STOCK MARKET DEVELOPMENT AND ECONOMIC GROWTH IN A DYNAMIC CGE MODEL: THE CASE OF SAUDI ARABIA

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CHAPTER I

INTRODUCTION

Problem Statement

Stock markets are becoming an important issue in developing countries, where the need is for capital to finance many promising projects. The importance of stock markets to long-run economic growth is emphasized in several theoretical and empirical studies. Regarding Saudi Arabia, Looney (1990) said,

> One might argue that as long as the country was experiencing the stimulating effect associated with increased oil revenues during the 1970s and early 1980s, there was little to worry about adequate liquidity for funding various private sector activities, including investment in plants and equipment. With reduced oil revenues, however, there is increased concern in Saudi Arabia that the Saudi Arabian Monetary Agency (SAMA) will not be able to assure adequate liquidity for financing a steady expansion in private sector activity. (p. 111)

In addition to the decline in oil revenues, Saudi Arabia faces other challenges to its economic expansion. One of these is the fact that, because charging interest is prohibited in Islam, Saudi Arabian banks are inefficient (Askari, 1990). People avoid making loans from the banking system or investing in it; consequently, about 50% of all Saudi Arabian bank deposits, most of them in checking accounts, is deposited in foreign banks. In the private sector alone, Siddiqi (1999) estimates that $500 billion is invested outside the country. This situation creates a need for a mechanism to finance firms and encourage

people to save money that does not contradict the people's beliefs. The stock market is considered to be a good solution to this problem, as it is one of the easiest ways to finance firms and enable savers to have access to their investments at any given time. In addition, the stock market gives investors a higher return than typical interest rates do, and this higher return will encourage people to save and to invest in the stock market. Although the stock market in Saudi Arabia is the largest in capitalization among Arabic countries (SAMA, 1998), it has not been well developed. For example, the stock market in Saudi Arabia is not open to foreign investors and incorporates no stock exchange. Because all trade is through the banking system, an investor requires a significant amount of time to liquidate stocks. In other words, the stock market in Saudi Arabia reflects the inefficiency of the banking system in which it operates. The policy makers in Saudi Arabia are thinking of opening up the stock market to foreign investors, building a stock exchange, and relaxing some of the regulations in order to make the market efficient. Since policy makers in Saudi Arabia are primarily concerned with long-run economic growth, they would like to know the economic effect of the proposed changes to the stock market. A model, which quantifies the relationship between domestic macroeconomics and monetary variables on one hand, and the growth of the stock market on the other, should serve to clarify the economic effects incurred by the proposed changes. The primary research question of this proposal is, then, "What will be the impact of the stock market on economic growth in Saudi Arabia?"

Objectives

The objectives of this study are two-fold: first, to include a financial sector in a dynamic CGE of Saudi Arabia; and second, to determine the effect of stock market on the economic growth in Saudi Arabia.

Methods and Procedures

This study will determine the impact of the stock market on the Saudi Arabian economy. A dynamic computable general equilibrium model (CGE) will be used in this study. A CGE simulates the working of a market economy in which prices and quantities adjust to clear markets for products and factors. The model specifies behavior for optimizing consumers and producers in the Saudi Arabian economy. The government is included in the model as an explicit agent which captures all transactions in the circular flow of income.

Although different types of quantitative tools can be used to study the policy options, such as an input-output model, linear programming, or an econometric model, CGE models are more suitable for the Saudi Arabian economy because the central authority does not fully control the different quantity variables in the economy, and because "the economy has many agents independently maximizing their own welfare functions and jointly—but inadvertently—determining an outcome that can be affected only indirectly by the planner or the policy maker" (Dervis, et al., 1982, p.131).

Another advantage to employing CGE models is that they allow the policy makers to use instrument variables to affect specific targets, where input-output and linear programming models "usually do not contain variables that can be considered to be instruments controlled by policy makers in such market economies. Although policy

makers can benefit from the consistent economy-wide picture provided by the models, they cannot easily relate the computed variables to any actual policy decisions" (Dervis, et al., 1982, p. 131). Also, unlike an econometric model that is in partial equilibrium, the CGE is a general equilibrium model. Dervis, et al. (1982) define the CGE models as price-endogenous, multi-sector, non-linear models that are linked around an input-output matrix in a Walrasian general equilibrium framework. By using the CGE model, one can estimate the effect of the stock market on all related variables in the economy. In Saudi Arabia, policy makers at the Ministry of Planning use CGE models to quantify the relationships among economic variables.

