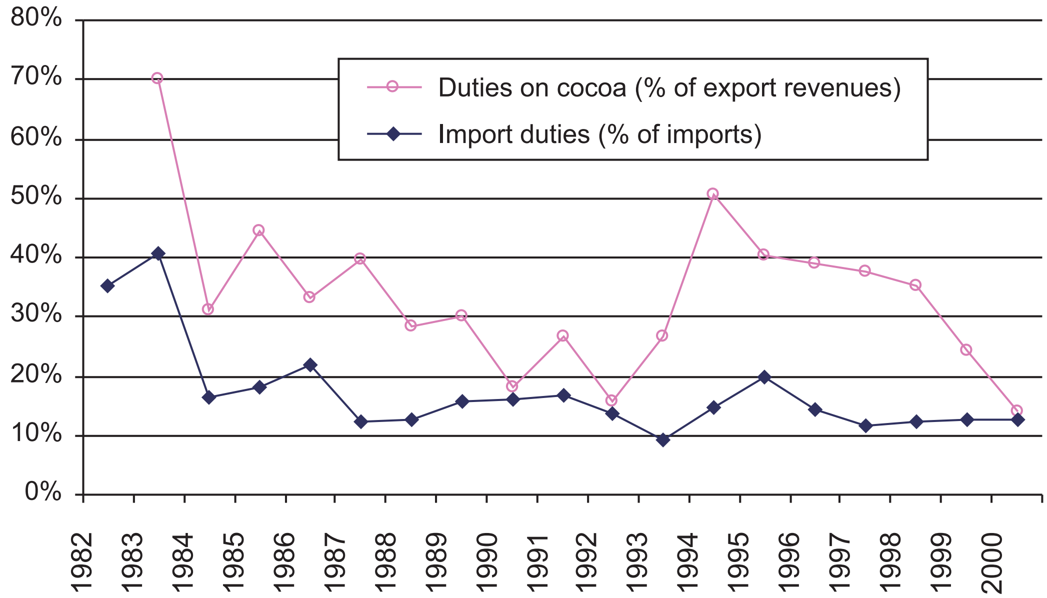


Figure 3.9: Effective Tariff Rates on Trade (World Development Indicators 2002, Oduro [2000], International Monetary Fund)

Figure 3.9 shows the effective tariff rates on imports and on cocoa exports. The effective tariff rates are computed as the ratio of duties actually collected over the total value of imports resp. exports. The five-year averages of these rates are reported in Table 3.1, which also contains the degree of exchange rate overvaluation (computed from official and parallel exchange rate data in Reinhart and Rogoff [2004]). The tariffs on non-cocoa exports were so low as to be negligible (low single digits). While the tariffs on cocoa are not exactly low, their importance among overall exports is decreasing as the revenue from cocoa exports has been overtaken by both gold and non-traditional exports over the course of the 1990s. What Figure 3.9 and Table 3.1 tell us is that as opposed to tight money and austere fiscal policy (which did not happen), trade liberalization was very much real and sustained.

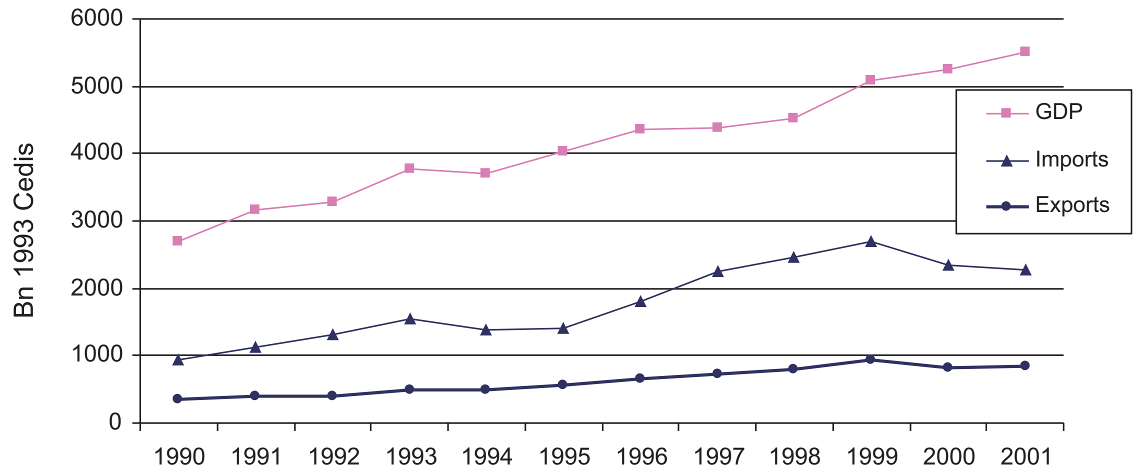


Figure 3.10: GDP, imports, and exports in real terms (author's estimates, Chapter 7)

Import tariffs went down and stayed that way, minor fluctuations notwithstanding; exchange rate overvaluation was eradicated by the beginning of the 1990s; and as can be seen in Figure 3.10, both imports and exports were growing as shares of GDP.

Thus, the goals of trade liberalization have been mostly achieved, with the exception of a viable balance of payments position. Looking at the data, we see a continuous nominal depreciation of the exchange rate, approximately (but not exactly) keeping pace with inflation, and a steady increase in volumes of exports and imports, in absolute terms as well as as a share of GDP (Figure 3.10). Although imports and exports grew at about the same rate, the trade balance was always in deficit as the total volume of imports exceeded that of exports by a large margin.

In the early ERP, the overriding objective of trade policy was stimulation of exports. Since 1990s, competing policy objectives have emerged: "Expansionary fiscal and monetary policies have placed pressure on the balance of payments making import liberalization balance of payments incompatible as well as placing pressure on the government budget making import liberalization through reduced tariffs fiscally incompatible" [Oduro 2000].

As a result of the investment surge in mining, gold exports are now ahead of cocoa, but since the former are dominated by transnational firms, the net foreign exchange inflows they generate are comparatively small because of profit repatriation and salaries of expatriate staff [Oduro 2000].

The export-led growth dominated by few primary commodities (cocoa, gold and timber) also made Ghana increasingly vulnerable to fluctuations in international commodity prices. Ghana experienced a double terms of trade shock starting 1999 (Figure 3.11), with cocoa prices low and oil prices high. The results were a further

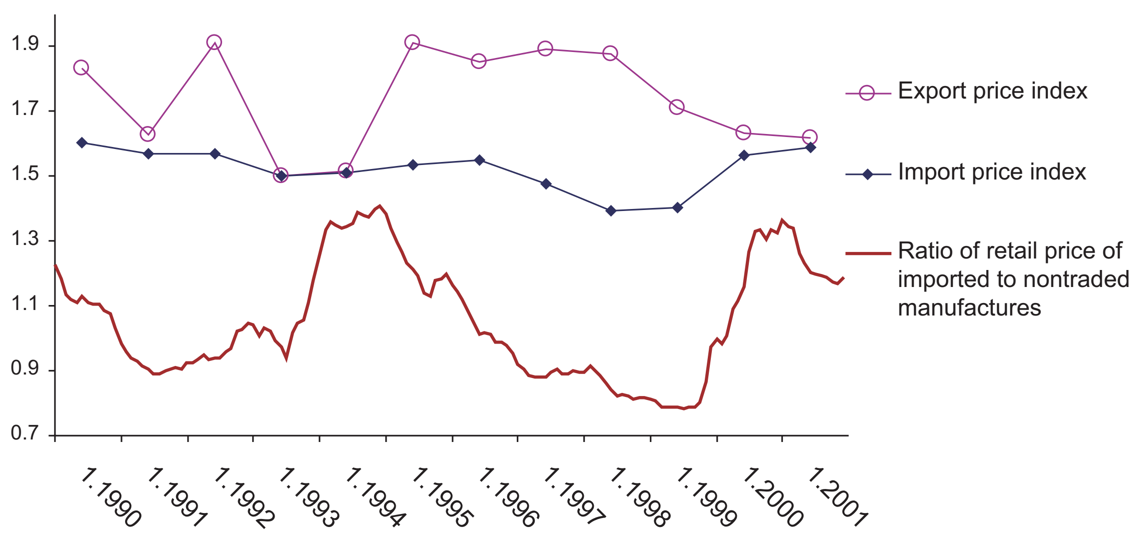


Figure 3.11: Some Price Indices (IMF Ghana Desk Country Reports and author's estimates)

increase in external debt and inflation, as well as a substantial devaluation.

The continuing current account deficits were financed by capital inflows, especially official transfers - leading to a steady increase in external debt from 36.6% of GNP (1982) to 128.3% (2000) (Figure 3.4). While donor assistance was plentiful in the 1980s, the macroeconomic instability in the 1990s (exchange rate instability, rapid money supply growth, inflation, and high government budget deficits) had a negative effect on aid flows [Harrigan and Younger 2000], as a glance on Figure 3.5 will confirm.

Based on this discussion, we would like to ask the following questions: firstly, what are the main drivers of import demand? To be precise, how responsive is import demand to the relative price of imports vs. domestically produced goods, and is there an additional increasing time trend in import demand due to the structural opening up of the economy? (The corresponding question with regard to export supply has already been posed in the previous section). Secondly, it would be very interesting to understand the behavior of the exchange rate and the degree to which it interacts with the domestic price level. As Figure 3.11 shows, the exchange rate's behavior was quite volatile, so that prices of imports relative to nontraded goods varied over as much as a factor of two; thus the role of floating exchange rate as the stabilizer for the real exchange rate deserves to be questioned.

3.3 Summary

Ghana is representative of small, open, poor primary commodity producers. In the 1980s, Ghana undertook a radical reform program that largely followed the standard Structural Adjustment blueprint, including elimination of subsidies, opening to trade and capital flows, floating the exchange rate, and combating inflation with high interest rates. In the 1980s, this was accompanied by high foreign exchange inflows, both grants and loans, and the combination resulted in high GDP growth, in particular in the import sector, as well as an accumulation of a large external debt. In the 1990s, the growth rate of the economy diminished, capital formation remained low, current account deficits persisted, and a high inflation rate was combined with periods of "freely falling" exchange rates.

Most structural reforms were concluded by 1991, so that the structure of the economy was comparatively stable during the 1990s. The question of whether the stagnating state of the economy happened because of particular features of the structural adjustment program (such as excess fiscal austerity and high interest rates), or because the latter was not followed consistently enough (meaning mainly too high government deficits), or for other reasons altogether, is far from being settled. Based on the discussion of the literature, we have formulated a number of specific policy-relevant questions and hypotheses that we will attempt to answer in the body of the thesis.

Chapter 4

Currently Used Methodologies

This section reviews the strengths, weaknesses, and common assumptions of the different model types used to assess impacts of structural adjustment programs.

Developing country economies have a number of distinctive features that influence the nature of models that are built to understand their behavior. One of these is a much greater magnitude of shocks (externally or internally caused, such as volatility of export prices or money printing binges by the government) compared to the developed countries - thus, double-digit inflation or depreciation rates are commonplace and triple digits are not unheard of, especially in the context of an adjustment program. Another such feature is relatively simple financial systems (though less so with every passing year). Another is a great variety of economic structures among different countries: for example, it makes a lot of difference whether the main export of the country is largely produced by small farmers, a handful of rich landowners, or largely foreign-owned firms doing resource extraction. Yet another is data paucity - while much data exists, it is often scattered among agencies, its coverage can vary greatly and merely putting enough data for a model together can be a major effort.

The large shocks together with poor data have important implications for modeling. Firstly, linear models are not plausible in view of the large impacts, and lack of data means that the shape of nonlinearities must often be derived from parables and stylized facts. It is thus perhaps not surprising that there is no agreement among different modelers regarding even the direction of certain impacts and causal connections, as we will see in this chapter.

Secondly, much as in quantum mechanics, high cost of getting data means that conservation laws, whenever they can be found, have to be milked for all they can yield. In quantum mechanics the conservation laws are called symmetries, in economics, accounting identities. Thus accounting and precise definitions of equilibria have a much larger importance in models of developing countries, both for cross-checking the data one has and for inferring data one does not have.

Four model types are commonly used to assess impacts of structural adjustment programs. First of all, there are the fixed ratio models RMSM-X and the Financial Programming Framework that are used by most World Bank and IMF country desk practitioners. These are very crude models and the validity of their equations has been empirically tested and shown to be very poor. They are not at present to the author's knowledge taken seriously by any research economist; however, their implicit assumptions still shape much of the debate around structural adjustment, in addition to guiding the back-of-the-envelope estimates that IMF country economists use as a starting point for negotiating new structural adjustment programs.

The two model types most popular for applied analysis of structural adjustment programs are econometric models and and CGE models. These are in a sense opposites: econometric models allow for rigorous significance testing but their theoretical limitations restrict them to comparatively few variables and simple, mostly linear equations. On the other hand, CGE models are constructed around a refined accounting framework and set virtually no limit to the amount and type of variables and functional relationships used. However, they are completely incapable of empirical verification, and a CGE model with virtually any behavior can be calibrated to any economy, with no way to distinguish between different causal stories[1]. Within CGE models, there are two major schools of thought, neoclassical and structuralist, distinguished by certain characteristic assumptions. The main assumption on which they differ is whether productive capacity is fully employed at all times, with all markets clearing through price adjustments (neoclassical) or whether market clearing through quantity adjustment has an important role to play as well (structuralist). We will discuss further differences between the two views in the body of this chapter.

Finally, microsimulation models are a recently fashionable methodology to assess finer-grained distributional impacts of changes in macro and sectoral variables. They work by specifying simple household behavior functions in response to these variables, and then estimate these functions for each of the households in a household survey. This is then used to represent impacts of macro variables on each of the households modeled. While the results are clearly not reliable on the individual household level, the households can then be grouped in various ways, and the group averages and intra-group distributions can be more robust. While microsimulation is a promising technique, such a model still needs a separate macro model to drive it, and will inherit the latter's weaknesses.

In the following, we discuss the strengths, weaknesses, and common assumptions of these models in more detail.

[1] While it is possible to build models that to a large extent incorporate the virtues of both types without the drawbacks, as demonstrated e.g. by the Inforum models Meade [2002], these have to the author's knowledge never yet been used in the context of structural adjustment policies.

4.1 Fixed Ratio Models

Interestingly, although most World Bank and IMF rhetoric is based on the neoclassical tradition, the models the country desk practitioners still use in both institutions rely not on diminishing returns and flexible ratios (such as output per worker or output per unit of capital) of the neoclassical school, but on fixed ratios combined with accounting identities.

4.1.1 Key assumptions

The two most important fixed ratios are the capital to actual output ratio (known as the Incremental Capital Output Ratio, or ICOR) and the nominal output to money supply ratio (constant velocity of money). RMSM-X (Revised Minimum Standard Model - eXtended), the World Bank staple model, uses both; the IMF financial programming framework uses the constant velocity of money assumption and assumes that output is unaffected by the program.

4.1.2 Strengths

The main strength of these models is their simplicity, and the ability to fit together the key macro variables, namely national accounts, the balance of payments, and the government deficit.

The models also provide simple, intuitive connections between three key policy variables, namely government deficit, total investment, and the exchange rate , and three key policy targets, namely balance of payments, domestic price level, and real

GDP.

4.1.3 Main weakness

The main weakness of these models is that the simple, intuitive behavioral equations that are implied by the fixed ratios are not supported by the data.

The constancy of the capital/output ratio has been tested by Easterly [1997], who in a wide range of statistical tests found no evidence for constancy of the capital-output ratio. For instance, regressing Gross Domestic Product (GDP) growth on Gross Domestic Investment over GDP country-by-country (which should yield the ICOR by country), he found a positive and significant relationship in only 11 out of 138 countries tested. Other regressions were similarly disappointing. Similarly, Reinhart [1991] tested the assumptions of the RMSM-X model and found no support for the constancy of ICOR; the constant velocity of money hypothesis was rejected in about half of the countries in the sample, including Ghana.

Given the shaky theoretical foundations of the two models, it is not surprising that they are not taken too seriously even by the people using them. Thus, Mussa and Savastano [1999] in their discussion of how IMF conditionalities are formed admit that "[The] educated guess embodied in the performance criteria is typically an outcome of the negotiation with the authorities, not the result of rigorous statistical estimation". However, when no explicit model is used one has to resort to a mental model, and the discussion on p.33 of Mussa and Savastano suggests that no influence of monetary and fiscal policy on output growth is still an implicit assumption, so that monetary and fiscal tightening are expected to reduce inflation while having no recessionary effects on output.

4.2 Statistical Macro Models

Much of the theoretical work done on the effects of adjustment policies takes the form of econometric models that rely on time series regression (country-specific or cross-country) to find behavioral coefficients. The most prominent of these is the model by Khan and Knight [1981, 1985] who estimated a small dynamic econometric model, estimated its parameters on a pooled cross-section time-series sample of 29 countries, and used the estimated model to conduct hypothetical policy experiments. The simulation of a typical IMF program produced a sharp price deflation in the first year, followed by a temporary burst of inflation; output contracted sharply in the first year, then rose above its full-employment level, and then gradually approached equilibrium.

4.2.1 Main assumptions

The main assumption of most econometric models it that the dependent variables are linear functions of the independent variables (possibly after appropriate transforms such as taking a logarithm) plus random noise. There is a variety of additional assumptions on the fine structure of the noise, used to draw conclusions from the errors in a given regression to statistical significance of its coefficients.

4.2.2 Strength

The main strength of econometric models is the ability to rigorously specify measures of confidence and significance of model results.

4.2.3 Weaknesses

Macro-econometric models have two major weaknesses. Firstly, they are comparatively data-hungry, in that they need many data points to come up with statistically significant estimates. Unfortunately, time series for individual developing countries are often too few and too short. On the other hand, cross-country regressions usually come up with non-significant coefficients due to large variations between countries.

Secondly, due to theoretical limitations most econometric models have few variables and few equations, most of them linear. Macro-econometric models have recently been used to "inspire" Computable General Equilibrium models [Ferreira et al. 2003], but to the author's knowledge they have never been integrated into a comprehensive accounting framework in the context of developing economies (the work of Inforum on industrialized countries shows that this is possible, but quite labor-intensive).

Thus, Haque and Khan [1998] conclude that the existing econometric models "don't capture the complex ways in which policy variables are related to the ultimate objectives of programs."

4.3 Computable General Equilibrium Models

Computable General Equilibrium (CGE) models are currently the dominant methodology for assessing distributional impacts of macro policies. The CGE model literature is rich in alternative formulations, somewhat fragmented, and full of sometimes quite subtle detail. Thus here we briefly touch upon the points that appear pertinent, without a claim for exhaustiveness.

The main organizing principle of CGE models is comprehensive tracing of nominal money flows through the economy, and determination of a set of prices and sectoral output levels that allow all markets to clear. During the past fifteen years or so, this focus on flows has been augmented by representation of asset stocks and financial markets.

4.3.1 Key assumptions

The defining assumption of CGE models is that of flow equilibrium in all markets, both in nominal and in real terms. This is expressed by calibrating each model to a Social Accounting Matrix (SAM) that is a complete description of nominal money flows inside the country and has to fulfill a balancing requirement. This balancing requirement is equivalent to a conservation law for money, that is, to the statement that money can be created or destroyed only in the financial sector or outside of the country.

As we will see below, CGE models allow to calibrate any causal story to any country's data. Thus, there are two distinct schools of CGE modeling, neoclassical and structuralist, each with its favorite set of key assumptions and causal stories. We discuss these in Section 4.4.

4.3.2 Strengths

The CGE technique has two main strengths. Firstly, the SAM structure is a mature accounting framework for integrating the various types of data and for tracing of economy-wide effects of policies.

Secondly, within that framework there is still a large scope for storytelling about specific parts of the economy and alternative causal mechanisms. The CGE literature of the past two decades is rich in alternative stories of how, for example, credit can impact real output. The variety of model formulations is large enough that we cannot cover it here, and have to refer the interested reader to Kraev [2003].

Computable General Equilibrium (CGE) methodology has over the past three decades developed quite a powerful toolkit for assessing distributional impacts of certain kinds of policies, in particular those working through relative prices. Combining CGE models with microsimulation techniques (covered below) allows to further extend the analysis from sectoral aggregates and representative household groups to cover substantially more detailed distributional impacts.

4.3.3 Weaknesses

The main weakness of CGE models is that they are fundamentally non-testable. The way a CGE is built is first to specify an a priori causal structure ("story") and then calibrate it to a Social Accounting Matrix of a given country. The behavioral parameters are hereby specified in a largely ad hoc manner. Thus any story can be calibrated to any country.

The traditional CGE models use a base year SAM to calibrate the share parameters of the model, and mostly use unrelated studies or guesstimates for the remaining behavioral parameters; in the best case (e.g. Demery and Demery 1991), some parameters are estimated from single-equation regressions. As CGE models also aim to represent medium-term equilibria, the time series they produce (if any) are typically only interpreted in qualitative terms.

There are two unfortunate results of this practice: firstly, models with very different behavior can be calibrated to the same data, with no ready measure of which formulation best describes a given country (see e.g. the controversy in Sahn et al. 1996, de Maio et al. 1999, Sahn et al. 1999). Second, even if one has settled on a given causal structure, the behavioral parameters cannot be directly calibrated to data. The usual solution are borrowing parameter estimates from unrelated studies, ad hoc sensitivity tests and "reasonable range" guesstimates, none of which seem very satisfactory.

A different way of addressing the uncertainty in free parameters is discussed by Harrison et al. [1993], who assume a priori probability distributions for all free parameters and proceed to do simultaneous sensitivity analysis on all of them, generating probability distributions for output variables. However, this approach seems to have two flaws that limit its use in applied models: firstly, the a priori probability distributions still have to be guesstimated, and secondly, doing a full unconstrained sensitivity analysis on all free parameters simultaneously is likely to produce a spread of end results so large as to be of no practical use.

Thus, until the CGE methodology is modified to allow for significance and quality-of-fit measures akin to those of econometrics, CGEs will remain little more than elaborate a priori stories, a medium for narrating the modeler's favorite theories in a consistent framework, but with little rational reason to prefer one such story to another.

The second major weakness of the CGE methodology is that due to its flow equilibrium core, it is not really comfortable with integrating stocks and stock-flow relationships. As stocks such as the money supply or the foreign currency reserves are clearly important in practice, most applied CGE models since 1990 have attempted to integrate them. However, all such attempts were largely ad hoc, compared to the standardized SAM framework for describing flows. Thus, there is a need for a formalism to represent financial stocks that is as clean as the SAM formalism, and integrates cleanly with the SAM to satisfy stock-flow relationships. In this thesis, we will introduce such a formalism.

4.4 The Major Theoretical Differences between Neoclassical and Structuralist CGE Models

There are at present two major traditions in CGE modeling. The neoclassical tradition tends to assume full employment of labor and capital, sectoral adjustments driven by relative prices, and aggregate price level driven by money supply. Structuralist tradition tends to assume quantity adjustments of output and cost-driven prices. Here we present the two traditions in more detail.

4.4.1 Neoclassical CGE Models

Neoclassical CGEs have their intellectual roots in Walras' model of the competitive economy [Walras 1984] and Solow's model of economic growth [Solow 1956]. Their motto is "sound theoretical foundations", mainly used to mean close adherence to Walras' model. Decaluwé and Martens [1988] summarize the structure of neoclassical CGEs as follows:

> Only relative prices matter, producers are profit maximizers facing non-increasing returns to scale, consumers are insatiable utility maximizers, and production factors are paid according to their marginal revenue productivity. The model's solution provides a set of prices, which, by making all these individual optimizations feasible and mutually consistent, clears all markets simultaneously.

Robinson [1989] gives a lucid and detailed description of "the" neoclassical model of an open economy.

In practice, the distinguishing assumptions of the neoclassical models are full capacity utilization, full employment[2] and prices determined by marginal productivity rules. Because of the full employment assumption, adjustment to a disturbance such as an export price shock takes place through reallocation of labor between productive sectors (driven by relative prices) without substantial changes in overall real

[2] In view of the neoclassical school's emphasis on sound theoretical foundations, it is rather amusing that one of their main distinguishing assumptions, namely full employment, has no basis either in data or in general equilibrium theory. We will return to that point in Section 4.4.3.

output. Labor reallocation (and possibly new investment patterns over the longer term) change labor intensities and therefore labor productivity and thus wages in different sectors to match the new set of relative prices.

As the neoclassical economy always operates at capacity, the typical way to determine the level of investment (going back to Solow [1956]) is to set it equal to the level of savings (in real terms), known as the neoclassical closure. However, models in the neoclassical tradition also use other closures (for example an endogenous savings ratio that passively accommodates investment demand) though virtually always those with full employment.

The Walrasian framework also naturally dictates the mechanism determining the aggregate price level. Because of Walras' law (if all markets but one clear, so does the last one) one only needs $n-1$ prices to clear all n markets in the model. "However, the behavioral assumptions are such that typically all the supply and demand functions are homogenous of degree zero in all prices. Thus, one is free to add an additional equation defining a numeraire price index, which defines a unit of account and has no effect on the equilibrium value of any real variable" [Robinson 1989]. This is typically (e.g. Agénor et al. [2000]) augmented with a simple macro model that gives a definition of money supply (e.g. as sum of domestic government liabilities, implicitly assumed to be all monetized, and foreign exchange reserves). One proceeds to define money demand as a multiple of the numeraire price level (calling the inverse of the proportionality constant the velocity of money), and sets money demand equal to money supply. Then government deficit and the balance of payments developments together determine the money supply, which in turn determines the aggregate price level. One way to look at this mechanism is to say that supply is given from the real side, and nominal aggregate demand determines the price level. Thus we have here a pure demand-pull model of price determination.

The interesting property of that whole mechanism is that neither government deficit, nor the money supply, nor the aggregate price level, have any impact on the full employment state of the economy. Neither are relative prices affected, unless the government uses the deficit spending to change the composition of demand. Thus in a Walrasian world, fiscal austerity reduces prices without incurring any recessionary impacts whatsoever.

The picture is somewhat complicated by introducing foreign trade, because once the domestic nontraded good aggregate price level is fixed with the above mechanism, the nominal exchange rate determines the relative price of exports and imports compared to nontraded goods ("the real exchange rate") which has real effects. Through this channel, movements in the domestic aggregate price level can influence the balance of payments and the composition of domestic output. However, this complication can be (and often is, e.g. in Devarajan et al. [1990]) easily circumvented by postulating a fixed balance of payments in foreign currency terms and letting the nominal exchange rate adjust to achieve that. The result is that the nominal exchange rate scales proportionally to the domestic aggregate price index, so that the real exchange rate remains unchanged.

The first neoclassical CGE was a model of Korea by Adelman and Robinson [1978]. Since then, there have been countless implementations of the basic framework for different countries, with essentially identical structure (Decaluwé and Martens

[1988] provide an extensive review) . Worthy of note is the "123" model [Devarajan et al. 1990, 1993, Devarajan and Go 1998, Agénor et al. 2000] which reduces the framework to the bare essentials of the structure.

An early attempt to integrate financial markets into the neoclassical CGE model was made in a model of Turkey [Lewis 1985, 1992, 1994]. A substantially more advanced and influential model that incorporates many structuralist features is the maquette [Bourguignon et al. 1991, 1992]. The maquette is really a model template, that allows for variable employment for some sectors/labor types, and for markup pricing in some sectors; however, its treatment of the aggregate price level is strictly monetarist. The basic structure of the maquette has since been used in many applied models (see e.g. the whole issue containing Bourguignon et al. [1991]), so that at present the maquette is the most widely used framework to incorporate financial effects in a model with sectoral structure.

Almost all CGE models of industrialized countries are neoclassical (see e.g. the review of the models of NAFTA in Stanford [1992]). The structuralist CGE tradition has to date focused on developing countries, and its techniques are described below.

4.4.2 Structuralist CGE Models

The other branch of CGE models for developing countries is the structuralist school. While the "patron saint" of neoclassical CGE's is Walras, those of the structuralist school are Kalecki, Kaldor and Keynes [Kalecki 1971, Kaldor 1957, Keynes 1936]. The structuralist motto is "capturing the institutional specifics of the economy at hand". The leading figure of this tradition is Lance Taylor, who describes the structuralist techniques in Taylor [1991] and Taylor [2004]. True to their motto, the structure of individual structuralist models varies much more than that of their neoclassical counterparts, thus the description below refers to typical and frequent features, rather than to a uniform "structuralist model".

In contrast to the neoclassical models (that hinge on full capacity utilization and relative price-driven shifts in composition of output) structuralist models work mainly through quantity adjustment, often resorting to fixed ratios where a neoclassical model would have relative price dependence. The structuralist prototype is the model of Kalecki [1971], with employment and output freely adjusting to demand up to the maximum productive capacity of the economy (as would follow from perfect complementarity of labor and capital). As in this setup the marginal product of at least one of the factors of production is zero, marginal productivity pricing is abandoned in favor of markup pricing (price being equal to a markup over variable costs of production). The markup is usually constant when the economy operates below capacity, and is the adjusting variable once capacity is reached. In practice, many models such as Rosensweig and Taylor [1990] or Easterly [1990] effectively assume the maximum capacity to be infinite, focusing on short-term adjustments in output (often of recessionary nature).

Since in this model in an economy operating below maximum capacity the output adjusts freely to demand, there is really no place for demand-pull inflation, and money supply, while well-defined, has no particular role to play. To explain the occurrence of persistent inflation in most developing countries one then has to resort to some kind of cost-push formulation. The structuralist favorite is competing claims, for instance simultaneous indexation of wages and price determination as a fixed markup on wage costs, leading to a steady inflation spiral.

While early structuralist models had many attractive features representative of the developing country reality, such as variable capacity utilization and bottom-up price determination, they also made many stylized assumptions that were in their way no less restrictive than their neoclassical counterparts, such as constant wages and constant aggregate real investment. Even in relatively refined models such as Rosensweig and Taylor [1990] or Easterly [1990] the prices are still determined purely from the side of costs. However, structuralist models built since the late nineties such as Vos [1998] rely on a sector-dependent combination of price and quantity adjustments, meeting many of the criticisms of the early models.

4.4.3 Whose assumptions are better?

Given two schools with such different assumptions, it is natural to ask which of these assumptions, if any, are to be preferred. Note that neither school's position is logically indivisible - it is quite possible, and in fact quite useful, to mix and match assumptions from both schools. While, as we discussed before, the CGE methodology does not allow to empirically verify the assumptions of a model, still we can attempt to draw some preliminary comparisons here, with a view towards more empirical verification later in the thesis.

Full Employment vs. Output Adjustment

A frequent neoclassical claim is that quantity adjustment in the product markets only happens in the short term, while in the longer term price adjustment coupled with full employment can be expected to prevail [Robinson 1989, p.928]. The source for that is often claimed to be found in general equilibrium theory.

Unfortunately, reading up on the theory (Arrow [1974] and Tobin [1982]), shows that there is no reason to expect full employment to obtain even in the long run unless there are future and contingent markets for all commodities, a requirement presently (and in the foreseeable future) not technically possible in any economy, let alone those of developing countries. Thus the frequently heard neoclassical contention that full employment will automatically occur if markets are allowed to operate freely has no basis whatsoever even in general equilibrium theory, let alone in practice[3].

Thus variable and demand-driven output (with diminishing or constant returns to labor) is symptomatic not of the "short term" or "excess capacity", but rather of the behavior of particular sectors. A frequent heuristic associates variable output with "modern sector" and fixed (in the short term) output with "agriculture". That view is supported by the excellent data fit of demand-driven models of developed countries such as LIFT [Meade 2002] and also recognized in recent models of the neoclassical school such as the maquette [Bourguignon et al. 1991, 1992]. Models

[3] In a sense, this can be regarded as a case of missing markets, but this insight is not much help in practice as the necessary markets would involve futures in every conceivable commodity conditional on every possible future state of the world.

combining fixed-output (price-clearing) and flexible-output sectors are known as fix-flex models.

Nominal Price Determination

The neoclassical and structuralist views on the role of credit and money supply lead one to expect radically different responses to the same policy packages. Which one should we believe? The answer might lie in the classic quote from Keynes [Keynes 1925] that compares monetary policy to a string attached to the real economy: "you can pull on a string but you can't push on a string". The structuralist vision would then correspond to a string stretched taut, with credit supply being a limiting factor of production; and the monetarist view would be that of a limp string that can be pulled quite a way before much real impacts materialize.

If one puts the question that way, it would seem that the issue cannot be decided a priori: a given economy might better fit one of the two descriptions, and indeed switch between modes as a result of policy packages (for example, a harsh restriction of credit could conceivably push an economy from a capacity constrained excess-demand mode into a credit-constrained mode). Thus it would seem that to adequately address the relationship between credit and the real economy, a financial CGE model must also be capable of such an endogenous switch. Once a model is capable of different modes, one could compare the behavior of the model to the behavior of the actual economy and determine which of the mechanisms turns out to dominate, and thus turn a theoretical debate into an empirical one.

A recent example of such a model is a model of the impacts of fiscal deficit reduction in India Naastepad [2001, 2002b,a], capable of different "modes" and of endogenous mode-switching. In this model, depending on the policies applied and on the evolution of the economy, one particular constraint (demand, supply, or credit) may prove to be binding, and correspondingly price behavior will correspond to either the structuralist or the monetarist model of the role of credit and price formation.

Summing up, one can expect different sectors within the same country to be either supply-constrained at full employment of productive capacity, or to work below maximum capacity with output driven by demand. Likewise, the relative strength of demand-pull and cost-push factors in price formation is an empirical question. The two model traditions provide us with a valuable vocabulary of possible model formulations, but we will have to go beyond the CGE methodology to decide which of these are actually applicable to Ghana during the period we are interested in.

The following section provides an overview of an extension to macro/sectoral models that promises a greater insight into distributional impacts of a given change in macro behavior.

4.5 Microsimulation Models

"Microsimulation" refers to modeling of income and consumption of distinct individuals or households, instead of resorting to representative household groups (RHGs) as the traditional CGE models do. The idea goes back to Orcutt [1957], but was not used for analysis of macro-poverty links until the late nineties. Davies [2003] provides a review of microsimulation in other contexts.

Starting with Cogneau [1999], a number of models attempted to use microsimulation for analysis of macro-poverty links by combining the well-tested CGE apparatus with the micro data provided by one or several household surveys. This was approached in two different ways, top-down and integration.

The top-down approach solves a traditional CGE with a limited number of household groups, and then uses a microsimulation model to generate household behavior that reproduces the output of the CGE model. The specification of the microsimulation model can range from simple pro-rating as in Bussolo and Round [2003] to models econometrically estimated from a household survey that endogenize the labor supply choices of each household, such as Bourguignon et al. [2003] and Ferreira et al. [2003].

The integration approach, represented by Cogneau and Robilliard [2000] and Cockburn [2002], uses the individual households directly in the CGE instead of representative households. This approach appears more promising than top-down for several reasons: it comes closer to the vision of general equilibrium in Arrow [1974]; it has the potential for household heterogeneity to have impacts on sectoral and macro aggregates; and, according to Cockburn [2002], it presents "very little technical difficulty".

While CGE/microsimulation models appear to be a promising methodology for assessing fine-grained distributional impacts of macro policies, one should not forget that a CGE/micro model, be it top-down or integrated, is subject to the same choices and weaknesses as other CGE models, especially as regards choice of closure and validation.

If the closure of a CGE/micro model is not a good description of the country in question, the model is in danger of giving finely disaggregated, false results (of the models mentioned here, only Bussolo and Round [2003] conduct systematic closure exploration, and of the rest, only the model of Ferreira et al. [2003] has a modular structure that would easily permit such exploration.)

Validation is another chronic problem of CGE models that is inherited by CGE/micro models. Of all the models discussed, only Ferreira et al. [2003] compare the model predictions to a later household survey, concluding "we cannot claim that this approach [can] predict the distributional outcomes of [...] policy packages with any accuracy".

An interesting potential of CGE/micro models would be in addressing gender-related distributional issues; however, to the author's knowledge, that has not yet been attempted, possibly in part because most survey data is still household-level, not individual-level.

Summing up, microsimulation is a promising extension of the CGE technique for assessing fine-grained distributional impacts, but we should not expect it to address any of the other weaknesses of CGE models that we have discussed.

4.6 Summary

This chapter has reviewed the major types of models used to evaluate macro and distributional impacts of structural adjustment programs. Briefly, the fixed-ratio models are not useful at all because of their reliance on assumptions not supported by the data. Econometric models can provide measures of confidence for their output but are not by themselves well equipped to handle the large amount of variables and the nonlinear relationships needed to understand distributional impacts. CGE models use a well-developed Social Accounting Matrix formalism that allows them to cleanly handle large amount of flow variables and nonlinear relationships, but lack an equally clean formalism for describing stocks and stock-flow relationships. Furthermore, the practice of calibrating the CGE models to data for one year and guesstimating the remaining parameters allows any CGE model to be calibrated to any country, making empirical comparison of the quality of fit of different CGE models impossible.

From this list of strengths and weaknesses we can see some properties of an adequate methodology: to allow validation of behavioral relationships (measures of significance etc.), it should use data time series rather than just data for an individual year; to allow representation of macro as well as sectoral effects, it should be based on a comprehensive accounting framework; this accounting framework should combine the well-tested SAM technique for tracing flows with an equally clean formalism for describing financial stocks and stock-flow relationships (flow-of-funds).

In Chapter 6 we describe how our approach addresses these requirements; first, however, Chapter 5 introduces some accounting concepts useful for that discussion.

Chapter 5

An Introduction to Useful Accounting Concepts

This chapter provides an introduction to some accounting formalisms that we will use and refine in the subsequent chapters. The two major formalisms discussed here are firstly, the Social Accounting Matrix (SAM) that is commonly used to represent nominal currency flows inside an economy under the assumption of flow equilibrium, together with the corresponding accounting for real product flows; and secondly, the Financial Accounting Matrix (FAM) that contains the stocks of financial assets. The FAM is less common in applied models, and one of the innovations of this thesis will be to integrate it with the SAM to represent nominal flow *dis*equilibria and their impacts on financial stocks over time. This chapter introduces and discusses the FAM concept, leaving the details of how we make use of it to later chapters.

5.1 Social Accounting Matrix

A Social Accounting Matrix is simply an ordered listing of all money flows between different parts of an economy at a specific level of disaggregation. To illustrate the concept, let us start from a simple money flow chart and see how it is represented in SAM form.

Figure 5.1 is a simple representation of money flows in an economy. Blocks denote different accounts, arrows represent money flows between them (all money flows are converted to domestic currency). The value added generated in the Production block is distributed between firms, households, and government in the Income Distribution block. The resulting disposable incomes flow, according to the demand

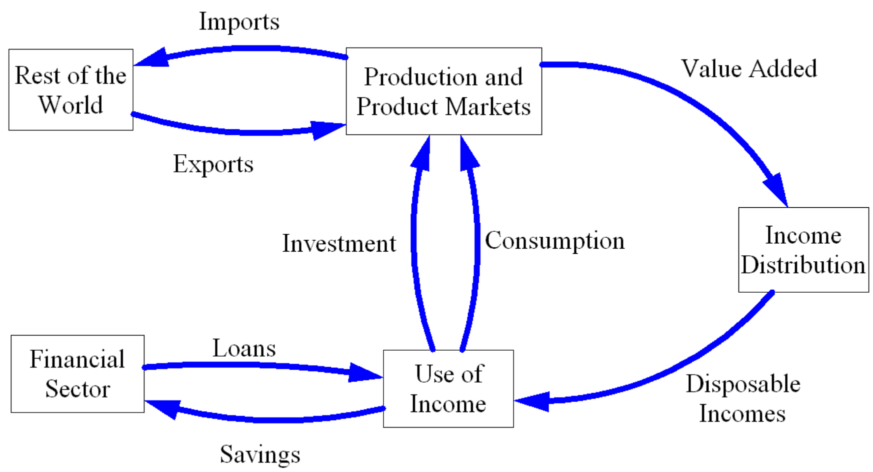


Figure 5.1: A simple money flow diagram

patterns, partly into the Production block (as final consumption and investment expenditures) and partly into the Financial Sector block as savings. From the financial sector, money is injected back into use of income accounts through loans. Foreign trade is by SAM convention also routed through the Product Markets account: total demand from final domestic consumption demand, investment demand, and export demand, is matched to GDP (value added) plus imports.

Let us now see how such a flow chart would be represented as a SAM. Each of the blocks becomes an account of the SAM, listed in exactly one row and exactly one column. The content of the cell belonging to column A and row B then denotes the money flow from A to B. In our example, the SAM corresponding to Figure 5.1 is depicted in Table 5.1. We see that all money inflows into the product markets, for instance, are contained in the first row, and all money outflows from the product markets in the first column of the matrix.

A Social Accounting Matrix is primarily useful to describe nominal flows and

From / To	Product Markets	Income Distribution	Use of Income	Financial Sector	Rest of the World
Product Markets			Consumption and Investment		Exports
Income Distribution	Value Added				
Use of Income		Disposable Incomes		Loans	
Financial Sector			Savings		
Rest of the World	Imports				

Table 5.1: A Simple Social Accounting Matrix

flow equilibria. A Social Accounting Matrix must be balanced, that is, the sum of each row must equal to the sum of the corresponding column, meaning that inflows into each account must equal the outflows (definition of a flow equilibrium). We will revisit this assumption in Section 5.3, but first let us discuss the SAM structure in some more detail.

The tiny SAM of Figure 5.1 and Table 5.1 is useful as a first introduction to the concept, but too simplified to be of much use in practice. For example, the treatment of intermediate inputs in it is entirely absent. Let us now consider a more realistic SAM structure that closely corresponds to the one that we will be using in this thesis. Since the transition between flow chart format and table format is straightforward, we only reproduce it as a flow chart, this being in our opinion the more intuitive format.

The flow diagram of the more detailed SAM is pictured in Figure 5.2. Here, each arrow represents an array (a bundle) of time-dependent flows, and each rectangle represents a group of accounts in the SAM. As the traditional SAM is a flow-equilibrium system, total inflows into each account must equal total outflows, thus nothing accumulates in any of the rectangles. Let us walk through the SAM to understand how it fits together. Let us begin with the Use of Income group of

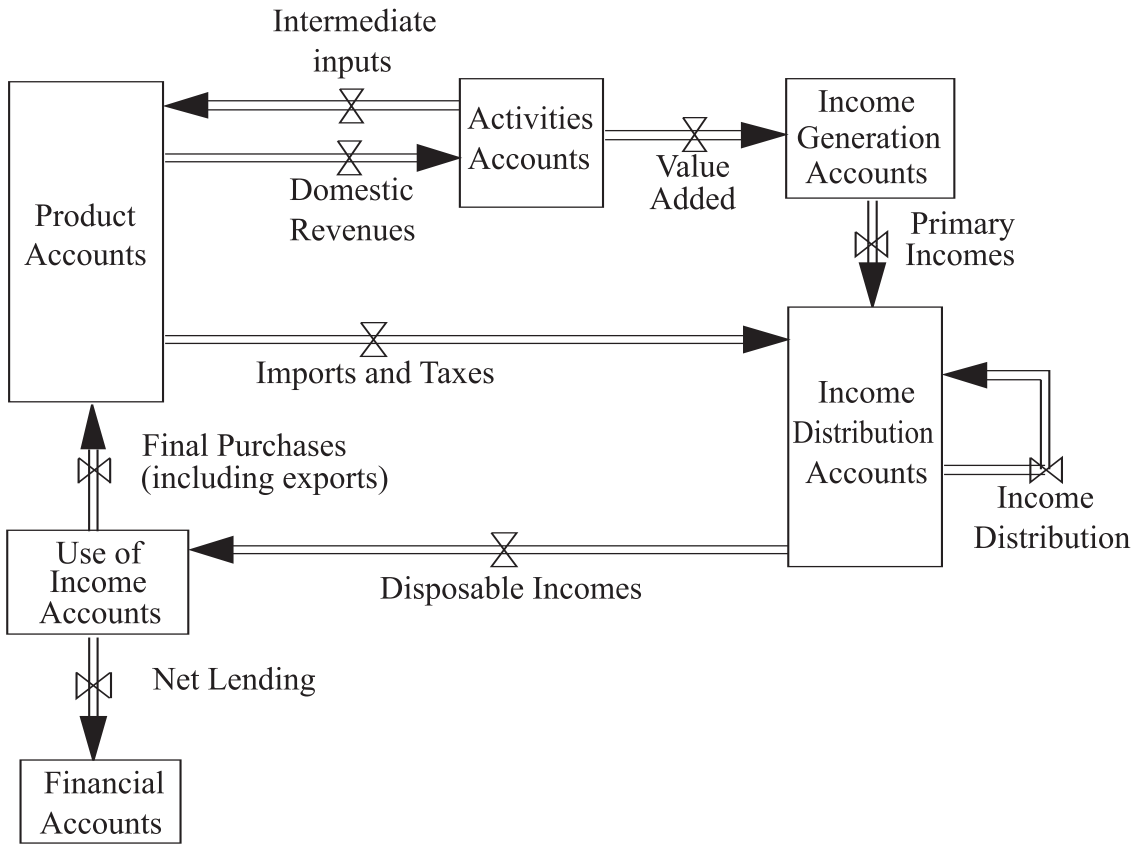


Figure 5.2: A more realistic SAM

accounts. It has a sub-account for each of the "institutions" in the model. The distinct institutions we consider here are the private sector, the commercial banks, the central bank, the government, and the rest of the world (foreigners). Each of these has a disposable income inflow and an outflow of nominal purchases (the latter being zero for both banks). If the purchases of an institution do not equal its disposable income, the difference must be made up by net lending. Flow equilibrium requires that the sum of all institutions' net lending flows must equal zero.

Next in the loop, the "Nominal Purchases" group of flows represents the product demand of each of the institutions for products of each of the six product types distinguished in the model[1]. All inflows of money into the product markets have their place here. For example, the product demand of the "Rest of the World" institution for the different products describes exports, and the demand of the private sector is equal to consumption plus investment demand. Finally, the demand emanating from the government use of income account is just that, government demand; and the commercial banks and the central bank do not purchase any products (a stylization common in models).

All the money entering each of the six product accounts is split between taxes and producer revenues. The latter are divided between imports and revenues of domestic firms. The taxes and import revenues go to the "Income Distribution" group of accounts (to the sub-accounts of government and of the Rest of the World, respectively), while the revenues of domestic firms (comprising both domestic and export sales) go to the "Activities" group of accounts. From these revenues, intermediate input costs are subtracted (and go back into the product markets), while the rest of the money, that is the value added by each sector, goes to the "Income Generation" group of accounts. The "Income generation" group of accounts converts the value added by sectors into value added that accrues to different factors of production,

[1]Food crops, cocoa, mining, manufacturing, government services and other services. This particular choice of products and corresponding productive sectors is justified in Chapter 7.

that is, different labor types (male/female, formal/informal, and urban/rural) and firm profits. The "Primary Private Incomes" group of flows converts income by labor type into income by institution, giving all labor income to households and all profit income to firms.

We thus come to the "Income Distribution" group of accounts, with a sub-account for each institution (this time splitting the private sector into firms and households). As we described above, its two inflow groups are "Primary Private Incomes" giving the incomes of firms and households, and "Imports and Taxes" giving the incomes of government and of foreigners. These incomes are redistributed between the sub-accounts of the different institution with the "Income distribution" group of flows. This group of flows describes property incomes (such as interest payments) and transfer payments (such as aid grants to the government from the rest of the world, transfers from the government to households, and private transfers from abroad). The resulting total incomes are the disposable incomes of each institution, going from their "Income Distribution" accounts into their "Use of Income" accounts.

We have now completed the circulation of money loop that corresponds to Figure 5.1. The two major changes from Figure 5.1, apart from increased detail, are demand for intermediate inputs and the disappearance of the side loop of Figure 5.1 that went to the Rest of the World. The reason for this is as follows: The intermediate input demand has been omitted from our first discussion of the SAM concept only to simplify presentation; and the Exports/Imports side loop has now been integrated into the main circular flow, merely a change of notation.

5.2 Real Product Flows

Our discussion of the circular flow of money in the previous section must have left the reader (especially one with any exposure to Ecological Economics ideas) wondering: “But what about the real product flows that are the basis for much of the nominal flows you discuss”. Our answer is that an accounting system for real flows naturally fits with the nominal flow accounting above.

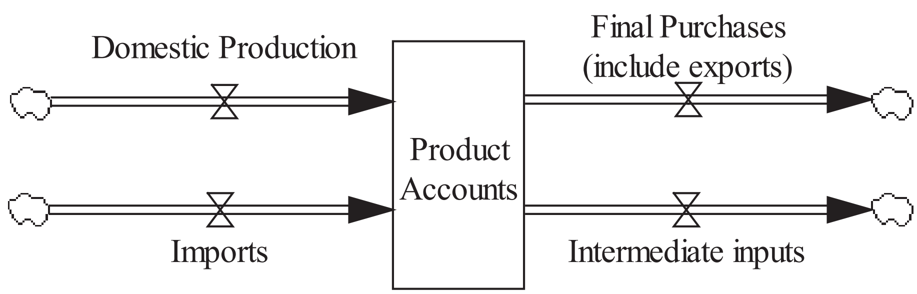


Figure 5.3: Real Product Flows

Figure 5.3 shows the flow chart of that accounting system. Note that this flow chart is essentially identical to a part of Figure 5.2 involving the Product and Activities account groups, except that the arrows point the other way because goods flow in the opposite direction to money being paid for them. The real and nominal product flows can be converted one into another by means of the appropriate price indices.

The next thing that an ecological economist could object to here is that the product flows appear to go from a void and end in another void, contrary to conservation of matter. Our response to that is that “real product flows” still refer to the *value* of the products (measured in constant, that is, inflation-adjusted, prices) rather than to the material content thereof, and value does indeed continually get created in the process of production and destroyed in the process of consumption (unlike money, that tends to circulate in closed loops).

As Daly Daly [1996a, p.28] remarks, there is probably a fairly close connection between the flow of value in real terms and the corresponding material flows (especially in an economy that is as close to subsistence level as Ghana); thus the real product flows could be used to estimate material throughput. However, we do not do this here as it would take us beyond the scope of an already ambitious program. This is not meant to imply that material throughtput is irrelevant to economic analysis; but in our case, just compiling and analyzing data on money flows and corresponding product flows is enough of a challenge in itself.

We do use the real material flows accounting to compute intermediate input requirements, using the Leontief approach (Chapter 7).

This almost completes our introduction into the SAM accounting technique. One last issue to discuss is the relationship of the equilibrium assumption to the SAM methodology. As we have discussed above, a "proper" SAM must "balance", that is, the sum of each row must equal the sum of the corresponding column. Translated to the flow chart representation, this means the total inflows into each account must equal total outflows, which in turn means there can be no accumulation of stocks anywhere. This abstraction can perhaps be justified if one works with only one time slice, as e.g. the CGE's do, though even there stocks have been introduced in various ad hoc ways. The assumption of flow equilibrium, however, is entirely untenable if one wants to consider a series of SAMs for several years, as we do. Each of the institutions we consider will typically have a deficit or a surplus (government deficit, current account deficit, etc.) that will over time determine the behavior of important stocks such as the foreign debt or the money supply.

The question thus arises of how best to integrate stocks with the SAM formalism. We are certainly not the first to attempt that. In fact, the Social Accounting Matrix methodology has itself been adapted to describe stocks and stock-flow relationships. However, as the description of that technique in Taylor [1990] illustrates, the resulting SAMs become large and unwieldy very quickly. We will take another approach, namely combining an almost-unchanged SAM with a different entity called the Financial Accounting Matrix. We introduce and discuss the latter in the following section, and leave the details of its integration with the SAM to the following chapters[2]

5.3 Financial Accounting Matrix

The purpose of the Financial Accounting Matrix is keeping track of financial stocks in an economy, that is, of total liabilities of different agents in an economy toward one another. In the same way that a flow of money always goes *from* an agent *to* another agent, a financial asset is a liability of one agent to another. Thus, in the same way that a Social Accounting Matrix (SAM) is a systematic listing of monetary flows in an economy, the Financial Accounting Matrix (FAM) is a systematic listing

[2]Essentially, we throw out the financial sector accounts of the SAM and feed the net lending flows into the FAM instead. However, implementing this fairly intuitive idea turns out to be not quite trivial.

of the financial stocks, in a square table such as Table 5.2. The first instance known to the author of arranging financial stocks for use in a model in the form of a FAM, rather than a series of double-entry balance sheets, is Easterly [1990].

In the FAM, assets of agents are arranged in rows, and liabilities in columns. Thus for example, the intersection of "Commercial Bank Liabilities" and "Household Assets" is an asset of households and a liability of commercial banks, that is, deposits held by households at the commercial banks.

While the SAM and the FAM thus share some common features, there are also important differences between them. Firstly, the FAM need not fulfill any "balancing" requirement. In fact, the difference between the total assets (row sum) and total liabilities (column sum) of an agent equals the agent's net worth, and can be positive or negative[3].

A second difference between the SAM and the FAM is that while most processes in the SAM such as e.g. private purchases of food) are described by a single entry in the SAM, even "simple" financial transactions typically affect more than one entry in the FAM. For example, a bank loan to the private sector will in the simplest case increase the stock of loans of the private sector to the banks, as well

[3]This is one of the reasons we think the FAM notation is superior to the double-entry balance sheet notation commonly used to describe financial stocks e.g. in CGE models. In the double-entry notation, any financial stock must appear twice, once as somebody's asset and another time as somebody else's liability. Thus there is twice the number of symbols to keep track of (not a negligible problem as there is typically a lot of symbols already), and the requirement "every asset appears twice" generates a handful of additional equations to keep track of – while with a FAM, it's automatically satisfied as a FAM is a single-entry system.

Issuer / **Holder**	Private Sector Liabilities	Commercial Bank Liabilities	Central Bank Liabilities	Government Liabilities	Foreigners' Liabilities
Private Sector Assets		Deposits held by Private Sector, local- and **forex-**denominated	Cash held by Private Sector	Government Bonds held by Private Sector	
Commercial Bank Assets	Loans from Banks to Private Sector, local- and **forex-**denominated		Cash and Required Deposits held by Banks	Government Bonds held by Banks	**Foreign Exchange held by Banks**
Central Bank Assets		Rediscount		Government Bonds held by Central Bank	**Central Bank Foreign Exchange Reserves**
Government Assets			Government Deposits at the Central Bank		
Foreigners' Assets		**Commercial Banks' Foreign Liabilities**	**Central Bank's Foreign Liabilities**	**Government's Foreign Debt**	

Table 5.2: Structure of the Financial Accounting Matrix
Bold type denotes assets denominated in foreign currency

as increase the stock of private sector's deposits by the same amount. This makes the task of disentangling the different causes of changes in financial stocks less than trivial. (We will address that by developing a new formalism called Transaction Matrices, see Chapter 7.)

The position of an asset in the FAM as presented in Table 5.2 does not uniquely define the asset. An important additional characteristic is the denomination of an asset (e.g. domestic or foreign currency); in addition, asset types of the same denomination can have other properties (e.g. time deposits vs. checking deposits) that distinguish them. However, location in the FAM plus denomination exhausts the types of assets commonly differentiated in CGE models. [4]

In principle, any non-diagonal cell of the FAM can be occupied (Diagonal cells' values are irrelevant since they represent "institutions' liabilities towards themselves"). However in practice, in any given model only a small part of these assets will be represented. Thus in Table 5.2, private sector is not allowed to borrow from abroad, and the government does not lend to private sector. The choice of assets to allow in a model should be guided by the realities of the country being modeled.

The FAM structure we present here is, in fact, the one we use for Ghana in this project. The private sector is allowed to hold deposits, cash and government

[4] In more general terms, "denomination" can be used to distinguish between different types of assets that have the same issuer/holder combination, for example demand deposits, savings deposits, and equity all issued by commercial banks and held by the private sector. The FAM is thus not really a matrix but a stack of matrices (or a three-dimensional array), whose thickness is determined by the complexity of a given country's financial sector. However, in the present project we will not need that richness, and "denomination" will only refer to the cedi/forex distinction.

bonds, and borrows from commercial banks. Both loans and deposits can be either denominated in local currency (cedis) or in foreign currency (dollars). Commercial banks borrow cedis from the central bank, accept deposits of either denomination from the private sector, and borrow in dollars from the rest of the world. They hold the resulting assets in form of government bonds(cedi-denominated), forex reserves, cash and cedi deposits at the central banks, and loans to the private sector of either denomination. The central bank issues cash, accepts deposits from and gives loans to commercial banks as just discussed, makes loans to and accepts deposits from the government, both cedi-denominated, and has foreign assets and liabilities, both forex-denominated. As a matter of stylization, we pretend that the government holds all its assets as cash or deposits at the central bank, and that all foreign exchange entering the country as aid or official loans is held at the central bank on the government's behalf. On the other hand, we distinguish between the central bank's foreign liabilities (roughly of the same magnitude as its forex reserves) and the government's foreign debt (a much larger and growing stock).

5.3.1 Monetary Aggregates and Control of Money Supply

Now that the FAM is defined, let us introduce some closely related concepts that will be useful in our analysis in later chapters. The first concept we would like to introduce here is that of a fractional reserve banking system. The fractional reserve banking system derives its name from the reserve requirements imposed on the commercial banks. The primary reserve requirement mandates that the commercial banks will hold a certain fraction of their assets as deposits with the central bank, called required deposits. The secondary reserve requirement mandates that the commercial banks will hold an additional fraction of their assets in form of government bonds.

The other important concepts are the monetary base and the broad money supply. Monetary base is the sum of all liquid claims of non-government agents on the central bank. Reading from the FAM, we see that in our case this means the cash holdings of the private sector plus and cash and central bank deposits held by commercial banks. (In the following, we will also refer to commercial banks as "deposit money banks" or DMBs). The broad money supply is important as a proxy for overall demand in the economy, and the government attempts to control it through control of the monetary base[5], with the reserve requirements providing the link between them.

Broad money is the sum of claims of all non-government agents on the banking system, that is on the central bank or the commercial banks. Again reading from the table, we see that that in our FAM that equals cash and deposits held by the private sector.

This is the view of money supply from the side of the liabilities of the banking system. However, one can also look at it from the side of assets. As banks typically engage in financial transactions more than in current transactions, the gross stock of assets (or liabilities) of the central bank or the commercial banks will typically be much larger than their net worth. Thus, a frequent stylization in applied models

[5]This describes typical monetary policy in developing countries. In developed countries such as the US, the policy is instead to target interest rates and let money supply be demand-determined.

is assuming that the net worth of commercial banks as well as of the central bank is zero. But even if we do not make this assumption, we can still re-cast the definitions of the money supply in terms of banking system assets, as we are about to see.

To make the presentation more compact, let us introduce some notation. Let us refer to the institutions that issue and hold assets by the letters $\{p, b, c, g, w\}$, where p stands for the *p*rivate sector, b for commercial *b*anks, c for the *c*entral bank, g for *g*overnment, and w for the rest of the *w*orld. Further, let us describe the denomination of a stock by l for *l*ocal currency and \$ for foreign exchange. Then we can describe an entry of the FAM as $\Phi_{d\,i_1 i_2}$, where $d \in \{l, \$\}$ and $i_1, i_2 \in \{p, b, c, g, w\}$. In accordance with the matrix notation, the first (row) index refers to the issuer, and the second (column) index to the holder of the financial stock in question. Thus for example, $\Phi_{\$\,pb}$ refers to forex-denominated deposits of the private sector at the commercial banks.

Now we can restate our definitions of monetary base and broad money as

$$MB = \Phi_{l\,pc} + \Phi_{l\,bc} \tag{5.1}$$

$$M = \Phi_{l\,pc} + \Phi_{l\,pb} + \Phi_{\$\,pb} \tag{5.2}$$

Let us define the net worth of the central bank and the commercial banks as the sum of their respective assets net of their respective liabilities. This can be written as

$$\Omega_c = \Phi_{l\,cb} + \Phi_{l\,cg} + \Phi_{\$\,cw} - (\Phi_{l\,pc} + \Phi_{l\,bc} + \Phi_{l\,gc} + \Phi_{\$\,wc}) \tag{5.3}$$

$$\Omega_b = \Phi_{l\,bp} + \Phi_{\$\,bp} + \Phi_{l\,bc} + \Phi_{l\,bg} + \Phi_{\$\,bw} - (\Phi_{l\,pb} + \Phi_{\$\,pb} + \Phi_{l\,cb} + \Phi_{\$\,wb}) \tag{5.4}$$

Assets		Liabilities	
Net CB Claims on Government	$\Phi_{l\,cg} - \Phi_{l\,gc}$	Private Cash Holdings	$\Phi_{l\,pc}$
Net Central Bank Forex Reserves	$\Phi_{\$\,cw} - \Phi_{\$\,wc}$	DMB Cash Holdings and Deposits	$\Phi_{l\,bc}$
Loans to DMBs	$\Phi_{l\,cb}$	Net Worth	Ω_c

Table 5.3: Central Bank Balance Sheet

Assets		Liabilities	
Net Claims on Government	$\Phi_{l\,bg} + \Phi_{l\,cg} - \Phi_{l\,gc}$	Private Cash Holdings	$\Phi_{l\,pc}$
Net Forex Reserves	$\Phi_{\$\,cw} + \Phi_{\$\,bw} - \Phi_{\$\,wc} - \Phi_{\$\,wb}$	Private Deposits	$\Phi_{l\,pb} + \Phi_{\$\,pb}$
Credit to Private Sector	$\Phi_{l\,bp} + \Phi_{\$\,bp}$	Net Worth	$\Omega_c + \Omega_b$

Table 5.4: Banking System Balance Sheet

By inserting that into (5.1), we get

$$MB = \Phi_{l\,cb} + (\Phi_{l\,cg} - \Phi_{l\,gc}) + (\Phi_{\$\,cw} - \Phi_{\$\,wc}) - \Omega_c \tag{5.5}$$

$$\begin{aligned} M = {} & \Phi_{l\,bp} + \Phi_{\$\,bp} + (\Phi_{l\,bg} + \Phi_{l\,cg} - \Phi_{l\,gc}) \\ & + (\Phi_{\$\,cw} + \Phi_{\$\,bw} - \Phi_{\$\,wc} - \Phi_{\$\,wb}) - \Omega_c - \Omega_b \end{aligned} \tag{5.6}$$

To see the implications of these identities, it may be helpful to restate these identities in terms of balance sheets (Tables 5.3 and 5.4).

Much of the apparent complexity in the topic of money supply comes from the fact that we can consider it either from the asset side of these tables, or from the liability side, and the two totals are identically equal. Thus, money supply is often talked about as "credit" whereas its importance in economics comes mainly from its being a close proxy for private sector's liquid assets, which (besides being important in their own right) are an important determinant of demand.

Also due to the "dual nature" of the money supply, a policy whose goal is to change an item on one side of the banking system balance sheet often works by targeting some item on the other side. This is how that works out: in both tables above, net worth only changes gradually (mainly through interest flows), and the other items on the liability side are generally outside of the banking system's direct control, being an outcome of private sector's decisions to hold a certain amount of cash or deposits. However, as the sum of the right side *always* equal the sum of the left side, central banks attempt to control money supply by influencing the items on the right side. Thus, to control broad money supply, one can limit credit to the private sector e.g. by increasing interest rates, and limit net claims of the banking systems on government by either restricting new government borrowing or trying to get the private sector to buy some of the bonds currently held by the banking system.

The net effect of a fractional reserve banking system is that the broad money supply, which according to Table 5.4 can be regarded as either outstanding loans or as the available liquidity in the economy, is largely determined by market forces rather than by central bank decisions as to how much new cash to bring into circulation. This is more pronounced in economies with deep financial systems such as the USA, where the total value of deposits far exceeds the cash in circulation, and therefore changes in the interest rate (which is the price of credit) of fractions of a percentage point have a measurable effect on the volume of outstanding credit;

the effect is strong enough that developed country macroeconomics often ignore the volume of broad money altogether, focusing on the interest rate instead. In contrast, in developing countries where the total deposits are of the same order of magnitude as cash in circulation, the influence of interest rates on money supply is weaker, and broad money is closer related to monetary base; so that the policy importance of the monetary base is higher in the developing countries.

5.4 Summary

The Social Accounting Matrix formalism is a well-developed accounting framework for tracing nominal money flows within an economy, including its interactions with the rest of the world. It naturally integrates with accounting of real product flows as well. However, standard balancing requirements for a SAM imply a state of flow equilibrium that is an unrealistic abstraction, particularly if one is considering a time series of SAM's. A more realistic approach would allow for some flow disequilibria and thus would require financial stocks to absorb these.

In the present thesis, the financial stocks involved are arranged in the form of a Financial Accounting Matrix (FAM). In this chapter, we introduce and discuss the FAM concept and its relationship to money supply and fractional reserve banking system, and will discuss its integration with the SAM in later chapters.

Chapter 6

The Approach of This Thesis

This chapter reviews the approach that this dissertation takes towards answering the research questions. The subsequent chapters elaborate each of the steps reviewed here.

6.1 Introduction

As we have stated in Chapter 1, this thesis aims to answer three interrelated questions. Firstly, what was the cause of Ghana's poor macroeconomic performance in the 1990s, manifested in balance of payments problems, high inflation, and low GDP growth (compared to the second half of the 1980s)? Secondly, what were the distributive impacts of economic policies, specifically structural adjustment policies, during the 1990s? Finally, does the behavior of the Ghanaian economy during the 1990s confirm common assumptions of developing country models of either structuralist or neoclassical school?

In the discussion of the literature on models of developing countries in Chapter 4, we have seen that within the most used methodology for such models, Computable General Equilibrium (CGE) models, there are two opposed schools. The neoclassical school emphasizes relative price-driven allocation adjustments under permanent full employment, along with price levels determined by money supply. The structuralist school emphasizes quantity adjustments in output (and therefore variable employment of both labor and capital) and cost-driven prices. We have seen that the question of which of these theories is more realistic is an empirical one, and furthermore that it cannot be answered from within the CGE methodology, because the latter only uses data for one year in model calibration, and always uses more parameters than data points, and thus is incapable of falsification.

We have thus concluded that to decide between alternative hypotheses about the economy's behavior, we need to consider data time series rather than just data for one year. Furthermore, to cleanly handle the many variables needed to describe macro-sectoral interactions, we need an explicit, clean accounting framework. This framework should relate to each other both the different flows in any one year and the stock-flow relationships that hold over time. We found that the SAM formalism used in CGE's is good at the former (flow tracking) but not the latter (stock-flow relationships). This observation is the starting point of the method we use.

The research is segmented into distinct incremental steps, as described below.

6.2 Stock-Flow Consistent Accounting, Social Accounting Matrices and SAM/FAM Time Series

We use time series (mostly from the International Monetary Fund Ghana country desk reports) for sectoral output (real as well as nominal), balance of payments statistics, government accounts, and financial stock data to compile a complete description of money and product flows in the Ghanaian economy in each year from 1990 until 2001 (a Social Accounting Matrix time series) and an account of the financial stocks during the same period that is consistent with the nominal flows. To our knowledge, this is the first time that formal, complete and consistent flow of funds accounts have been compiled for a developing country for such an extended period of time.

We use the Financial Accounting Matrix to store the financial stocks; from the FAM we can compute the (revaluation-corrected) change in net worth of each agent, which equals net lending flows of each agent. This provides a link to the SAM. This way of estimating net lending flows is particularly valuable as normally net savings in the SAM are estimated as a residual and are thus very error-prone.

The compilation of the dataset is discussed in detail in Chapter 7.

6.3 Examination of the Behavior of Key Variables

Once the flow of funds for 1990-2001 dataset is compiled, we can proceed to investigate it for answers to our original question, namely the causal relationships that determined the behavior of the Ghanaian economy during the time period.

We do this by considering key behavioral variables such as the share of imports in domestic absorption or the price level, and see whether they can be explained using common assumptions such as those discussed in Chapter 4. As the time series for the real variables are still rather too short to make formal statistical significance testing reliable, we use the data from 1990 until 1997 to calibrate the equations, and then use the data from 1998 until 2001 for validation, by looking on how the equation fitted to the earlier period performs during the latter. If an equation passes this test well, we have a reason to expect that if we calibrate it to the whole time period, it will also perform well in the future and in counterfactual simulations. The details of this process are narrated in Chapter 9.

In contrast to the real-side variables that are available only yearly, for the nominal variables such as the exchange rate, the Consumer Price Index and the money supply, we have the luxury of monthly series for all of our period (even though financial stock coverage is somewhat shaky in the first couple of years). This allows us to investigate their interrelationships using rigorous econometric techniques (to be precise, ARIMA-X). The technical details of the process are presented in Chapter 11.

These chapters are the central part of the dissertation, in that the careful testing of alternative behavioral assumptions (such as whether a given sector is price- or quantity-clearing, or whether inflation is mainly driven by money supply or by cost factors) will allow us to evaluate both the models and the non-model research on the issue. If a given story about the economy's behavior depends on a behavior that is not present in the data, such a story can be discounted.

6.4 Methodological Contributions Towards a Model

This dissertation does not include building a model of the Ghanaian economy. The reason for that is that a CGE model would not tell us anything we did not know before building it, and a rigorously estimated dynamic model is beyond the scope of this already expansive project.

However, we do formulate two methodological suggestions, one major and one minor, that would be useful for building such a dynamic model.

The major suggestion is a formalism for describing financial stock behavior, useful for the following reason: While computing the changes in net worth as discussed in Section 6.2 allows us to make the SAM and the FAM *consistent*, it does not yet allow us to represent how a different vector of net lending (say, less government deficit) would impact the different financial stocks. To do that, we need an efficient way to represent financial transactions, which is not a trivial task as any financial transaction (such as deposit creation) affects several accounts in the FAM.

Our way of dealing with this is in our view this thesis' main contribution to economic modeling methodology, a technique we decide to call the Transaction Matrix (TM) formalism. The idea behind it is to formulate a "vocabulary" of financial transactions possible in a given economy; some linear algebra then allows us to easily decompose a given change in the FAM into the different transactions that caused it, and conversely to write out the implications of a given transaction for all stocks in the SAM. This massively simplifies the representation of financial sector behavior, as the TM formalism automatically takes care of the accounting restrictions that until now have made the modeling of the financial sector so tedious, and leaves the modeler free to specify behavior.

The Transaction Matrix formalism and the resulting simple decomposition of FAM dynamics are presented in Chapter 8.

The minor contribution is a bit of somewhat tricky accounting needed in an open economy model that combines demand-driven and supply-constrained sectors. It is presented in Chapter 10.

6.5 In-depth Discussion of Implications for Theory and Policy

While the Chapters 9 and 11 inspect many important aspects of the Ghanaian economy's behavior, they do not provide an overall picture of the interactions between the different parts, and thus are not by themselves useful for evaluating existing policies and making policy suggestions.

Therefore, Chapters 12 and 13 provide an extensive discussion of the results. Chapter 12 pulls all the disparate threads into an overall understanding of the Ghanaian economy's structure and behavior and uses that understanding to answer the last research question, namely the extent to which the Ghanaian economy can be said to conform to either neoclassical or structuralist theories of how a developing economy behaves.

Chapter 13 builds on that understanding to address the other two research questions, namely the reasons for the worsening macroeconomic performance of the 1990s and the distributional impacts thereof. It also contrasts the intended vs. the likely consequences of each component of the structural adjustment policy package in Ghana, and provides some recommendations in the cases where current policies are found to be deficient.

6.6 Discussion

This section's purpose is to answer two questions that are likely to occur to the reader at this point, namely the extent to which we address environmental constraints on GDP and the novelty of the proposed method.

How does this approach address environmental constraints on GDP growth? The main feature of our approach is its closeness to the available data. As the scope of the project is already quite ambitious, we cannot include any kind of ecosystem data into the project due to both poor data availability and additional work involved. The question then transforms into "what kind of environmental constraints on GDP growth can we hope to see in the data that we explore?". The main way in which such constraints are likely to translate into economic data is by forcing the sector in question to be supply-constrained rather than demand-driven. The way to distinguish between these two modes from the data is to look at how price behaves with respect to supply. If an increase in price goes together with an *increase* in supply, we probably have to do with a demand-driven sector; if an increase in supply is typically associated with a *decrease* in price, we probably are dealing with a supply-constrained sector.

Let us go through the productive sectors and see in which of these is there a possibility that environmental constraints were binding during the 1990s[1]. Firstly, services, both governmental and private, are not likely to have been constrained by environmental factors, as service provision relies mainly on labor and comparatively small amounts of capital (mostly imported in the Ghanaian case). Likewise, manufacturing relies mainly on labor and imported capital, and also on intermediate inputs. Thus manufacturing will only be constrained by environmental factors if the latter constrain provision of intermediate inputs, i.e. if the extractive indus-

[1]Our focus on behavior observed in the data will allow us to understand the Ghanaian economy in the 1990s. However, its conclusions need to be enjoyed with caution, as constraints that were not binding in the past can well become so in the future. Jumping ahead, in Chapter 9 we will see that agriculture has hit a supply constraint in about year 1995. It is not unlikely that forestry or mining might also hit resource constraints in the future even if they have not yet; but prediction of such events is beyond the scope of the present effort.

tries are environmentally-constrained. Thus our first candidate for environmental constraints are extractive industries, which in Ghana means forestry and mining.

Finally, the environmental constraints are quite likely to be felt in agriculture. While population has grown, the share of population in agriculture has remained virtually constant, and the area of arable land has, if anything, diminished due to the encroachment of the savannah from the south of the country.

We will test these hypotheses in Chapter 9.

What will this approach contribute to economic theory or methodology? We envision three major contributions to modeling methodology in this thesis. Firstly, it is to our best knowledge the first time that a complete, consistent flow of funds time series dataset at this level of disaggregation has been compiled for a developing country. In spite of all the data limitations we have discussed, demonstrating that compiling such a dataset extending for over a decade is possible for a country like Ghana is in itself a non-negligible contribution. A Social Accounting Matrix is useful because it provides a complete snapshot (at a certain disaggregation level) of an economy's structure in a given year; SAM/FAM time series augment that with a representation of how this structure has evolved over time and how the economy has reacted to past disturbances.

This will lead directly to the second contribution, namely empirical verification of common CGE assumptions that were incapable of verification within the CGE methodology itself. Questions such as: "Does non-traded production lie on a productivity frontier, implying a tradeoff between nontraded production and exports, or is nontraded production determined by demand? Does money supply determine the price level, or vice versa?" can now be addressed empirically, within a complete, consistent dataset.

While these first two contributions are based mainly on combining existing techniques in a somewhat novel way, the last one, namely the Transaction Matrix formalism, is to the best of our knowledge entirely novel. This formalism cleanly separates the structure of the financial sector ("What transactions are allowed? What assets are the different agents allowed to hold? What are the accounting identities we wish to impose?") from the description of agent behavior. The way this is achieved is that in a given model, the choice of a particular transaction matrix "vocabulary" lays down the structural constraints, and enforces them automatically, whatever behavioral decisions the individual agents may make.

6.7 Summary

This thesis proceeds in several steps. Firstly, we compile a complete (at a given level of aggregation), consistent dataset of financial stocks, nominal money flows, and real product flows for Ghana in 1990-2001. Then, we investigate key time series from that dataset to arrive at individual behavioral equations as well as a qualitative understanding of the economy's behavior. Then, we make some methodological suggestions that would be useful in building a dynamic model based on the insights gained. Finally, we discuss the implications of our findings for both theory and policy.

The major contributions of this thesis to theory and methodology are compilation of a consistent SAM/FAM time series for the period 1990-2001, use of that dataset to empirically verify assumptions of CGE models that up to now had to be specified a priori, and suggesting a compact formalism for describing financial stock behavior that cleanly separates structural constraints from behavioral descriptions.

Chapter 7

Compilation of a SAM/FAM Time Series 1990-2001

In this chapter, we describe the compilation of a stock-flow consistent dataset covering twelve years. The major data sources are IMF Ghana country desk reports and International Financial Statistics time series data.

7.1 Data Sources

To compile the SAM/FAM time series, we use five major groups of data, namely prices, financial stocks, balance of payments, fiscal data, and sectoral production data, listed in Table 7.1. All data were received as XLS files, with the exception of the data in IMF country reports, which had to be entered into XLS tables by hand.

Note that the order in which they are listed here roughly reflects their reliability. Firstly, prices such as food prices, interest rates, or the exchange rate, can be easily observed by anyone, and are available on a monthly basis. While errors are possible in computing aggregate indices such as the GDP deflator, we still rank price data as the most reliable.

Second, financial stocks, such as government debt or the assets and liabilities of the central bank, are continuously kept track of by the financial entities involved, and are available on a monthly basis as “exact measurements”.

Third, balance of payments data are estimated rather than directly measured, but because they are reasonably well observable (all exports and imports must cross the border at one of a small number of points) and because of the importance of foreign exchange to a small, open economy like Ghana, they are fairly reliable[1].

Fourth, government transactions are spread over many ministries and agencies and are only assembled into an overall picture after the fact, and thus although "directly observed" by the government, still are less reliable than the previous three.

Finally, sectoral production data include estimates on many not readily observable activities, and are likely to be tainted by underreporting and estimation errors, and are thus least reliable of all.

The reader might be wondering why we list data for individual sectors when the overall GDP decomposition by sector in real as well as nominal terms is available from both the World Bank and the IMF. The reason is that both of these are based on the same real-side GDP disaggregation from the Ghana Statistical Service, and this GDP disaggregation appears upon closer examination somewhat suspect, as discussed in Section 7.1.

[1]At least, this is likely to be true during the period in question, as the liberal trade policies provided little incentive for smuggling. The picture was quite different during the late seventies to early eighties, when hugely overvalued exchange rates led to massive smuggling of cocoa [Aryeetey and Harrigan 2000].

Data Series	**Time Period**	**Freq.**	**Source**	**Comment**
Prices				
CPI Decomposition	1982-2003	M	BoG XLS file	
Interest rates	(1990/91)-2003	M	IFS	
Interest rates	*1994-2003*	*M*	*BoG*	
Exchange rate	1970-2003	M	BoG	
Wholesale crop prices	1970-2001	M	Ministry of Agriculture	
Financial Stocks				
Central Bank and Commercial Bank Balance Sheets	1990-2003	M	IFS	Do not show denomination of deposits and loans
Central Bank and Commercial Bank Balance Sheets	12.1991-2003	Q	BoG	Show denomination of deposits and loans
Government Domestic Debt by Holder	1990-1998	Y	BoG	

Government Domestic Debt by Holder	1999-2003	M	BoG	
Government Foreign Debt	1990-2003	Y	BoG	
Balance of Payments				
Export volume and price by export type	1989-2002	Y	IMF country reports	
Imports oil/non-oil volume and price	1989-2002	Y	IMF country reports	
BoP Services and transfers	1989-2002	Y	IMF country reports	
Fiscal Accounts				
Fiscal Accounts	1989-2001	Y	IMF XLS file from BoG	
National Accounts				
Sectoral GDP disaggregation	*1989-2001*	*Y*	*WDI 2002*	
Sectoral GDP disaggregation	*1989-2001*	*Y*	*IMF country reports*	

Real Private Investment	1989-2001	Y	IMF XLS file from BoG	
Cocoa Bean Production	1990-2001	Y	IMF country reports	Volume and nominal value
Operations of the Cocoa Board	1990-2001	Y	IMF country reports	
Principal food crops	1990-2001	Y	IMF country reports	Volume and nominal value
Fish catch	1989-2001	Y	IMF country reports	Volume and nominal value
Logs and Timber	1990-2001	Y	IMF country reports	Volume
Minerals	1990-2001	Y	IMF country reports	Volume and nominal value
Manufacturing	1990-2001	Y	IMF country reports	Volume index
Electricity	1988-2001	Y	IMF country reports	Volume
Social Accounting Matrix				
Social Accounting Matrix for 1993	1993		Powell and Round [2000]	Low labor type disaggregation
Social Accounting Matrix for 1993	1993		Powell et al. [1997]	Unpublished

Table 7.1: Data Sources. The italicized sources have not been used in compiling our dataset.

Problems and Probable Errors in the Data

Splicing together of different tables into a coherent framework forces one to know each of the tables fairly intimately, and thus makes it easier to notice inconsistencies, strange behavior, and likely errors in them.

The table with the highest density of apparent errors is the national accounts table. Firstly, upon plotting the shares of different sectors in GDP in real terms (Figure 7.1) one notices that they are strangely constant from 1993 to 2001. This is quite unlikely given that all macro variables, such as current account deficit and government spending, vary greatly during the period. Nor are the subsectoral data from this table compatible with the raw data on the same subsectors from the IMF country reports (Figure 7.2 shows the corresponding series for manufacturing). Therefore we have to conclude that the official sectoral GDP decomposition was probably obtained from an educated guess on overall GDP growth rate by prorating according to 1993 shares of subsectors, 1993 being the date of the last major estimation effort for national accounts.

The problems with national account data do not stop there. Firstly, government demand as GDP component is taken to be equal to government current expenditure from the fiscal accounts. This is incorrect because firstly, a large part of government current expenditure (for example, interest payments on government debt) is not part of government demand in the national accounts sense; and secondly, a part of government capital expenditure belongs into government demand as well.

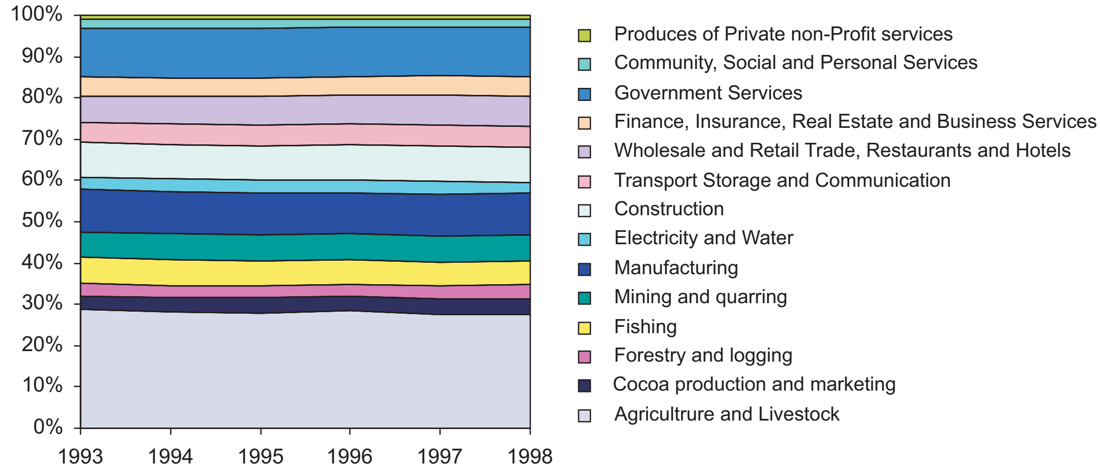


Figure 7.1: Shares of Subsectors in Value Added

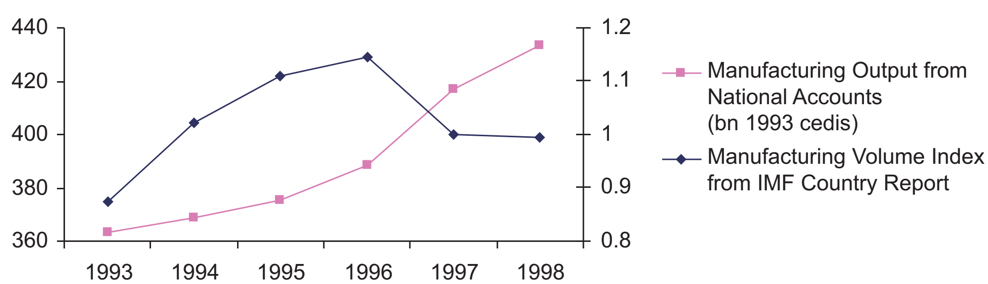


Figure 7.2: Manufacturing output discrepancy

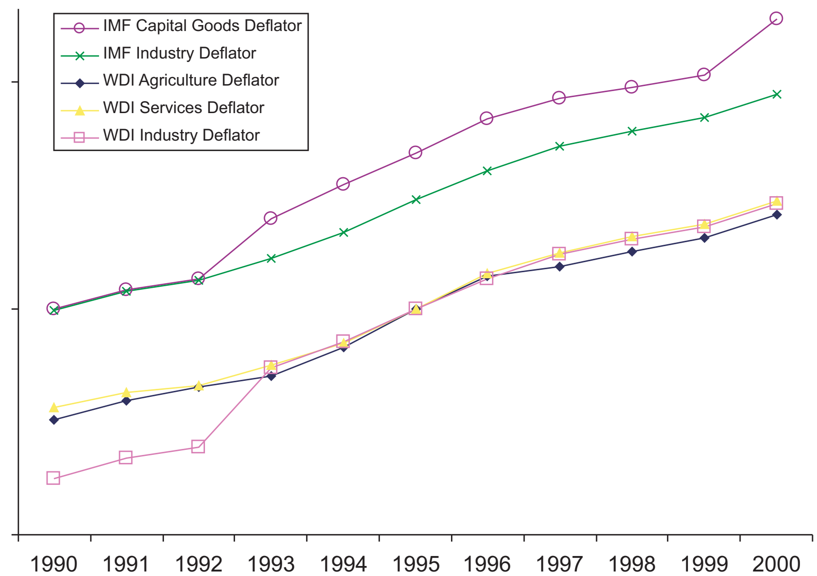


Figure 7.3: Sectoral Deflators (Source: World Development Indicators 2002; International Monetary Fund)

Another, more subtle error has to do with sectoral deflators. In 1993, as national accounts were comprehensively re-estimated, the deflator for industry was changed by about a factor of two (Figure 7.3). For pre-1993 data to be comparable to post-1993 data, the former would have to be adjusted to account for that change of deflator. For sectoral output, that was done by the IMF but not by the World Bank so that the latter's nominal industry output series display a jump in 1993. Unfortunately, while the IMF adjusted its pre-1993 deflators for sectoral data, apparently it did not do so for investment (Figure 7.3).