The model used to formalize the theoretical relationships in this study is a dynamic CGE model. In this model we set a behavior equation for the agents in the economy, where each agent in the economy maximizes its own objective. After that we get data to solve our model for a base run. The CGE model assumes that the economy is in equilibrium in the base year; thus, the model should reproduce the base-year data of the social accounting matrix (SAM). The next step is to update the data. The CGE model is designed to enable a simulation of short-term and long-term impacts, to derive the supply of, and the demand for, commodities and factors in each sector, and then to work to find a solution that provides a set of prices and wages that drive excess demands to zero. To solve the model, parameters are either taken from previous studies or calibrated. Calibration requires some exogenously specified parameter values because, for some equation sets, the number of parameters exceeds the number of equations.

A CGE model is built implicitly on the SAM for Saudi Arabia. The SAM provides a consistent picture of the flow-of-funds accounts of the separate institutions or "actors" in the economy that one may wish to distinguish (Dervis, et al., 1982).

The difference between a static and a dynamic CGE is that in a dynamic CGE, the model runs forward over a number of years by updating all the exogenous variables entering the static model, such as the change in exchange rate, the shift in capital stock, the growth of the labor supply, etc., and by determining a new comparative static solution for each year. The model presented in this study is a dynamic CGE applied to the Saudi Arabian economy. The economy is aggregated into nine sectors:

1. Agriculture, fishing, and forests;
2. Mining, quarrying, and fuel;
3. Manufacturing and industry;
4. Electricity, gas, and water;
5. Construction;
6. Commerce, restaurants, and hotels;
7. Transport, communication, and storage;
8. Finance, insurance, and banking; and
9. Services.

Each sector produces a homogenous output. Therefore, in a dynamic CGE framework, the effect of the stock market on the Saudi Arabian economy will be determined.

Organization of the Writing

This study will be presented in six chapters. Chapter I is an introduction. A review of the literature which focuses on the stock market and economic growth is presented in Chapter II. Chapter III analyzes the stock market in Saudi Arabia. Chapter IV addresses the dynamic CGE model for Saudi Arabia. Chapter V discusses simulation scenarios and their results. And, finally, a summary of this study and its policy implications will appear in Chapter VI.

CHAPTER II

LITERATURE REVIEW

Introduction

Three major surges in growth theory have occurred in this century: the first is the Harrod-Domar model; the second surge is the neoclassical growth theory in which Solow (1956) is the most important figure; and the third surge in growth theory was initiated by the work of Romer (1986) and Lucas (1988) and is called "the theory of endogenous growth."

In these theories, the accumulation of capital plays an important role in determining the growth of the economy and the Steady-State. The problem that many developing countries face is a deficiency in capital accumulation. Therefore, such countries need a well-developed financial sector to enable firms to finance their needs. The stock market is one of the easiest ways to finance firms and enable savers to have access to their investments at any time. Moreover, the stock market gives investors a higher return than interest rates, which encourages people to save and invest in the stock market.

Emerging Stock Markets

World stock markets are booming and stock markets in developing countries account for a disproportionately large share of this boom. According to the International

Finance Corporation (IFC) 1997 over the past ten years, world stock market capitalization rose from $4.7 trillion to $15.2 trillion, and the share of emerging market capitalization in the world stock markets jumped from less than 4% to 13%. The value of shares traded on emerging markets increased from less than 3% of the world total in 1985 to 11% in 1996. The flow of money from the international portfolio to emerging stock markets soared from $0.1 billion in 1985 to approximately $45.7 billion in new foreign money for emerging stock markets in 1996. The emerging markets' share of the world GNP in 1995 was 19%. However, the emerging markets' share of the world population in the same year was 84%. The presence of the stock market in developing countries will encourage people in these countries to invest their savings in the stock market since the return in the stock market is usually higher than the interest rates.