The failure to correct the deflator then skews the nominal-investment-to-nominal-GDP ratio upwards; Figure 7.4 shows the ratios of real investment to real GDP and of nominal investment to nominal GDP, the investment and GDP series

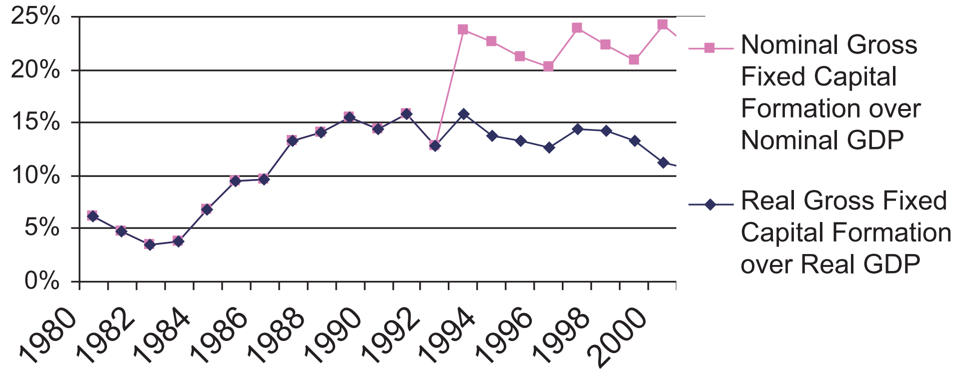


Figure 7.4: Investment to GDP ratios computed from nominal resp. real time series (source: International Monetary Fund).

taken directly from IMF data. We see that if we use the nominal values and just compare 1990 values to 2000 values, then the share of investment in GDP *increases* from 1990 to 2000; however, if we use real values of the same variables to build the ratio, investment as share of GDP *decreases* over the same period - a difference of considerable policy relevance.

The IMF-originated spreadsheets we have used come from Bank of Ghana rather than from an official IMF source. However, comparison to official IMF documents confirms the phenomenon. Thus, the investment-to-GDP ratio in 1996 is 13.8% when computed from the Statistical Annex to the 1998 IMF Ghana country report; the same ratio equals 23% when computed from the Statistical Annex to the 2000 report. The series in 2000 Annex start with year 1993, so the effect we describe is not visible from any one Annex alone. In an IMF Occasional Paper on Ghana [Leite et al. 2000, Table 3.4] the investment to GDP ratios are given for years 1975, 1985, 1993, and 1998, and equal 12%, 9.5%, 22%, and 25%, respectively; these numbers are discussed in the text as "[...] Investment in structures and equipment appears to be increasing steadily". Thus the confusion we discuss here appears to be alive and well.

As a result of all these problems with available aggregate data, we decided to re-compile sectoral output and national account tables using raw sector-level data and a Leontief assumption for intermediate inputs with the coefficients derived from the 1993 Ghana SAM. The following section describes how this was done and combined with the other data to form complete SAM/FAM time series for 1990-2001.

7.2 Sectoral Structure

To reconstruct national accounts from the original sub-sectoral data, we have to decide on the level of sectoral aggregation that we want to use. Aggregating too much can hide important details of sub-sectoral behavior, but disaggregating too much can make the resulting framework unduly complex, as well as produce a misleading illusion of precision if the chosen disaggregation level is not supported by available data.

The standard sectoral disaggregation for Ghana used in the 1993 SAM as well as in the compilation of sub-sectoral data is reproduced in Table 7.2. Unfortunately, the sub-sectoral data available from the IMF country reports does not allow to re-compile the accounts at that disaggregation. As Table 7.1 shows, "raw" sub-sectoral on both volume and price is only available for Agriculture and Livestock, Cocoa Production and Marketing,Fishing, and Mining and Quarrying. Further, volume data (but not producer price data) is available for Forestry and Logging,

Agriculture	**Industry**	**Services**
Agriculture and Livestock	Mining and Quarrying	Transport Storage and Communication
Cocoa Production and Marketing	Manufacturing	Wholesale and Retail Trade, Restaurants and Hotels
Forestry and Logging	Electricity and Water	Finance, Insurance, Real Estate and Business Services
Fishing	Construction	Government Services
		Community, Social and Personal Services
		Producers of Private Non-Profit Services

Table 7.2: The Sectoral Disaggregation of Ghana National Accounts

Manufacturing, and Electricity. No “raw” volume time series is available in the IMF Country Reports on any other subsector; however, one can use government fiscal data to estimate government services.

Based on this, we have decided to use the stylized sectoral aggregation portrayed in Table 7.3. There are two sub-sectors each in primary, secondary, and tertiary sectors. Agriculture is divided into cocoa production and food production for domestic use, consisting of food crops and fishing. For all of these, both volume and producer price index time series are available from IMF Country Reports IMF [2003, 1998]. We separate cocoa out because it is the leading agricultural export, and aggregating it with the rest would not allow us to investigate e.g. elasticities of transformation between cocoa and domestic food production.

The remaining primary sub-sector, forestry, is in our framework grouped with industry, for the following reasons: Firstly, it is in the Ghanaian case a non-sustainable extraction industry; second, it uses wage labor and comparatively high amounts of fixed capital and is not in the short-term constrained by the weather or other agricultural productivity factors. In all these, it is similar to mining or manufacturing, and different from food crop or cocoa production, which in Ghana is mostly done by small landowners with very primitive technology (and thus minimal fixed capital). As it makes sense to aggregate sub-sectors of similar structure and behavior, we thus group it into the “Other Industry” sector, together with electricity and manufacturing. Another similarity of these three sub-sectors is that only volume time series are available, but no prices. We rescale these volume time series to 1993 constant currency using the sub-sector values from the 1993 Ghana SAM.

Sectors	Nontraded Production	Exports	Imports	Total Production Volume Series	Nontraded Producer Price Deflator
Food Production	Yes	No	Yes		
Food Crops				IMFCR	IMFCR
Fishing				IMFCR	IMFCR
Cocoa	Yes	Yes	No	IMFCR	IMFCR
Mining	No	Yes	No	IMFCR	IMFCR
Other Industry	Yes	Yes	Yes		CPI[Industry]
Manufacturing				IMFCR	
Electricity				IMFCR	
Forestry and Logging				IMFCR	
Construction				See text	
Government Services	Yes	No	No	See text	CPI
Non-Government Services	Yes	Yes	Yes	See text	CPI[Services]

Table 7.3: The Sectoral Grouping Used in This Thesis

Finally, as no data is available on the construction sector, it is proxied by taking the 1993 value from the 1993 SAM and assuming it to be proportional to the total of the other three industry sub-sectors through time. By adding these four (respectively, adding the first three and rescaling to account for construction), we obtain the volume series for "Other Industry". As the producer price deflator we take the CPI component describing industrial prices, rescaled to average value of 1 in 1993. The reason it is titled "Other Industry" is because it does not include mining.

Mining is separated from the rest of the secondary sector because of its unique position in Ghana. Namely, most of mining is foreign-owned, and produces almost exclusively for export. The high share of foreign ownership implies that the mining sector investment is not constrained by domestic factors such as credit availability. Finally, according to the 1993 SAM, the operating surplus in mining is 49%, as opposed to average 31% in the rest of the secondary sector. Finally, as export statistics are more readily available than statistics on nontraded goods, there is both price and volume data on mining. All these features set the mining sector apart from the rest of the secondary sector.

Finally, in the tertiary sector we distinguish between government and non-government services. Government services nominal value is taken to equal the sum of government wages and salaries and government current expenditure on goods and services. In our stylized account, we pretend that the government is the sole entity that pays for government services (and provides them to everybody for free). We use the CPI (rescaled to average value 1 for 1993) as the deflator for government services (it being one of the few price indices we have), and from that can define the volume of government services as the ratio between nominal value and the deflator.

Finally, we have non-government services. For these, no data is available in the IMF reports[2], not the least because a large part of these is provided by the informal sector, and is largely untaxed and unmeasured. The informal sector functions as a residual reservoir of labor exhibiting underemployment, and is thus likely to be demand-driven. Having no data on non-traded services, we formulate a hypothesis in Section 7.4. However we need to remember that while there is real data on the other sectors, non-traded non-government services are basically a placeholder: the values are in the right ball park, but we cannot base any conclusions about the structure of the Ghanaian economy on the time behavior of our non-traded non-government services.

Fortunately, the data situation on traded goods and services is somewhat better than on non-traded ones. On the export side, IMF country reports contain price and volume time series for over a dozen of goods exports sub-categories, as well as separately for services. On the import side, there are separate price and volume series for services, non-oil goods, and oil. Unfortunately, there is no distinction between food and manufacturing imports, so we have to assume the share of each of these two is constant and equals the share in the 1993 SAM, and that they both have the non-oil goods imports deflator.

Table 7.4 summarizes the sources for the export and import components.

[2]Except for commercial bank income/expenditure tables. But as the financial system in Ghana is extremely thin, these are a small share of the total.

Sectors	Export Volume	Export Producer Price	Import Volume	Import Price Deflator
Food Production	N/A	N/A	Pro-rated from non-oil imports	Non-oil import deflator
Cocoa	IMFCR	IMFCR	N/A	N/A
Mining	IMFCR	IMFCR	N/A	N/A
Other Industry	IMFCR	IMFCR	Pro-rated from non-oil imports	Non-oil import deflator
Non-Government Services	IMFCR	IMFCR	IMFCR	IMFCR
Oil	N/A	N/A	IMFCR	IMFCR

Table 7.4: Imports/Exports By Sector

7.3 Overall Accounting Framework

In a standard CGE manner, we use a Social Accounting Matrix to handle the nominal flows associated with production, consumption and distribution. For all accounts except the Use of Income accounts, the usual adding-up restrictions are imposed. This means that outflows into other SAM accounts must always equal inflows from other SAM accounts, and thus there is no accumulation of money in any of the accounts. The exception is the Use of Income accounts of the different institutions. These accept the disposable incomes as inflows, and from them the demand outflows are taken, with the residual being the net lending of the particular institution. These net lending flows, rather than go to another part of the SAM, leave the SAM and are cumulated inside the Financial Accounting Matrix (FAM), which stores the financial assets/liabilities of the individual institutions toward each other. All capital transactions (i.e. transactions that involve no change in net financial wealth), such as portfolio reallocation by households or issue of government bonds, then take place through changing the entries of the FAM.

7.4 Structure of the Social Accounting Matrix

To compile a Social Accounting Matrix time series, we combine national accounts, balance of payments, and government accounts data with the Social Accounting Matrix for 1993 compiled by the Ghana Statistical Service. We track product flows in nominal as well as in real terms. Table 7.7 shows the structure of the SAM.

To make the presentation more compact, we use vector notation. Thus, the

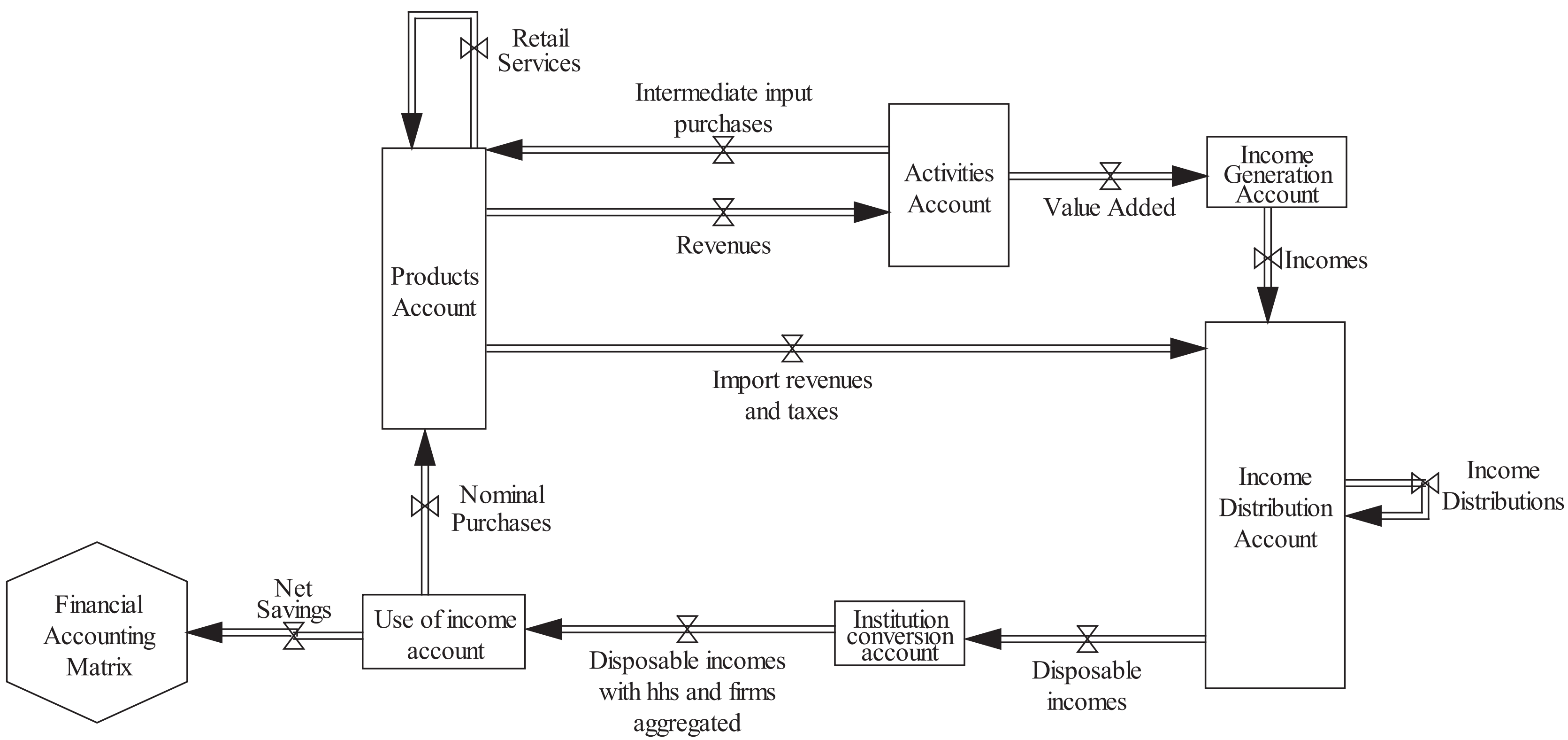


Figure 7.5: Our Overall Accounting Framework as a Flow Chart

index s goes over the set of sectors that we denote as

$$\{food, cocoa, industry, mining, govt, services\}$$

. The index f goes over the different factors of production, in our case consisting of operating surplus and all eight combinations of male/female, skilled/unskilled, and employee/mixed income. The index ι goes over institutions with firms and households separated, that is, *h*ouseholds, *f*irms, commercial *b*anks, *c*entral bank, *g*overnment and the rest of the *w*orld, denoted as

$$\iota \in \{h, f, b, c, g, w\}.$$

Finally, i refers to institutions with firms and households combined into a "*p*rivate sector", that is

$$i \in \{p, b, c, g, w\}.$$

The reason for using the two different indices is that while in the SAM it is both possible and useful to distinguish between firms and households, the data for the FAM does not allow such a distinction, as we will see in the section discussing the FAM.

Having defined the indices, we can now use matrix notation to populate the SAM. For example, the intermediate input demand of sector s_1 for products of sector s_2 can now be denoted as $II_{s_1 s_2}$ in nominal terms and $ii_{s_1 s_2}$ in real terms (1993 cedis). This is another notation we use throughout this document: lowercase names refer to real or volume terms (1993 prices), and the corresponding uppercase names refer to the corresponding quantities in current prices.

	Products s	Activities s	Use of Income i
	$ret_{s_1 s_2}$		
Products s		$ii_{s_1 s_2} = ii^{nt}_{s_1 s_2} + ii^{ex}_{s_1 s_2}$	a_{is}
Activities s	$diag(rev_s)$		
Income Generation		$y_s = y^{ex}_s + y^{nt}_s$	
Income Distribution	$im_s = im^{nonoil}_s + g^{oil}_s$		

Table 7.5: The real production flows

One final remark on notation: in a matrix of flows (such as the intermediate inputs matrix defined above) we use the first index to refer to the *source* of the flows and the second index to refer to the *destination* of the flow (traditionally these are referred to as sources and *uses* of funds). This appears to us to be the most natural notation; however one has to be aware that if one writes these matrices out consistently with the SAM convention (columns denote sources, rows denote uses), then the first index refers to *columns*, not rows as usual in matrices.

Having introduced the requisite notation, we are ready to discuss how the SAM fits together. First, consider the product markets in volume terms, detailed in Table 7.5. As we discussed in Section 7.2 we have data on constant prices revenue of each productive sector except non-traded non-government services, as well as constant-price exports and imports of each sector.

Now we define the nontraded revenue in services to be proportional to the sum of all other revenues, with the factor of proportionality derived from the 1993 SAM. Now we can denote rev_s the total real revenue of domestic activities, by ex_s the

Need X Units of / For One Unit of	Cocoa	Food	Mining	Other Industry	Nongov. Services	Gov. Services
Cocoa		.029		.083	.119	
Other Agric.		.140		.043	.053	
Mining				.254	.053	
Other Industry		.040		.332	.044	
Nongov. Services				.249	.223	
Gov. Services				.038	.229	

Table 7.6: The Leontief Matrix

exported part thereof, and by nt_s the non-traded part thereof, we can determine nt_s as

$$nt_s = rev_s - ex_s \tag{7.1}$$

We then assume, as is common in models, that all activities use Leontief technology, This determines intermediate input demand for export industries and nontraded industries, respectively:

$$ii^{ex}_{s_1 s_2} = l_{s_1 s_2} ex_{s_1} + \begin{cases} ii^{cocoa} & \text{for} \quad s_1 = industry \text{ and } s_2 = cocoa \\ 0 & \text{otherwise} \end{cases} \tag{7.2}$$

$$ii^{nt}_{s_1 s_2} = \begin{cases} l_{s_1 s_2} ex_{s_1} & \text{for} \quad s_1 \neq government \\ ii^{gov} \cdot \frac{l_{s_1 s_2}}{\sum_s l_{s_1,s}} & \text{for} \quad s_1 = government \end{cases} \tag{7.3}$$

Here $l_{s_1 s_2}$ is the Leontief matrix computed from the 1993 SAM (Table 7.6). ii^{cocoa} refers to the part of cocoa crop that was not exported raw, but processed prior to export and thus classified as industrial exports. While processed cocoa products are thus integrated into industrial exports, their share in industrial exports is not constant, and so cannot be represented through the Leontief technology. Likewise, the share of goods and services vs. wages in the provision of government services is not fixed but determined by the government, and this is accounted for in (7.3). Now that we know revenues and intermediate input cost, we can define the two real GDP components:

$$
\begin{aligned}
y_s^{ex} &= ex_s - \sum_{s_2} ii_{ss_2}^{ex} && (7.4)\\
y_s^{nt} &= nt_s - \sum_{s_2} ii_{ss_2}^{nt} && (7.5)
\end{aligned}
$$

We take real private investment demand i_s directly from the IMF country report. All oil imports are done by the government-owned Tema Oil Refinery, here integrated with the government. Thus we denote the oil import vector (with only one nonzero component, equaling real oil imports) g_s^{oil}. The rest of government expenditure g_s^{nonoil} consists of two components, government services and government capital expenditure. Both of these are known in nominal terms from the fiscal accounts; we deflate the former by the CPI and the latter by the industry price index (both price indices are discussed in the Nominal SAM). Now we can decompose imports into oil and non-oil,

$$im_s^{total} = im_s^{nonoil} + g_s^{oil}.$$

In all that follows, the superscript im will refer to non-oil imports. Now that we have determined all the in- and outflows of the product markets, we can determine private consumption as a residual:

$$c_s = rev_s + im_s^{nonoil} - g_s^{nonoil} - i_s - ex_s - \sum_{s_1} ii_{ss_1} \tag{7.6}$$

Now that all demand pieces are defined, we group them into the overall demand matrix

$$a_{is} = \begin{cases} c_s + i_s & \text{for} \quad i = p \\ g_s^{oil} + g_s^{nonoil} & \text{for} \quad i = g \\ ex_s & \text{for} \quad i = w \\ 0 & \text{for} \quad i = c \quad \text{or} \quad i = b \end{cases} \tag{7.7}$$

From / **To**	Prod.	Act. s	Inc. Gen. f	Inc. Distr. ι	Use of Income i
Products s	$Ret_{s_1 s_2}$	$II_{s_1 s_2}$			A_{is}
Activities s	$Rev_{s_1 s_2}$				
Income Generation(f)		Y_{af}			
Income Distribution ι	$IMT_{s\iota}$		$Y_{f\iota}$	$ID_{\iota_1 \iota_2}$	
Use of Income i				$Y_{\iota i}$	
Capital accounts i					$diag(S_i)$

Table 7.7: Overall Social Accounting Matrix Structure

Now that all real flows are determined, let us proceed to the SAM in nominal terms. First, let us introduce the different prices: The producer prices of nontraded goods, imports, and exports are denoted by P_s^{nt}, P_s^{im} and P_s^{ex}, respectively. The market wholesale prices are then equal to $P_s^{nt}(1+t_s^{nt})$, $P_s^{im}(1+t_s^{im})$ and $P_s^{ex}(1+t_s^{ex})$, respectively. Finally, we assume that imports and nontraded goods actually sold carry a retail service margin, so that the market retail prices $\tilde{P}_s^{nt}$, $\tilde{P}_s^{im}$ equal

$$\tilde{P}_s^{nt} = P_s^{nt}(1 + t_s^{nt}) + \sigma_s P_{service}^{nt}(1 + t_{service}^{nt}) \tag{7.8}$$

$$\tilde{P}_s^{im} = P_s^{im}(1+t_s^{im}) + \sigma_s P_{service}^{nt}(1+t_{service}^{nt}) \tag{7.9}$$

For lack of better information, we assume the share of imports is the same across intermediate imports and final demand. We can then define the retail absorption deflator as

$$\tilde{P}_s^{abs} = \frac{\tilde{P}_s^{im} im_s + \tilde{P}_s^{nt} nt_s}{im_s + nt_s}. \tag{7.10}$$

Then the nominal counterparts of the real flows we have discussed can be computed straightforwardly as

$$I_s = \tilde{P}_s^{abs} i_s \tag{7.11}$$

$$C_s = \tilde{P}_s^{abs} c_s \tag{7.12}$$

$$G_s^{nonoil} = P_s^{abs} g_s^{nonoil} \tag{7.13}$$

$$II_{s_1 s_2} = \; = P_{s_2}^{abs} ii_{s_1 s_2} \tag{7.14}$$

$$\tag{7.15}$$

The remaining nominal inflows into the product markets are retail services and exports, valued at their respective market prices

$$EX_s = P_s^{ex}(1+t_s^{ex})ex \tag{7.16}$$

$$Ret_{s_1 s_2} = P_{service}^{nt}(1+t_{service}^{nt}) ret_{s_1 s_2} \tag{7.17}$$

The outflows, on the other side, are valued at producer prices,

$$IM_s = P_s^{im} im^{nonoil} + P_s^{oil} g_s^{oil} \tag{7.18}$$

$$Rev_s = P_s^{nt} nt_s + P_s^{ex} ex_s \tag{7.19}$$

with the rest going to taxes

$$T_s = P_s^{nt} t_s^{nt} nt_s + P_s^{ex} t_s^{ex} ex_s + P_s^{im} t_s^{im} im_s \tag{7.20}$$

Since both taxes and import revenues go from the product account to the income distribution account, we group them into a matrix

$$IMT_{s\iota} = \begin{cases} IM_s & \text{for} \quad \iota = w \\ T_s & \text{for} \quad \iota = g \\ 0 & \text{otherwise} \end{cases} \tag{7.21}$$

Likewise, we group the final demand flows into a matrix

$$A_{is} = \begin{cases} C_s + I_s & \text{for} \quad i = p \\ G_s^{oil} + G_s^{nonoil} & \text{for} \quad i = g \\ EX_s & \text{for} \quad i = w \\ 0 & \text{for} \quad i = c \quad \text{or} \quad i = b \end{cases} \tag{7.22}$$

Knowing the revenues and the intermediate input costs for both nontraded and export goods allows us to define value added (minus taxes) as

$$VA_s^{ex} = P_s^{ex} ex_s - \sum_{s_2} II_{ss_2}^{ex} \tag{7.23}$$

$$VA_s^{nt} = P_s^{nt} nt + s - \sum_{s_2} II_{ss_2}^{nt} \tag{7.24}$$

$$VA_s = VA_s^{ex} + VA_s^{nt} \tag{7.25}$$

This value added is distributed across factors of production according to sector-specific fixed shares F_{sf} derived from the 1993 SAM (Table 7.8):

$$VA_{sf} = F_{sf} VA_s \tag{7.26}$$

	Cocoa	Food Crops	Mining	Other Industry	Non-Government Services	Government Services
Comp. of Employees Skilled Male	12%	2%	14%	7%	15%	34%
Comp. of Employees Unskilled Male	35%	8%	27%	6%	13%	18%
Comp. of Employees Skilled Female	2%	0%	0%	1%	2%	16%
Comp. of Employees Unskilled Female	6%	1%	2%	1%	4%	11%
Mixed Income (Gross) Skilled Male	5%	14%	1%	20%	11%	0%
Mixed Income (Gross) Unskilled Male	24%	57%	6%	20%	10%	0%
Mixed Income (Gross) Skilled Female	0%	0%	1%	1%	4%	0%
Mixed Income (Gross) Unskilled Female	9%	17%	1%	10%	27%	0%
Operating Surplus (Gross)	7%	0%	49%	31%	14%	20%
Indirect Taxes on production	0%	0%	0%	1%	0%	0%

Table 7.8: Factor Shares in Value Added

We can then define the total income flow to a factor of production as

$$Y_f = \sum_s VA_{sf} \tag{7.27}$$

This income is then distributed to institutions as

$$Y_{f\iota} = \dots \tag{7.28}$$

Inside the Income Distribution account, there is a number of flows:

$$ID_{\iota_1\iota_2} = \dots \tag{7.29}$$

From $Y_{f\iota}$ and $ID_{\iota_1\iota_2}$ arises the disposable income of each institution,

$$Y_\iota^D = \sum_f Y_{f\iota} + \sum_{\iota_1} ID_{\iota_1\iota} - \sum_{\iota_2} ID_{\iota\iota_2}. \tag{7.30}$$

As this disposable income vector comes from accounts ι that separate firms and households, and goes to accounts i that count them together as the private sector,nd after summing up households' and firms' income into "private", the disposable income flows are a matrix $Y_{\iota i}$ that sums up the firm and household disposable income into private sector disposable income, and sends all the other institutions' disposable incomes to these institutions. Now we can finally define the net lending flow vector

$$S_i = \sum_\iota Y_{\iota i}^D - \sum_s A_{is}, \tag{7.31}$$

closing the loop.

7.5 Financial Accounting Matrix

We have introduced Financial Accounting Matrix (FAM) in Chapter 5 as a way to present the liabilities of various institutions towards one another. The FAM only contains assets that are by their nature some other institution's liabilities, such as deposits, cash or government bonds. Table 7.9 is the complete listing of FAM entries in our dataset. As we have discussed in Chapter 5, we denote the entries of the FAM by $\Phi_{d\,i_1 i_2}$, where $d \in \{l, \$\}$ is the denomination, local or foreign exchange (the latter assumed to be dollars), and $i_1, i_2 \in \{p, b, c, g, w\}$ where p stands for the $p$rivate sector, b for commercial $b$anks, c for the $c$entral bank, g for $g$overnment, and w for the rest of the $w$orld. The first index refers to the issuer, and the second to the holder of the liability stock in question. Thus for example, $\Phi_{\$\,pb}$ refers to forex-denominated deposits of the private sector at the commercial banks. The reader might note that Table 7.9 contains two additional entries, namely $\Phi_{l\,gp}$ and $\Phi_{l\,gb}$ that describe loans to government-owned enterprises (the latter are by convention classified as part of the private sector, together with all other firms), and government deposits at commercial banks. While these are stocks that appear in the data, we will stylize them away for use in the model (see Chapter 8), because the composition of the government's domestic asset portfolio is not at the center of the present research. The stylization will also illustrate the use of the Transaction Matrix technique we develop for efficiently working with FAM time series.

7.5.1 FAM Time Series Compilation

The FAM time series are compiled from two major sources: firstly, balance sheets of the commercial banks and the central bank, and secondly, data on government debt stocks. Let us discuss the specifics of each in turn.

The assets and liabilities of the central bank and of the commercial banks

Issuer / **Holder**	Private Sector Liabilities	Commercial Bank Liabilities	Central Bank Liabilities	Government Liabilities	Foreigners' Liabilities
Private Sector Assets		Deposits held by Private Sector, local- and **forex-**denominated	Cash held by Private Sector	Government Bonds held by Private Sector	
Commercial Bank Assets	Loans from Banks to Private Sector, local- and **forex-** denominated		Cash and Required Deposits held by Banks	Government Bonds held by Banks	**Foreign Exchange held by Banks**
Central Bank Assets		Rediscount		Government Bonds held by Central Bank	**Central Bank Foreign Exchange Reserves**
Government Assets	*Loans to and equity in state-owned enterprises*	*Government Deposits at Commercial Banks*	Government Deposits at the Central Bank		
Foreigners' Assets		**Commercial Banks' Foreign Liabilities**	**Central Bank's Foreign Liabilities**	**Government's Foreign Debt**	

Table 7.9: Structure of the Financial Accounting Matrix
Bold type denotes assets denominated in foreign currency

are among the standard financial statistics, and are collected on a monthly basis. We could find three different datasets with that information, each with its set of flaws. Two were obtained as spreadsheets directly from the Bank of Ghana, and one is an excerpt from the International Financial Statistics available online from the International Monetary Fund. While the datasets were roughly consistent with each other, the actual numbers in the IFS and Bank of Ghana datasets were not identical.

The first of the Bank of Ghana datasets was monthly and quite finely disaggregated, but only started in 1996, continuing through to the present. This is the dataset that is used by the Bank of Ghana itself. The second Bank of Ghana dataset is quarterly, and starts in December 1991. Finally, the IFS dataset is monthly and goes all the way back into the 1980s, but is less disaggregated than the others, and in particular does not show denomination of deposits and loans. As the data on denomination is necessary to distinguish between nominal increases due to savings and due to capital gains, this is not a negligible flaw.

It would have been nice to use the dataset that the Bank of Ghana (BoG) itself uses, as it is closest to the original data and most disaggregated. However, its insufficient time coverage led us to choose the IFS dataset. It would perhaps have been optimal to somehow splice the two together, using BoG data where available and IFS data otherwise, but the effort required to do that cleanly would be outside of the scope of the present project.

Once we have decided to use the IFS dataset, we have to reconstruct the partition of deposits and loans into local currency- and forex-denominated. We do this by computing the respective shares of the different denominations from the quarterly BoG dataset, and applying those shares to the IFS totals.

This procedure has two potential problems. First of all, the quarterly dataset does not cover the first two years of our period. However, this turns out not to be a problem as these years were the beginning of a transition period, when forex-denominated loans and deposits were just beginning to be introduced. Thus, as Figure 7.6 shows, in the early 1990s the share of forex-denominated stocks in the to-

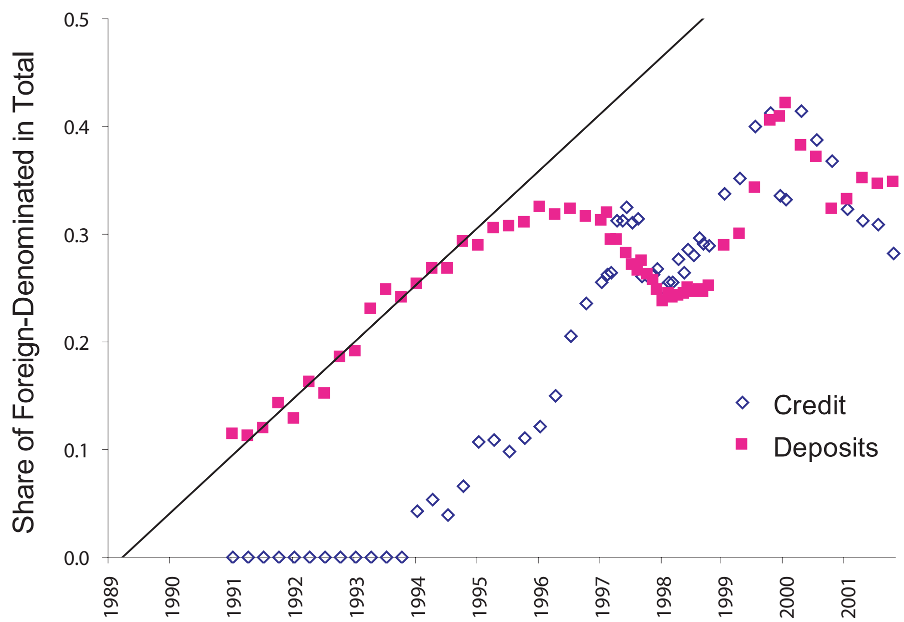


Figure 7.6: Share of foreign-denominated loans and deposits in the respective total

tal was actually zero for loans, and was growing pretty linearly for deposits, allowing a credible extrapolation back to January 1990.

The second problem is of a statistical nature, namely that since the local- and forex- denominated stocks have been produced by pro-rating from a total, their residuals will probably be correlated, leading to spurious relationships if one does not formulate one's regressions carefully. This is not by itself tragic, but something to bear in mind for when we investigate the data.

The other time series necessary to compile the FAM are the government's debt stocks. These are unfortunately only available yearly until 1999, and monthly afterwards for domestic debt, and only yearly for foreign debt. Thus if we want to infer monthly time series from these, some interpolation scheme is called for. The simplest would be piecewise constant or piecewise linear interpolation, but as we are going to differentiate the series (to determine net savings, portfolio adjustment, etc.), this would have generated spurious discontinuities. Therefore, we use matlab to interpolate the yearly data using piecewise cubic functions, giving us piecewise quadratic derivatives.

A final piece of data that is missing in the SAM is the amount of forex held by the private sector in cash form (as opposed to deposits at banks). Anecdotal evidence suggests that is not negligible, but unlike for domestic cash, we do not see a way of estimating this, and thus assume it to be zero. Therefore, net worth estimates are likely to somewhat underestimate the net worth of the private sector and somewhat overestimate the current account deficit. A possible alternative approach to estimating that would be that the ratio of forex cash to domestic cash held by the public is equal to the ratio of forex-denominated deposits to local currency-denominated deposits, as both are outcomes of portfolio optimization by different population groups. However, transaction demand is likely to play a higher role for cash than for deposits, so that estimate would likely err in the opposite direction from ours; and ours (no forex cash held by the private sector) is easier to construct.

7.5.2 Net lending flows implied by the FAM

Since the FAM gives us information on all financial stocks in the economy, we can use it to find the changes in net worth, and thus the net lending, of each institution. As most savings of the poorer households are in the form of goods rather than financial assets, that would be an under-estimate of total savings. However, it would still be useful as it is financial savings that make resources available for new loans; and adequately accounting for non-financial savings would be a separate project in itself.

The changes in net worth of any institution are due to two sources: flows of new net lending and revaluation of old asset stocks. In our case, the latter refers to valuation changes of forex-denominated stocks due to changes in the exchange rate. We need to correct for these before we can isolate the effect of the new savings flows. This is done as follows.

Let e be the exchange rate, cedis to the dollar (available on a monthly basis). Let's define the depreciation rate of the cedi as

$$\hat{e}(t) = ln(e(t)) - ln(e(t-1)) \tag{7.32}$$

Then the change in Φ due to revaluation equals

$$(\Delta\Phi_{\$\, i_1 i_2})_{from\ revaluation} = \hat{e}\Phi_{\$\, i_1 i_2} \tag{7.33}$$

$$(\Delta\Phi_{l\, i_1 i_2})_{from\ revaluation} = 0 \tag{7.34}$$

(for derivation of (7.33), see Section 8.1.) Thus we can define the change in Φ net of revaluation as

$$D\Phi(t) = [\Phi(t) - \Phi(t-1)] - (\Delta\Phi)_{from\ revaluation} \tag{7.35}$$

and then the total change in net worth net of revaluation equals

$$S_i(t) = \sum_{d,i_1} D\Phi_{d\,ii_1}(t) - \sum_{d,i_1} D\Phi_{d\,i_1 i}(t) \tag{7.36}$$

which is nothing else but the net lending flow S_i that connects the SAM to the FAM.

7.6 Reconciliation

As we are working with fairly low-level data in a tight accounting framework, it is unavoidable that even after weeding out obvious errors in the data, such as those discussed above, the results will not "add up". Typically, any given table, such as a balance of payments or government accounts, is already forced to add up by those compiling it. However, when one aims to bring the different tables together into a watertight SAM/FAM framework, the different estimates for the same quantity (e.g. government deficit from the fiscal accounts vs. overall change in government liabilities in the financial stocks) typically do not match. The question then arises of how to reconcile different estimates of the same quantity.

We opt for using a hierarchical framework. This works as follows.

If there are two different estimates for a quantity, the hierarchical approach to reconciliation works by choosing the estimate from the more reliable data group, and if necessary adjusting the other group to match.

In most cases, reconciliation can be done by simply choosing the less reliable term as the residual. For example, nontraded food production is computed as the difference between total production of the industrial sector from sectoral statistics and industry exports from balance of payments data. However, there is one important case where one has to actually adjust the different datasets to match each other, and that is reconciliation of the net lending flows between the FAM and the SAM. This is discussed in the following section.

SAM/FAM reconciliation In this section, we describe our solution of the following problem: The SAM is determined from balance of payments, fiscal, and sectoral production accounts, in particular determining the net lending flows from each institution into the FAM. On the other hand, from the FAM itself we get an alternate estimate of the same quantity as described in Section 7.5.2 .

According to our hierarchical approach, the FAM estimate takes precedence over the SAM estimate, but there is no obvious residual to absorb the discrepancy. We solve that by adjusting the SAM data as follows. We have five institutions in the net lending vector, to wit, nonbank private sector, commercial banks, central bank, government, and the rest of the world. Note that as the SAM accounting is watertight (and thus money doesn't accumulate in the SAM) the sum of the five net lending flows must be identically zero (a version of the law of Walras).

We adjust the net lending of commercial banks by distributing the discrepancy to the private sector (with the assumed vehicle being either interest income on deposits or profit distribution to owners); the net lending of the central bank are assumed to accrue to the government - a common practice in applied models, according to which the net worth of the central bank can only change through revaluation. This leaves the private sector, the government, and the rest of the world. Due to the law of Walras, it is sufficient to reconciliate two of these and the third will automatically fall into line.

We thus complete the FAM/SAM reconciliation by spreading out the discrepancy in government deficit proportionally over all fiscal accounts, both revenue and expenditure, and likewise spreading the discrepancy in current account deficit proportionally across imports, private current transfers, and non-interest income debits, as the least easily observable components. The percentage to which they had to be rescaled for each of the years in the dataset is shown in Figure 7.7.

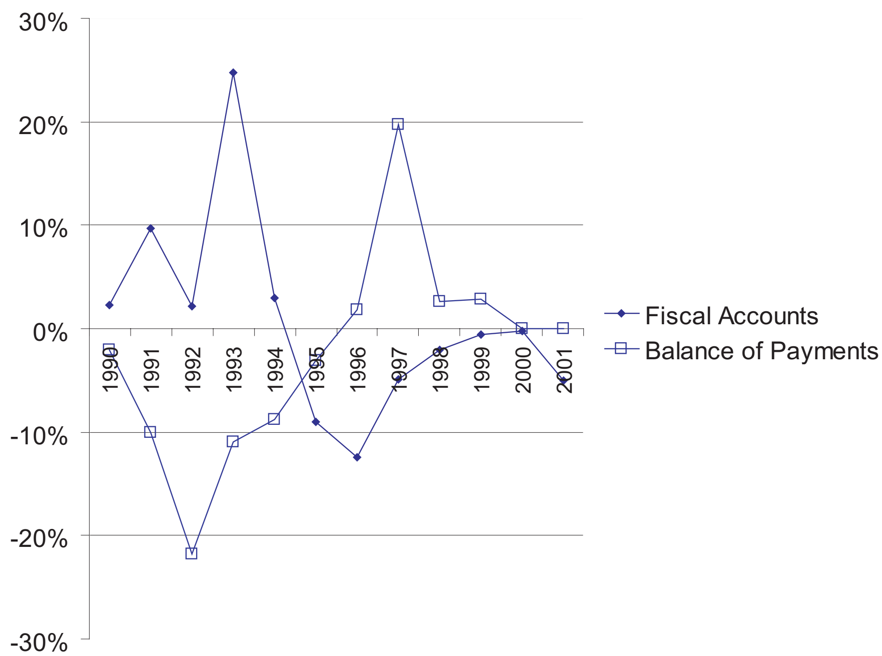


Figure 7.7: Relative Adjustments During FAM/SAM Reconciliation

The last type of data adjustment we undertake is a smoothing of early jumps. As there were major overhauls of reporting systems in 1991-1993, many data definitions have changed then, which caused jumps in some data series. To somewhat alleviate that effect, when a series that was fairly stable post-1993 had apparently spurious discontinuities pre-1993, these were smoothed out in a way that preserved post-1993 values.

7.7 Discussion

7.7.1 Are Different Levels of Household Aggregation in Different Parts of the Framework Defensible?

One issue certainly needing discussion is whether a model that aggregates all households together with firms for the handling of financial stocks can have any claim on credible representation of distributional issues. We would like to argue that this is indeed the case.

Firstly, including financial stocks at all has to be an improvement on ignoring them, especially if one is interested in modeling macro policies and variables such as inflation. Second, a better disaggregation of financial stocks is simply not allowed by the data - the only way to get e.g. more disaggregated deposit data would be to make it up, introducing hidden assumptions. The way we do it, the difference in aggregation is out in the clear, easy for others to evaluate.

Finally, the main impact of more disaggregated financial stock data on the rest of the model would be through the influence of the wealth of different household groups on their consumption demand. However, we would like to argue that the consumption patterns of different household groups are not different enough for that effect to matter much. We support this claim by examining the results of Powell and Round [2000] who built a multiplier model based on the Ghana 1993 SAM (with a substantial disaggregation of factors of production and household types) and subjected it to unit income injections into various accounts (namely cocoa, mining, construction, and education and health). While direct impacts on the incomes of the different household groups clearly depended greatly on the specific place where the income injection happened, the indirect effects (i.e. the effects working through the income-consumption demand loop) only depended in magnitude on the total on-impact income that accrued to all households (Figure 7.8), and their pattern was virtually constant across all four injections (Figure 7.9). From this we conclude

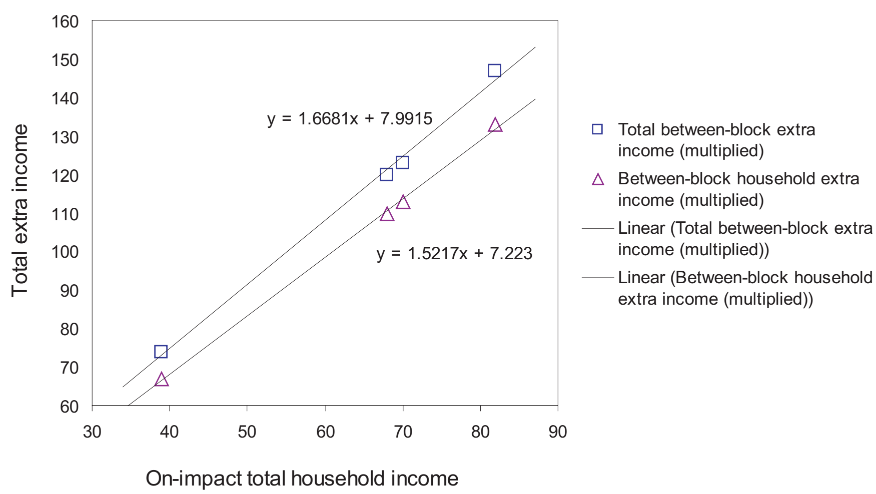


Figure 7.8: Total Multiplier Effect as Function of Total On-Impact Household Income

that the effects working through the income-expenditure loop are largely macro phenomena. Therefore, keeping this part of the model fairly aggregated does not taint the results of the more disaggregated sectoral/factor of production part of the model.

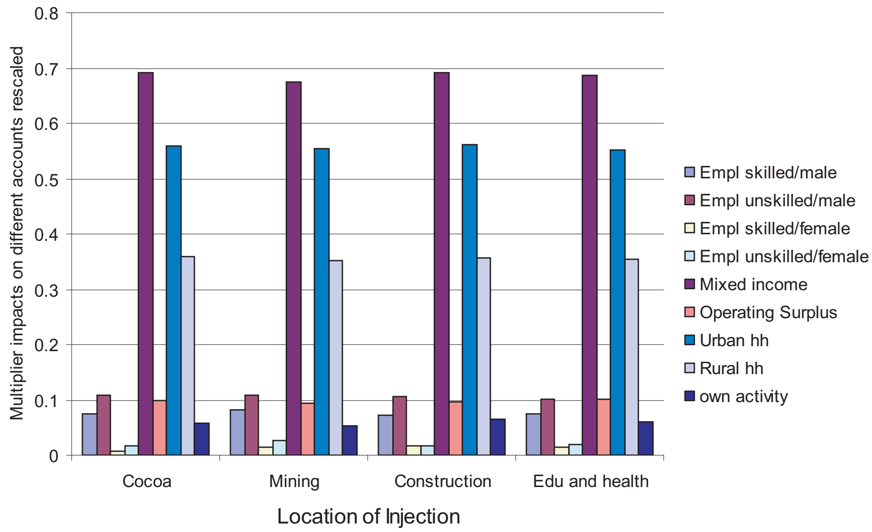


Figure 7.9: The Patterns of Multiplier Income For Different Injections

7.8 Summary

The challenges in compiling a complete flow of funds time series for Ghana for the 1990s are typical of a developing country. While much data is available, it is widely scattered and occasionally gravely deficient. In our case, the official Ghana Statistical Service estimates of real GDP time series by sector are very probably not trustworthy.

However, it is possible to compile what we think is a reasonably credible stock-flow consistent yearly SAM/FAM time series for 1990-2001 (including real product flows) using a combination of sectoral level output and price data, balance of payments, fiscal and financial stock time series. To reconcile the different estimates, we adopt a hierarchical approach, with financial stock data being considered more reliable than balance of payments data, which in turn takes precedence over fiscal and sectoral output data.

First, using sectoral, balance of payments, and fiscal time series together with the Social Accounting Matrix available for 1993, we construct reasonably credible time series of medium-disaggregation Social Accounting Matrices for the period in question. Then, combining financial stock data available from the IMF and data obtained directly from Bank of Ghana, we compile a yearly series of FAMs and derive the net lending flows implied by these FAM time series. The SAM time series is then adjusted to be consistent with these net lending flows.

Most of the financial time series are actually available on a monthly basis. While that does not fit the overall accounting framework, the additional data points will be useful in investigating behavior through time series econometric techniques.

Chapter 8

Decomposing the FAM dynamics

How does the Financial Accounting Matrix Φ evolve over time? There are three basic sources for changes in the financial stocks held by the agents: revaluation, current transactions, and capital transactions. Revaluation refers to the change of the price of the stocks. In our case, if the exchange rate changes, the value of foreign currency-denominated holdings is going to change accordingly (remember we value all financial stocks in domestic currency). Current transactions refer to transactions that change the net worth of participating agents. For example, if the government pays wages to its employees, the net worth of the government decreases and that of the private sector increases. Finally, capital transactions do not change the net worth of participating agents. An example is a household making a deposit at a bank: the household's deposits increase while its cash holdings decrease by the same amount, without changing its net worth; likewise the asset composition of the bank changes (more deposits (liabilities), more cash (assets) and probably more deposits at the central bank (assets)), but its net worth remains unaffected. The changes to the FAM from each of these sources are described differently; let us discuss each in turn.

8.1 Revaluation

Suppose an agent holds an amount V of an asset of denomination d, so that its price in local currency is P^d. Then the value of that asset stock that appears in the SAM equals $V \cdot P^d$. If the price P^d changes, then the change in the asset stock value arising from the change in P^d is

$$\partial_t \left(VP^d \right) = \left(\partial_t P^d \right) V = \frac{\partial_t P^d}{P^d} \left(VP^d \right) = \left(\partial_t ln(P^d) \right) \cdot \left(VP^d \right) = \hat{P}^d \cdot \left(VP^d \right) \quad (8.1)$$

where $\hat{P}^d$ is a shorthand notation for $\partial_t ln(P^d)$.

Applying that to all of the FAM, we get

$$(\partial_t \Phi_{di_1 i_2})_{from\ revaluation} = \hat{P}^d \Phi_{di_1 i_2} \quad (8.2)$$

In our case there are only two denominations, local currency l and foreign exchange \$, so

$$\hat{P}^d = \begin{cases} 0 & \text{for} \quad d = l \\ \hat{e} & \text{for} \quad d = \$ \end{cases} \quad (8.3)$$

where $\hat{e}$ is the depreciation rate of the local currency.

8.2 Current Transactions

The actual current transactions – purchases of products, transfers, taxes, etc. – are carried out in the SAM. What goes into the FAM is the *net* resulting change in each agent's net worth, that is, each agent's lending, which we have earlier denoted by S_i. Note that whenever we say "net worth" in this chapter, we mean "financial net worth", that is we do not count stocks of physical capital towards net worth, and thus all purchases, even of capital goods such as machinery or buildings, count as "current transactions". This is convenient to do because these are also handled in the SAM, so that here we can concentrate exclusively upon financial stock dynamics.

The question now is how to feed them into the FAM, as each agent has multiple different asset stocks that these net lending flows could potentially feed into. The way we choose to tackle this is to have the net lending flows feed into each institution's cash balances, i.e. its stock of central bank-issued local currency-denominated liabilities. All institutions are then assumed to re-balance their portfolios according to whatever portfolio preferences they have. Thus the change to the FAM from current transactions can be written as

$$\partial_t \Phi_{from\ current\ transactions} = \sum_i S_i \cdot [lic]. \tag{8.4}$$

Here $[lic]$ is used to denote a 3-dimensional matrix such that

$$[lic]_{di_1 i_2} = \begin{cases} 1 & \text{for} \quad d = l, i_1 = i, i_2 = c \\ 0 & \text{otherwise} \end{cases} \tag{8.5}$$

Feeding the net lending flows into the cash holdings in this way is justified for two reasons: firstly, a large part of the transactions are indeed cash-based; and secondly, those institutions that enter non-cash transactions are likely to rebalance their portfolio between different assets much faster than the current transactions can happen (financial markets clear a lot faster than real goods do), so it doesn't really matter which of their assets their net savings are hooked up to.

The final question with this scheme is whether it also works for the central bank, as its liabilities towards itself do not change its net worth. But as we mentioned in Chapter 5, since S_i is the only leakage from an otherwise leak-less SAM, we always have

$$\sum_i S_i = 0 \tag{8.6}$$

and thus the change in net worth of the central bank from the other net lending flows (that change the amount of central bank's liabilities held by other institutions) will exactly equal S_c. Thus the system is consistent, and we are ready to discuss the final and most interesting source of changes in the FAM, namely capital transactions, such as portfolio rebalancing.

8.3 Capital Transactions

The final source of changes in the FAM are capital transactions. These have two properties that can complicate models: firstly, any capital transaction affects several entries in the FAM; secondly, these always change in such a manner that the net worth of the institutions involved is unchanged. The first of these properties is liable to lead to a proliferation of equations, the second is a constraint that has to be watched, unless errors arise in these equations.

Let us illustrate that in a simple example: a firm taking up a local-currency denominated loan from a local commercial bank. For each dollar of the loan value, the amount of the firm's debt stock (Φ_{lbf}) increases by a dollar, and so does the amount of the firm's deposits at that bank (we assume the loan takes the form of deposits, rather than a cash payout to the firm). This is a very simple example; in the case of deposit creation, households give cash to banks and acquire deposits there, but then the bank deposits some of that cash at the central bank (primary deposit requirement) and buys government bonds for a further share of the cash (secondary deposit requirement), so that multiple FAM stocks are affected as a result of one rather simple transaction.

How can we describe these changes in a simple way, with preferably only one equation per transaction? We propose to do so by introducing a new formalism that we call transaction matrices. It is based on the observation that while a transaction, such as creation of new loans, affects several entries in the FAM, the impact on all of them is proportional to the amount of the transaction. To further elaborate on our example of loan creation, let us define a matrix Λ^{loan}, as pictured in Table 8.1. Using the notation we introduced earlier, this matrix can also be written as

$\Lambda^{loan}_{li_1i_2}$	h	f	b	c	g
h					
f			1		
b		1			
c					
g					

Table 8.1: The transaction matrix for creation of new local-currency denominated loans

$$\Lambda^{loan} = [lbf] + [lfb] \tag{8.7}$$

Suppose the banks make a new loan of size ψ_{loan}. Then from our brief discussion of the process of loan creation above we see that the total change in Φ due to that loan equals

$$(\Delta\Phi_{li_1i_2})_{from\ loans\ to\ firms\ in\ local\ currency} = \Lambda^{loan}_{li_1i_2} \cdot \psi_{loan}$$

We thus see that with the help of the transaction matrix, we only need one (matrix) equation to represent one transaction. In addition to that, properly constructed transaction matrices will automatically make sure that capital transactions do not affect the net worth of the institutions involved. "Properly constructed" here means simply that each transaction matrix Λ must fulfill

$$\sum_{i_1} \Lambda_{i_1 i} - \sum_{i_1} \Lambda_{i i_1} = 0 \quad \text{for all } i \tag{8.8}$$

Thus the transaction matrix formalism to describe financial stocks solves both problems outlined above, allowing for a simple representation of financial stocks in a dynamic model. If we have a transaction matrix for each transaction allowed in the model, and use the index λ to number them and the number ψ_λ to describe the amount of a transaction of type λ happening at a given moment, then the changes in the FAM from capital transactions can be written simply as

$$(\partial_t \Phi_{d i_1 i_2})_{from\ capital\ transactions} = \sum_\lambda \psi_\lambda \Lambda^\lambda_{d i_1 i_2} \tag{8.9}$$

This is an extremely useful decomposition as it effectively separates the structure of the financial sector from the behavior of the institutions therein. The transaction matrices $\Lambda^\lambda_{d i_1 i_2}$ are constant and describe the kinds of transactions that are *possible* in a given economy ("Can households hold foreign exchange? Can firms borrow abroad?") whereas the "transaction flows" ψ_λ describe the decisions of individual agents as to which of the possible transactions they actually want to undertake. Hereby the net worth constraint of every institution is automatically observed.

The only thing left to watch for is that none of the entries of Φ should be allowed to become negative - essentially a boundary condition; but all the "accounting constraints" are observed automatically given that all transaction matrices are "properly constructed".

8.4 The Master Equation for FAM Dynamics

Now that we have understood how to model each of the sources of changes in the FAM, we can pull them together to formulate the master equation describing the FAM dynamics:

$$\partial_t \Phi_{d i_1 i_2} = \hat{P}^d \Phi_{d i_1 i_2} + \sum_i S_i \cdot [lic] + \sum_\lambda \psi_\lambda \Lambda^\lambda_{d i_1 i_2} \tag{8.10}$$

This is sufficient for a constructive description of FAM dynamics in a SAM/FAM model. The exchange rate behavior, determined elsewhere in the model, will determine the first term, the net lending vectors will come from the SAM, and the transaction flows ψ_λ can be whatever the agents who control them want them to be - the transaction matrix formalism will automatically enforce all the net worth constraints that would have to be imposed as additional equations had we wanted to directly specify the dynamics of the individual FAM entries.

8.5 Reconstructing Transaction Flows From FAM Time Series

We have just seen how, given an initial value of the FAM together with time series for the exchange rate and the net lending of each institution, as well as the values of the transaction flows, we can reconstruct the time path that the FAM follows. As our approach starts with data, however, we are also interested in the opposite operation: given the values of the FAM for every moment in time (that we have assembled from Central Bank statistics) and exchange rate time series, decompose the FAM changes into revaluation, net lending, and capital transactions. Once we have achieved that, we can seek to describe the transaction flows in terms of portfolio-equilibrating behavior of the institutions, stylize the FAM while preserving everybody's net worth by omitting or modifying some of the flows, and play many other interesting games.

The question thus is: given a set of transaction matrices $\Lambda^{\lambda}_{di_1i_2}$ and time series for the FAM $\Phi_{di_1i_2}(t)$ and the exchange rate $e(t)$, find $S_i(t)$ and $\psi_\lambda(t)$.

The first part, namely finding $S_i(t)$, is simple. Let us define the revaluation-corrected change in Φ as

$$D\Phi_{di_1i_2} = \partial_t \Phi_{di_1i_2} - \hat{P}^d \Phi_{di_1i_2} \tag{8.11}$$

Then

$$D\Phi_{di_1i_2} = \sum_i S_i \cdot [lic] + \sum_\lambda \psi_\lambda \Lambda^{\lambda}_{di_1i_2} \tag{8.12}$$

and since all the transaction matrices are properly constructed, the first term is the only one that contributes to changes in institutions' net worth. Thus we can find S_i as the change in revaluation-corrected net worth,

$$S_i = \sum_{d,i_1} (D\Phi_{dii_1} - D\Phi_{di_1i}) \tag{8.13}$$

This is exactly how we determined S_i in Chapter 7, Equation (7.31).

The second part of the problem, namely determining ψ_λ, turns out to require a bit more theory, but is quite cheap in computational terms. First of all, representing "any" net worth-preserving (after we have cleaned away the other terms) change in the FAM through a linear combination of transaction matrices is clearly only possible if we have "enough" transaction matrices. This representation will be unique if we have "just enough" transaction matrices rather than "too many". Roughly, this means that we need as many TMs as there are nonzero non-cash entries in the FAM. To make that statement more precise, we will need some linear algebra.

First of all, note that the decomposition (8.12) is unique iff the TMs are linearly independent. We can re-cast the problem (8.12) as "decompose $D\Phi$ into a linear combination of TMs up to an error in the local cash terms". Now let V be the space of all "valid" FAMs, i.e. all FAMs that could in principle occur in a given economy. Let W be the five-dimensional space of all combinations of local cash terms only, i.e.

$$W = span\{[lic] | i \in Inst\} \tag{8.14}$$

Then let us define a semi-positive definite scalar product on V that is zero exactly over W. Let $X^1, X^2 \in V$, then

$$\left\langle X^1, X^2 \right\rangle = \sum_{d,i_1,i_2} X^1_{d,i_1,i_2} X^2_{d,i_1,i_2} - \sum_i X^1_{l,i,c} X^2_{l,i,c} \tag{8.15}$$

This means that $\langle X^1, X^2 \rangle$ is the sum of pairwise products of all entries of the two matrices except the local-denominated cash entries. If we had left out the second sum (the one after the minus sign) in (8.15), we would have had the canonical scalar product on the space of all FAMs - that is, the exact same expression that we would have gotten by writing out all elements of each FAM as a very long vector (with as many elements as there are entries in a FAM) and computing the "normal" scalar product of the two vectors.

With the inclusion of the second sum, (8.15) is equivalent to dropping the local-denominated cash terms (local-denominated central bank liabilities) and *then* flattening out both FAMs into vectors and computing the "regular" scalar product.

Thus, the product (8.15) of a FAM with itself is the sum of squares of all its components except the local-denominated central bank liabilities. This is the same as saying that this scalar product is zero exactly on W.

Now consider the quotient space V/W, that is the space of equivalence classes, where two vectors in V are considered equivalent if they differ only by an element of W (that includes zero). Thus if v_1 and v_2 are two FAMs, and we say $v_1 = v_2$ in V/W, this means $v_1 - v_2 = w \in W$. In our case, this means that an element of V/W is the set of all FAMs in V that differ at most in the local-denominated central bank liabilities. Any valid FAM X in V automatically has a corresponding element $\pi(X)$ in V/W, namely the set of all matrices that differ from X by at most local-denominated central bank liabilities.

As the local-denominated central bank liabilities are precisely the elements ignored by the scalar product (8.15), the latter is a well-defined, positive definite scalar product on the quotient space V/W.

If the transaction matrices form a basis of V/W, then we can use a scalar product (any well-defined scalar product on V/W, so (8.15) will do) to uniquely decompose any element of V/W into a linear combination of the transaction matrices.

Let the matrix A contain the pairwise scalar products of the transaction matrices:

$$A_{\lambda_1\lambda_2} = \left\langle \Lambda^{\lambda_1}, \Lambda^{\lambda_2} \right\rangle \tag{8.16}$$

and B be the inverse of A

$$B = A^{-1} \tag{8.17}$$

then standard linear algebra (basis change in a linear space with a scalar product, see Appendix B) shows that if we define ψ_λ by

$$\psi_\lambda = \sum_{\lambda_1} B_{\lambda\lambda_1} \left\langle \Lambda^{\lambda_1}, D\Phi \right\rangle \tag{8.18}$$

then

$$D\Phi_{di_1i_2} = \sum_\lambda \psi_\lambda \Lambda^\lambda_{di_1i_2} \text{ as elements of } V/W \tag{8.19}$$

which is the same as saying

$$D\Phi_{di_1i_2} = \sum_\lambda \psi_\lambda \Lambda^\lambda_{di_1i_2} + \sum_i w_i \cdot [lic] \quad \text{for some } w_i \tag{8.20}$$

Since the first term of (8.20) has no impact on net worth (being a sum of transaction matrices), the change in net worth of institution i from (8.20) is equals w_i, and therefore $w_i = S_i$ and (8.20) is in fact the decomposition (8.12).

Note that this decomposition is computationally efficient because B is a constant matrix (it is obtained from the constant transaction matrices). Thus the only computation we need to do at each time step is to compute the scalar product of $D\Phi$ with each TM, and then multiply the resulting vector by the square matrix B.

Thus the transaction matrix decomposition is made constructive. This construction also allows us to exactly answer the question "is a given set of TM's enough? Exactly enough?". The answer is as follows: if the matrix A in (8.16) is singular and thus won't invert, the matrices are not linearly independent, and one should omit some. If A inverts, one defines ψ_λ by (8.18) and then computes the residual w from (8.20). If w is indeed in W, that is, consists only of local cash entries, then we have enough transaction matrices; if not, we need to add some more to explain the other entries in the residual.

The final question worth discussing here is: what reason we have to assume that the transaction matrices do form a basis of V/W? First of all, we have constructed the TMs according to our wishes, so we can make sure they're a basis if we want to. The question then becomes, does it *make sense* to use a set of TMs that are a basis of V/W? We would say that it definitely seems wise to use enough transaction matrices to enable us to span the changes in the financial stock composition allowed by the structure of the economy. It is not as clear whether one should use "just enough" of them, or instead use a larger, linearly dependent set. Since in the latter case one could select a basis out of the larger set and represent the rest of the TMs as linear combinations thereof, the question seems to be largely one of style. If one is building a toy model and for some reason wants to allow lots of redundant transactions, there does not seem to be an a priori reason not to. However, if one wants to start from data and have a unique decomposition, as we do, it seems wise to make the TMs be a basis, as we do. The next section describes the transaction matrices we use on our dataset.

8.6 The Transaction Matrices We Use

The transaction matrices we use are listed in Table 8.2.

8.7 Summary

This chapter has described a novel way to describe financial stock dynamics. Any financial transaction typically affects several financial stocks, making it difficult to see what transactions gave rise to the observed financial stock behavior. By using a collection of constant matrices describing the structure of the financial sector in a given country, we can decompose the changes in the financial stocks into revaluation, current transactions, and capital transactions in a computationally efficient way. Conversely, the formalism derived here allows us to directly specify the portfolio allocation behavior of the different institutions while *automatically* observing the wealth constraints of the institutions. This formalism thus greatly simplifies the specification and estimation of portfolio behavior in stock-flow consistent models.

A	Private Creation of Local Currency-Denominated Deposits	$[l : pb] - [l : pc] + [l : bg] - [l : cg]$
B	Private Purchases of Government Bonds	$-[l : pc] + [l : pg] - [l : cg]$
C	Private Creation of Forex-Denominated Deposits	$-[l : pc] + [l : bg] - [l : cg] + [\$: pb]$
D	Private Local Currency-Denominated Borrowing from Commercial Banks	$[l : pc] + [l : bp] - [l : bg] + [l : cg]$
E	Private Forex-Denominated Borrowing from Commercial Banks	$[l : pc] - [l : bg] + [l : cg] + [\$: bp]$
F	Commercial Banks' Purchases of Government Bonds	$-[l : bc] + [l : bg] - [l : cg]$
G	Commercial Banks' Borrowing from Abroad	$[\$: bw] + [\$: wb]$
H	Central Bank Exchanging Currency	$-[l : wc] - [\$: cw]$
I	Commercial Banks Borrowing in Local Currency from the Central Bank	$[l : cb] + [l : bc]$
J	Commercial Banks' Purchases of Forex from the Central Bank	$-[l : bc] + [\$: bw] - [\$: cw]$
K	Central Lending to Government	$[l : cg] + [l : gc]$
L	Central Bank Borrowing From Abroad	$[\$: cw] + [\$: wc]$
M	Government Foreign Borrowing	$[l : gc] + [\$: cw] + [\$: wg]$
N	Renormalization of Government Deposits at Commercial Banks	$[l : bc] + [l : gb] - [l : gc]$
O	Central Bank Lending to Government-Owned Enterprises	$[l : pc] + [l : cp]$

Table 8.2: Transaction Matrices Used in this Thesis

Chapter 9

Investigation of key individual time series and their policy implications

This chapter is the core of the dissertation. Here, we investigate the behavior of key macro and sectoral variables during the 1990s, so as to understand the behavior of the economy in response to various disturbances.

This chapter is the foundation of the subsequent analysis: In Chapter 10, we sketch out some accounting that follows from this chapter's analysis; then, after another exploratory chapter (Ch. 11), we devote Chapter 12 to comparing the insights gained to the common stories about structural adjustment in Ghana and common assumptions of models of structural adjustment that we had discussed in Chapters 3 and 4, respectively. Finally, in Chapter 13 we use the discussion of Chapter 12 as a base for explaining the behavior of the Ghanaian economy during the 1990s and making policy suggestions.

The investigation of data in this chapter is divided into two sections. Section 9.2 looks at the supply side of the product markets, namely the validity of the Incremental Input-Output Ratio, the determinants of investment, and the existence of price substitution between production for the domestic market vs. for export. Section 9.3 investigates the demand side of the product markets, namely at the sources of demand injections, the savings ratio, the consumption demand, and the price elasticity of substitution between imports and domestically produced goods. Most of the data (except prices) used in these sections is available on a yearly basis, giving us a total of 12 data points per variable. This is barely enough to make reliable statistical inferences; Section 9.1 discusses our way of addressing that.

As this chapter goes through quite a lot of data, each section is followed by a section summary as an orientation help to the reader.

9.1 A method for dealing with short data series

While for the financial series, twelve years of monthly data allow us to use a variety of statistical techniques to analyze the data, the situation is more constrained for real macro and sectoral data. With such short time series, there is a high danger of spurious regression, that is, of equations fitting well by chance rather than as an expression of an underlying causal relationship.

We address this in the following manner: data from 1990 until 1997 are used for calibration of the equations, and data from 1998 until 2001 to validate it. Thus, if the equation that fits well in the calibration period also performs well during the validation years, we conclude that it reflects a causal relationship; otherwise, we discard it.

This procedure is also useful to get a feeling for how good the model could be as an instrument of prediction. Once the equations have been validated in the manner described above, one could then re-calibrate them to the data for the whole twelve years and use them to predict behavior for 2002 onwards. The ability of the equation to predict data for 1998-2001 using only data for 1990-1997 could then be regarded as an indicator of its likely ability to predict future behavior for which no validation data is available. While doing that is outside of the scope of the present dissertation, it will be useful in further work on the issue.

All equations tested attempt to explain the independent variable (for example, share of imports in consumption of manufactured goods) by means of a (possibly time-lagged) dependent variable (for example, a relative price) with a possible inclusion of a time trend. Besides using the non-lagged value, we try out a fixed lag (using the value of the independent variable a fixed time, say three months ago), and an exponential-distributed lag (a weighted average with the weight decaying exponentially as a function of lag). This gives us three options for lag specification; an independent decision is whether to include a time trend or not, resulting in six possible equations. The coefficients to be optimized are an intercept, the coefficient of the independent variable, a time trend where included, and a time constant where a time lag is included.

To interpret the time trend and time constant coefficients, one should note that the unit of time here is one month, thus a time constant of 3 means a lag time of 3 months, and a time trend of 0.05 means 0.05 per month thus .6 per year.

Since the real-side data are available yearly, and some price series are available monthly, in such cases the equation was formulated using monthly data, and the resulting forecast was then summed up at yearly intervals to enable comparison with the yearly data. In the cases where the independent data was available yearly, interpolation was used to compute lags that were not multiples of a year.

We estimate the equation by minimizing the squared error of the equation over the estimation period. As the time lags are a nonlinear function of the lag time, nonlinear estimation is used.

To make it easier to compare prediction errors in different variables, we first estimate a constant approximation to the independent variable during the estimation period (1990-1997), and then use it to compute R^2 measures for both the estimation and the validation period (the latter being 1998-2001) in the standard way: suppose the error of the constant approximation is e_c, and the error of another approximation over the same period is e. Then the R^2 over that period is defined as $R^2 = 1 - e/e_c$. Note that while inside the estimation period adding another variable always leads to an improved R^2 in the usual manner, the extended equation may well (and often does) have worse fit than a constant over the validation period. Thus the R^2 is quite often negative over the validation period.

Another criterium for equation validity is the value of the time constant that describes the lag with which the independent variable influences the dependent variable. We limit the lag to 36 months, in our view an ample margin to allow changes in the independent variable to have their impact. If the value of the time constant from the optimization process actually hits the 36-month maximum, we take that as a sign of a spurious regression and disregard that particular equation. This practice is confirmed by the fact that such equations typically also have quite high errors in the validation period.

After selecting the equation that, when estimated over the estimation period, does best at predicting the validation period behavior, and is thus presumably the best causal description of the independent variable, we re-estimate it for the whole period 1990-2001.

The results are summarized in a table for each of the variables inspected. The best equation's name is framed and the corresponding constant values are in bold, as are the constants for that equation re-estimated using data from the whole time period. If the estimated value of a time constant equals 36, the constants of that equation are set in slanted type to indicate that they're suspect.

To provide visual information over the behavior of the time series investigated as well as the predictions thereof, we include a graph with each table. There, the diamonds are the data points being approximated, the thin lines are all the different equations estimated over the estimation period, and the thick blue line is the best equation being estimated over the whole period.

Having explained the methodology, we are now ready to discuss the individual results.

9.2 Supply Side

9.2.1 Incremental Capital-Output Ratio

The first thing we test is the infamous Incremental Capital-Output Ratio or ICOR, that is the assumption that new investment translates in strict proportion into increases in output as $\Delta y = \sigma \Delta K = \sigma I$, with σ being the actual ICOR. This can be reformulated as

$$\frac{\Delta y}{y} = \sigma \frac{I}{y}$$

, that is the growth rate of GDP is proportional to ratio of investment to GDP, or also as $\Delta y / I = \sigma$, that is the growth rate of GDP divided by investment is a constant.

We first test the second formulation. The time series $\Delta y / I$ turns out to have a

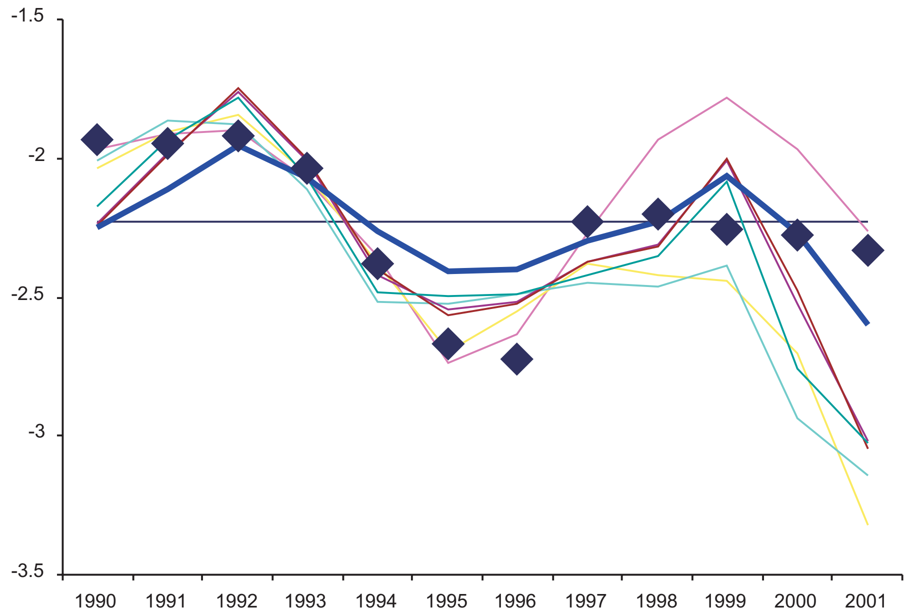


Figure 9.1: Ratio of Investment to GDP (log scale)

mean of .626 and a standard deviation of .501, thus a t-ratio of 1.25 - not significant even at 10% level. If we use *last year's* investment to allow for an installation lag, the t-value is 1.33 - also not significant.

Finally, we regress the rate of growth of GDP on ratio of investment to GDP, using both the this year's and last year's investment at the same time as two explanatory variables. We get an R^2 of 12% and neither of the explanatory variables is significant at the 10% level (t-values of .019 and .698, respectively).

We thus conclude that in accordance with the references quoted in our discussion of ICOR in Chapter 4, the incremental capital-output ratio is not constant at all.

Industry Imports	Intercept	Time Trend	Relative Price Elasticity	Relative Price Time Constant	Interest rate elasticity	Interest rate Time Constant	Estimation R^2	Validation R^2
Constant only	-2.23						0%	0%
Exponential delay	*0.09*	*-0.0161*	*-4.11*	*33.79*	*0.11*	36	*98%*	*-2815%*
Fixed delay	-0.18	-0.0081	-1.38	7.5	-0.01	35.74	91%	-8951%
No delay	-0.36	-0.0052	-1.02		-0.02		79%	-8422%
Exponential delay,no trend	0.26		-1.34	3.49	-0.03	1	74%	-4314%
Fixed delay, no trend	.268		-1.34	3.84	-0.034	1	-74%	-4472%
No delay, no trend	0.27		-1.34		-0.034		72%	-5344%
Best equation estimated on the whole interval	-1.59(.31)		-0.53(.47)	7.89	-0.017(.0086)	1.00	-2%	

Table 9.1: Ratio of investment to GDP as function of relative price of imports and of interest rates

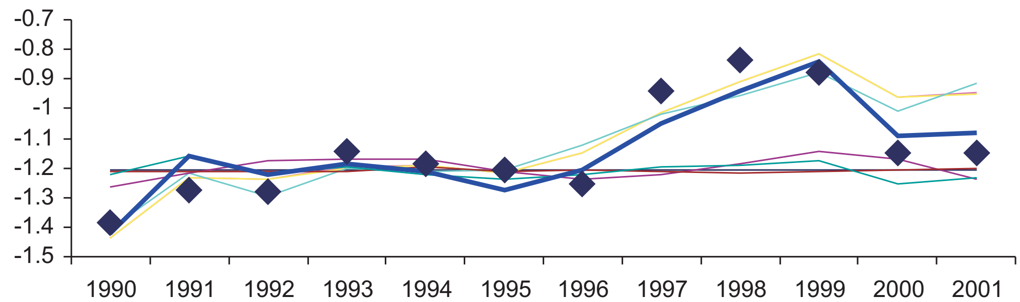
9.2.2 Real Investment

We try to predict the ration of investment to GDP in real terms as a function of interest rates on treasury bills and the relative price of imported vs. domestically produced manufactured goods. The latter is a proxy for return to investment as most capital equipment is imported, and most of it is used in domestic manufacturing.

As in most of the equations investigated in this chapter, we take the natural logarithm of both the dependent and the independent variable, so that the coefficients can be interpreted as dimensionless elasticities. We make an exception for the interest rate.

This equation does very badly at prediction during the validation period, with none of the formulation able to out-perform the constant approximation. However, we can look at patterns in estimated coefficients, and try to draw conclusions from these.

What we see is firstly, a falling time trend that has disturbing implications for the overall capital stock in the country. Second, the relative price elasticity is pretty consistently slightly above -1, implying a high degree of responsiveness to relative prices. In particular, in the case of a currency depreciation, investment could be expected to contract quite strongly, so that it would shrink even in nominal terms. The response to interest rates corresponds to investment over GDP shrinking by one to four percent (not percentage points) for each percentage point increase in interest rates - a substantial response if we consider that the interest rates have ranged between 10% and 50%.



	Intercept	Time Trend	Elasticity	Time Constant	Estimation R^2	Validation R^2
Constant only	-1.21				0%	0%
Exponential delay	**-1.30**	**0.0042**	**-0.74**	**4.25**	**79%**	**67%**
Fixed delay	**-1.30**	**0.0042**	**-0.73**	**4.47**	**79%**	**67%**
No delay	-1.34	0.0039	-0.42		75%	65%
Exponential delay, no trend	*-0.98*		*-1.11*	*36*	*7%*	*21%*
Fixed delay, no trend	*-1.20*		*-0.05*	*35*	*0%*	*-3%*
No delay, no trend	-1.17		-0.19		4%	9%
Best equation estimated on the whole interval	**-1.20 (0.06)**	**0.0033 (0.0005)**	**-1.00 (0.23)**	**3.67**	**98%**	

Table 9.2: Ratio of exports to nontraded goods in industrial production as function of relative price

9.2.3 Ratio of exports to nontraded goods in industrial production

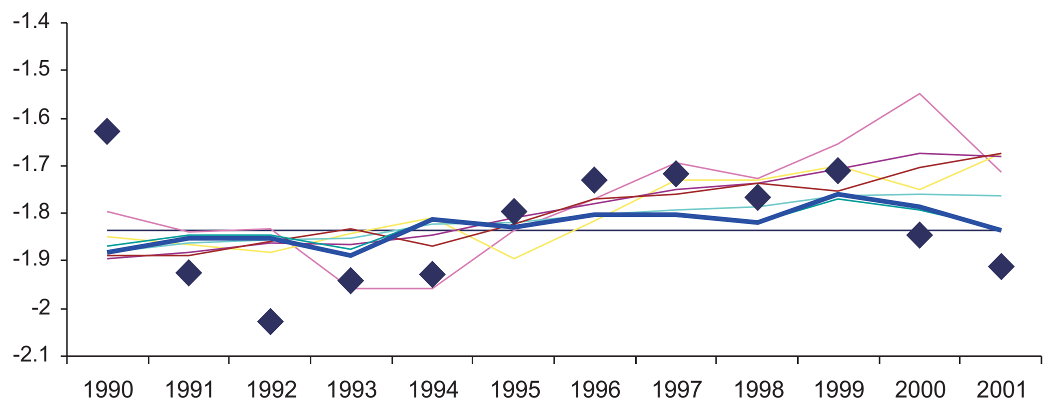
In comparison to investment, we are quite successful at predicting the ratio

of exports to nontraded goods in industrial production. The following features leap to the eye: firstly, equations that include a time trend do vastly better in the validation period than those that do not. This can be understood as reflecting the opening up of the economy over the 1990s; all the more so as the time trend decreases if we estimate the equation for the whole 12 years of the 1990-2001 period. That can be seen as corresponding to a slowing-down of the opening-up process in the second half of the period after the drastic trade reforms have had their initial impact during the first half.

A more surprising result is that the relative price elasticity turns out to be consistently negative, and is actually greater in absolute value if we use the whole time period. This is at first glance surprising as this means that higher prices of exports relative to nontraded manufactured goods lead to an *increase* of nontraded manufactured goods production compared to export production. This is completely contrary to what one would expect from a traditional neoclassical supply-constrained productivity-frontier profit-optimizing model.

However, it is fully consistent with a demand-driven nontraded manufacturing sector, as common e.g. in structuralist models: if exports prices rise relative to domestic manufactures, this means an increase in income when measured in terms of domestic manufactures, and thus increased demand for the latter, and thus increased production thereof. The fact that the elasticity is higher in absolute value if we estimate the equation using the whole period rather than just 1990-1998 is consistent with this interpretation: during the second half of the period, exports were a larger share of the economy, and thus we'd expect this effect to be stronger, as it in fact is.

This conclusion is also corroborated by separating out mining exports (virtually all mining output is exported) from the rest of industrial exports (table not reproduced here). As mining has a completely separate capital stock from the rest of the industry, one would expect the substitution effects between nontraded and export production to become more pronounced if one excludes mining exports. However, upon excluding mining the equation fit became much worse (though the price elasticity remained negative) - exactly what one would expect upon excluding an



	Intercept	Time Trend	Elasticity	Time Constant	Estimation R^2	Validation R^2
Constant only	-1.84				0%	0%
Exponential delay	*-1.85*	*-0.0098*	*3.28*	*36*	*42%*	*-404%*
Fixed delay	-1.87	-0.0014	0.71	30	14%	-155%
No delay	-1.89	0.0008	0.05		5%	-23%
Exponential delay, no trend	*-1.92*		*0.51*	*36*	*14%*	*-219%*
Fixed delay, no trend	-1.91		0.37	18	13%	-198%
No delay, no trend	**-1.88**		**0.15**		**4%**	**42%**
Best equation estimated on the whole interval	**-1.99 (0.05)**		**0.42 (0.15)**		**10%**	

Table 9.3: Ratio of exports to nontraded goods in agricultural production as function of relative price

important injection if nontraded industry output is demand-driven.

We can thus conclude that the nontraded manufacturing output is demand-determined.

9.2.4 Ratio of exports to nontraded goods in agricultural production

The picture for agriculture is quite different from that for industry. Firstly, the time trend in the ratio of exports to nontraded production is unstable over different formulations, but largely negative. The reason for this is probably that while nontraded production is expanding along with total area under cultivation (more on that below), far and away the only export crop is cocoa, and its production is restricted to forested areas, whose total area is shrinking.

The other result is a uniformly positive price elasticity of substitution. Its values vary between .71 and .15, but the equation with best fit in the validation period (actually the only one to outperform the constant) has a price elasticity of .15, which changes to .42 when the same equation is estimated over the whole period. This is not implausible, as cocoa is an embedded crop and the lifetime of a tree is several years. Thus while a farmer might devote differing amounts of effort to tending the trees during different years, this doesn't lead to a price response nearly as strong as one would have if cocoa competed with food crops for scarce soil.

The positive price elasticity of substitution between exports and nontraded crops indicates a supply-constrained sector where production allocation decisions are made on the basis of relative price. Let us examine the data for the agricultural sector a little closer to see whether the supply constraint hypothesis can be corroborated.

9.2.5 Behavior of the Agricultural Sector

Let us consider three data variables: first, the ratio of the wholesale food price index (average over the major food crops) to the Consumer Price Index - a measure of the relative price of food crops; second, total food crop production per acre, and finally, total land area under cultivation (Figure 9.2).

We see that a clear change in behavior sets in at about the middle of our period, in year 1995 (the two periods are separated by the dotted line). Prior to 1995, land area under cultivation is virtually constant, and food price moves in

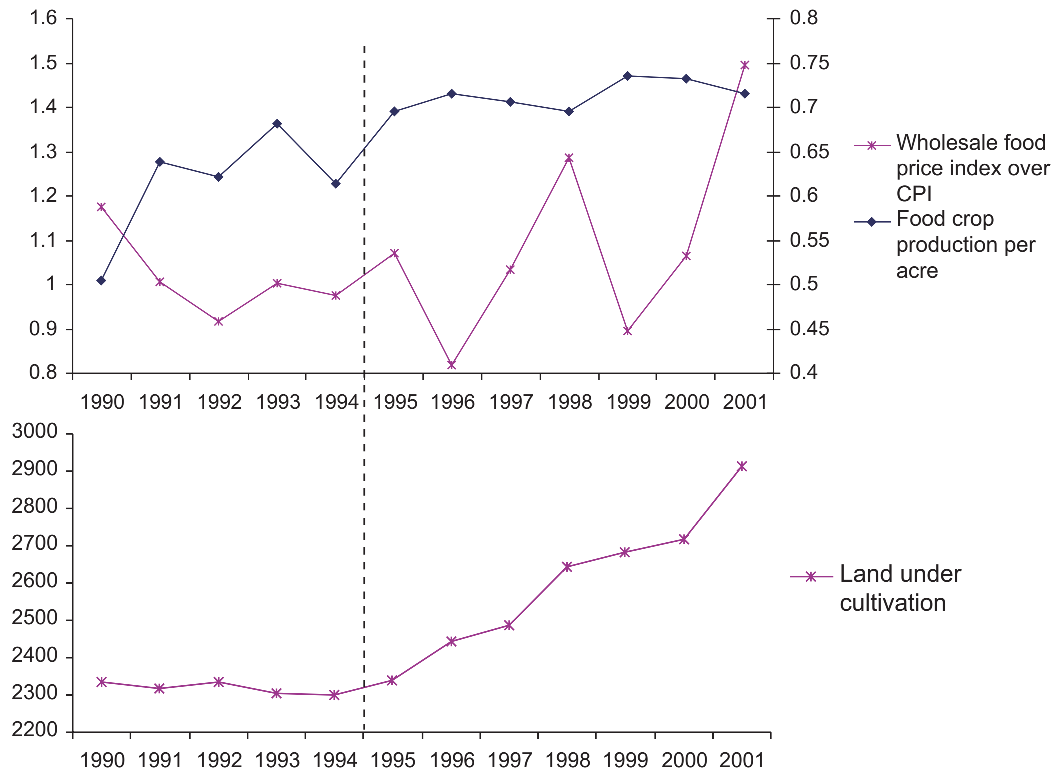


Figure 9.2: Food crop production, wholesale price of food crops relative to the CPI and land area under cultivation

the same direction as production. That indicates a demand-driven regime (apart from 1990 which must have been an exceptionally bad harvest). However, from 1995 onwards, the area under cultivation grows steadily, and decreases in production (due to adverse weather conditions) are accompanied by an *increase* in price, indicating a supply-constrained regime. It thus seems likely that around 1995, population growth has caught up with the country's capacity to supply food crops, so that the agricultural sector has switched from a demand-driven to a supply-constrained regime.