The trading of shares within emerging markets rebounded strongly in 1996, up 49% in value terms, to almost $1.5 trillion, from 1995's figure. The number of domestic companies listed in emerging markets was 11,296 in 1987 and 22,263 in 1996, a rise of 97% (IFC, 1997). Value traded for the same period jumped about 8.3 times, while the market capitalization in emerging markets during this period increased more than 5 times; in developed markets, the market capitalization for the same period increased about 1.4 times. In other words, the growth of market capitalization in emerging markets was about 530% and in developed markets about 140% (all the numbers are calculated from tables in IFC 1997).

Efficiency of the Stock Market in Developing Countries

An economy that hopes to make efficient use of its resources must ensure that capital flows freely to its most productive uses. Financial markets provide the

clearinghouse in which funds are allocated between savers and borrowers. Efficient allocations of capital into investment projects endorse economic growth. Funds which go to less attractive projects will lead to less-than-optimal economic growth.

One of the important functions of the stock market is to enhance the efficiency of investments. In fact, one might argue that this is its distinctive feature, since in most countries external equity represents only a small proportion of the financing needs of corporations (Dailami and Atkin, 1990). The stock market can impose a degree of control over the investment behavior of countries through its continuous valuation of their stock prices and the implied possibility of mergers and takeovers (Dailami and Atkin, 1990). A high price for a firm's stock makes it advantage for the firm to raise capital through issuing new equities to finance investment.

Another important function of the stock market is to serve as a source of economy impacting mechanisms. The economy needs some mechanism for effecting change in corporate governance. There are two mechanisms in a stock market. First, shareholders can discharge management directly. Second, mergers and acquisitions are possible (Dailami and Atkin, 1990).

Cho (1986) argued that a well-functioning equity market is a necessary condition for improving allocation efficiency through the liberalization of interest rates and other restrictive regulations imposed on the banking sector in developing countries. However, if a stock market does not exist, then a more moderate approach towards financial sector liberalization and a degree of government intervention in the financial system is necessary.

Some studies have focused on emerging markets (Errunze and Losq, 1985; Sharma and Kennedy, 1977; Darrat and Mukherjee, 1987; Kapur and Ravallion, 1988). In general, these studies find mild pricing inefficiencies in these markets and detect a first-order serial correlation in stock prices. As a result of inadequate information, positive serial correlation is possible. For example, securities in Mexico exhibit a high degree of positive serial correlation; since this is an actively traded market, the explanation is more likely information inadequacies. In emerging markets, information may be inadequate because of barriers to the dissemination of information, and companies appear to reveal less information with a greater time lag than is the norm in developed markets. On the other hand, negative serial correlation is more likely to occur in thin, speculative markets; Zimbabwe is a good example (Dailami and Atkin, 1990).

The Stock Market and Economic Activity

The stock market is one of the important financial sectors in the economy, affecting the economy in different ways. High-return projects need long-run commitments, but investors, in general, are reluctant to invest their savings for a long period. Therefore, without a liquid market, there is less investment in these projects (Levine, 1991). The stock market offers consumers who have been subjected to liquidity shocks with channels of exchanging investments with other agents who have not encountered such a shock and who wish to increase the share of their wealth that is in the form of productive assets. Bencivenga, et al. (1996) have shown that the rise of the stock market may provide liquidity. Savers in this case have shares, which they can liquidate at any time, and firms have capital, which has been raised by issuing these shares. Through

the stock market, firms can raise the capital they need, and investors have access to their savings at any time by liquidating their equities.

The acquisition of information about firms becomes important in the stock market (Holmstrom and Tirole, 1993). Since information becomes profitable for investors, investors are stimulated to research and observe firms. The allocation of resources is improved by available and better information, which stimulates economic growth. However, a different opinion is given by Stiglitz (1994), who argues that the prices of shares in well-functioning stock markets reveal information about the firm. Therefore, quick public disclosure will reduce incentives for expending private resources to obtain information. Demirguc-Kunt, et al. (1996) say that by providing better information and decreasing monitoring costs for investors and financial intermediaries, stock markets lower the cost of both external debt and external equity. A case study done by Kwon, et al. (1997), using a regression for the Korean stock market, found that the Korean stock market incorporates information on macroeconomic variables in stock market returns. The significant factors are the divided yield, the foreign exchange rate, the price of oil, and the money supply. The Korean stock market is more sensitive to real economic activities than to inflation or interest rate variables.