Such a regime switch would also explain the bad fit of the equations, as well as the somewhat surprising fact that the fit of the best equation was actually better for the validation period ($R^2 = 42\%$) than for the estimation period ($R^2 = 4\%$) - the reason for the latter being that the supply-constrained mode represented by the positive price elasticity did not kick in before 1995.

Thus we can conclude that as indicated by all the available data, agricultural production for domestic use has hit a binding supply constraint around year 1995.

Section Summary

This section has investigated some important relationships related to the supply side of the product markets. We began by testing the venerable Incremental Capital Output Ratio, and found it to be as devoid of factual support as was the case in all previous research on the issue.

Then, we turned to the investment-to-GDP ratio as function of the relative price of domestic manufactures to imports, as well as of the interest rate on treasury bills. The performance of all equations was quite poor during the validation period (perhaps not surprising, as investment is notorious for being hard to predict); still, the signs and even values of the estimated coefficients were quite stable, and indicated an elasticity larger than one with respect to the relative price of imported vs. domestic manufactures, and a response of one to four percent to each percentage point of interest rates.

Finally, investigating the reaction to relative price of exports vs. goods produced for the domestic market showed drastically different behavior across sectors. In industry, the data strongly indicated that production for domestic market was demand-driven. In the case of agriculture, the data showed a change of regime in the middle of the period under investigation, as the growing population pushed the sector's capacity to supply food crops, so that the sector was clearly supply-constrained from year 1995 onwards.

9.3 Demand Side

9.3.1 Demand Injection Decomposition

As we turn to the demand side of the product markets, the first thing we look at are the sources of injections and leakages in the economy. The simplest way to look at them is to plot each institution's net savings over time (Figure 9.3), as net savings represents the difference between the injection and the leakage that are provided by the institution in question.

Another way to represent the same data is the Taylor decomposition (discussed in detail in Berg and Taylor [2000]). That is defined as follows: Suppose GDP is completely demand driven. By diving each institution's income by total GDP, we get its 'leakage ratio'. That would be the savings ratio for the private sector, the overall tax ratio for the government, etc. By comparing that with that same institution's demand, we can see what the GDP would be like if the only leakage and injection were due to that institution. It is straightforward to show that the actual GDP is a weighted average of these what-if GDPs (derivation is given in Berg and Taylor [2000]). This representation is shown in Figure 9.4.

Both these figures show the same pattern, namely that the government was the major driver of the economy throughout the period. It is perhaps not surprising in a small poor developing country such as Ghana to see that the rest of the world is a net drain on demand, even after accounting for foreign aid inflows; nor is it a big surprise to see that interest payments on government debt (that's the main source of the deposit money banks' income) is a comparable drain on demand. What is somewhat more surprising is that the private sector is likewise a net demand sink, with private savings exceeding private investment throughout. This would seem to imply that investment is not constrained by availability of savings. Thus we see that to the extent that output was demand-determined, government was the major driver of economic growth. We have seen in the previous section that domestic manufacturing production is in fact demand-driven. Although there is no data available for services, services are quite likely demand-driven as well due to the nature of the sector. Thus at least half of GDP is likely due to demand-driven sectors, and therefore government deficit reduction is likely to have strong recessionary impacts. We will return to this line of thought in Chapter 12.

9.3.2 Net Private Savings

Here we attempt to explain net private savings (that is savings minus investment) as a share of private disposable income, as a function of the treasury bill interest rate. Note that our estimate of net private savings is fairly reliable, as it is directly derived from monthly financial stock data.

There are two things worth observing here. First, net savings is more stable than investment, suggesting a flexible savings ratio that accommodates investment demand. Secondly, interest rates appear to have no predictive power whatsoever in explaining its variation, which is somewhat surprising, as theory predicts that increases in interest rates should decrease investment and increase savings, thus increasing net savings.

For modeling purposes, this implies that it would make sense to model total

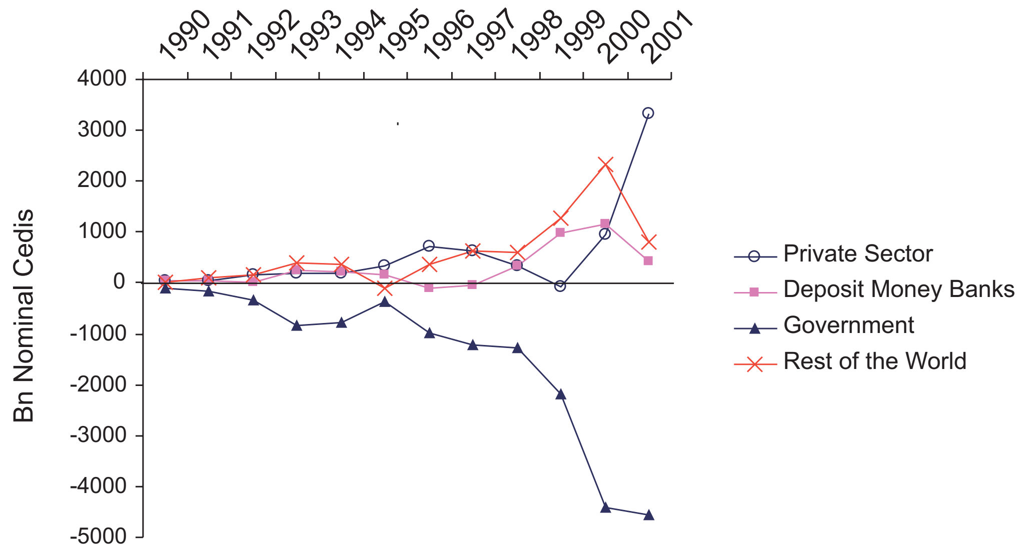


Figure 9.3: Net Lending By Institution

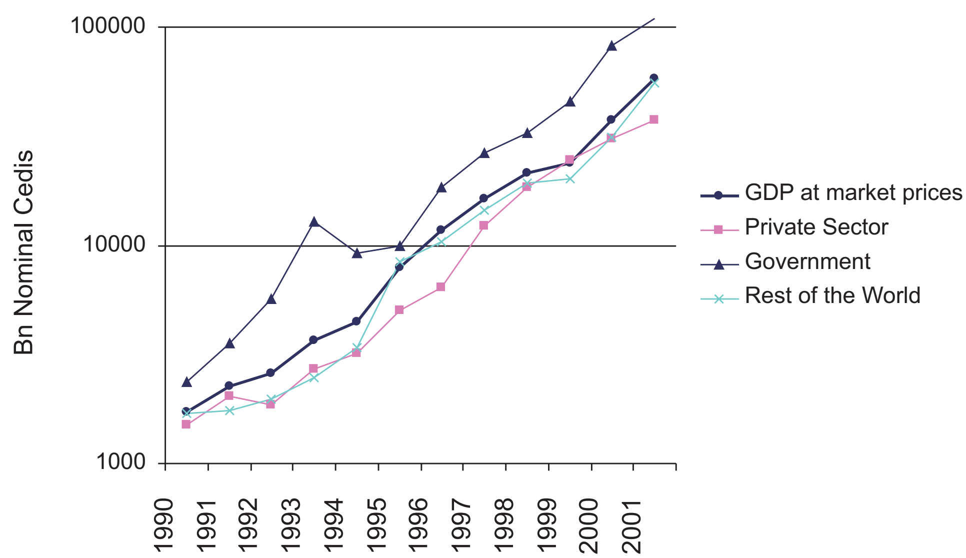
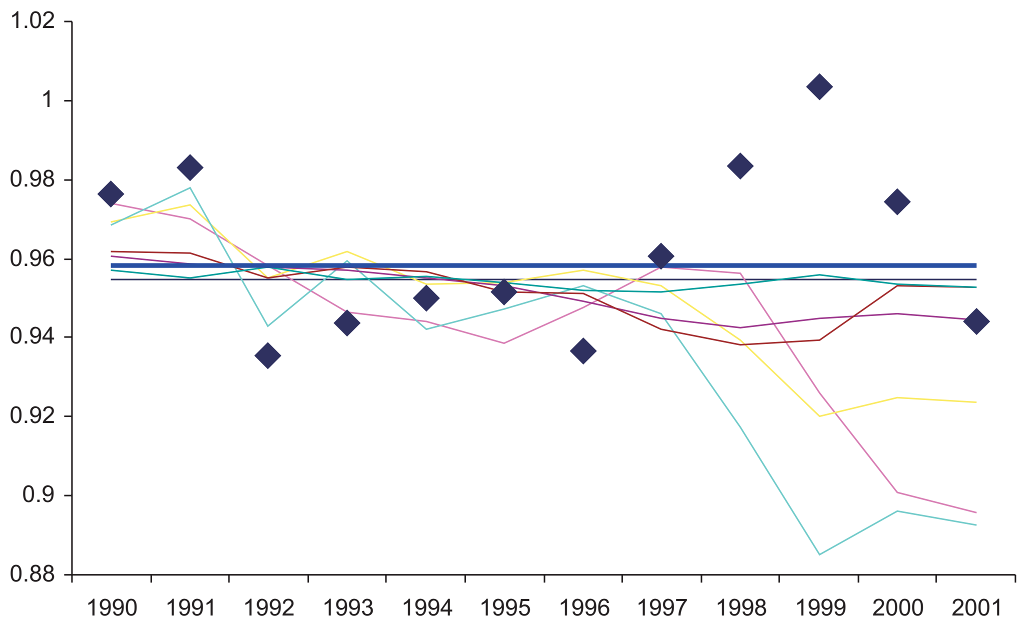
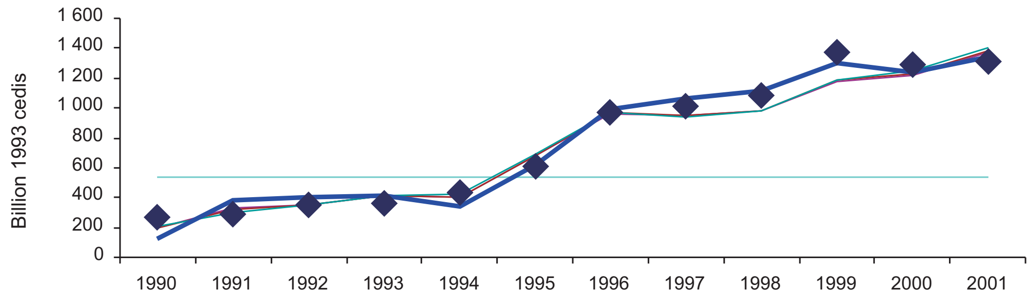


Figure 9.4: Taylor Decomposition of Demand Injections



Industry Imports	Intercept	Time Trend	Elasticity	Time Constant	Estimation R^2	Validation R^2
Constant only	0.95				0%	0%
Exponential delay	*0.85*	*-0.0014*	*0.0063*	*36*	*52%*	*-554%*
Fixed delay	0.95	-0.0005	0.0010	1	38%	-269%
No delay	0.93	-0.0009	0.0020		54%	-908%
Exponential delay, no trend	*0.98*		*-0.0010*	*36*	*10%*	*-85%*
Fixed delay, no trend	0.98		-0.0009	18	14%	-92%
No delay, no trend	0.96		-0.0002		0%	0%
Best equation estimated on the whole interval	0.96 (0.006)		0 (0.0007)		3%	

Table 9.4: Private consumption plus investment as share of private disposable income



	Intercept	Coefficient of consumption	Elasticity	Time Constant	Estimation R^2	Validation R^2
Constant only	537				0%	0%
Exponential delay	-992	1.28	-0.73	1.09	97%	97%
Fixed delay	-1056	1.51	0.94	2.35	97%	95%
$\boxed{\text{No delay}}$	**-964**	**1.16**	**-0.61**		**97%**	**97%**
Best equation estimated on the whole interval	**-941**	**1.06 (0.14)**	**-0.51 (0.14)**		**98%**	

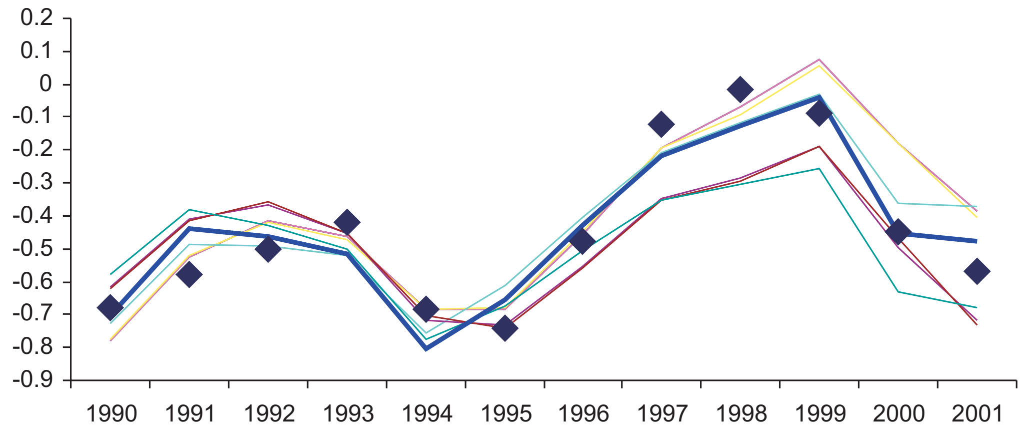
Table 9.5: Consumption of industrial goods as function of total consumption and relative price

private demand and then allocate investment and consumption out of that total, rather than define separate investment and consumption demand functions.

9.3.3 Consumption Function

If we follow the logic of the previous sections, then to fully specify the private consumption demand by sector it is sufficient to specify consumption of nontraded industrial goods. Total private demand as a share of private disposable income is fairly stable, nontraded agricultural goods are supply-determined, and after specifying the investment function we can take demand for services as the residual.

So here we specify consumption of industry goods as function of total con-



Industry Imports	Intercept	Time Trend	Elasticity	Time Constant	Estimation R^2	Validation R^2
Constant only	-0.52				0%	0%
Exponential delay	-0.61	0.0075	-1.24	4.49	89%	71%
Fixed delay	-0.62	0.0036	-1.16	3.57	88%	73%
No delay	**-0.63**	**0.0035**	**-1.01**		**79%**	**87%**
Exponential delay, no trend	-0.44		-1.16	3.64	59%	77%
Fixed delay, no trend	-0.44		-1.13	3.87	59%	75%
No delay, no trend	-0.47		-1.01		53%	75%
Best equation estimated on the whole interval	**-0.58 (0.13)**	**0.0027 (0.0014)**	**-1.16 (0.31)**		**88%**	

Table 9.6: Ratio of imports to nontraded goods in consumed industrial goods as function of relative price

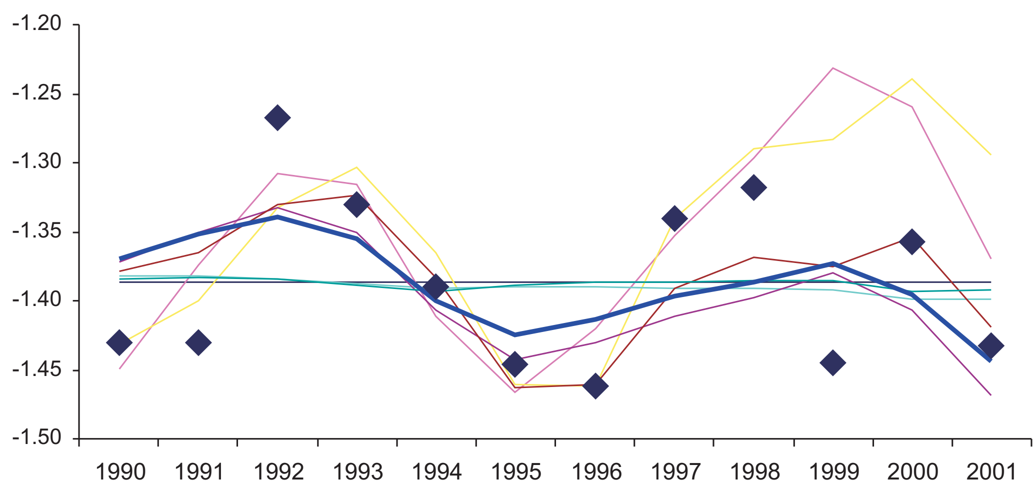
sumption. The fit is quite good. The function here is actually

$$C_I = const_1 + (const_2 + \epsilon * P) * C$$

where C_I is the consumption of industrial goods, $const_1$ is the intercept, ϵ is labeled in the table as "elasticity" (not really an elasticity in this case) and P is the ratio of retail price of industrial goods to retail price of food.

9.3.4 Ratio of imports to nontraded goods consumption

The last relationship we investigate here is the relative price response of import demand. We do it for demand for industrial goods and for services.



	Intercept	Time Trend	Elasticity	Time Constant	Estimation R^2	Validation R^2
Constant only	-1.39				0%	0%
Exponential delay	*-1.70*	*0.0022*	*-1.46*	*36*	*76%*	*-434%*
Fixed delay	-1.52	0.0013	-0.53	18.68	80%	-442%
No delay	-1.38	0.0001	-1.01		0%	1%
Exponential delay, no trend	-1.44		-0.60	31.18	37%	-28%
$\boxed{\text{Fixed delay, no trend}}$	**-1.44**		**-0.37**	**18.17**	**58%**	**32%**
No delay, no trend	-1.39		-0.02		0%	0%
Best equation estimated on the whole interval	**-1.44 (0.02)**		**-0.38 (0.11)**	**18.36**	**51%**	

Table 9.7: Ratio of imports to nontraded in consumed non-government services as function of relative price

(There is no actual data on the split of goods imports into agricultural and industrial, and in the 1993 SAM industrial imports are the majority by far; in compiling the dataset, we have assumed a fixed ratio of industrial to agricultural imports. However, as the agricultural supply constraint made itself felt in the second half of the 1990s, the share of agricultural imports in the total could well have increased - so it would have been cleaner to do this here for goods imports as a whole. On the other hand, the World Bank figures (only available for some years) on the ratio of agricultural to industrial imports suggest that ratio is quite stable. Therefore, we stay with the present formulation for now.)

The predictive power of the constant price elasticity of substitution is quite strong in the case of industry. All variants of the equation that include time trend have a validation R^2 over 70%. The actual elasticity always comes out larger than one, which is good news for trying to control import demand through relative price adjustments.

On a more disturbing note, the ratio of imports to nontraded industrial goods exhibits a disturbing increasing time trend; in itself this is a manifestation of the opening of the economy during the 1990; however, as we have discussed in Chapter 3, imports have consistently outgrown exports. Fortunately, this trend is substantially lower if we estimate the equation for the whole period, indicating a slowdown in endogenous import growth.

The fit was less good for services, with the price elasticity being still consistently negative but varying in absolute value among different functional forms.

Summary

In examining the demand side of the product markets, we have seen that government demand was the major driving force of the economy in the period we examine. Private savings net of investment were actually positive throughout, thus also a net demand drain. The ratio of private disposable income to total private demand (consumption plus investment) was quite stable at about 0.96, possibly implying a savings ratio that adjusts to meet investment demand. Finally, the share of imports vs. domestic goods in consumption demand for manufactured goods in real terms was found to be extremely responsive to their relative price (relative price elasticity of substitution larger than one). This means that the balance of payments will be quite responsive to both the exchange rate and the domestic price level.

Chapter 10

Fix-flex Accounting in an Open Economy

Once one has estimated the price elasticities of import demand and export supply, as we have in the preceding chapter, the question naturally arises of how to integrate the resulting functional relationships into the overall model structure, if an overall model is what one's after. This chapter solves some not particularly deep but somewhat tricky accounting issues that arise thereby, namely when one attepmts to combine several demand-driven and several supply-constrained sectors in an open economy such as that of Ghana. This accounting would be at the heart of a dynamic model if building one could fit into this already ambitious project. As it is, it is something of a note on the margins, as it were.

10.1 A Fix-Flex Framework in an Open Economy

The problem we will solve here is the determination of imports and nontraded production given aggregate demand levels, when for some of the sectors nontraded production meets demand, but for other sectors total nontraded production is given in advance. Suppose that all relaive prices are known (in a model, they would evolve dynamically in a different module); thus in demand-constrained sectors the allocation of production between nontraded goods and exports is given. Likewise, assume we know the export volumes for the sectors whose nontraded production is demand-driven.

Now consider an increase in aggregate demand, and the way it gets distributed among imports and nontraded goods. In demand-driven sectors, domestic production will grow along with imports, maintaining a fixed import-to-nontraded volume ratio. This could be the case for manufactures in Ghana. On the other hand, for supply-constrained sectors, such as agriculture, all extra demand will spill directly into imports.

So far, so simple. However, the picture is complicated by two extra developments: fistly, demand-driven and supply-constrained sectors use each other's output as intermediate inputs. Secondly, domestic trasport and retail services, although demand driven, are only supplied by domestic producers, and are not directly demanded by consumers, but rather are bundled with the final goods that consumers demand.

While all these restrictions could conceivably be formulated as implicit constraints on the solution, we feel it is desirable to make the computations explicit. That will make them more transparent, clarify the causal structrure, and speed up the numerical solution process. As several hundred runs, at least, are typically necessary for numerical estimation and sensitivity analysis of a dynamic model of the size ours would have to be, speed is not a negligible factor.

Let us formulate the problem precisely. First, consider the flow equilibrium condition in the goods markets, in real terms - it is always observed as any product or service bought by somebody must be sold by somebody else. Let E be the vector of exports by sector, A the total absorbtion (private consumption plus investment plus government final demand), II the total intermediate input demand, I imports, and N non traded production. All of these are vectors with the elements corresponding to sectors. Further, let S denote the square matrix describing derived demand for transport and retail, so that derived demand for transport and retail equals $S(I+N)$. All rows of S are zero except the row corresponding to transport and retail services, with the entries in this row containing the sector-specific values of the retail markup. As transport and retail itself does not attract a retail markup (it can use retail as intermediate input, but that is taken care of in the Leontief matrix below), the diagonal entries of S are all zero, and thus $S^2 = 0$.

With the notation just introduced, we can formulate the flow equilibrium condition in the goods markets, in real terms:

$$E + A + II + S(I + N) = I + N + E \tag{10.1}$$

Now intermediate inputs can be decomposed in intermediate inputs used by private sector for export production, by private sector for nontraded production, and by the government. We assume that the private sector uses a Leontief technology, while the government determines the composition of its intermediate input demand arbitrarily. Thus we have

$$II = II_g + LE + LN \tag{10.2}$$

with L being the Leontief matrix. For easier manipulation let us define total demand as

$$D = I + N \tag{10.3}$$

Then (10.1), after canceling out the exports on both sides and inserting (10.2) and (10.3), becomes

$$D \quad = \quad (A + II_g + LE) + LN + SD \Leftrightarrow \tag{10.4}$$

$$
\begin{aligned}
(1-S) &= D\,(A+II_g+LE)+LN \Leftrightarrow &(10.5)\\
D &= (1+S)\,[(A+II_g+LE)+LN] &(10.6)
\end{aligned}
$$

The second transition holds as $S^2 = 0$, and therefore $(1-S)^{-1} = (1+S)$ (with 1 denoting the unity matrix throughout). The equation (10.6) is actually a quite intuitive version of the product flow equilibrium: total demand equals absorption plus intermediate input demand, with the retail/transport markup on top of everything.

If we denote

$$
\begin{aligned}
\tilde{A} &= (1+S)\,(A+II_g+LE) &(10.7)\\
\tilde{L} &= (1+S)L &(10.8)
\end{aligned}
$$

then (10.6) can be re-written as

$$
D = \tilde{A} + \tilde{L}N \tag{10.9}
$$

Here $\tilde{A}$ is a combination of known quantities and is therefore known; likewise $\tilde{L}$. Having thus converted the basic conservation law into a form suitable for convenient manipulation, let us now turn to allocating demand between imports and nontraded goods.

To begin with, let's pretend all sectors are demand driven and therefore for each sector i the ratio σ_i of nontraded goods to imports is a function of relative price and therefore fixed for our purposes. Let σ be a diagonal matrix whose diagonal entries are σ_i. Then the constant ratio relationship can be written as

$$
N = \sigma I + SD \tag{10.10}
$$

because the domestic transport and retail services are not subject to that ratio relationnship, but are supplied purely domestically, as a markup on demand.

Using (10.9) we can re-write (10.10) as

$$
\begin{aligned}
N &= \sigma(D-N)+SD= && (10.11)\\
&= \sigma(\tilde{A}+\tilde{L}N-N)+S(\tilde{A}+\tilde{L}N)= && (10.12)\\
&= (\sigma+S)\tilde{A}+[(\sigma+S)\tilde{L}-\sigma)]N \quad \Leftrightarrow && (10.13)\\
\left[1+\sigma-(\sigma+S)\tilde{L}\right]N &= (\sigma+S)\tilde{A} && (10.14)
\end{aligned}
$$

We are now almost at our goal. However, the reader must at this point resist the urge to invert the matrix in front of N in (10.14), as (10.14) is not in truth valid for all sectors, but only for demand-driven ones. All of our manipulations starting with (10.10) only consisted in rearranging terms without mixing up the different sectors, and thus the equality (10.14) is still true for the demand-driven sectors, but not for supply - constrained ones.

Let us denote

$$
\begin{aligned}
B &= 1+\sigma-(\sigma+S)\tilde{L} && (10.15)\\
&= 1+\sigma-(\sigma+S)(1+S)L && (10.16)\\
A^{(1)} &= (\sigma+S)\tilde{A} && (10.17)\\
&= [(\sigma+S)(1+S)](A+II_g+LE) && (10.18)
\end{aligned}
$$

Then (10.14) can be rewritten as

$$BN=A^{(1)} \qquad (10.19)$$

Note that the matrix B is constant and is computed in a straigthforward manner from the known matrices describing import to nontraded ratio, retail markups and the Leontief technology. Likewise, the vector $A^{(1)}$ is easily computed by multiplying the exogenous demand injections by a constant matrix.

Now (10.19) is still only true for the elements corresponding to demand-driven sectors. To isolate these, let us split the vector N into the supply-constrained and demand-driven components

$$N = \begin{pmatrix} N_s \\ N_d \end{pmatrix} \tag{10.20}$$

and look at the corresponding block-matrix representation of (10.19):

$$\begin{aligned} \begin{pmatrix} B_{ss} & B_{sd} \\ B_{ds} & B_{dd} \end{pmatrix} \begin{pmatrix} N_s \\ N_d \end{pmatrix} &= \begin{pmatrix} A_s^{(1)} \\ A_d^{(1)} \end{pmatrix} \Leftrightarrow \\ \begin{pmatrix} B_{ss}N_s + B_{sd}N_d \\ B_{ds}N_s + B_{dd}N_d \end{pmatrix} &= \begin{pmatrix} A_s^{(1)} \\ A_d^{(1)} \end{pmatrix} \end{aligned} \tag{10.21}$$

As we have said before, only the lower half of (10.21), that is the part referring to demand-driven sectors is true. Thus we finally arrive at the precisely true expression for the demand-driven sectors:

$$B_{ds}N_s + B_{dd}N_d = A_d^{(1)} \tag{10.22}$$

As the nontraded output of the supply-constrained sectors vector N_s is known, we can solve (10.22) for N_d as

$$N_d = B_{dd}^{-1}\left(A_d^{(1)} - B_{ds}N_s\right) \tag{10.23}$$

Inserting that into (10.20) we obtain the whole nontraded output vector N. Inserting it into (10.9) gives us the total demand D, and solving (10.3) for I gives us imports by sector.

10.2 Summary

This section derived the accounting for determining total volumes of imports and nontraded production given total absorbtion and export volumes, in an open economy combining supply-constrained and demand-driven sectors. It took into account relative price-determined ratios between imports and nontraded goods, retail ratios, and the demand for intermediate inputs.

Once the derivation is done, the actual computation required is quite simple. This can be a useful component of a dynamic model of a fix-flex open economy with an arbitary number of sectors.

Chapter 11

Econometric Investigation of Monthly Time Series

11.1 Introduction

In contrast to the real-side variables investigated in the previous chapter, for which only yearly series are available, most nominal and financial variables, such as the Consumer Price Index, exchange rate and the interest rates, are available on a monthly basis for all or most of the period in question. We are thus able to conduct much more rigorous statistical hypothesis testing, and proceed to do so in the present chapter. We restrict ourselves to analyzing the behavior of two key nominal prices, namely the Consumer Price Index (CPI) and the exchange rate (cedis to the dollar), and of the broad money supply. We use the Stata statistical package throughout. As in the previous chapter, we provide individual summaries for each section, instead of one chapter summary; the summaries in this chapter are brief and technical, with the discussion of implications for theory and policy reserved for later chapters.

Let us denote the natural log of the consumer price index by `cpi`, the natural log of the exchange rate by `er`, and the natural log of the broad money supply `m2`. (As changes in the value of either macro price are typically in proportion to its current value, it is common practice to consider them in log form). As we will see below, all these three variables are first order integrated (I(1)), as is common for nominal time series.

We begin by listing the explanatory variables suggested by economic theory for each of our three dependent variables, and running a regular least squares regression using these. Unfortunately, since all three dependent variables are I(1) nonstationary, the results of these regressions are only meaningful if the variables are cointegrated. Using the Durbin-Watson statistic, we fail to find cointegration in all three cases

In the absence of cointegration, we have to resort to ARIMA-X (Autoregressive Integrated Moving Average with eXogenous variables) regressions using first differences and lags of independent variables (Stata command `arima`).

For those independent variables that are only available yearly (namely GDP and export and import dollar price indices), we first interpolate them to monthly using an algorithm due to Prof. Clopper Almon, and then only use the 12 month-seasonal difference `S12.X(t)=X(t)-X(t-12)`[1] in the regressions, as results arising from using any shorter differences would likely be an artifact of the interpolation method used.

To find out the correct lag structure for the variables where original data series were monthly, we first regress the dependent variable on fifteen lags of each independent variable in turn, as well as `ar(1/6,12)` and `ma(1/6,12)`, with the 12-month autoregressive lag inserted to account for possible seasonal effects, and note

[1] For those of our readers unfamiliar with Stata, an explanation of the notation is in order at this point. The expression `D.X` or `D1.X` refers to the first difference of the variable `X`, that is, `D.X(t)=X(t)-X(t-1)`. `LN.X` refers to lag of order N; for example, is, `L5.X(t)=X(t-5)`. `SN.X(t)` refers to the "seasonal difference"; for example, `S4X(t)=X(t)-X(t-4)`. These operators can be nested – for example, `L2S3.X(t)=X(t-2)-X(t-5)=L2D.X(t)+L3D.X(t)+L4D.X(t)`.

Further, `1/5` is a short notation for 1,2,3,4,5 (as the usual notation 1-5 could be confused with subtracting 5 from 1).

down the lags of the independent variable that prove significant.

We use the information thus obtained to formulate a first, rather generously overparametrized regression, and use it as a first in a model identification process, generating a sequence of ever simpler models while at each step computing several statistics to make sure that residuals still behave as white noise and that we are not losing substantial quality of fit.

Finally, we test the predictive qualities of the model we have thus identified by using it to predict its corresponding dependent variable from January 1998 onwards, one time with coefficients estimated from the whole dataset, and one time with coefficients estimated using only pre-1998 data. The details for each dependent variable are presented below.

11.2 Consumer Price Index

To explain the behavior of the Consumer Price Index, we use the following variables: Money supply (broad money `m2`, computed from the side of liabilities of the banking system) and real GDP as the traditional price level determinants in the velocity of money equation; exchange rate, wholesale price of food crops and price of fuel (the latter being government-controlled) as important components of cost; and the interest rate on government bonds. All of these variables except the interest rate are taken in natural log terms.

The relationship between the price level and the money supply is of particular interest to us due to its relevance to both theory and policy, as we have discussed in Chapters 3 and 4. Figure 11.1 shows inflation and broad money growth rate for our period.

On the policy side, a vision of an active money supply that drives the aggregate price level while being itself to a large extent controlled by the government is at the core of IMF-inspired adjustment programs. On the theoretical side, the direction of causality between the price level and the money supply is one of the key differences between structuralist and Walrasian/monetarist CGE models.

As we have seen in Chapter 4, in structuralist models prices are determined from the side of costs, with no direct influence of the money supply on prices; the main indirect channel would be through interest rates, larger money supply leading to more credit supply, lower interest rates and thus lower inflation pressure from the cost of borrowing.

In Walrasian/monetarist models the picture is almost exactly reversed. To begin with, the standard money demand equation $Py = V(r)M$ means that an increase in the money supply translates ceteris paribus directly into a proportional increase in the price level; secondly, increasing interest rates will increase money demand, lowering the velocity of money and *lowering* the price level. The question of which of these two views is correct is crucial for choosing and evaluating monetary policy options.

The role of the interest rate is important as the interest rate is a common policy tool for inflation control. It was for inflation control purposes that the interest rates in the 1990s were set so high in Ghana. The interest rate is an interesting variable in this context, as it is considered by monetarists to stimulate money demand and thus its increase would be expected to *decrease* inflation; while structuralists consider it

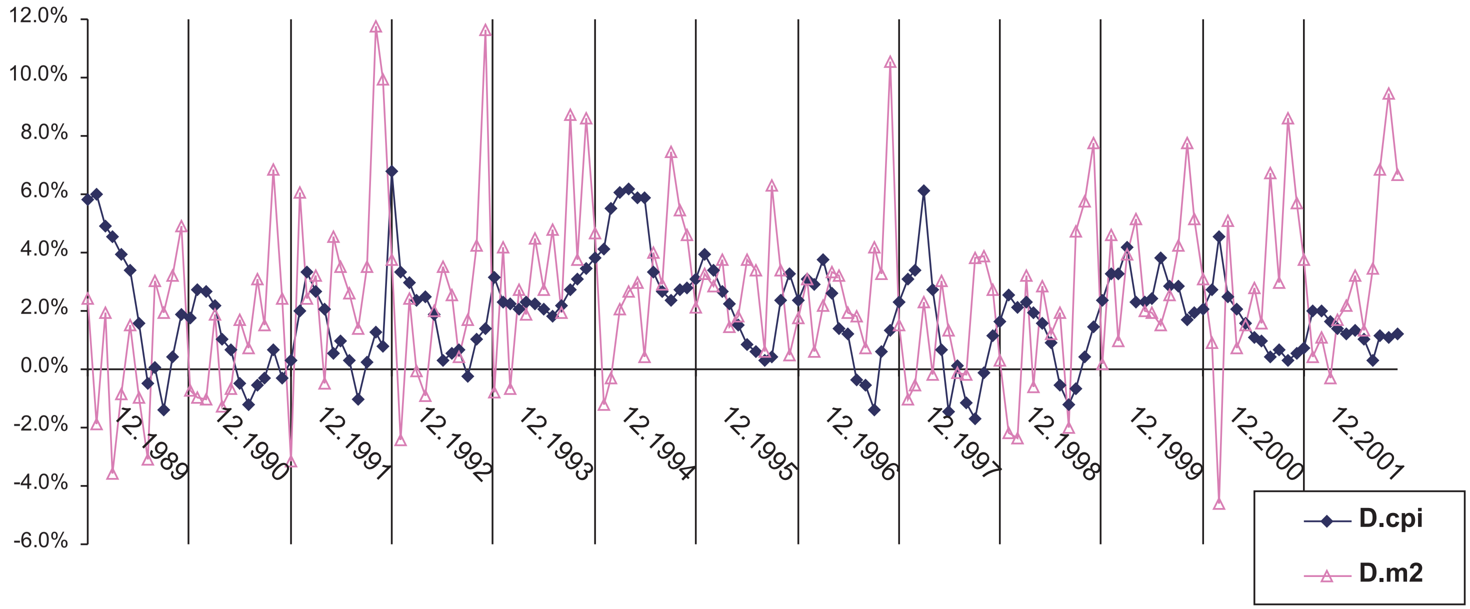


Figure 11.1: Inflation and Money Supply Growth

D.cpi	D.m2	D.er	D.fuel	D.food	D.rtb
Significant lags	1-9	-	1	0-2	1-3

Table 11.1: Preliminary Lag Structure Examination for CPI

primarily as a component of cost and thus would expect its increase to lead to an *increase* in inflation. Thus the sign of its coefficient will be quite interesting to see. We take the interest rate on treasury bills rather than, say, the interest rate on deposits, because it is closely related to the other key domestic interest rates, and because it is the actual instrument that the Bank of Ghana uses for the purposes of inflation control.

To begin our analysis, let us first test the CPI for stationarity. Augmented Dickey-Fuller test (`dfuller cpi,trend regress`) returns ADF=-0.51, corresponding to $p = .98$. Augmented Dickey-Fuller test on *D.cpi* and *D.er* returns ADF=-4.6, corresponding to $p = 0.001$. Thus we conclude that `cpi` is I(1).

We proceed to run a regular least-squares regression

```
reg cpi mb gdp er fuel food rtb; dwstat
```

which returns a d-value of .285, well below the cointegration significance threshold. Thus the variables are not cointegrated and we have to run an ARIMA-X regression.

To find out the correct lag structure, we first run

```
arima D.cpi X L.X ... L15.X, ar(1/6,12) ma(1/6,12)
```

where the variables `X` are listed in Table 11.1. GDP does not appear in the table because it has been interpolated from a yearly series and thus we will only use `S12.gdp`.

From Table 11.1 we see that the impacts of money supply are significant over a long period, while impacts of rises in wholesale food crop prices (denoted `food`) and fuel prices are almost instantaneous and the results are less clear for the other variables. Based on that information, we formulate the first regression which is reported in Table 11.2.

The meaning of the different columns of Table 11.2 bears some explanation. Akaike's Information Criterion and Schwarz's Criterion are used to compare quality of fit for different models while adjusting for the different number of coefficients in different models, with more negative values meaning better fit (as both are derived from log-likelihood). We computed them using the Stata command `arimafit`. Portemanteau (Q) statistic (Stata command `wntestq`)and Bartlett's (B) statistic (`wntestb`) are measures of whether the residuals behave like white noise. For compactness reasons, we only report the corresponding p-values, that is, the probabilities that a given residuals sequence has been produced by a white noise process. Therefore, higher p-values are evidence for white noise and therefore for a good model.

We start from a generously overparametrized regression, including autoregressive and moving average terms `1/6` and `12`, the latter being there to account for possible seasonal effects. In successful steps we can whittle that down to `ar(1)` which is then highly significant and remains so throughout the latter regressions.

In the next step, we proceed to trim down the independent variables. To see whether a variable (meaning all of its lags) belongs into the regression, we use two measures: firstly, we use the Stata command `test` to test the hypothesis that the coefficients of all of the lags of that variable are zero; secondly, we use `lincom` to test

ARMA terms	Exo terms	AIC	SIC	wntestq	wntestb
ar(1,2,12) ma(1,2,12)	D.m2. . . L12D.m2, S12.gdp, D.er. . . L6D.er, D.fuel. . . L2D.fuel, D.food. . . L3D.food, D.rtb. . . L4D.rtb	-781	-668	77%	92%
ar(1,2) ma(1,2)	D.m2. . . L12D.m2, S12.gdp, D.er. . . L6D.er, D.fuel. . . L2D.fuel, D.food. . . L3D.food, D.rtb. . . L4D.rtb	-778	-671	84%	99.90%
ar(1) ma(1)	D.m2. . . L12D.m2, S12.gdp, D.er. . . L6D.er, D.fuel. . . L2D.fuel, D.food. . . L3D.food, D.rtb. . . L4D.rtb	-779	-677	76%	78%
ar(1)	D.m2. . . L12D.m2, S12.gdp, D.er. . . L6D.er, D.fuel. . . L2D.fuel, D.food. . . L3D.food, D.rtb. . . L4D.rtb	-779	-681	47%	36%
ar(1)	D.m2. . . L12D.m2, D.fuel. . . L2D.fuel, D.food. . . L3D.food, D.rtb. . . L4D.rtb	-782	-700	74%	70%
ar(1)	D.m2. . . L12D.m2, D.fuel. . . L2D.fuel, D.food. . . L3D.food	-781	-719	13%	78%
ar(1)	D.m2. . . L12D.m2, D.fuel. . . L2D.fuel, D.food. . . L2D.food	-783	-724	13%	79%
ar(1)	D.m2. . . L12D.m2, D.fuel. . . L2D.fuel, D.food. . . L2D.food	-783	-724	13%	79%

Table 11.2: ARIMA-X model identification for `D.cpi`

Sample: 13 to 136	Number of obs = 124	Semi-robust
Wald chi2(20) = 244.07	Log likelihood = 412.7643	Prob > chi2 = 0

D.cpi		Coeff.	Stdev.	z	$P > z$	95% Conf. Interval	
m2	D1	0.025	0.028	0.90	36.9%	-0.030	0.080
	LD	0.074	0.036	2.10	3.6%	0.005	0.144
	L2D	0.079	0.041	1.91	5.6%	-0.002	0.160
	L3D	0.080	0.042	1.89	5.9%	-0.003	0.163
	L4D	0.163	0.039	4.21	0.0%	0.087	0.239
	L5D	0.133	0.042	3.16	0.2%	0.051	0.215
	L6D	0.096	0.042	2.27	2.3%	0.013	0.179
	L7D	0.009	0.041	0.21	83.0%	-0.072	0.089
	L8D	0.005	0.030	0.18	86.0%	-0.053	0.064
	L9D	0.008	0.034	0.23	81.5%	-0.058	0.074
	L10D	-0.013	0.032	-0.43	67.1%	-0.076	0.049
	L11D	0.004	0.033	0.14	89.3%	-0.061	0.070
	L12D	-0.025	0.028	-0.91	36.5%	-0.079	0.029
fuel	D1	-0.001	0.010	-0.10	92.4%	-0.021	0.019
	LD	0.042	0.015	2.73	0.6%	0.012	0.072
	L2D	0.016	0.013	1.24	21.7%	-0.009	0.040
food	D1	0.015	0.010	1.47	14.2%	-0.005	0.035
	LD	0.022	0.011	1.97	4.9%	0.000	0.045
	L2D	0.029	0.009	3.31	0.1%	0.012	0.046
_cons		0.0004	0.0063	0.06	95.5%	-0.0120	0.0127
ar	L1	0.706	0.072	9.85	0.0%	0.566	0.847
/sigma[2]		0.0086	0.0006	15.28	0.0%	0.0075	0.0098

Table 11.3: ARIMA-X regression for `D.cpi`

whether the sum of all the lags' coefficients is zero. If both of these give p-values above 30%, the variable is a candidate for elimination.

In the first step, we eliminate GDP and the exchange rate, without any losses in quality of fit or in the likeness of residuals to white noise. Then we do the same to the interest rate, ending up with a regression presented in Table 11.3.

The regression of Table 11.3 is further summarized in Table 11.4, where we report the values and standard deviations of the sum of each variable's coefficients (describing the total impact of a change in that variable on the price level), as well

[2] /sigma refers to the standard error of the disturbance

Variable	Terms included	Value	Stdev	Coeff. p	Variable p	Total Impact
m2	D...L12D	0.673	0.213	0.20%	0.51%	0.85
fuel	LD...L2D	0.057	0.024	1.90%	2.70%	0.07
food	D...L2D	0.066	0.025	0.90%	1%	0.08
cons		0.0004	0.0062	96.00%	95%	
ar(1)		0.706	0.071	0.00%		

Table 11.4: Summary of ARIMA-X regression for `D.cpi`

as the probability that all of that variable's coefficients are zero. The column "Total Impact" shows the overall impact of each variable after accounting for the positive feedback loop between prices and money supply (see Section 11.4) that increases all impacts by 27%.

What do we learn from these tables? First of all we see that interest rates, exchange rate and GDP do not have a significant direct impact on the price level. On the other hand, the impact of changes in broad money supply is substantial, with a 1% increase in broad money supply leading to over a .85% increase in the CPI after inflation inertia is taken into account; the total impacts of fuel prices and wholesale food crop prices are smaller but also not negligible, with a 1% increase in either leading to a total .08% resp. .07% increase in CPI. These two price indices are much more volatile, and their impacts are almost instantaneous, whereas the impact of increases in money supply takes about a year to fully work itself out. Thus, the contributions of the price of fuel and the wholesale price of food crops to inflation at any given time could in principle be larger than those of money supply. However, we can see that this is rarely the case from Figure 11.2, which shows the respective contributions to inflation over time of each of the three independent variables (reconstructed from the regression in Table 11.3).

A hopeful sign is that the constant turns out to be entirely non-significant ($p =$ 96%), so that inflation is completely predicted by changes in our chosen independent variables, without a constant term that would have stood for an exogenous trend in the price level and thus would have suggested we have omitted some of the inflation determinants, namely those causing that trend.

Another way of assessing how well the regression of Table 11.3 is by using it for forecasting part of the data, in the manner of Chapter 9. For this, we use the `predict` command of Stata to predict `cpi` from January 1998 onwards. We have several options to construct such a forecast: firstly, we can use the *actual* values of the variable in a previous month to predict the value of the variable at the next time step. This will result in a very good fit as that was the expression whose error was maximized in the regression in the first place. However, this is not a good indicator of prediction quality as we would not know the previous' month inflation when predicting a moment several months into the future. Thus, to get a better estimate of predictive power of our regression, we should determine each month's inflation recursively, using last month's predicted value in the autoregressive term (option `dynamic()` in Stata). If such an approach gives good results, that would be encouraging, but not quite enough - after all, the regression coefficients were determined using the data for the whole period, not just the pre-1998 period. Thus, the next step is to re-run the regression of Table 11.3 using only data up to January 1998, and use the resulting coefficients to do post-January 1998 predictions. If that approach is good at prediction, we have some reason for confidence.

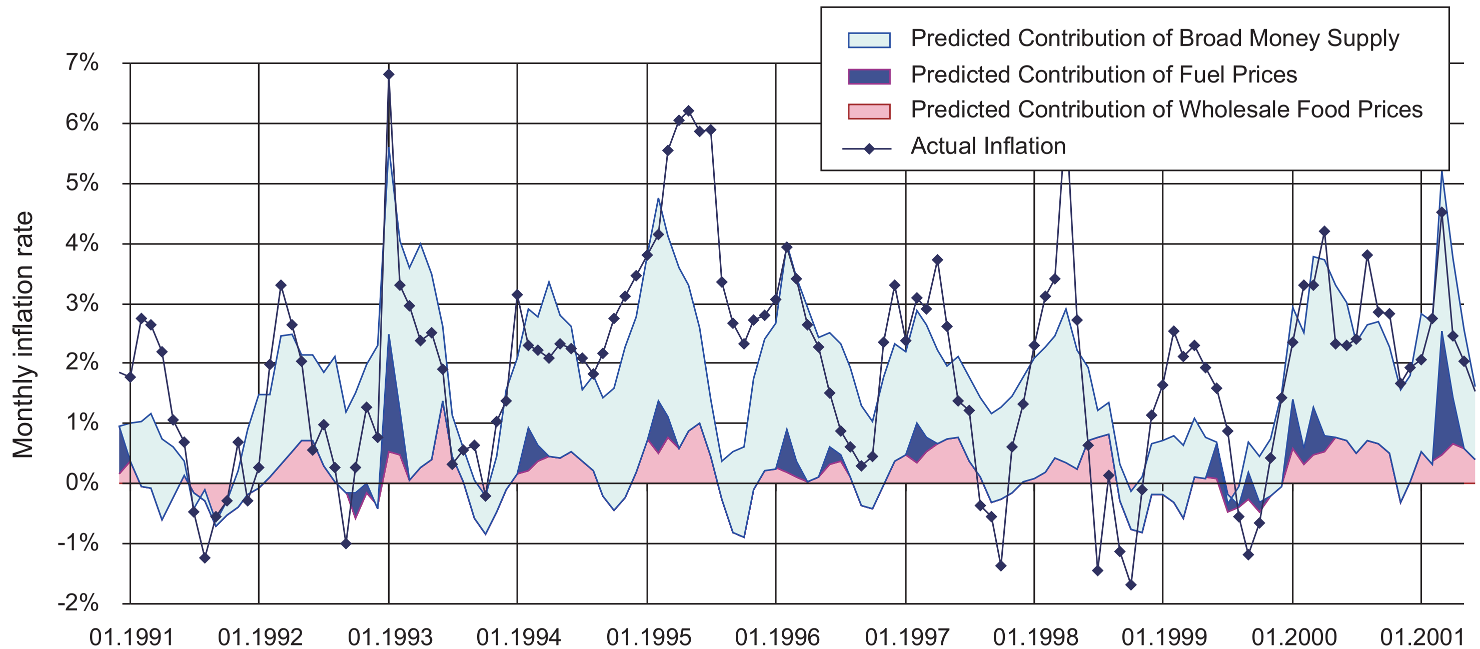


Figure 11.2: Contributions to Inflation Derived from Table 11.3

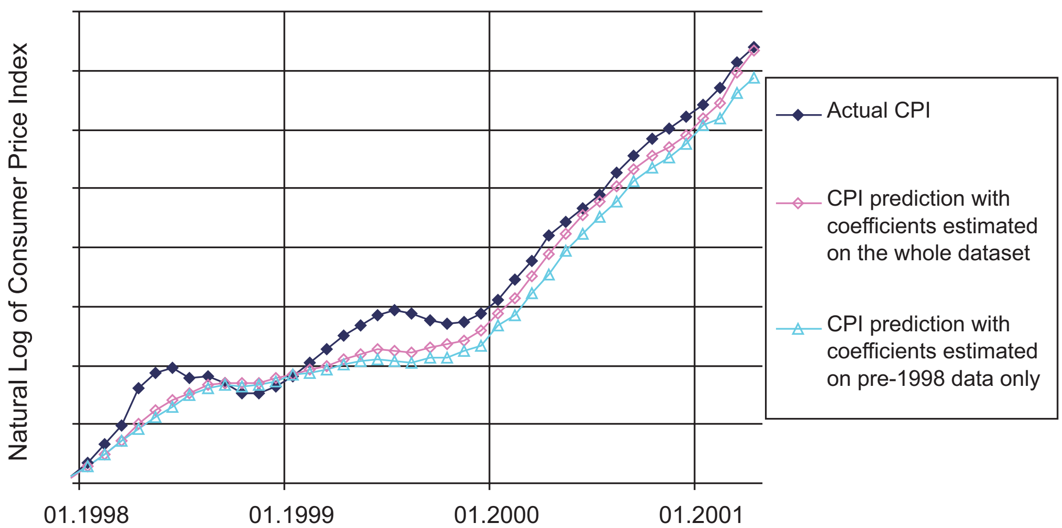


Figure 11.3: Actual CPI vs. predictions from ARIMA-X regressions

We should note that even the latter approach is not fully equivalent to the approach of Chapter 9, as model identification, that is the choice of variables and lags in Table 11.3 was also made using the whole dataset. To make the testing quite clean, we should repeat the model identification process using only pre-1998 data; however, as this step would require much more effort than the previous ones, we regretfully omit it. The results are shown in Figure 11.3 and are quite encouraging - all three versions do quite well at predicting the CPI several years into the future. The predictions are both accurate and robust with respect to the choice of estimation time period.

A plausible way of interpreting the deviations would be to say that the CPI occasionally outgrows our prediction due to some short-term cost shock, but always tends back to the medium-term value that is predicted by our regression.

On this hopeful note, we conclude the investigation of the price level and turn to understanding one of its major determinants, namely the broad money supply.

11.2.1 Summary

Investigation of the price behavior gives us both expected and unexpected results. On the expected side, money supply is highly significant for price formation, and takes its effect gradually over with a lag of two to nine months. Increases in fuel and wholesale food crop prices are also highly significant, but their impacts happen over a much shorter period (lags 0-2). Using just these three variables, we can predict `cpi` surprisingly well four years into the future (1998-2001), with coefficients estimated using pre-1998 data only.

On the surprising side, exchange rate depreciation, interest rate changes, and GDP growth appear to not have significant direct influence on inflation.

11.3 Money Supply

The first issue we have to address in this section is the justification of the definition of money supply that we will use. The main options are definition from the liability vs. asset side of the banking system and monetary base vs. broad money (for an introduction to these terms, see Chapter 5).

Regarding the first of the two choices, we choose to define money supply from the side of the banking system's liabilities. This is preferable from both monetarist and structuralist theoretical perspectives as the money supply is meant to represent the liquidity held by the private sector.

Broad Money vs. Monetary Base

As for the choice between monetary base and broad money, the first question one might ask is whether it makes any difference. In fact, if the reserve requirement is exactly observed, simple algebra shows the two are proportional. Thus, while from the theoretical side it would seem preferable to take broad money as a measure of private sector's liquid assets, it is common in CGE models [Kraev 2003, Table 2.2] to take the monetary base as the money supply whose market is cleared by the price level.

However in the case of Ghana, where interest rates above 30% were not at all unusual in the 1990s, the reserve requirement was *not* exactly observed. In fact, it was common for the banks to have liquidity (in the form of government bonds) well in excess of the reserve requirement, making base money and broad money two independent variables.

We test the constancy of the ratio between monetary base and broad money by first computing the log of that ratio for each month (by subtracting the log of monetary base `mb` from the log of broad money `m2`) and then testing it for stationarity using the Augmented Dickey-Fuller test, which returns $Z(t) = -2.202,\ p = 0.4900$. Thus, we conclude that the two definitions of money supply are not in fact proportional, and it does make a difference as to which one we use. We use broad money `m2` as it would seem a better measure of the private sector's liquid assets, and use the monetary base `mb` as one of its explanatory variables.

Choice of Explanatory Variables

We choose the following explanatory variables: Consumer Price Index `cpi`, the interest rate on government bonds `rtb`, the exchange rate `er`, and the monetary base `mb`. Of these, all are in log terms except `rtb`, which is measured in percentage points.

We choose these independent variables for the following reasons: We have seen in Section 11.2 that the direct effect of interest rate increases on inflation is not significant. In itself, this did not settle the question of the total effect of the interest rates on inflation, as a theoretically important channel is the influence of interest rates on money supply - something we would not observe in the regression of Table 11.3 as money supply is also an independent variable there.

As we have discussed in the previous section, an important way in which raising interest rates could combat inflation is by reducing the money supply (as the private sector chooses to hold government bonds rather than liquidity when interest rates rise). Whether they do so or not is an important question for monetary policy.

The role of the CPI is important to complement our understanding of the CPI-money supply causality. In monetarist theory, money supply drives prices through clearing of the money market. In structuralist theory, prices can drive money supply through demand for working capital - firms are assumed to create/repay loans so as to hold an amount of liquidity proportional to the nominal value of their stock of goods being processed, and thus proportional to the price level.

We have seen in the `cpi` section that the money supply has a strong influence on the price level, but the question still remains whether there is also causality pointing in the other direction, creating a feedback loop, or whether the money supply is largely unaffected by the price level.

Exchange rate is included because the money supply has a substantial foreign currency-denominated component, making revaluation a potentially important contribution to money supply growth. Finally, monetary base is important as it is more or less directly controlled by the central bank and is an important policy instrument.

Model Identification and Estimation

First of all, let us note that `m2` is nonstationary, I(1): ADF for `m2` gives Z(t)=-2.26, $p = 0.26$, ADF for `D.m2` gives Z(t)=-9.7999, $p = 0.0000$. Regressing `m2` on `rtb`,`cpi`, `er` and `mb` gives us a $d = .1844$, way below the 10% significance level (.322) for cointegration. Thus the variables in question are not cointegrated, and we will resort to ARIMA-X regression as before. We have seen before that `cpi` is I(1). So are the other independent variables: ADF for `rtb` gives $p = .91$, and ADF for `D.rtb` gives $p = 0.0000$; ADF for `er` gives $p = .83$, and ADF for `D.er` gives $p = 0.0000$; ADF for `mb` gives $p = .23$, and ADF for `D.rtb` gives $p = 0.0000$.

Now we proceed to identify and estimate the model using the same strategy as in the previous section, with the regressions described in Table 11.5. The regression we ultimately arrive at is shown in Table 11.6 and summarized in Table 11.7.

Looking at these tables, we see that `cpi` has no significant influence on the money supply. Further, in contrast to the `cpi` regression, all variables' impacts are quite quick, taking no more than two months to develop. Monetary base increase by

ARMA terms	Exogenous terms	AIC	SIC	wntestq	wntestb
ar(1/6,12) ma(1/6,12)	D.rtb. . . L5D.rtb, D.cpi. . . L9D.cpi, D.er. . . L9D.er, D.mb. . . L9D.mb	-698	-558	97%	100%
ar(1/2) ma(1/2)	D.rtb. . . L5D.rtb, D.cpi. . . L9D.cpi, D.er. . . L9D.er, D.mb. . . L9D.mb	-668	-557	98%	92%
ar(1/2)	D.rtb. . . L5D.rtb, D.cpi. . . L9D.cpi, D.er. . . L9D.er, D.mb. . . L9D.mb	-670	-565	97%	92%
-	D.rtb. . . L5D.rtb, D.cpi. . . L9D.cpi, D.er. . . L9D.er, D.mb. . . L9D.mb	-672	-574	97%	61%
-	D.rtb. . . L3D.rtb, D.cpi. . . L3D.cpi, D.er. . . L4D.er, D.mb. . . L2D.mb	-705	-653	95%	54%
-	D.rtb. . . L3D.rtb, D.cpi. . . L3D.cpi, D.er. . . LD.er, D.mb. . . L2D.mb	-713	-671	95%	81%
-	D.rtb. . . L2D.rtb, D.cpi. . . L3D.cpi, D.er. . . LD.er, D.mb. . . L2D.mb	-714	-674	96%	87%

Table 11.5: ARIMA-X model identification for `D.m2`

Sample: 4 to 156	Number of obs = 153	Semi-robust
Wald chi2(12) =111.1	Log likelihood = 370.0599	Prob > chi2 = 0

D.m2		Coeff.	Stdev.	z	$P > z$	95% Conf. Interval	
rtb	D1	0.0002	0.0011	0.18	86.0%	-0.0020	0.0024
	LD	-0.0010	0.0010	-0.98	32.9%	-0.0031	0.0010
	L2D	-0.0027	0.0012	-2.21	2.7%	-0.0051	-0.0003
cpi	D1	-0.104	0.183	-0.57	56.9%	-0.462	0.254
	LD	0.129	0.267	0.48	62.9%	-0.394	0.651
	L2D	-0.062	0.312	-0.20	84.1%	-0.674	0.549
	L3D	-0.089	0.198	-0.45	65.2%	-0.477	0.299
er	D1	0.028	0.082	0.34	73.5%	-0.134	0.189
	LD	0.157	0.070	2.24	2.5%	0.020	0.295
mb	D1	0.195	0.047	4.18	0.0%	0.104	0.287
	LD	0.114	0.020	5.79	0.0%	0.076	0.153
	L2D	0.016	0.023	0.68	49.5%	-0.030	0.062
_cons		0.017	0.004	4.35	0.0%	0.009	0.025
/sigma		0.022	0.001	14.63	0.0%	0.019	0.024

Table 11.6: ARIMA-X regression for `D.m2`

Variable	Terms included	Value	Stdev	Coefficient p	Variable p
rtb	D . . . L2D	-0.0035	0.0015	2.0%	1.0%
cpi	D . . . L3D	-0.127	0.203	29.0%	86.0%
er	D . . . LD	0.185	0.870	3.3%	3.8%
mb	D . . . L2D	0.326	0.052	0.0%	0.0%
cons		0.017	0.004	0.0%	

Table 11.7: Summary of ARIMA-X regression for `D.m2`

one percent increases money supply by about .3%, and exchange rate depreciation of 1% increases money supply by a little under .2%. An increase in the interest rate by ten percentage points results in an extra 3.5% decrease in the money supply[3], in accordance with the portfolio balance theory.

A more worrying development is a constant of .017, corresponding to an exogenous yearly growth rate of money supply of $.017 \times 12 \approx 20\%$. This becomes even more worrying once we use the model of Table 11.6 to predict `m2` from January 1998 onwards, once using the coefficients of Table 11.6 and once using the model of Table 11.6 re-estimated using only pre-1998 data. As Figure 11.4 shows, the constant trend dominates the predictions in both cases, and the predictions fail to capture the slowdown of money supply growth in 1998. We would like the behavior of money supply to be explained by the explanatory variables and its own past values – there is little theoretical justification for an exogenous constant growth rate. Therefore, we repeat the model identification process, this time forcing the constant in the regressions to be zero throughout. The model identification process is portrayed in Table 11.8, with the model we arrive at shown in Table 11.9 and summarized in Table 11.10. The predictions derived from that model are shown in Figure 11.5. As before, Total Impact refers to the total medium-term impact after accounting for

[3] It is perhaps worth reminding the reader that unlike the other variables, `rtb` is measured in percentage points (`rtb`=17 corresponding to 17%) and not considered in log terms. Thus, while a one percent change in the growth rate of the money supply means `D.m2`=0.01, an increase of the interest rate by one percentage point means `D.rtb`=1. This is the reason that the coefficients of the interest rate typically have two leading zeros after the comma.

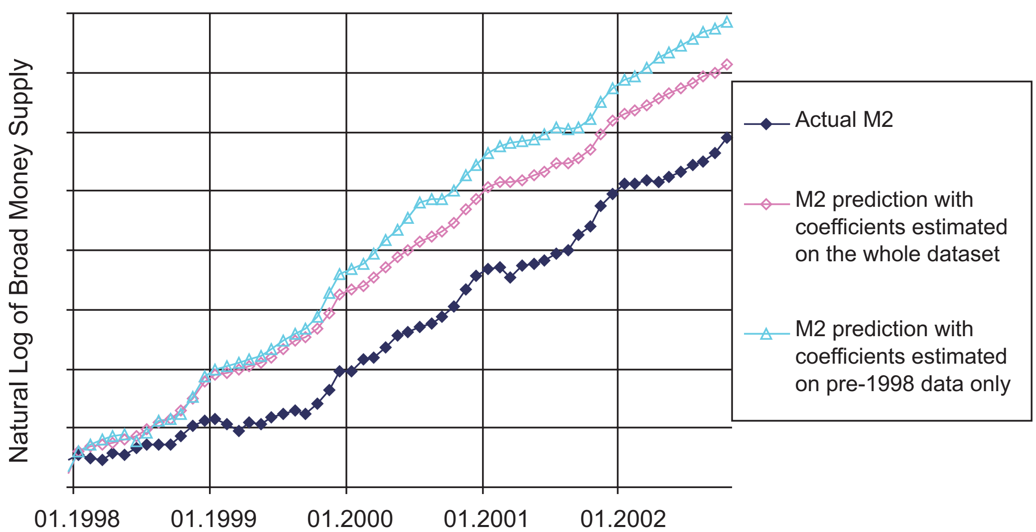


Figure 11.4: Actual M2 vs. predictions from ARIMA-X regressions

the effect of the feedback loop between money supply and prices, discussed below in Section 11.4.

As the constant was significant in the regressions of Table 11.5, removing it naturally results in lower Akaike and Schwarz scores; however, we are compensated by much better behavior of the predictors, as well as higher significance values. We see that both predictors still over-estimate the values of `m2`, but by a lower margin, and their behavior is much more similar to actual `m2` behavior. Furthermore, the predictor from the model estimated with pre-1998 data has very similar behavior to that estimated using the full data. Thus we conclude that the model seems to be robust with respect to choice of estimation data period and reasonably-well behaved, even if unfortunately not as precise as the model for `cpi`.

Our explanation for the comparatively poor precision of the model is that our definition of `m2` perforce had to omit foreign exchange cash (mostly dollar bills)

ARMA terms	Exo terms	AIC	SIC	wntestq	wntestb
ar(1/6, 12) ma(1/6, 12)	D.rtb. . . L5D.rtb, D.cpi. . . L9D.cpi, D.er. . . L9D.er, D.mb. . . L9D.mb	-658	-518	99%	100.00%
ar(1/3) ma(1/3)	D.rtb. . . L5D.rtb, D.cpi. . . L9D.cpi, D.er. . . L9D.er, D.mb. . . L9D.mb	-663	-546	95%	50.00%
ar(1/3)	D.rtb. . . L5D.rtb, D.cpi. . . L9D.cpi, D.er. . . L9D.er, D.mb. . . L9D.mb	-655	-547	95%	86.00%
ar(1)	D.rtb. . . L5D.rtb, D.cpi. . . L9D.cpi, D.er. . . L9D.er, D.mb. . . L9D.mb	-656	-555	96%	78.00%
-	D.rtb. . . L5D.rtb, D.cpi. . . L9D.cpi, D.er. . . L9D.er, D.mb. . . L9D.mb	-658	-560	96%	77%
-	D.rtb. . . L3D.rtb, D.cpi. . . L2D.cpi, D.er. . . L2D.er, D.mb. . . L3D.mb	-691	-646	89%	40%

Table 11.8: ARIMA-X model identification for `D.m2`, no constant

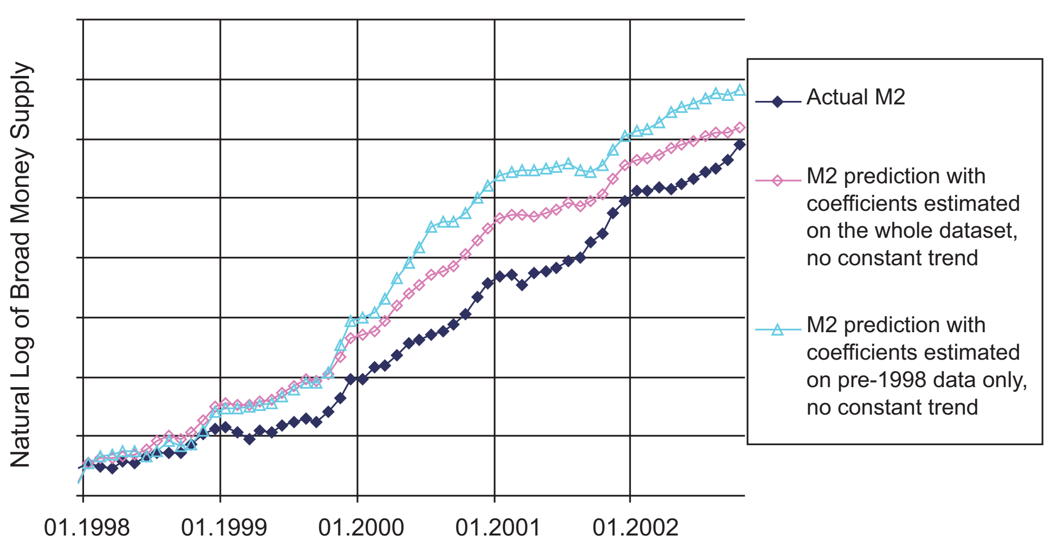


Figure 11.5: Actual M2 vs. predictions from ARIMA-X regressions without a constant term

Sample: 4 to 156	Number of obs = 153	Semi-robust
Wald chi2(14) =333.62	Log likelihood = 360.889	Prob > chi2 = 0

D.m2		Coeff.	Stdev.	z	$P > z$	95% Conf. Interval	
rtb	D1	-0.0007	0.0013	-0.52	60.1%	-0.0033	0.0019
	LD	-0.0021	0.0010	-1.97	4.9%	-0.0041	0.0000
	L2D	-0.0038	0.0014	-2.68	0.7%	-0.0066	-0.0010
	L3D	0.0006	0.0008	0.65	51.6%	-0.0011	0.0022
cpi	D1	0.071	0.178	0.40	68.9%	-0.278	0.421
	LD	0.150	0.290	0.52	60.5%	-0.418	0.718
	L2D	0.108	0.227	0.47	63.5%	-0.338	0.553
er	D1	0.144	0.096	1.50	13.5%	-0.045	0.332
	LD	0.223	0.089	2.50	1.2%	0.048	0.398
	L2D	-0.001	0.084	-0.01	99.3%	-0.166	0.165
mb	D1	0.222	0.051	4.31	0.0%	0.121	0.323
	LD	0.138	0.021	6.54	0.0%	0.097	0.180
	L2D	0.034	0.028	1.20	22.9%	-0.021	0.090
	L3D	-0.032	0.022	-1.45	14.6%	-0.075	0.011
/sigma		0.023	0.002	12.84	0.0%	0.019	0.026

Table 11.9: ARIMA-X regression for `D.m2`, no constant

Variable	Terms included	Value	Stdev	Coefficient p	Variable p	Total Impact
rtb	D...L3D	-0.006	0.0018	0.1%	0.0%	-0.008
cpi	D...L2D	0.329	0.085	0.0%	0.1%	0.418
er	D...L2D	0.366	0.103	0.0%	0.2%	0.465
mb	D...L3D	0.363	0.053	0.0%	0.0%	0.461

Table 11.10: Summary of ARIMA-X regression for `D.m2`, no constant

held by the populace. Anecdotal evidence suggests that this is a not insubstantial component, as dollars are widely used as a store of value; however it is not easy to measure and thus no data on it was readily available. While it is thus not included in our definitions of either `m2` or `mb`, it still affects them through portfolio re-balancing, introducing the imprecision we observe. It would be interesting to attempt to deduce the actual amount of foreign currency held by the populace by optimizing this predictor, but we will not attempt that here.

As the model without a constant trend exhibits more reasonable prediction behavior and is the more reasonable from a theoretical perspective, we will use it as the base for further analysis. Thus, from Table 11.10 we observe that a ten percentage point increase in the interest rate actually decreases the money supply growth rate by 6%, monetary base growth and exchange rate depreciation both have coefficients of about 0.36, and the CPI is now highly significant with a coefficient of 0.33. All of these effects happen within three months, and are then all increased by a factor of about 1.27 over the next year, as discussed in the next section.

11.3.1 Summary

This section investigated the dependence of the broad money supply growth on the changes in interest rates, inflation, exchange rate depreciation, and base money growth, as well as its own past values. The results show no autoregressive or moving-average components, but a strong dependence on the exchange rate, monetary base, and Consumer Price Index, as well as a significant but not huge response to interest rates; all coefficients have signs and magnitudes that are reasonable from a theoretical standpoint.

From a .37 coefficient of the depreciation rate in the `m2` regression, combined with the fact that exchange rate depreciation was not significant in the `cpi` regression, we draw the somewhat surprising conclusion that the main channel for the impact of currency depreciation on inflation is not through cost-push, but through revaluation of the money supply.

In contrast to the CPI regression, all effects are quite fast, taking at most 3 months for the full impact to be felt; the predictions of post-January 1998 values based on the regressions exhibited realistic behavior and were quite robust with respect to the estimation time period, but were not as precise as the CPI predictors, tending to over-estimate money supply.

11.4 Price Level - Money Supply Feedback Loop

As we have seen in the previous sections, if we consider broad money supply `m2` to be given in advance (as a function of time), a change of one percent in `m2` will over time lead to a change of about .33 percent in `cpi`; conversely, if we consider the price level to be exogenous, a one percent increase in it will lead over time to about a .67 percent increase in `m2`.

In reality, neither of them is given, but rather both evolve (approximately) according to their behavioral equations that we have estimated in the previous section. Therefore, the two variables form a feedback loop - a change in the money supply, happening for whatever reason, will lead to an increase in the price level, which will in turn lead to an increase in money supply, etc., amplifying the initial

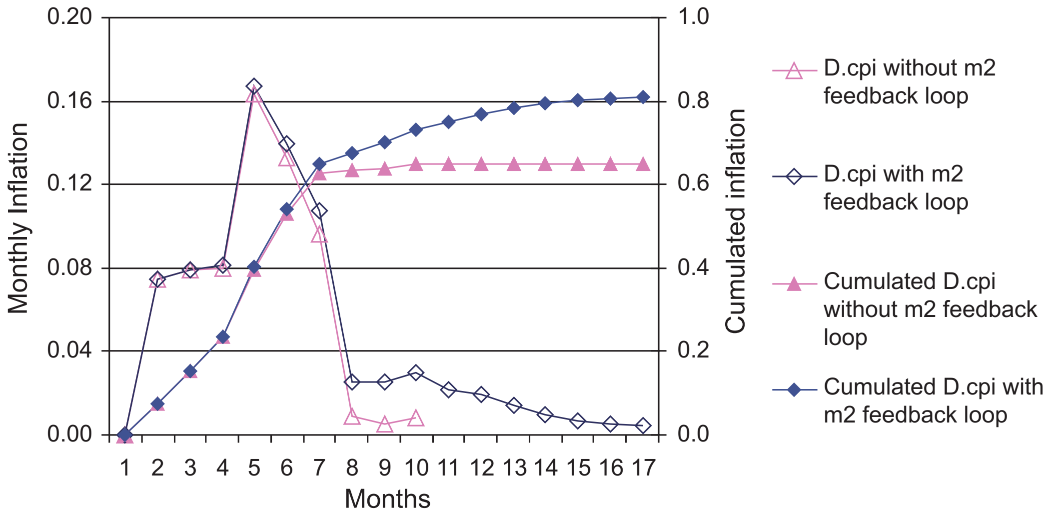


Figure 11.6: Impact of a unit increase in `m2` on `cpi`

impact. In fact, the total impact can be computed as a geometric progression and found to be $1/(1-0.33*0.67) \approx 1.28$, so that the extra impact of the feedback loop equals 28% - not huge, but not negligible either.

Out of curiosity, we also plot the incremental and cumulative impacts of a unit increase in `m2` on `cpi` and vice versa, as a function of time, with and without taking into account the feedback loop. The time profiles are shown in Figures 11.6 and 11.7, respectively. We see that the feedback loop in each case plays out during about a year after the no-feedback impact is over, and increase the total impact by the expected 28%.

11.5 Exchange Rate

Let us now turn to the investigation of the exchange rate. We will use the following explanatory variables: The interest rate on government bonds `rtb`, as it is claimed to influence the exchange rate via the Uncovered Interest Parity (UIP) condition;

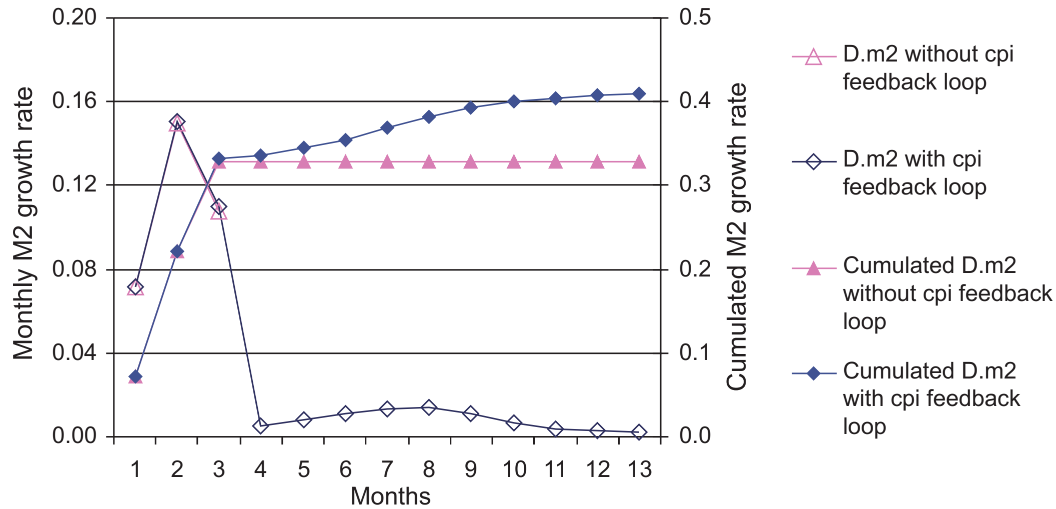


Figure 11.7: Impact of a unit increase in `cpi` on `m2`

the Consumer Price Index `cpi`, dollar index of import prices `impp`, and dollar index of export prices `expp` (these three in log terms) as determinants of the real exchange rate (that the nominal exchange rate is supposed to regulate in Walrasian CGE models); real GDP `gdp` as proxy for import demand, also in log terms; and total foreign exchange reserves `total_res`, defined for our purposes as foreign-denominated assets of the central bank and the Deposit Money Banks, measured in months of imports. All of these are available monthly, with the exception of `expp`, `impp` and `gdp`. The latter are only available yearly and have been interpolated to monthly with an algorithm due to Prof. Clopper Almon (a form of piecewise cubic interpolation). To lower the chances for the choice of interpolation method to influence our regression results, we only use yearly differences (`S12`) of these three variables where differences are required.

As before, we find out that `er`, that is, the natural log of the nominal exchange rate, is I(1): Augmented Dickey-Fuller test (`dfuller er,trend regress`) returns

D.er	D.rtb	D.cpi	D.total_res
Significant lags	0,4	6,7,12	-

Table 11.11: Preliminary Lag Structure Examination for the Exchange Rate

-1.475, corresponding to $p = .83$; while Augmented Dickey-Fuller test on `D.er` returns -6.636, corresponding to $p = 0.0000$. Upon running a least squares regression on all of our independent variables (`reg er rtb cpi impp expp gdp total_res; dwstat`) we get a d-value of .096, far below the .322 10% significance threshold for cointegration. Thus again we resort to the ARIMA-X procedure as we had done for `cpi` and `m2`.

First, we regress `D.er` on fifteen lags of the first difference of each of the independent variables that are available monthly, with the significant lags listed in Table 11.11. We now use that information to choose a starting point for the model identification process. The model identification process is summarized in Table 11.12. The model we arrive at is presented in Table 11.13 and summarized in Table 11.14. The meaning of the columns is the same as in the CPI discussion above. The only additional aspect worth discussing is the different way of computing "Total Impact" when it is based on a coefficient of a seasonal difference.

The "Total Impact" column is meant to describe the long-term (aggregated) impact on the dependent variable of a unit change in the corresponding independent variable. Thus, when several lags of the independent variable are used, we have to add up the coefficients of all these lags. Now using a 12-month seasonal difference of a variable `X` means that a sudden jump in `X` from one month to the next will show up in all 12-year periods that include these two months, that is, twelve times.

ARMA terms	Exo terms	AIC	SIC	wntestq	wntestb
ar(1/6) ma(1/6)	D.rtb. . . L4D.rtb, D.cpi. . . L12D.cpi, S12.impp, S12.expp, S12.gdp, D.total_res. . . L8D.total_res	-634	-527	85%	99.55%
ar(1/3) ma(1/3)	D.rtb. . . L4D.rtb, D.cpi. . . L12D.cpi, S12.impp, S12.expp, S12.gdp, D.total_res. . . L8D.total_res	-626	-531	85.24%	90%
ar(1/3)	D.rtb. . . L4D.rtb, D.cpi. . . L12D.cpi, S12.impp, S12.expp, S12.gdp, D.total_res. . . L8D.total_res	-606	-517	98%	98%
ar(1)	D.rtb. . . L4D.rtb, D.cpi. . . L12D.cpi, S12.impp, S12.expp, S12.gdp, D.total_res. . . L8D.total_res	-610	-526	98%	72%
ar(1)	D.rtb. . . L4D.rtb, D.cpi. . . L4D.cpi, S12.impp, S12.expp, S12.gdp	-611	-567	87%	85%
ar(1)	D.rtb. . . L2D.rtb, D.cpi. . . LD,cpi, S12.impp, S12.expp	-614	-588	87%	95%

Table 11.12: ARIMA-X model identification for `D.er`

Sample: 13 to 144 Number of obs = 132

Wald chi2(6) =89.76 Log likelihood = 314.5662 Prob > chi2 = 0

D.er		Coeff.	Stdev.	z	$P > z$	95% Conf. Interval	
rtb	D1	0.0021	0.0007	3.21	0.1%	0.0008	0.0034
	LD	0.0006	0.0011	0.50	61.4%	-0.0016	0.0027
	L2D	0.0010	0.0014	0.76	44.9%	-0.0017	0.0038
impp	S12	0.197	0.068	2.88	0.4%	0.063	0.331
expp	S12	-0.033	0.028	-1.19	23.6%	-0.088	0.022
_cons		0.023	0.005	4.39	0.0%	0.013	0.033
ar	L1	0.425	0.058	7.26	0.0%	0.310	0.539
/sigma		0.022	0.001	20.02	0.0%	0.020	0.024

Table 11.13: ARIMA-X regression for `D.er`

Variable	Terms included	Value	Stdev	Coefficient p	Variable p	Total Impact
rtb	D...L2D	0.0037	0.0019	5.4%	1.3%	0.0037
impp	S12	0.196	0.068	0.4%	0.4%	2.35
expp	S12	-0.033	0.028	23.0%	23.0%	-0.40
cons		0.022	0.005	0.0%		
ar(1)		0.424	0.058	0.0%		

Table 11.14: Summary of ARIMA-X regression for `D.er`

Therefore to compute the total impact of a variable that enters the regression as a seasonal difference we need to multiply the coefficient of the seasonal difference by the length of the "season", in our case 12. A different way of looking at that is that `S12.X` refers to a *yearly* change in `X`, while `D.er` is a *monthly* depreciation rate. Therefore the factor 12 is needed to make the units match. Thus, the total impact of a change in the import dollar price index `impp` is composed of the coefficient of `impp` in the regression (0.196) and the factor 12 coming from the seasonal difference.

Before discussing the implications of the model we have just estimated, we proceed to test the predictive abilities of the chosen model, similarly to the previous two sections.

We compare the actual course of `er` after January 1998 (an arbitrary cut-off point chosen for compatibility with Chapter 9) with two different forecasts: the coefficients of the first were estimated using all data and the coefficients of the second were estimated using only pre-Jan. 1998 data. The results are shown in Figure 11.8.

Unfortunately, we see that this model performs much worse than the models for `cpi` and `m2` did. The predictor whose coefficients use all data performs decently if not brilliantly, but the predictor using the same model but with coefficients estimated from pre-1998 data comes out as essentially only a trend line, unable to reproduce, even partially, the sharp depreciation of 2000. Thus we get neither good prediction, nor even a moderate degree of robustness with respect to choice of the estimation data period.

This failure leads us to attempt, in analogy to our procedure in the case of `m2`, a

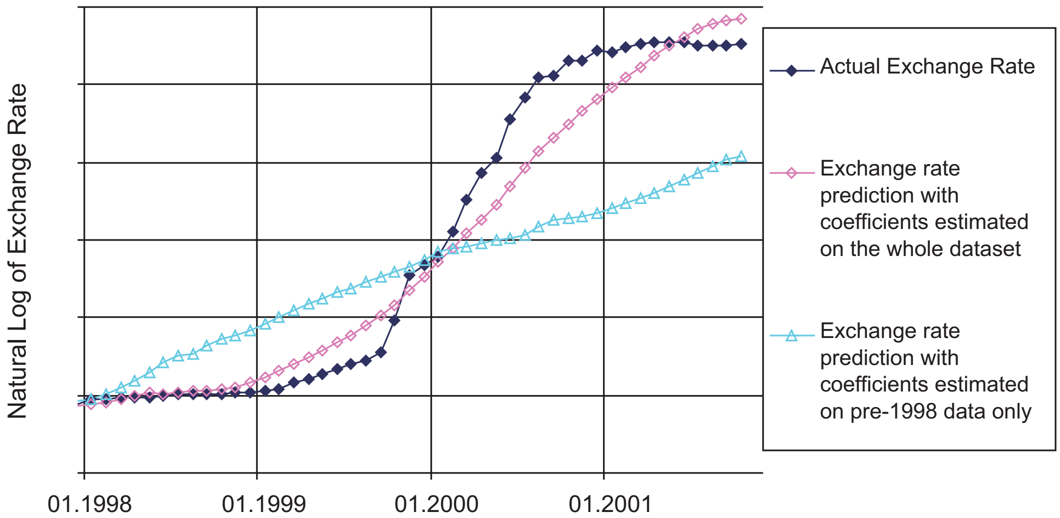


Figure 11.8: Actual exchange rate vs. predictions from ARIMA-X regressions

fresh model identification while forcing the constant to be zero in all the regressions. Unlike the case of `m2`, however, this attempt does even worse at prediction, as shown in Figure 11.9. Therefore we take the with-constant regressions as the more reliable and base our subsequent discussion on them, while keeping in mind that their results should be taken with a larger dose of scepticism than those of the previous sections.

The only variables having a significant influence on the exchange rate are interest rates and the import price index, together with a strong constant (meaning a stable exogenous depreciation). Further, inflation, GDP growth and the change in total foreign exchange reserves appear to not have a significant influence on currency depreciation, at least not the kind of linear influence that can be detected by a regression.