Different models (Saint-Paul, 1992; Devereux and Smith, 1994; Obstfeld, 1994) demonstrate the effect of the stock market in diversifying risks. These models show that since the risks of higher-return projects can be diversified through the internationally integrated stock market, economic growth can be promoted by shifting investments to higher-return projects.

The principal-agent problem is one of the important problems facing any economy. An efficient stock market can help to relieve the principal-agent problem (Jensen and Murphy, 1990). The stock market makes it easier to tie the manager's compensation to stock market performance (Levine and Zervos, 1996). Scharfstein (1988) argues that managers maximize a firm's stock price because of the threat of takeover. Consequently, the threat of a corporate takeover in well-functioning stock markets can mitigate the principal-agent problem and promote efficient resource allocation and growth (Levine and Zervos, 1996). The continuous adjustment of stock prices in stock markets can help in monitoring managers of publicly traded corporations, thereby improving corporate governance (Claessens, et al., 1995).

Different theories of economic development consider the lack of capital one of the major problems that developing countries face (Basu, 1997). The internationally integrated stock market can provide the economy with the capital it needs to invest. Since capital accumulation is one of the important sources of a higher economic steady-state, through the equity market the country can stimulate the necessary capital. Demirguc-Kunt, et al. (1996) argue that the level of development of financial markets, especially equity markets, and their determination of corporate financing choices, have been overlooked by theory. This argument indicates that economies without well-functioning stock market may suffer from three types of imperfections: first, opportunities for risk diversification are limited for investors and entrepreneurs; second, firms are unable to optimally structure their financing packages; third, countries without well-functioning markets lack information about the prospects of firms whose shares are traded, thereby lessening investment promotion and efficiency.

The Development of the Stock Market and Long-Run Growth

Theorists disagree about the importance of stock markets for economic growth. On the negative side, Mayer (1988) argues that even large stock markets are unimportant sources of corporate finances. Devereux and Smith (1994) say that greater risk-sharing through internationally integrated stock markets can decrease saving rates and lead to slower economic growth. In addition, Stiglitz (1985, 1994) mentions that the liquidity of the stock market will not strengthen incentives for acquiring information about firms. Robinson (1952) says that the financial sector does not stimulate economic growth. In his view, financial development simply responds to development in the real sector. Finally, Morck, et al. (1990a,1990b) argue that stock market development can hurt economic growth by easing counterproductive corporate takeovers.

On the positive side, Friend (1972) states "the stock market affects the functioning of the economy in two principal ways. First, market developments may affect the national income through their influence on the aggregate propensities to consume, to save, and to invest. Second, even with a given level of saving and investment, market arrangements can result in a more or less efficient allocation of investment funds" (p.212). Levine (1991) studies the function of the stock market by allowing investors to diversify their portfolios, hence enabling them to hedge against unsystematic risk which can lead to potentially overwhelming financial loss. Therefore, the existence of the stock market tends to raise economic growth, by making agents more willing to invest a given amount of available savings in risky, more productive technology, rather than in riskless assets.

Also taking a positive view of the impact of efficient stock markets on economic development, Bencivevenga, et al. (1996) emphasize the importance of liquidity, a process which the stock market can simplify, for economic growth, because most profitable investments need a long-run commitment of capital, whereas savers are reluctant to invest in long-run projects. Holmstrom and Tirole (1993) suggest that liquid stock markets can raise investors' incentives to obtain information about firms and improve corporate governance. Mobilizing sufficient resources for investment is surely a necessary condition for any economy to thrive and expand; the stock market is crucial for the most efficient allocation of resources towards investment (Berthelemy and Varoudakis, 1996). Finally, Obstfeld (1994) argues that resource allocation can be improved by international risk sharing through internationally integrated stock markets, and such risk sharing can accelerate the rate of economic growth.