How can we explain such strange results? The reason for the results we get, we think, is that the exchange rate dynamics appear to have two distinct regimes,

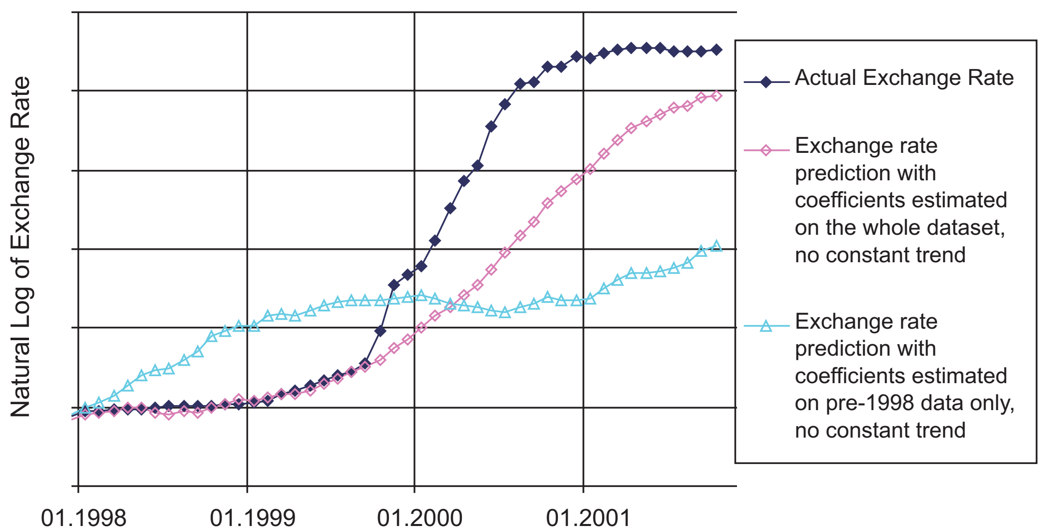


Figure 11.9: Actual exchange rate vs. predictions from ARIMA-X regressions without a constant term

managed floating and freely falling, that correspond to quite different relationships between the exchange rate and the other variables. The difference between the two was discovered, tested and discussed in Reinhart and Rogoff [2004], who also provide a classification into freely floating and freely falling periods for most countries, including Ghana.

The classification of Reinhart and Rogoff [2004] was based on parallel exchange rates, of which they also provide monthly time series for most countries. The depreciation of their parallel exchange rate, along with the depreciation of the official exchange rate we have been using, is shown in Figure 11.11. The upper horizontal bars at the bottom of Figure 11.11 indicate the periods classified in Reinhart and Rogoff [2004] as "Freely Falling/Managed Floating" (as opposed to 'Managed Floating"). In our view, their classification is somewhat puzzling, in particular the classification of 1993 as non-falling and of the first half of 1999 as falling. Thus, we did an ad-hoc re-classification, with the lower horizontal bars at the bottom of Figure 11.11 indicating our definition of freely falling periods.

During our period of study, there were two freely falling and three managed floating episodes, as can be seen from Figure 11.11. Freely falling periods are characterized not only by higher depreciation values, but also by much higher volatility of the depreciation rate; furthermore, when plotting `D.er` against `D.cpi` in Figure 11.10 separately for all freely falling and all managed floating episodes, we see a fairly close association between the two during managed floating, but not freely falling episodes. Running a simple least squares regression gives us $R^2 = .007$ for the freely falling group and $R^2 = .1058$ for the managed float group. (When doing the same regressions using the classification of Reinhart and Rogoff [2004], the two groups appeared much more similar, with $R^2 = .0052$ and $R^2 = .0403$, respectively).

The different relationship between `er` and `cpi` during the two modes might be the reason for the low significance of the exchange rate in the `cpi` regressions, and of `cpi` in the exchange rate regressions.

We thus conclude that a better understanding of the exchange rate behavior and its relationship to other variables would require separate study of freely falling and managed floating episodes, as well as of the (perforce nonlinear) mechanics of the switch between the two regimes, which is unfortunately beyond the scope of the present study.

Figure 11.10: Inflation vs. Depreciation for Falling vs. Floating Periods

11.5.1 Summary

Following the same model identification strategy that led us to success in explaining the behavior of `cpi` and `m2`, we identify a model of exchange rate behavior. The only two significant variables turn out to be the import price index, each 1% increase in it translating into a 4% depreciation over a year's time; and the interest rate, with interest rate increase by 1% *increasing* depreciation by one third of a percent.

Unlike in the cases of `cpi` and `m2`, however, the estimated model proves to be quite bad at predicting values of `er` when used as a recursive equation. When we estimate the same model using only pre-January 1998 data, essentially only the constant term survives. The prediction behavior is even worse when we repeat the model estimation over regressions without a constant.

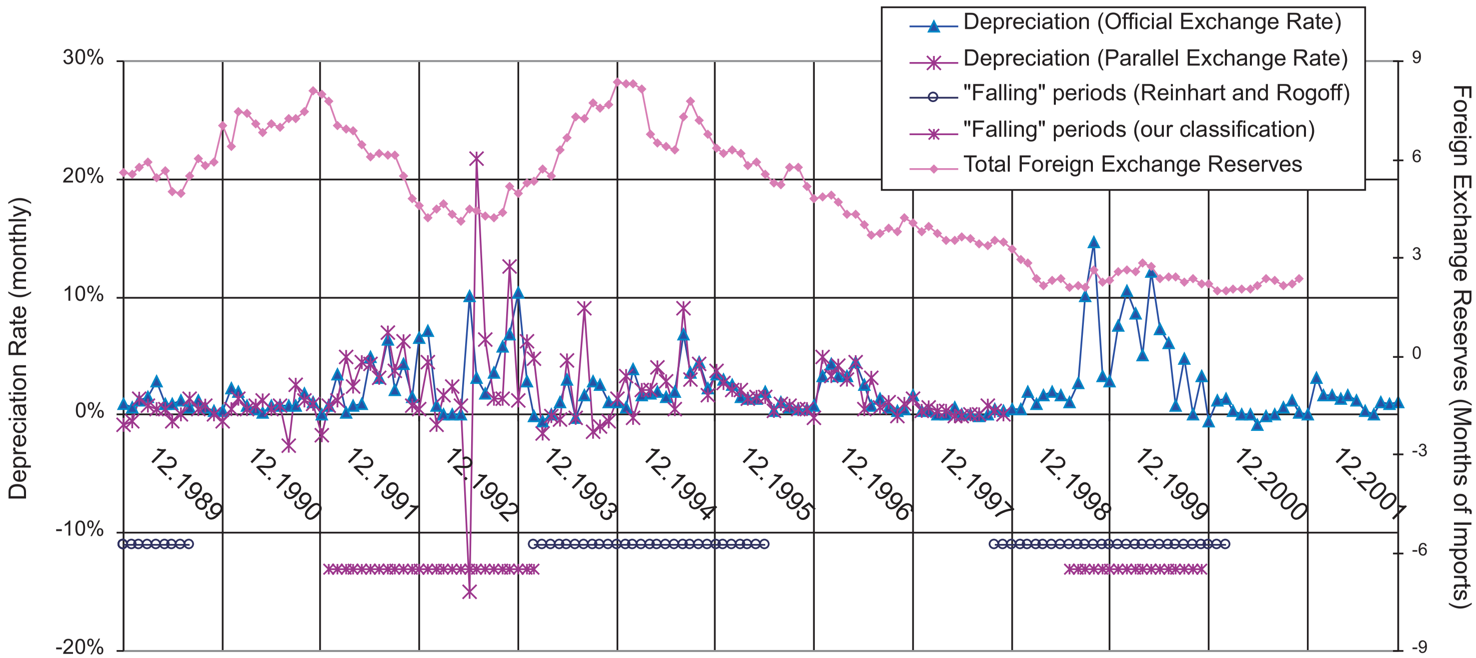


Figure 11.11: Exchange Rate Depreciation, Falling/Floating Periods, and Foreign Exchange Reserves

These problems, together with a brief qualitative discussion of exchange rate behavior, lead us to conjecture that better understanding of the exchange rate behavior would require separate study of managed floating and freely falling periods, as well as of the conditions for the change between the two modes.

Chapter 12

Discussion I: Implications for Theory

This chapter discusses the contributions of this project to methodology and theory, including the evaluation of common CGE model assumptions to the Ghanaian case. The following chapter uses that discussion to answer the policy questions posed in this thesis, provide a more general evaluation of the effects of structural adjustment policies in Ghana, and make policy suggestions.

12.1 Methodological Innovations

12.1.1 Dataset Compilation

We have demonstrated that in spite of low data quality and availability, it is feasible to construct stock-flow consistent SAM/FAM time series for Ghana for more than a decade.

Such an exercise is worthwhile for several reasons: firstly, in the process of the compilation one discovers the errors and inconsistencies in the data and can to an extent correct for these, or at least draw conclusions as to which uses of that data are meaningful even in view of the errors and which are not.

Secondly, the resulting dataset allows one to get a better overall picture of the economy than individual time series or a SAM for one year could have allowed.

Thirdly, a sufficiently long stock-flow consistent SAM-FAM time series provides a sufficient data base for estimation *and* validation of a multisectoral dynamic model. A complete set of real and nominal flow time series allows us to derive the causal behavior of the model from history, instead of specifying it a priori as the CGE models do, be they neoclassical or structuralist. Further, if we split the SAM-FAM time series into an estimation and a validation segment, we can also gain an idea of how good the chosen causal structure is at predicting future behavior of the economy. Such an approach unites the advantage of a CGE-like ability to handle sectoral disaggregation and a high number of variables with an ability to specify measures of confidence of the model output.

While that is not a novel approach for industrialized countries with their high data availability, to the best of our knowledge this is the first time such a dataset has been compiled for a developing country.

12.1.2 Systematic Integration of Financial Stock Time Series with Flow Data

In developing countries, financial asset stock time series are available and generally more reliable than most flow data. This is firstly, because stock data are more easily observed than flow data (as a point observation is enough to pin down a stock variable, while we have to observe a flow variable over a period of time to measure it); secondly, because unlike data on physical quantities, most financial stocks are automatically measured, the numbers in a bank's computer *defining* the corresponding stock; and finally, because typically the banking sector is the most modernized part of an economy in terms of data collection and processing. This is true for both the private banking sector and the central bank.

Besides being interesting in its own right, knowledge of financial asset stock time series allows us to get more reliable estimates for net financial savings (net lending) of each institution. In an economy where some important sectors are demand-driven (that is, probably, any economy), knowledge of net lending is important to account for injections and leakages contributing to the aggregate demand. Unfortunately, net lending is normally computed as a residual from flow data, and is thus quite unreliable; using asset stocks for that purpose makes for a much more reliable estimate.

12.1.3 Testing Nonlinear Relationships on Short Data Series

While we are lucky enough to have monthly time series for the key nominal indicators such as the Consumer Price Index, the exchange rate, and the money supply, the real-side sectoral data, along with most nominal flow data, is only available on a yearly basis.

As our sample length of 12 years is too short to allow for rigorous econometrics, we use a different method to evaluate hypotheses of real-side behavior. We take the years 1990-1997 as the estimation period and the years 1998-2001 as the validation period. We use the estimation period data to estimate the coefficients of (mostly nonlinear) behavioral hypotheses and then use their ability to predict the validation period data as the way to choose between the different hypotheses.

This approach has the potential to increase our confidence in the choice of functional form, as a good fit in the estimation period does not necessarily translate into a good prediction ability in the validation period. On the other hand, if a functional formulation was good at predicting the validation period data when estimated with only estimation period data, we can have some confidence in its predictions for the future (or counterfactuals in the past) when estimated using the data of both periods.

12.1.4 A Simple Core for a Dynamic Fix-Flex Model

Using the method just describe to test behavioral hypotheses, we find, not surprisingly, that the Ghanaian economy contains both supply-constrained and demand-driven sectors. Further, the allocation of total demand between imports and domestically produced goods is dependent on their relative price; some sectors need intermediate inputs from both supply-constrained and demand-driven sectors; and demand for domestic retail services (that form a substantial part of the huge informal service sector) is a proportion of total goods sold, no matter their origin, while itself demanding intermediate inputs both imported and domestic - all in all, quite a jigsaw puzzle.

While setting up the model equations to satisfy all these descriptions is not terribly hard, it is not exactly trivial either; thus, Chapter 10 outlines the accounting for the real side of a model that would conform to the findings of Chapters 9 and 11 and into which we can directly plug the functions estimated in Chapter 9.

Unfortunately, actual implementation of such a model is beyond the scope of the present effort.

12.1.5 A Compact Formalism for Description and Analysis of Financial Stock Dynamics

The Transaction Matrix formalism presented in Chapter 8 allows for an elegant integration of a Social Accounting Matrix describing the nominal flows in the economy with a Financial Accounting Matrix describing the gross asset stocks.

By using a collection of constant matrices describing the structure of the financial sector in a given country, this formalism allows us to decompose the changes in the financial stocks into revaluation, current transactions, and capital transactions in a computationally efficient way. Conversely, the transaction matrix formalism allows us to directly specify the portfolio allocation behavior of the different institutions while *automatically* observing the wealth constraints of the institutions. This formalism thus greatly simplifies the specification and estimation of portfolio behavior in stock-flow consistent models.

The following section contrasts the results of our analysis of Ghanaian data to common assumptions of economic models we have discussed in Chapter 4.

12.2 Structure of the Ghanaian Economy Compared to Common Model Assumptions

12.2.1 Structuralist vs. Monetarist views on Price Formation

As the reader will recall from Section 4.4, the descriptions of price formation and its relationship to money supply and interest rates are the main point of disagreement between monetarist and structuralist models.

According to the monetarist view, the price level is determined so as to clear the money market. Therefore money supply growth drives inflation, with no influence in the opposite direction. Furthermore, increasing interest rate levels is supposed to both decrease money supply and increase money demand, thus lowering inflation.

On the other hand, structuralist theory stresses the influence of cost factors on inflation, and takes the money supply to be either largely irrelevant to price formation or driven by the price level. The latter connection is supposed to work through demand for working capital: firms are supposed to hold an amount of cash for daily operations, which is proportional to the cost of their intermediate inputs, and thus roughly proportional to the overall price level. Thus, the demand for money grows in proportion to inflation. If we further suppose that a significant part of that working capital is borrowed, we see that an increase in interest rates will increase the cost of production, and according to the cost-view of price formation, that will lead to higher inflation. Summing up, structuralist theory would expect price level to drive money supply rather than vice versa, and an increase in interest rates to *increase* inflation.

A final structuralist mechanism important for price formation is indexation feedback loops. In the simplest example, we would have a firm owner increasing product prices so as to guarantee a certain profit after the wage costs are accounted for; at the same time, workers push for wages that are high enough when measured in terms of the end product, so an increase in the product price automatically leads to an increase in wages, leading to more product price increases, etc. This is also referred to as the inflation from distributional conflict. It can lead to explosive or stable dynamics, depending on the strength of the feedback; but in any case if there is a price increase for any other reason, it will be amplified by this feedback loop.

Now let us turn to the econometric evidence and see which of these theories it supports.

Price-Money Supply Causality

As Sections 11.2 and 11.3 show, broad money supply growth decidedly drives inflation, with a 1% increase in broad money supply causing about 0.67% (p=0.20%) total increase in the price level, spread over nine months. On the other hand, a 1% increase in the price index leads to a fairly quick (2-3 months) increase of .33% in the money supply ($p = 0.00\%$).

Thus in the question of money supply-price direction of causality, neither side of the theoretical debate is right on its own. In the short term of 0-3 months, the influence of CPI on money supply prevails, while in the medium term (2-10 months) the reverse direction of causality comes into its own, resulting in an inflation-money supply feedback loop. This feedback loop results in an increase of any impact on `cpi` or `m2` by an additional 28%, spread over about a year after the direct impact has taken place.

Influence of the Interest Rate on Inflation

In this issue, the monetarists carry the upper hand - the direct influence of interest rates on inflation is non-significant. Thus the cost-push effect of higher interest rates appears to be negligible, and the main channel through which interest rates impact inflation is through their influence on money supply, discussed below. This is perhaps not surprising as the banking system in Ghana is quite thin and the degree of industrialization low; thus the role of loans from the formal banking sector in production is likely quite low compared for example to the economies of Latin America (that provided much of the inspiration for structuralist theory).

Influence of the Interest Rate on Money Supply

In contrast to the question of price-money supply causality, the measured influence of interest rates on money supply is quite in agreement with orthodox portfolio balance theory: according to the latter, higher interest rates on government bonds are expected to lead to portfolio substitution from money to bonds, reducing money supply - and so they do, an increase of 10 percentage points in the interest rate reducing money supply by 6% ($p = 0.1\%$), spread over three months, with an additional 2% increase happening over the following year due to the `cpi/m2` feedback loop.

While the effect is statistically significant and has the sign expected by theory, the practical usefulness of interest rates as an instrument for control of money supply is quite limited by two factors: firstly, the magnitude of the effect is extremely small - ten percentage points is a hefty interest rate increase, yet a one-time 8% reduction in money supply is merely a blip against its typical yearly growth rates of 20% and more. This is most likely due to the very thin banking system in Ghana. Secondly, the money supply reduction is a static effect: only *changes* in the interest rate affect money supply, so the positive effect of money supply reduction is felt only once, as the interest rates are increased; whereas the negative effects of high interest rates, namely reduced investment and increased interest payment costs to the government, are felt continuously, as long as the interest rates remain high.

Thus we can conclude that interest rates are not an effective tool for money supply control in Ghana.

The role of cost factors

We have included three potential cost factors among the explanatory variables for the price level: the price of fuel (government-controlled), wholesale price of food crops, and the exchange rate. The first two were seen to be significant, impacting the CPI quite quickly (which might be the reason for their prominence in discussions of inflation in Ghana) with total impacts of coefficients of about .08 each ($p = 1.9\%$ for fuel and $p = .9\%$ for wholesale food crop price). As Figure 11.2 showed, while these impacts were not negligible, they were on the whole much smaller than the impact of the money supply.

Interestingly, the exchange rate was completely insignificant as an explanatory variable for the price level. On the other hand, exchange rate was a significant explanatory variable for the money supply, with a 1% depreciation leading to a .37% increase in the money supply, spread over three months. This is in the reasonable range for a country with imports equal to over a third of GDP. Most of this impact is probably due to revaluation - as Figure 7.6 shows, about 30% of deposits are foreign-denominated; while no data is available for foreign exchange cash holdings, a similar figure does not seem unreasonable.

Remembering that total impact of money supply in the cpi equation was .85, the medium-term impact of a 1% depreciation is $.37\% \times .85 \approx 0.31\%$.

It is interesting that depreciation impacts prices primarily through revaluation-induced money supply growth, rather than through direct cost factors. Given the time profiles of both effects, it is likely that the revaluation is really working *instead of* direct cost-push rather than masking it, as the other cost factors work almost instantaneously, so an import-cost-push impact of depreciation would likely also be felt within 2-3 months. On the other hand, the channel through money supply takes at least 4-5 months to be felt at all, and is therefore slow enough that it would not mask cost impacts of the exchange rate.

Constant Velocity of Money Assumption

Having thus largely understood the interactions between price formation and money supply, we are in a good position to check the verismilitude of the constant velocity of money assumption that is the simplest version of monetarist theory. (The constant velocity of money hypotheis states that the price level is proprotional to money supply and inversely proportional to GDP.)

That relationship is cetainly not identically true. For one thing, broad money supply, GDP and the Consumer Price index are not cointegrated. Furthermore, in our ARIMA regression (Table 11.3) the dependence of the price level on GDP comes out non-significant (though that is possibly due to the fact that we had to use an interpolation of yearly GDP instead of genuine monthly time series).

On the other hand, the “stylized fact” that money supply growth over time translates into inflation more or less percentage point for percentage point appears to be pretty accurate. We have seen that in fact a one percent increase in money supply results in a 0.85% rise in the price level, spread over the next 18 months or so. As the standard deviation of the total impact of `cpi` on `m2` in Table 11.10 was $0.085/0.329 \approx 26\%$ of the coefficient’s value, our overall coefficient of 0.85 that was derived from it is not significantly different from 1. Thus, we cannot reject the hypothesis represented by this stylized fact.

However, the cost-push influence of fuel and wholesale food crop prices comes on top of the money supply-induced inflation, so that we have to conclude that the picture of inflation in Ghana is (perhaps not surprisingly) a hybrid of monetarist and structuralist mechanisms.

12.2.2 Output Determination and the Balance of Payments

The polarization between structuralist and monetarist views that we have seen in the previous section is to a large extent mirrored in the polarization between structuralist and Walrasian/neoclassical views on output determination, as we have discussed in Section 4.4.

While Walrasian models always assume full employment, and therefore conclude that a decrease in production in a part of the economy is necessarily followed by an increase in production in some other part of the same economy (the displaced labor is assumed to be automatically re-employed *somewhere*), the structuralists tend to let output, together with employment, be determined by demand in Keynesian fashion.

Walrasians claim to draw support for the full employment assumption from general equilibrium theory (incorrectly, as we saw in Section 4.4.3); structuralists cite empirical studies of structural adjustment in support of their approach. Thus, Taylor [1988] in a collection of 18 case studies concludes that the primary reason for improvements in balance of payments were decreases in import demand due to decreases in overall demand, as well as increases in exports due to decreases in domestic demand - all quantity effects; relative price effects did not appear important in the short run.

It is worth noting that the debate on output determination is not as polarized as that on price determination; as discussed in Kraev [2003], the models built within both traditions since the early 1990s increasingly include hybrid formulations, allowing some sectors (such as agriculture) being supply-constrained at full employment, and some (such as industry and services) being demand driven.

Incremental Capital Output Ratio

The first hypothesis we tested was the Incremental Capital Output Ratio, that is the hypothesis that the increase in GDP is proportional to investment with a fixed proportionality ratio. Our investigation of the Incremental Capital Output Ratio is in agreement with earlier studies thereof in concluding the ICOR is useless as a description of a country's output.

Sources of Demand

Thanks to using financial stock time series, we can construct pretty reliable estimates of the sources and sinks for aggregate demand during our period (Figures 9.3 and 9.4). Perhaps surprisingly, we find that the Government was the *only* net demand source during the 1990s, and all other institutions, that is, the private sector, the Deposit Money Banks, and the Rest of the World, were net demand sinks.

We could interpret this in two ways: either as saying that government deficits held consumption and therefore imports at artificially high levels, or to say that the government was the main driver of the economy. In either case, it is clear that as long as a substantial part of GDP is demand-driven (and we will see below that there is evidence for that), cutting government deficits will, ceteris paribus, have a substantial adverse effect on GDP.

Savings-Investment Balance

As we have mentioned in Section 7.1, in the 1990s investment in real terms was probably falling as share of GDP (after correcting the apparent deflator error in IMF data). It was hypothesized that a reason for this was insufficient savings supply, and higher interest rates were suggested as a remedy for that. However, we have just seen that the private sector (households and firms combined) is a net *sink* of funds; also, the Deposit Money Banks consistently had excess liquidity in the 1990s - hardly a picture one would expect if insufficient funds for lending were the limiting factor in investment.

The ratio of savings-investment gap to private disposable income is quite stable, much more stable than the ratio of investment to GDP. That suggests that investment mainly happens from own funds, implying passive savings and a limited role of the formal banking sector as source of loans.

Agriculture

Our examination of the data in Section 9.2.5 indicates that agricultural production hit an aggregate supply constraint around year 1995. Since then, a production frontier between food crop production and cocoa (dominant agricultural export) production is a plausible model, with a relative price elasticity of the ratio of cocoa to food crops of about .33. The relative scarcity of food crops has also been increasing since 1995, as indicated by the wholesale food crop price index to Consumer Price Index ratio.

Industry

When we estimated the relative price response of the exports to nontraded production in manufacturing, we came up with a relative price elasticity of -1. This is quite surprising from the Walrasian point of view, as it says that as export price *increases* relative to the price of non-traded manufacturing goods (all other things being equal), *more* units of nontraded goods are produced per each unit of exports.

This seems perverse if we think of export production and nontraded goods production as being substitutes on a productivity frontier. However, it makes perfect sense if we assume that the nontraded manufacturing production (i.e. production for domestic consumption) is demand-driven, rather than supply-constrained by a productivity frontier. Then, if the price of exports increases, that means more income for export-producing households, and therefore more demand for both imports and domestic goods, and therefore more domestic goods being produced.

Thus, we conclude that the nontraded industrial sector is demand-driven.

Do relative Price Effects Matter to the Balance of Payments in the Short Term?

Based on the data investigation in Chapter 9, we conclude that relative price effects have a modest impact on exports, but a substantial immediate impact on import demand.

On the export side, in the case of agriculture we observe (in the period beginning 1995) a price elasticity of substitution of .33 between cocoa and food crop production - modest but not negligible. In the case of industry, the relative price elasticity is -1, indicating a nontraded sector primarily driven by demand effects, and thus quantity-driven, rather than price-driven, adjustment.

On the import side, the imports to nontraded goods ratio of industry (excluding oil) responds to relative price with a quite high price elasticity of substitution, namely -1. This means that the total nominal amount (in domestic currency) spent on imports is largely independent of the relative price. This, in turn, implies that changes in that relative price due to import tariffs or exchange rate depreciation will produce a proportional response in import volume in foreign exchange terms. For example, an extra tariff of 10% is likely to induce a decrease of about 10% in the volume of manufacturing imports, and thus a 10% decrease in the component of foreign exchange outflow that is due to that particular category of imports.

Thus, we conclude that both relative price effects *and* quantity effects are quite strong in the Ghanaian case, even in the short term, and neither can be safely ignored.

Trends in exports and imports

In addition to relative price effects, the ratios of nontraded goods to exports and of nontraded goods to imports (both for industrial goods) exhibit a secular trend.

The trend for the ratio of imports to nontraded goods is yearly 3% growth (4% when estimated only for the period 1990-1997); for the ratio of exports to nontraded goods is 4% yearly growth (5% when estimated only for the period 1990-1997).

From this we can conclude that the opening-up process of the Ghanaian economy is still going on, although slowing down. The reason this is alarming is that the baseline value for imports is almost twice that for exports, thus if both continue growing at comparable rates, continuing severe balance of payments problems are guaranteed.

Such a straightforward trend analysis has to be taken with a grain of salt, however, as different components of exports have been exhibiting quite different behavior. While cocoa production has been largely stagnant, non-traditional exports have been growing quite fast and have in fact just exceeded cocoa in volume at the end of our period.

12.2.3 Exchange Rate Determination

Exchange rate determination is a question that typically gets much less attention in CGE models than either price determination or output determination. Walrasian models often assume a fixed balance of payments; combined with imports' and exports' dependence on relative prices, that essentially means the nominal exchange rate's role is to keep the real exchange rate (ratio between domestic and foreign prices) more or less constant, compensating for any jumps in the domestic price level. Since the structuralist models typically focus on quantity adjustments, they are likely to work with fixed or policy-determined exchange rates, rather than specify independent behavior for them.

Another popular theory for explaining the behavior of the exchange rate is Uncovered Interest Parity, which states that the exchange rate is determined by equalization of future returns from owning Ghanaian vs. other nation's bonds. Thus, an increase in interest rates on government bonds is supposed to lead to an appreciation of the currency. Taylor [2004, Ch. 10] contains a rich discussion of the various approaches to modeling the exchange rate.

In the case of Ghana, our interviews with Bank of Ghana staff suggest that forex scarcity and balance of payments considerations are the driving force of depreciation.

Unlike the fairly conclusive regression results on price level and money supply that we have discussed above, our attempts to explain the behavior of the exchange rate were only moderately successful. Here is the gist of our findings.

Initial Observations on Exchange Rate Behavior

The first thing that deserves note about dynamics of the exchange rate is that it switches between two distinct modes, which can be called “managed floating” and “freely falling” (following Reinhart and Rogoff [2004]); exchange rate depreciation tends to be mild and to lag between inflation, and then experience a sudden slide, changing the real exchange rate by almost a factor of two, followed by another quiescent period.

The observation of the graphs suggests that the freely falling periods are associated with low foreign exchange reserves and low imports to nontradables price ratio, and that there is an association between inflation and depreciation, but we could not discover any of these connections in regressions. The probable reason for that is a nonlinear form of some or all of these relationships.

Does the Exchange Rate Try to Equalize Real Exchange Rate?

Not really. The dollar price index for imports was the most significant variable in the regressions, but the dollar price index for exports was not significant. Also, CPI was not significant.

Further, the dynamic behavior of the exchange rate can hardly be called stabilizing. The alteration of floating/falling periods was the cause of more drastic changes in relative prices than any other factor in the economy, as can be seen e.g. in the third series of Figure 3.11.

Does the Exchange Rate Respond to the Interest Rate?

Yes, but perversely. Interest rate coefficients in the exchange rate regression were low but significant (total impact 0.37% extra depreciation per extra percentage point of interest rate, $p = 5.4\%$), and surprisingly, positive, i.e. indicating that interest rate increases lead to *depreciation*. Thus we conclude that Uncovered Interest Parity is not a useful theory for explaining exchange rate behavior in Ghana, and high interest rate are at least not conducive to lowering depreciation rates.

12.2.4 Is building CGE models worthwhile?

As we have seen in this chapter, neither structuralist nor neoclassical theory by itself suffices to explain the observed behavior of the Ghanaian economy. However, by judiciously combining the structuralist and the neoclassical assumptions, we could specify a model that would conform to most of our empirical findings (with the notable exception of exchange rate dynamics).

The reader might now ask why, then, we did not build such a CGE model? We would respond by wondering what the point of such an exercise would be. CGE modelers typically say that that the point of CGE models is not prediction but finding qualitative relationships and "orders of magnitude" of impacts. However, as there is no way to verify a CGE model, then if the model is to be credible, the qualitative relationships must already be well understood for us to specify model equations! And once we have invested the effort into finding out the causal relationships (as we have done in this project), it is not clear what further insight even a perfectly specified CGE model would give us, especially as it could lay no claim to numerical accuracy.

Thus we would argue that the CGE literature of the past two decades was extremely important in creating a vocabulary of alternative causal hypotheses and model formulations, and the questions that one has to ask in order to specify the "right" CGE model are a very good guide to an overall understanding of the economy, as the current project illustrates. However, once the "right" CGE model structure has been identified through careful inspection of the data, the value added of actually building one appears to us to be very low.

A more fruitful approach would be to use the whole dataset to estimate a dynamic model with the causal structure that we have found in the data. Unlike CGE models, such a model would not be overdetermined, and having estimated it to time series, we would both be able to use it for predictions and at the same time have an idea of the reliability of those predictions, much like in the models of Inforum for the industrialized countries.

While building such a model would be quite interesting, at the present moment it would take us far beyond the scope of what is already an extensive project. We thus regretfully leave that for the future.

12.3 Summary

This thesis has made a contribution both to modeling methodology and to the theoretical debate between the structuralist and Walrasian/monetarist schools.

On the methodological side, we have successfully compiled a yearly time series of complete nominal and real flow accounts and financial stock accounts for the Ghanaian economy, for a period of 12 years. This is to the best of our knowledge the first time such a dataset has been compiled for a developing country. A particularly useful innovation was integration of financial stock accounts with the traditional Social Accounting Matrix of flow accounts, allowing among other things for more reliable net lending estimates.

After using this dataset to investigate various aspects of the Ghanaian economy, we proceeded to formulate prototype accounting equations for a model conforming to our understanding of that economy. We have further created a compact formalism for description and analysis of financial stock dynamics.

On the theoretical side, we have used Ghanaian data to evaluate the controversies between the two major schools of CGE modeling (CGE currently being the dominant methodology for models of developing countries), namely neoclassical (Walrasian/monetarist) and structuralist, and to see to what extent the favorite theories of either school are useful in describing the behavior of the Ghanaian economy.

The result can be described as largely a draw between the two schools, both for price formation and output determination. For price formation, causality went from money supply growth to inflation in the medium term (3-9 months, total coefficient 0.67) and from inflation to money supply growth in the short term (0-3 months, total coefficient 0.33); the ensuing feedback loop increased all impacts on inflation and money supply growth by an additional 28%; however cost-push factors were also important.

Interestingly, the main channel for the influence of exchange rate on inflation appeared to be through revaluation-driven growth of the money supply, rather than through, for example, cost of imports. Further, interest rates did not have a significant direct influence on inflation, while *increases* in interest rates led to a statistically significant, but quite small, reductions in money supply.

On the output side, the export vs. nontraded supply of agricultural goods are likely on a productivity frontier, while domestic manufacturing production is demand-driven. Both quantity and relative price effects were found to be quite strong in determining the balance of payments, with relative price effects much stronger for import demand than for export supply.

Unfortunately, neither standard formulations, nor our regressions were able to provide descriptions of exchange rate dynamics that the data would support.

Summing up, neither of the two schools is by itself able to provide a description of the Ghanaian economy that would be compatible with the data. However, between them they provide a vocabulary of alternative formulations that is quite flexible; in fact, flexible enough for us to construct a realistic description of the Ghanaian economy (with the exception of exchange rate behavior) by judiciously combining elements of the two theories.

Chapter 13

Discussion II: Implications for Policy

The purpose of this chapter is to discuss the policy implications of the features of the Ghanaian economy discussed in the previous chapter. We approach this task from three mutually complementary angles.

Firstly, we look at the components of a structural adjustment package as described in Chapter 2, and based on the understanding of the Ghanaian economy we have gained in the past chapters, ask the question whether each of the policy measures therein was likely to have the consequences intended by the program, no consequences, or consequences that were entirely unexpected or opposite to the program intent.

Secondly, we turn to the three main research questions formulated in Chapter 1. Of these, the last, namely the applicability of standard model assumptions and theories to the Ghanaian economy, has been addressed in the previous chapter. Thus, only the first two remain, namely the causes of the poor macroeconomic performance in the 1990s and the distributional consequences thereof – these are the questions we will address.

Finally, we formulate a set of policy recommendations that would retain the positive aspects of the historical policies while improving upon them in the areas where they were deficient. As we have seen in Chapter 3, the Ghanaian economy did not undergo any dramatic structural change during the 1990s, therefore these policy recommendations are likely to be applicable to the present day as well.

13.1 What were the likely consequences of Structural Adjustment Policies in Ghana?

In this section, we go through the structural adjustment measures one by one and contrast each measure's intended impact with its likely actual impact, given our understanding of the Ghanaian economy as discussed in Chapter 12.

Decrease government deficit This measure is supposed to have a plethora of positive impacts. Let's go through them one by one.

Firstly, the resulting decrease in total demand is supposed to improve the balance of payments through decreasing the demand for imports. That is a realistic expectation, as import demand is proportional to GDP, other things being equal. As we have seen that the government was the major source of net demand, and that a large part of the economy is demand-driven, decreasing government deficit would doubtless be recessionary and therefore decrease the demand for imports. However, this decrease would be transient - as soon as the GDP would start growing again, be it because of government spending or private sector initiatives, import demand would surge right back up. A sustainable decrease in import demand can only be achieved through relative price adjustments and provision of domestic alternatives, both issues we will shortly return to.

Secondly, the decrease in total demand caused by smaller government deficits is supposed to improve the balance of payments by freeing up domestic productive capacity to supply more exports (as the IMF analytical approach, the Financial Programming Framework (FPF), implicitly assumes the total production is unaffected by the stabilization program). This argument is not valid in Ghana. In the case of agriculture, decreasing domestic demand could indeed somewhat stimulate exports. as agriculture is facing an aggregate productivity frontier. However, as food crops are a very large component of aggregate demand, and the relative scarcity of food has been increasing from 1995 onwards, it would take a very large decrease in GDP indeed for such an effect to take place.

In the case of industry, the argument has even less traction as domestic industrial production is demand-driven, thus an increase in domestic production will do nothing to harm exports.

The other hoped-for benefits of government deficit reduction are supposed to work depending on the source of funds to cover the deficit.

If the deficit is financed by borrowing from the central bank, i.e. by printing money, its reduction is expected to contribute towards inflation control. This argument certainly applies to Ghana.

If the deficit was financed by foreign borrowing, its reduction will improve the balance of payments. This argument is correct as far as it goes, as long as the amount of foreign borrowing can be determined by the government. However, in the case of poor countries such as those in the Sub-Saharan Africa, one could argue that the amount of capital inflows (largely consisting of foreign aid) is not directly under the government's influence, and is determined by the donors according to a variety of factors, with high government deficits actually more likely to be branded as "fiscal irresponsibility" and to decrease the aid inflows.

Finally, if the deficit was financed by borrowing from the domestic financial sector, deficit reduction is supposed to free up resources for private investment.

This argument's applicability to Ghana is limited in that the actual availability of loanable funds did not appear to be the limiting constraint on investment in Ghana (remember the banks had persistent excess liquidity and saving exceeded investment throughout). The limiting constraints on investment appeared instead to be high interest rates, lack of infrastructure, and lack of investor confidence.

Are any of these three constraints likely to be affected by a government deficit? If the interest rates are determined by the market to be just high enough for the market to accept the outstanding government debt, then a decrease in that debt (or at least in its rate of growth) would indeed have a decreasing influence on the interest rates, and thus stimulate investment. On the other hand, if the decrease in deficit is achieved by curtailing of investments in infrastructure such as roads, then the net effect on investment might well be negative. The final factor, namely investor confidence, is not defined well enough, and perhaps too controversial for us to discuss it here.

The final, and in our view most convincing, argument for decreases in government deficits is that such decreases would lead to lower interest payments in the future, and thus leave less funds for more productive uses. That is hard to disagree with, but is also less imperative than some of the other arguments, as we are explicitly forced to weigh off a decrease in today's government services against a decrease in future government services.

Summing up this somewhat lengthy section, in our opinion the only convincing macroeconomic arguments for control of government deficit in Ghana are firstly, the need to control growth in money supply so as to control inflation (applying to debt financed by borrowing from central bank), secondly, the need to keep the interest rates reasonably low (applying to debt financed by borrowing from the domestic banking system, and only if the interest rates are market-determined to just accommodate the government debt), and thirdly, the need to keep future interest payments reasonably low.

Curtail support programs such as input procurement and input subsidies for agriculture One of the measures to achieve a reduction of government deficit was a reduction or cancellation of government programs such as input procurement and input subsidies for agriculture. Besides the positive revenue impact, an intended consequence was to create a space for the private sector to fill that niche instead of the government, supposedly leading to greater efficiency.

In our view, that policy has achieved the reverse of its intended purpose. First of all, the private sector has apparently not sprung up to fill the gap, according to both the references in Chapter 3 and to the fact that since 1995, Ghana's food crop supply was increasingly scarce. This can be expected to have a row of adverse consequences. Firstly, as most of the poor in Ghana are food farmers, and most of the food farmers are poor, reduction in government support of agriculture has directly hit the poorest segment of society.

Secondly, as food production has not been able to keep up with demand, it is very likely that the shortfall was made up through imports. That, in turn, led to a worsening of the balance of payments and therefore higher depreciation rate. As we have seen that probably about a quarter to a third of Ghana's broad money supply is foreign currency-denominated, the increased depreciation translated into increased money supply growth and thus directly into higher inflation. Thus we come to the conclusion that curtailing government support of agriculture could well have damaged agriculture and *still* led to higher, or at least not lower, medium-term growth of money supply and inflation.

Our argument here worked the way it did because agriculture is experiencing an aggregate supply constraint. The story for domestic industry, which is demand-driven, is quite different, as we will see in the discussion of current account liberalization.

Reduce money supply growth This is supposed to control inflation. While the connection between money supply growth and inflation is contested theoretically, our econometric investigation of the Ghanaian case leads us to conclude that broad money supply growth is indeed the key driver of inflation. Our econometrics show that an increase in broad money supply translates almost one-to-one into a CPI increase (with the impact spread over a year and a half), in agreement with the constant velocity of money hypothesis that the monetarists (including the IMF) normally use.

Furthermore, it appears that the exchange rate's influence on inflation also works through the money supply (revaluation): as the exchange rate depreciates, the local currency value of foreign currency-denominated assets grows, increasing the total money supply and thus inflation (at a rate of about 0.31% total extra inflation per 1% extra depreciation, spread over about a year).

Thus, control of broad money supply is indeed the key to inflation control in Ghana. The question then is what level of inflation is to be targeted; this a question of policy choice rather than theory and thus cannot be decided in isolation, but must be weighed off against other policy goals. Now that we have econometric estimates of the strength of the connection, it becomes possible to discuss tradeoffs between inflation and other policy targets (the pursuit of which would lead to money supply increases).

Increase Interest Rates There are three often quoted reasons for increasing interest rates (meaning in the first instance interest rates on government bonds, but deposit and lending rates broadly follow the bond rates). Firstly, increasing the interest rates is supposed to stimulate savings, and thus provide more funds for investment. As we have already discussed, in the case of Ghana the problem lies with investment demand, not savings supply, and thus increasing interest rates in counterproductive for stimulating investment.

Secondly, high interest rates are supposed to prevent excessive depreciation of the currency, according to the Uncovered Interest Parity theory of interest rate formation. Unfortunately, the impact of interest rate on the exchange rate was *positive* in the regressions we ran. Thus at least in the Ghanaian case high interest rates do not appear to be a useful instrument for combating exchange rate depreciation.

Finally, high interest rates are supposed to lower the growth of money supply, with the consequences for inflation as discussed above. While controlling the growth of money supply is indeed a worthy goal, in the case of Ghana our econometrics indicate a very weak response of broad money supply to interest rates, with an interest rate increase of ten percentage points resulting in a one-time reduction of 8% in the money supply. The likely reason for that is a very thin financial system, resulting in little "portfolio rebalancing". Apart from its small magnitude, the money supply response to interest rates only happens at the time they are being raised; keeping them high thereafter has no influence on subsequent money supply growth rates, but has adverse effects on investment, as well as on the expenditure on interest payments to the government.

This latter side effect of high interest rates is directly in opposition to one of the goals of lowering government deficits, namely, lowering government interest payments. As interest rates on government debt are pushed above the market-determined rate, the cost of servicing that debt also goes up, reducing funds available to the government for other purposes.

Summing up, increasing interest rates (beyond the market-determined rate necessary to accommodate the government debt to the domestic banking system) is not an effective tool either for control of money supply growth or for support of the exchange rate. However, it has substantial negative consequences: depressing investment, increasing government interest payment obligations, and creating inflationary pressures.

Introduce floating exchange rates and depreciate the currency The resulting increase in domestic prices of exports and imports is supposed to make exports more competitive and to redirect demand away from imports. The overall reduction in domestic demand from reductions in government spending is supposed to make sure there is nonetheless no excess demand for domestic goods.

Our verdict as to this measure is that Ghana really has no choice in the matter. Firstly, given the persistent foreign currency shortage, the Bank of Ghana really does not have enough reserves to withstand even a mild currency attack, so fixing the exchange rate is not an option. Secondly, import demand is very responsive to relative prices, so Ghana couldn't really afford an overvalued exchange rate even if it could maintain it. A sad example is the end of our period: during years 1997-1999, Bank of Ghana intervened (quite mildly) to prop up the exchange rate, leading to its progressive overvaluation. The result was that just as the Bank of Ghana ran out of reserves in 1999, a terms of trade shock occurred, leading to a particularly nasty depreciation ("freely falling") episode.

So it seems to us that the only way Ghana could reverse the floating of the cedi is by completely reversing current and capital account convertibility reforms - not by a long way politically feasible even if it was desirable.

Once we accept that there is currently no viable alternative to the floating exchange rate regime, the tendency of the exchange rate to have freely falling periods is still quite damaging and should be avoided, if possible. The only two ways to combat that that we can suggest is firstly, for the central bank to refrain from propping up the currency, hopefully leading to more gradual depreciation regimes; and secondly, achieving a viable balance of payments position in the medium term. As long as the trade account, not even counting the debt service payments, is in the deep red, we cannot expect any currency stability. We will further discuss exchange rate policy in Section 13.3.

Liberalize the current account and reduce price distortions According to Aryeetey and Harrigan [2000], liberalizing the current account had the following goals: narrow the gap between official and parallel exchange rate, provide foreign exchange to ease import strangulation, achieve a viable balance of payments position, clear up arrears, and introduce current account convertibility.

With the exception of a viable balance of payments, the objectives appear to have been largely achieved. In general, guaranteeing a sufficient supply of capital goods and intermediate inputs is quite essential for Ghana, whose primary and secondary sector are not self-sufficient in either of these. The jump of GDP growth rates from the first five years of the 1980s to the next five years after that was in fact due primarily to capital goods and intermediate input availability, along with huge aid inflows that financed these.

While availability of imports necessary for production was doubtless a good thing, the concurrent glut of final goods is a different thing altogether. This is best discussed in the context of the next policy measure, namely elimination of price distortions.

"Eliminating Price Distortions" refers to abolishing import quotas and reducing import tariffs, while reducing subsidies to domestic producers. As a combination of tariffs and subsidies can easily be self-financing, it is not quite obvious to us what practical benefits such a policy is supposed to carry; what follows is the best we can do to make sense of the arguments presented.

The usual theoretical arguments are Pareto efficiency and comparative advantage. Yet comparative advantage theorems all presuppose a closed capital account; and the practical benefits of Pareto efficiency are not at all clear to the author. Clearly, absurdly high tariffs (say, several 100%) can have almost the same adverse effects as abolishing imports altogether; but the same can hardly be said for tariffs of several dozen percentage points. Sometimes it is also argued that lower prices for imports benefit consumers; however, as a the same time higher import consumption means less income to domestic producers (especially after taking into account the multiplier effects), this argument is not tenable without further refinement.

We have already discussed the subsidies on agricultural inputs; let us now turn to tariffs on manufactured goods. As we have seen in Chapters 9 and 12, the domestic manufacturing sector is demand-driven, and the distribution of overall demand for industrial output between imports and domestic goods is quite responsive to their relative price. Therefore it is safe to assume that the elimination or lowering of import tariffs had several adverse impacts: firstly, it negatively affected a source of government revenue; secondly, it worsened the balance of payments through increased demand for imports; and finally, it depressed domestic manufacturing, thus lowering the national income. As domestic manufacturing is *not* supply-constrained but demand-driven, depressing manufacturing of goods for domestic consumption did *not* contribute to increasing exports.

Summing up, liberalization of the current account was a quite important policy measure for reviving domestic production, and was largely successful and beneficial. The major exception is the elimination of protection of domestic industries through lowering of tariffs on imported manufactured final goods. This measure had several adverse consequences without bringing any benefits visible to the author.

Liberalize the capital account Allowing a higher measure of capital mobility is expected to attract more funds for investment. The most-cited adverse effects of opening up capital accounts are capital flight and boom-bust cycles in the credit markets, Latin America providing an abundance of examples for both. A further theoretical criticism [Daly 1996b] is that arguing for capital account liberalization is logically incompatible with comparative advantage arguments, as the latter are premised on closed capital accounts.

Unlike Latin America, Ghana does not provide much evidence for either of these adverse effects, nor indeed of the expected benefits. Net private transfers into Ghana are positive, owing mainly to remittances from Ghanaians working abroad. Capital flight does not appear to be a major issue, possibly because there was not much capital there to begin with; and the banking system is too thin, and the economy too little industrialized, for credit markets to develop substantial own dynamics that could strongly affect the rest of the economy.

On the side of expected benefits, the only major result appears to be the large investments by foreign-owned mining companies. However, as these investments mainly go towards buying capital goods (not produced in Ghana), the constraints on profit repatriation are weak, and the linkages between the mining sector and the rest of the economy are also quite weak, the net benefit to Ghana from the foreign investment in mining appears to be limited at best.

13.2 Answering Our Research Questions

After discussing each of the structural adjustment policy components in detail, we are now ready to address our research questions posed in Chapter 1. As the third of the three questions, namely the applicability to Ghana of commonly used theories, was extensively addressed in the previous section, our concern here is with the remaining two questions, namely the reasons for the slowdown in economic performance in the 1990s and the distributional consequences thereof.

This section does not add any new ideas to the in-depth discussion of the previous section. Its purpose is rather to convert the point-by-point analysis of the previous section into a more compact, unified narrative addressing the research questions.

13.2.1 Why Was Macroeconomic Performance Not Sustained?

This section discusses the reasons for Ghana's poor macroeconomic performance in the 1990s, as compared to the late 1980s, specifically its lower GDP growth rate, balance of payments problems, and persistent inflation.

Let us first consider the reasons for the upsurge of the late 1980s. We would say that there are three major reasons: firstly, a major inflow of foreign aid released the acute foreign exchange strangulation that the country was subject to in the beginning of the 1980s, allowing for extensive imports of capital goods and productive inputs. This stimulated domestic production across the board, as these productive inputs were at that point its main limiting factor. Secondly, the aforesaid inflow of foreign aid also served to stimulate domestic demand through multiplier effects. Finally, more reasonable current account policies (such as devaluing the exchange rate to a realistic value) and larger producer prices offered to cocoa farmers, among with other export promotion policies, led to an increase in export supply.

The side effects of that scenario were firstly, a buildup of foreign debt, as export supply could not catch up with the import demand, especially as the latter was stimulated by GDP growth; and secondly, a surge in inflation from the demand stimulus.

Unfortunately, the scenario as outlined above was not sustainable. On the one hand, as the economy became more and more open, exports and imports continued to grow at about the same rate. However, as they were starting from baselines differing by almost a factor of two, the result were persistent trade deficits. As the interest payments on the growing foreign debt also mounted and the abnormally large aid inflows of the 1980s were not sustained into the 1990s, the "Rest of the World" became, and remained throughout the 1990s, a net demand *sink*, so that now the multiplier effects from the balance of payments worked to *lower* GDP.

Let us now turn to sectoral output. As imported inputs and capital goods became freely available, they were no longer the limiting factors in industrial production; the limiting factor now was low demand (capacity utilization of medium and large factories was around 50% in 1990-1993). Unfortunately, due to the high degree of trade openness of Ghana in that period, any factor that increased demand for domestic manufactured goods also increased demand for imports, so that stimulating domestic industry was only possible at a cost of an even worse balance of payments. This was in fact what happened in 1992-94 (1992 being an election year), when the government ran massive deficits, pushing up money supply growth and further worsening the balance of payments (Figure 9.4).

Unfortunately, even such transient stimuli were negated by very high interest rates (over 40% being not unusual) that aimed to counter the inflationary consequences of the aforementioned money supply growth. While our regressions indicate that inflation control through interest rates probably was not very successful, it did crush the already-low investment-to-GDP ratio.

Turning to agriculture, we conclude that while the initial availability of imported inputs was beneficial, the elimination of government subsidies and procurement services largely negated these benefits. Thus, there was no basis for a sustainable growth in the agricultural sector, and local food supply became increasingly scarce. Though the level of disaggregation of our data does not allow us to directly verify that hypothesis, it seems very likely that shortage of locally produced food crops directly contributed to a larger import demand and thus to balance of payments worsening. The cocoa farmers were positively affected by higher cocoa purchasing prices, but as agriculture was now on a productivity frontier, reallocation of labor towards cocoa supply further contributed towards food crop scarcity.

Having thus understood GDP growth and balance of payments problems, let us turn to the persistent inflation. In Chapter 11 we have seen that the major driver of inflation was money supply growth, amplified by money supply - price level feedback loop, so that the medium-term impact of one percent extra money supply was about one percent extra inflation, corresponding to the monetarist predictions. While government borrowing did of course play an important role in money supply growth, an equally important factor was revaluation of the foreign exchange-denominated component of the money supply. Judging by our regressions, about one third of the money supply is foreign currency-denominated, so that for example a 3% depreciation would lead to a 1% increase in money supply and thus an about 1% increase in the price level, spread over about a year.

In contrast to money supply changes that take about 9 months to fully translate into price level increases (and to depreciation, whose influence on inflation also works through the money supply), the impact of wholesale food crop prices or fuel prices on inflation was almost instantaneous, taking one to three months. We would conjecture that this leads to higher visibility of inflation due to these causes, and thus to their relative prominence in inflation discussions.

13.2.2 What Were the Distributive Impacts of the Structural Adjustment Policies in the 1990s?

In this section, we address the remaining research question, namely the distributional impacts of the structural adjustment policies. As a deep investigation of household survey data was unfortunately beyond the scope of this project, we have to restrict ourselves to drawing conclusions from the sectoral discussion above to distributive impacts on the households grouped by their main source of income.

First of all, the state of the economy in the 1990s, while not stellar, was in many respects vastly superior to the state of the economy in the early 1980s, in the few years prior to the adoption of the structural adjustment program. All population groups have profited from the positive GDP growth and increased availability of imports, both production inputs and final goods. However, on top of that various sectors were affected differently. Employment in manufacturing was adversely affected by low demand, removal of protection, and high interest rates; the displaced workers ended up in the informal sector, mainly providing services. Likewise, agriculture, in particular food crop production, was adversely affected by removal of government support programs and competition from imports. Cocoa producers, while also adversely affected by removal of government support programs, fared comparatively better due to increased cocoa purchasing prices. The sector least adversely affected by liberalization was the informal sector, as it was never government-supported in the first place and produced almost exclusively nontradable goods, so faced no competition from imports.

Summing up, while positive GDP growth profited all population groups to some extent, the food farmers and formal sector employees fared worst of all, while informal sector was least adversely affected (largely by default). Thus the net incentives worked towards reallocation of the labor force into the informal sector, which is indeed what we saw in Figure 3.7.

This is a disturbing trend, as the informal sector is one of the least productive sectors of the economy, and offers few perspectives for development. To have a chance at working its way out of poverty, Ghana must find ways to stimulate its agricultural sector, which still contains the majority of the population and the vast majority of the poor, and its industrial sector, which is the most promising in terms of higher productivity, lowering of import dependence, and supply of high value added exports.

The next section outlines some policy suggestions towards achieving that goal.

13.3 Policy Suggestions

The problems Ghana faced in the 1990s were a result of several interlocking issues, most importantly a persistent trade deficit, a government that indulged in high deficits in election years, a supply-constrained agricultural sector, a manufacturing sector strangulated by high interest rates and low demand due in part to competition from imports, money supply that had a large foreign currency-denominated component, and a very strong responsiveness of inflation to money supply growth. This led to other problems, such as external and internal debt buildup and persistent inflation and currency depreciation. Clearly no single recommendation will suffice to tackle that complex of issues; however, we believe that the package presented here goes a long way towards addressing most of them. Not surprisingly, it involves some easy gains and some tough choices.

13.3.1 Trade Policy

We would argue that one of the most crucial issues to tackle is the balance of payments deficit. As long as it persists, foreign debt buildup and thus further hemorrhaging of interest payments will have negative impacts on government finances as well as aggregate demand. Furthermore, the ensuing continuous currency depreciation will result in higher inflation, with a strong possibility of increased use of foreign currency as a store of value and even in everyday transactions. As the share of foreign currency in the overall broad money supply would grow, the impact of depreciation on inflation would become ever stronger in a positive feedback loop, leading to higher inflation and possibly eventual effective dollarization of the country, robbing the government of the ability to use monetary policy as an instrument, an ability it still possesses now.

The balance of payments deficit must be tackled from both sides, import demand and export supply. We will discuss export supply below among the sectoral policy recommendations; let us now turn to import demand.

There are two possible reasons for an increase in import demand: firstly, a relative price shift making imports more attractive, and secondly, the inability of domestic producers to satisfy demand, leading to forced substitution. Insufficient domestic supply can only be addressed by supply-side measures and is thus discussed in the sectoral policies section. Here we only note that it is more likely to be relevant for the supply-constrained agriculture than for the demand-driven manufacturing.

Let us now turn to the influence of relative price on import demand. We have seen in Chapter 9 that the relative price elasticity of demand for industry imports is about -1. Thus, import demand responds strongly to relative price and a moderate increase in tariffs on manufactured consumption goods would be effective in lowering import demand, increasing demand for domestic industry as well as raising extra revenue. That would appear to us one of the easy, low cost/high gain measures. The key to doing it right is firstly, restrict the tariffs to final goods and the few capital goods for which domestic substitutes are readily available; secondly, keep the increases moderate; and finally, restrict the demand-redirecting measures to manufactured goods.

While this is not by itself a sufficient measure, it would provide fast balance of payments relief while stimulating import substitutes; whereas the equally necessary measures to expand export supply would take several years to kick in.

Note that reining in the share of imports in GDP is necessary; a mere expansion of exports (even if all the foreign exchange generated thereby accrues to Ghanaian firms and nationals) would lead to an increased GDP via the multiplier effects, and thus to a proportionate increase in imports, to a large extent negating the positive balance of payments effect of increased exports.

13.3.2 Sectoral Policies

While moderate tariffs on manufactured final goods imports will provide a degree of balance of payments relief and stimulus for domestic manufacturing, over the medium term it is necessary to expand the supply of exports and import substitutes.

First, consider industry. We have seen that interest rates are not an effective tool of monetary policy, while high interest rates are a serious impediment to investment. Therefore interest rates should be market-determined, and therefore positive in real terms and large enough to accommodate the substantial government debt, but not any higher than that. This should go a long way to stimulate investment and manufacturing for domestic consumption.

As industry as a whole is not supply-constrained, any program of support of export industries needs to be specifically targeted to reach these, rather than the whole of the secondary sector. As non-traditional exports are by far the fastest growing export component, the optimal approach to industrial export support is likely to consist in programs specific to each export sub-category, rather than broad macroeconomic measures of the kind that we discuss here.

In agriculture, on the other hand, the binding constraint is not demand deficiency but an aggregate supply deficiency. As at this point export crop and food crop production actually compete with each other for the total productive capacity, agricultural policies should aim to expand the productivity of the sector as a whole. Thus, the optimal policy interventions would be in provisions of infrastructure such as roads and storage facilities, along with credit and reinstatement of input procurement programs and input subsidies. If it is deemed essential that the latter is done by the private sector, then that should be achieved by first making sure the private sector solution works in parallel to the government-run system and only then dismantling the latter.

13.3.3 Fiscal Policy

One of the first questions that any policy proposal must address is its own financing. How should the above sectoral interventions be paid for?

Firstly, let us note that a substantial part of the cost of export promotion and agricultural support programs could be paid for by the proposed import tariff. Secondly, we need to remember that depreciation has a substantial impact on money supply growth. Therefore, policies that expand exports (or production of domestic food crops, leading to smaller food crop imports) and thus improve the balance of payments will lead to smaller depreciation and therfore decrease the rate of broad money supply growth. Thus it is quite feasible that cost-effective agricultural support measures, even if partially financed by money creation, might actually lead to lower money supply growth *and* better balance of payments, once the influence of lower depreciation rates is taken into account.

Having said this, it is still true that inflation in Ghana is extremely responsive to money supply growth, so there is a very strong argument for trying to keep the latter down. However, as the above example demonstrates, inflation control targets must be weighed off against the other policy targets, rather than treated as an overriding objective.

13.3.4 Exchange Rate Policy

While we were admittedly not as successful in explaining the exchange rate behavior through regressions as was the case with the other relationships, it appears that in broad terms the exchange rate responds to the relative price of domestic goods vs. imports and to the relative abundance of foreign exchange reserves.

Further, the apparent pattern of exchange rate movements were periods when depreciation rate was stable and lagged behind the rate of inflation, alternating with quite violent "freely falling" strong depreciation periods that re-aligned the relative prices while causing another surge of inflation. There were two freely falling episodes during our period. The second happened after a period of attempted exchange rate stabilization by the Bank of Ghana, and was the larger of the two.

The message that we extract from that is that the Bank of Ghana should under no circumstances attempt to prop the exchange rate up. Besides being costly to prop up and immediately increasing import demand, an overvalued exchange rate will correct itself anyway once the Bank of Ghana runs out of reserves, and the ensuing depreciation will be all the stronger for the delay.

In fact, in our view the problem of choosing the right intervention strategy in the exchange rate market might be likened to the optimal strategy of forest fire management. Just as inflation gradually accumulates to make an exchange rate overvalued, the dry wood in the forest accumulates and increases the fire hazard. If one tries to suppress every fire using all the resources one has, eventually there will be enough dry wood around to make the next fire too big to quench, and that maxi-fire could well cause more damage than any of the smaller ones we had suppressed. Instead, the correct method of fire management consists in igniting smaller, controllable fires on purpose as soon as there's a little dead wood around, and thus keeping the fires small.

Likewise, it might be worth while to consider an exchange rate policy that is based on watching some relative price indicator and intervenes to *depreciate* the exchange rate at first signs of overvaluation. There would be several positive consequences to such a strategy: firstly, one could hope to avoid the damaging maxi-depreciations that happen every so often in the "normal" course of affairs. Secondly, that little extra depreciation would help lower imports via relative price effects, thus reducing future depreciation pressures; thirdly, rather than losing money on propping the exchange rate up, the Bank of Ghana might actually make a bit of a profit while keeping it at a more realistic level.

The only downside would be higher import prices; however, slightly higher but more stable prices of imports might well be better than occasionally lower but more volatile prices.

13.3.5 Monetary Policy

One of the surprises that has emerged from the regressions is that during the period we investigate the interest rates were nearly useless as an instrument to control money supply growth. Thus the interest rates should be kept as low as the domestic credit market would allow while still being able to absorb the outstanding government debt.

Therefore, the major instrument of monetary policy available to the Bank of Ghana is control of the monetary base, especially of money creation from lending to the government. This should be used with caution, as discussed in the fiscal policy section.

13.4 Summary

In this chapter we have seen that the theoretical analysis we have conducted in this thesis was sufficient to answer our research questions as well as to conduct an overall assessment of structural adjustment policies in Ghana in the 1990s, and to make specific policy recommendations. The main reasons for the worsening macroeconomic performance were seen to be an overly liberal import tariff policy, a slowdown in foreign assistance, and a supply constraint in agriculture due to population growth and withdrawal of government support. These factors led to further problems, notably a severely deficient demand for domestic industry output, persistent balance of payments deficits and growing foreign debt. The overall distributional effects of structural adjustment were firstly, an overall increase in well-being compared to the crisis of early 1980s, and secondly, implicit (unintended) net incentives for labor relocation into the informal sector, which is problematic from both the perspective of productivity growth and poverty alleviation.

The recommended policies included stimulating demand for domestic manufactures through a targeted tariff on imported final goods; broad supply-side policies for the agricultural sector, such as infrastructure and input provision; and keeping the exchange rate from becoming overvalued through mild Bank of Ghana interventions.

On the monetary policy side, interest rates were almost useless as a means of controlling money supply, while currency depreciation had a strong impact on money supply growth through revaluation effects. Therefore, interest rates should not be increased beyond market equilibrium values; and measures that improve the balance of payments and therefore decrease depreciation could well lead to lower money supply growth and inflation, even if they are partially financed through money creation.

Chapter 14

Conclusion

As the specific implications of our analysis for economic theory and for Ghanaian macroeconomic policy have been discussed in detail in the previous chapters, and summarized at the end thereof, the purpose of this concluding chapter is not to give yet another summary, but rather to provide a bird's-eye discussion of the overall methodological strategy we have chosen in this thesis.

Our methodology can be summarized as follows: upon formulating the research questions and reviewing the literature on structural adjustment in Ghana, we proceed to a rather in-depth discussion of alternative models used for assessing structural adjustment. While in itself such a literature review is a logical start for research project such as ours, an unusual characteristic for a policy-question thesis was the depth of comparative analysis of alternative schools of CGE modeling.

Then, after compiling the dataset, we used two different techniques to analyze the time series. For monthly data we used orthdox ARIMA-X time series econometrics, while for yearly time series we used a somewhat more unusual technique of fitting alternative functional forms to data for the first two thirds of the period (1990-1997) and judging them by their predictive ability in the last third (1998-2001).

Having done so, we have pulled together all the results of these data investigations in detailed discussions, as is typical for a policy-oriented thesis.

Looking back, we can ask ourselves whether that was in fact a well-chosen path towards our main goal, namely understanding of the Ghanaian economy's structure and behavior in a way that is helpful for evaluating and formulating economic policy. Specifically, did our delving into CGE theory merely serve to satisfy the author's intellectual curiosity, or was it an essential step towards the policy analysis at the end the thesis? Likewise, was the combination of different methods for different parts of the dataset a fruitful choice, or did the imprecision in the yearly time series analysis taint whatever illusory precision we might have gotten out of the econometrics on montly series?

Regarding the first question, we think that the detailed discussion of alternative CGE formulations was essential to all of the subsequent analysis, by providing a series of alternative hypotheses on all parts of the economy. It is true that CGE models cannot be falsified, and therefore are not a research tool but rather an elaborate story-telling medium — but that is the very reason for their value. For the best part of the last three decades CGE models have served as the repository of whatever macroeconomic/sectoral stories their authors thought were key to describing the economies they modeled; thus the CGE literature is a hoard of economic policy lore.

It is true that some of the stories CGE models tell are completely unfounded. However, these stories were formulated in CGE form because they were well-respected in some economic policy circles (and quite possibly some stories, such as some implications of the full employment assumption, became influential in policy discussions solely because they were part of how CGE models traditionally behaved). If that is the case, such stories need to be carefully understood and refuted through data analysis, rather than ignored. On the other hand, some of the stories CGEs tell *are* true (such as the dominance of money supply in price level determination in the case of Ghana) and in such cases, CGE models deliver these stories already nicely converted to equation form, ready for empirical testing and use with better-designed modeling methods.

In other words, CGE models are incapable of providing any answers; but a good understanding of the CGE literature is quite useful for finding out the right questions.

Thus, detailed examination of CGE models gave us an overview of the alternative causal stories commonly used in describing developing economies such as Ghana. Was our approach to testing these alternative stories adequate to the task, and did it make the most of the data available?

We would like to argue that this was in fact the case. In the case of the yearly series, the number of data points (twelve per series) was just too small to apply any advanced statistical techniques, so optimization was the logical choice, particularly as it allowed us to test nonlinear functional forms as well. Likewise, constraining the estimation to the first two thirds of the data was in our view a useful if somewhat ad hoc method to verify predictive power of the different functional forms, lowering the danger of spurious fit. And we did in fact see that the best-fitting function in the estimation period was not necessarily the best predictor for the validation period.

Thus, the chosen methodology allowed us to extract reasonably robust conclusions from comparatively poor data.

The situation was quite different in the case of the monthly series. These did not only have an ample number of data points for rigorous econometrics, but also boasted of a much lower measurement error. Thus, the exchange rate is readily observed with almost no error; the Consumer Price Index and broad money supply less so, but still with much more precision than, say, production of food crops. Thus, we were able to not only find out the causal drivers of these variables (and eliminate important causal driver candidates) but also specify the time profiles of their respective impacts[1]. Thus, due to better data quality, we were able to gain a much more thorough understanding of the Consumer Price Index and broad money supply behavior than was the case for real-side varaibles we investigated.

The remaining question then is, do different levels of precision of the two methods present a problem when one tries to combine their conclusions for policy analysis? Our answer is, briefly, no. Less briefly, this issue is exactly the reason why we think that an informed, careful discussion such as presented in the previous chapters is the optimal way of integrating the insights we have gained about individual behavioral hypotheses – as opposed to a formal model of the whole economy, financial, sectoral and all. The reason we think so is that an informed discussion is a much better instrument for managing widely different levels of uncertainty about different parts of the system.

[1] The notable exception was the exchange rate behavior; however this is not very surprising as exchange rates are notorious for being hard to predict, just like investment functions.

In a formal model, all variables are *prima facie* created equal - all look like floating point real numbers. It is true that uncertainty in *parameters* can largely be addressed through systematic sensitivity analysis (though in the models of the complexity that we are considering here, the cost, both in terms of modeler effort and computational load, might well be prohibitive). However, systematic sensitivity analysis of a model with respect to alternative causal connections is almost impossible, and tends to result in the "anything could happen, really" kind of results. In a careful discussion, on the other hand, it is much easier to keep track of the different statements' different degrees of uncertainty, and to propagate these into conclusions of varying degrees of confidence.

This is not to say formal modeling is useless. When a model's methodology, causal formulations, and data are reasonably robust, it can give more precise insights than a verbal discussion, and sometimes produce surprises that lead to better understanding. The reader will have noticed that interspersed with analysis of the data in this thesis were chapters that laid foundations for a future formal model.

On the other hand, it is amazing how accurate intelligent back-of-the envelope estimates can be; and while substantial uncertainties remain both in the dataset (for example, we don't know sectoral producer prices) and in causal formulations (for example, exchange rate dynamics need more work), a verbal discussion remains the more versatile, and the more honest, method.

Appendix A

The structure of the SAM

This Appendix details the SAM structure of the SAM used in this thesis. The actual values of the SAM and FAM time series are available in an Excel file at http://www.glue.umd.edu/~ekraev/thesis/.

The basic blocks of the SAM are shown in Table A.1. The first row and the first column contain the names of the account groups, such as Products, Activities, etc. The letter behind each account group denotes the subscript used in representing the sub-accounts of that account group. There are four such subscripts: s, f, ι and i. s stands for sectors and has elements

1. Food Production
2. Cocoa
3. Mining
4. Other Industry
5. Government Services
6. Non-Government Services.

The subscript f stands for factors of production and has the elements

1. Employees Skilled Male
2. Employees Unskilled Male
3. Employees Skilled Female

To / From	Products s	Activities s	Income Generation f	Income Distribution ι	Use of Income i
Products s	Retail Services	Intermediate input purchases			Nominal Purchases
Activities s	Revenues				
Income Generation f		Value Added			
Income Distribution ι	Imports and taxes		Incomes	Income Distributions	
Use of Income i				Disposable incomes	
FAM i					Net Lending

Table A.1: The Blocks of the Social Accounting Matrix

4. Employees Unskilled Female
5. Mixed Income Skilled Male
6. Mixed Income Unskilled Male
7. Mixed Income Skilled Female
8. Mixed Income Unskilled Female
9. Operating Surplus.

The subscript ι stands for institutions with firms and households held separate, that is

1. Households
2. Non Financial Corporations
3. Financial Corporations alias Commercial Banks

4. Central Bank

5. Government

6. Rest of the World.

Finally, the subscript i stands for institutions with firms and households aggregated into "private sector", that is

1. Private Sector

2. Financial Corporations alias Commercial Banks

3. Central Bank

4. Government

5. Rest of the World

Each SAM block is at the intersection of some two account groups, and therefore has the corresponding two subscripts. For example, Value Added has the subscripts s and f, meaning it is a 9 times 6 matrix (remember in a SAM sources are in columns) describing the value added flows from the six sectors to the nine factors of production.

Appendix B

Decomposition with Respect to a Basis Using a Scalar Product

The purpose of this appendix is showing how, in a finite-dimensional vector space V with a basis, a scalar product $< \cdot, \cdot >$ can be used to decompose an arbitrary element u with respect to that basis.

Suppose the basis elements are $\{v_1, \ldots, v_n\}$. We are looking for numbers $a_1, \ldots, a_n$ such that

$$u = \sum_{i=1}^{n} a_i v_i \tag{B.1}$$

Since $\{v_1, \ldots, v_n\}$ are by assumption a basis, such a decomposition exists and is unique, by definition of a basis. The question is how to find the coefficients a_i effectively. This works as follows.

Theorem 1 *Let* $b_j =< u, v_j >$, $B_{ij} =< v_i, v_j >$ *and* $A = B^{-1}$. *Then* $a_i = \sum_j A_{ij} b_j$.

Proof: Consider the decomposition (B.1). Taking scalar products of both sides with each basis vector v_j gives us

$$\begin{aligned} < u, v_j > &= \sum_{i=1}^{n} a_i < v_i, v_j > \quad \Leftrightarrow & \text{(B.2)} \\ b_j &= \sum_{i=1}^{n} a_i B_{ij} \quad \Leftrightarrow & \text{(B.3)} \\ b_j &= \sum_{i=1}^{n} B_{ji} a_i & \text{(B.4)} \end{aligned}$$

where we have used $B_{ij} =< v_i, v_j >=< v_j, v_i >= B_{ji}$. If we define b to be the column vector made of the elements b_i, and a to be the column vector made of the elemens a_i, then (B.4) can be written in matrix notation as

$$Ba = b \quad \Leftrightarrow \tag{B.5}$$

$$a = B^{-1}b \tag{B.6}$$

or writing out the last equality element by element,

$$a_i = \sum_j A_{ij} b_j \tag{B.7}$$

Q.E.D.

The beauty of this result is that it holds in *any* finite-dimensional vector space V that has a scalar product. u and v_i can be anything, as long as they are something we can add up to each other and multiply by real numbers. For example, in our case they were equivalence classes of Financial Accounting Matrices.

Strictly speaking, in the proof above we have used, without proving it, that the matrix B would be invertible (that is, non-singular) if $\{v_1, \ldots, v_n\}$ are a basis of V. In fact, it is sufficient that they be linearly independent - but pursuing this thread too far would result in trying to write a crash course in linear algebra, a fate we'd like to avoid.

BIBLIOGRAPHY

I. Adelman and S. Robinson. *Income Distribution Policy in Developing Countries: A Case Study of Korea*. Stanford University Press, 1978.

P.-R. Agénor, S. Devarajan, W. R. Easterly, H. Fofack, D. S. Go, J. A. Izquierdo, C. E. Petersen, L. Pizzati, C. L. Scott, and L. Serven. *Macroeconomic Framework for Poverty Reduction Strategy Papers*. The World Bank, October 2000.

K. J. Arrow. General Economic Equilibrium: Purpose, analytic techniques, collective choice. *The American Economic Review*, 64(3):253–272, June 1974.

E. Aryeetey and J. Harrigan. Macroeconomic and sectoral developments since 1970. In Aryeetey et al. [2000], pages 5–31.

E. Aryeetey, J. Harrigan, and M. Nissanke, editors. *Economic Reforms in Ghana: the Miracle and the Mirage*. James Curry Press, Oxford, 2000.

E. Aryeetey and F. Tarp. Structural adjustment and after: Which way forward? In Aryeetey et al. [2000], pages 344–365.

J. Berg and L. Taylor. *External Liberalization, Economic Performance, and Social Policy*, volume 12 of *CEPA Working Paper Series I*. Center for Economic Policy Analysis, February 2000.

E. Borenszstein, M. S. Khan, C. M. Reinhart, and P. Wickham. The behavior of non-oil commodity prices. *IMF Occasional Papers*, 112, August 1994.

F. Bourguignon, W. H. Branson, and J. de Melo. Adjustment and income distribution: A micro-macro model for counterfactual analysis. *Journal of Development Economics*, 38:17–39, 1992.

F. Bourguignon, J. de Melo, and A. Suwa. Modeling the effects of adjustment programs on income distribution. *World Development*, 19(11):1527–1544, 1991.

F. Bourguignon, A.-S. Robilliard, and S. Robinson. *Representative versus real households in the macro-economic modeling of inequality.* Number DT/2003-10. DIAL, Paris, September 2003. Document de travail DIAL / Unité de Recherche CIPRE, http://www.worldbank.org/wbi/macroeconomics/modeling/RecentCourses/DC03/Session7/bourguignon.pdf.

M. Brownbridge, A. F. Gockel, and R. Harrington. Saving and investment. In Aryeetey et al. [2000], pages 132–151.

M. Bussolo and J. I. Round. *Poverty Reduction Strategies in a Budget-Constrained Economy: The Case of Ghana.* OECD Development Centre, 2003. Working Paper 220, http://www.oecd.org/dataoecd/58/46/2503657.pdf.

CEPA. *Macroeconomic Review and Outlook.* Center for Economic Policy Analysis, Accra, 1996.

J. Cockburn. *Trade Liberalization and Poverty in Nepal.* Center for Study of African Economies, 2002. CSAE WPS/2002-11 http://www.csae.ox.ac.uk/conferences/2002-UPaGiSSA/papers/Cockburn-csae2002.pdf.

D. Cogneau. *Labor Market, Income Distribution and Poverty in Antananarivo: A General Equilibrium Simulation.* Paris: DIAL, 1999. Mimeo.

D. Cogneau and A.-S. Robilliard. *Growth, Distribution, and Poverty in Madagascar: Learning from a Microsimulation Model in a General Equilibrium Framework*. Trade and Macroeconomics Division, IFPRI, Washington, DC, November 2000. TMD Discussion Paper No. 61, http://www.ifpri.org/divs/tmd/dp/tmdp61.htm.

P. Collier and J. W. Gunning. Why has Africa grown slowly? *Journal of Economic Perspectives*, 13(3):3–22, Summer 1999.

H. E. Daly. *Beyond Growth: The Economics of Sustainable Development*. Beacon Press, Boston, Massachusetts, 1996a.

H. E. Daly. *Beyond Growth: The Economics of Sustainable Development*, chapter 10. Beacon Press, Boston, Massachusetts, 1996b.

J. B. Davies. Microsimulation, CGE and macro modelling for transition and developing economies. http://www.wider.unu.edu/conference/conference-2003-2/conference%202003-2-papers/papers-pdf/Davies%20140403.pdf , April 2003.

L. de Maio, F. Stewart, and R. van der Hoeven. Computable general equilibrium models, adjustment, and the poor in africa. *World Development*, 27(3):453–470, 1999.

A. Deaton. Commodity prices and growth in Africa. *Journal of Economic Perspectives*, 13(3):23–40, Summer 1999.

B. Decaluwé and A. Martens. CGE modeling and developing economies: A concise empirical survey of 73 applications to 26 countries. *Journal of Policy Modeling*, 10(4):529–568, 1988.

L. Demery and D. Demery. Poverty and macroeconomic policy in malaysia, 1979-87. *World Development*, 19(11):1615–1632, 1991.

S. Devarajan and D. S. Go. The simplest dynamic general-equilibrium model of an open economy. *Journal of Policy Modeling*, 20(6):677–714, 1998.

S. Devarajan, J. Lewis, and S. Robinson. Policy lessons from trade-focused, two-sector models. *Journal of Policy Modeling*, 12:625–657, 1990.

S. Devarajan, J. Lewis, and S. Robinson. External shocks, purchasing power parity and the equilibrium real exchange rate. *The World Bank Economic Review*, 7: 45–63, 1993.

W. Easterly. Portfolio effects in a CGE model: Devaluation in a dollarized economy. In L. Taylor, editor, *Socially Relevant Policy Analysis: Structuralist Computable General Equilibrium Models for the Developing World*, chapter 11, pages 269–301. The MIT Press, Cambridge, Massachusetts, 1990.

W. Easterly. *The Ghost of Financing Gap - How the Harrod-Domar Growth Model Still Haunts Development Economics*. The World Bank, Washington, D.C., July 1997. Draft.

F. H. G. Ferreira, P. G. Leite, L. A. Pereira da Silva, and P. Picchetti. Aggregate shocks and income distribution: Can macro-micro models help identify winners and losers from a devaluation? Preliminary Draft. http://poverty.worldbank.org/library/view/12976, April 2003.

E. Gyimah-Boadi and R. Jeffries. The political economy of reform. In Aryeetey et al. [2000], pages 32–50.

N. U. Haque and M. S. Khan. Do IMF-supported programs work? - a survey of the cross-country empirical evidence. *IMF Working Papers*, WP/98/169, December 1998.

J. Harrigan and S. Younger. Aid, debt and growth. In Aryeetey et al. [2000], pages 185–208.

G. W. Harrison, R. Jones, L. J. Kimbell, and R. Wigle. How robust is applied general equilibrium analysis? *Journal of Policy Modeling*, 15(1):99–115, 1993.

I. Husain and R. Faruquee, editors. *Ghana: Frontrunner in Adjustment*, chapter 4. The World Bank, Washington, DC, 1994.

IMF. *Ghana: Statistical Annex*. Number 98/2 in IMF Staff Country Report. International Monetary Fund, January 1998.

IMF. *Ghana: Selected Issues*. Number 03/134 in IMF Country Report. International Monetary Fund, May 2003.

N. Kaldor. A model of economic growth. *Economic Journal*, 67:591–624, 1957.

M. Kalecki. *Selected Essays on the Dynamics of the Capitalist Economy*. Cambridge University Press, 1971.

R. Kanbur. Economic policy, distribution and poverty: The nature of disagreements, January 2001. http://www.people.cornell.edu/pages/sk145/papers/Disagreements.pdf.

J. M. Keynes. The economic consequences of Mr. Churchill. In *Keynes, Collected Writings*, volume 9. Cambridge University Press, 1925. Collected writings published in 1978.

J. M. Keynes. *The General Theory of Employment, Interest and Money.* Harcourt, Brace, New York, 1936.

M. Khan and M. Knight. Stabilization programs in developing countries: A formal approach. *IMF Staff Papers*, 28:1–53, March 1981.

M. Khan and M. Knight. Fund-supported programs and economic growth. *IMF Occasional Papers*, 41, 1985.

M. S. Khan. The macroeconomic effects of Fund-suported adjustment programs. *IMF Staff Papers*, 37(2):195–231, June 1990.

M. S. Khan, P. Montiel, and N. U. Haque. Adjustment with growth: Relating the analytical approaches of the IMF and the World Bank. *Journal of Development Economics*, 32:155–179, 1990.

T. Killick and M. Malik. Country experiences with the IMF programmes in the 1980s. *World Economy*, 15:599–632, September 1995.

T. Killick, M. Malik, and M. Manuel. What can we know about the effects of IMF programmes? *World Economy*, 15:575–597, September 1995.

E. Kraev. *Modeling Macroeconomic and Distributional Impacts of Stabilization and Adjustment Packages: Current Literature and Challenges*. CEPA Working Papers. Center for Economic Policy Analysis, New School for Social Research, New York, 2003.

S. P. Leite, A. Pellechio, L. Zanforlin, G. Bergashaw, S. Fabrizio, and J. Harnack. *Ghana: Economic Development in a Democratic Environment*, volume 199 of *IMF Occasional Papers*. International Monetary Fund, Washington, DC, 2000.

J. D. Lewis. *Financial Liberalization and Price Rigidities in a General Equilibrium Model with Financial Markets*. Number 211 in Development Discussion Papers. Harvard Institute for International Development, 1985.

J. D. Lewis. Financial repression and liberalization in a General Equilibrium model with financial markets. *Journal of Policy Modeling*, 14(2):135–166, 1992.

J. D. Lewis. Macroeconomic stabilization and adjustment policies in a General Equilibrium model with financial markets: Turkey. In J. Mercenier and T. Srinivasan, editors, *Applied General Equilibrium and Economic Development: Present Achievements and Future Trends*, chapter 3, pages 101–146. University of Michigan Press, 1994.

D. S. Meade. The lift model. Published where? When?, 2002.

M. Mussa and M. Savastano. The IMF approach to economic stabilization. *IMF Working Papers*, WP/99/104, July 1999.

C. Naastepad. Effective supply failures and structural adjustment: A real-financial model with reference to India. *Cambridge Journal of Economics*, 26:637–657, 2002a.

C. Naastepad. Trade-offs in stabilization: A real-financial CGE analysis with reference to India. *Economic Modelling*, 19:221–244, 2002b.

C. W. M. Naastepad. The macro-economic effects of directed credit policies: A real-financial CGE evaluation for India. *Development and Change*, 32:491–520, 2001.

V. Nyanteng and A. W. Seini. Agricultural policy and the impact on growth and productivity 1970-95. In Aryeetey et al. [2000], pages 267–283.

A. D. Oduro. Perfomance of the external trade sector since 1970. In Aryeetey et al. [2000], pages 168–184.

G. Orcutt. A new type of socio-economic system. *Review of Economics and Statistics*, pages 773–797, 1957.

J. J. Polak. Monetary analysis of income formation and payments problems. *IMF Staff Papers*, 5, November 1957.

M. Powell et al. A Social Accounting Matrix for Ghana 1993. Technical report, Ghana Statistical Service, 1997.

M. Powell and J. Round. Structure and linkage in the economy of Ghana: A SAM approach. In Aryeetey et al. [2000], pages 68–87.

C. M. Reinhart. A model of adjustment and growth: An empirical analysis. In M. S. Khan, P. J. Montiel, and N. U. Haque, editors, *Macroeconomic Models for Adjustment in Developing Countries*, chapter 2, pages 10–37. International Monetary Fund, Washington, D.C., 1991.

C. M. Reinhart and K. S. Rogoff. The modern history of exchange rate arrangements: A reinterpretation. *Quarterly Journal of Economics*, CXIX(1):1–48, February 2004.

S. Robinson. Multisectoral models. In H. Chenery and T. Srinivasan, editors, *Handbook of Development Economics*, volume II, chapter 18, pages 885–947. Elsevier Science Publishers, 1989.

J. A. Rosensweig and L. Taylor. Devaluation, capital flows, and crowding out: A CGE model with portfolio choice for Thailand. In L. Taylor, editor, *Socially Relevant Policy Analysis: Structuralist Computable General Equilibrium Models for the Developing World*, chapter 11, pages 302–332. The MIT Press, Cambridge, Massachusetts, 1990.

D. E. Sahn, P. A. Dorosh, and S. D. Younger. Exchange rate, fiscal and agricultural policies in Africa: Does adjustment hurt the poor? *World Development*, 24(4): 719–747, 1996.

D. E. Sahn, P. A. Dorosh, and S. D. Younger. A reply to de Maio, Stewart, and van der Hoeven. *World Development*, 27(3):471–475, 1999.

J. Sender. Africa's economic performance: Limitations of the current consensus. *Journal of Economic Perspectives*, 13(3):89–114, Summer 1999.

R. M. Solow. A contribution to the theory of economic growth. *The Quarterly Journal of Economics*, 70(1):65–94, 1956.

N. Sowa. Fiscal deficits, output growth and inflation targets in ghana. *World Development*, 22(8), 1994.

N. Sowa and J. Kwakye. *Inflaitonary Trends and Control In Ghana*. AERC Research Reports. African Economic Research Consortium, Nairobi, 1991.

J. O. Stanford. *C.G.E. Models of North American Free Trade: A Critique of Methods and Assumptions*. Economics Department, New School for Social Research, 65 Fifth Avenue, New York, NY 10025, April 1992.

L. Taylor. *Varieties of Stabilization Experience - Towards Sensible Macroeconomics of the Third World*. Clarendon Press, Oxford, 1988.

L. Taylor, editor. *Socially Relevant Policy Analysis - Structuralist Computable General Equilibrium Models for the Developing World*. Massachusetts Institute of Technology, 1990.

L. Taylor. *Income Distribution, Inflation, and Growth - Lectures on Structuralist Macroeconomic Theory*. Massachusetts Institute of Technology, 1991.

L. Taylor, editor. *External Liberalization, Economic Performance, and Social Policy*. Oxford University Press, 2001.

L. Taylor. *Reconstructing Macroeconomics : Structuralist Proposals and Critiques of the Mainstream*. Harvard University Press, 2004.

J. Tobin. Money and finance in the macroeconomic process. *Journal of Money, Credit and Banking*, 14(2):171–204, May 1982.

R. Vos. Aid flows and "Dutch Disease" in a General Equilibrium framework for Pakistan. *Journal of Policy Modeling*, 20(1):77–109, 1998.

L. Walras. *Elements of Pure Economics or the Theory of Social Wealth*. Porcupine Press, March 1984. French original published in 1874.