Atje and Jovanovic (1993), in their test of the effect of the development of the stock market on economic growth using a sample of 72 countries for the period of 1980 through 1988, have been able to obtain favorable results for the hypothesis that the development of the stock market has a positive effect on growth. Their results suggest that the relative size of a country's stock market helps to explain subsequent growth in per capita gross domestic product. However, Harris (1997) criticizes Atje and Jovanovic for using lagged investments in their cross-section model. Harris' argument is that lagged investment is not highly correlated with current investment and hence is not a good proxy for this variable. This gives rise to omitted-variable bias in the remaining variables. Thus, the level of stock market activity is correlated with subsequent investment and so its coefficient is biased upward (Harris, 1997). He estimates the same

model of Atje and Jovanovic with current investment instead of lagged investment and concludes that the stock market effect is much weaker than has been proposed by Atje and Jovanovic.

Murinde (1996) provides both a theoretical and empirical inquiry regarding the relationship between financial markets and economic growth. The author presents an endogenous growth model in which growth derives from the behavior of economic agents. He then estimates the model for seven Pacific Basin countries, and his findings support the importance of the stock market to the growth of the economy. In particular, his empirical analysis points out that stock market development is importantly linked to economic growth. He further extended the analysis using Atje and Jovanovic's 1993 endogenous growth model. In general, the results confirm a large effect of stock market on economic growth. In terms of policy relevance, the author argues that the finding of his paper lends support to those countries which aim to develop their stock markets in order to speed up their economic growth.

Levine and Zervos (1996), using cross-country regression, examine the association between stock market development and economic growth. They find a strong correlation between overall stock market development and long-run economic growth. They use the stock market as one of the explanatory variables, while the per capita GDP is the dependent variables. This study discovers that the coefficients of the stock market are positive and highly significant.

Overall, these empirical studies are consistent with theories that suggest a positive relationship between stock market development and long-run economic growth. The

results are inconsistent with theories that predict no correlation or a negative association between stock market development and economic performance.

As stock markets become increasingly important to the modern economy, their role in economic growth, inherent in the functions they provide, will be unmatched. Although other financial intermediations can provide some services, others are unique to the stock market. For instance, stock markets provide liquidity in a way that makes it easier for agents to access their savings at any time; savings in bank accounts, on the other hand, are not as liquid as in a stock market. As this study will show, creating an effective and efficient Saudi Arabian stock market is vital to the nation's economic growth and well-being.

CHAPTER III

CHARACTERISTICS OF THE FINANCIAL MARKET IN SAUDI ARABIA

Brief History

The stock market in Saudi Arabia began in 1935 when the Arabian Automobile Company went public. It was later liquidated. The largest increase in the number of publicly traded companies took place between 1976 and 1980, which corresponded to a national oil boom. At that time, about 19 companies went public. The number of traded companies at the end of 1984, when the market was unregulated, was 50. In 1999, 74 companies traded their shares in the stock market, which the Saudi government regulates.

Economic growth and development in Saudi Arabian economy, which has been taking place over the last two or three decades, favors a financial market for the rapid growth of the number of firms and for market capitalization.

Stock trading was unregulated prior to 1984. At that time, about 80 unregulated brokers were informally trading the stocks of about 50 Saudi companies. Saudi investors were allowed to invest in foreign securities, but equity ownership in Saudi companies is limited to Saudi citizens and, in a few cases, citizens of other Gulf Cooperation Council countries (Bahrain, Kuwait, Oman, Qatar, and the United Arab Emirates) (Butler, et al., 1992).

1984 is considered the start of the regulation of the Saudi Stock Market (SSM). The responsibility for the regulation of the securities market in Saudi Arabia is divided

between the Ministry of Commerce (MOC) and Saudi Arabian Monetary Agency (SAMA). The primary market, the Initial Public Offering (IPO) of company shares to members of the public, is regulated by the MOC, while SAMA regulates the secondary market. Since all "broker" participants are banks, they are subject to the usual central bank oversight of their operations. A Ministerial Committee for the Share Market and its sub-committee, the Supervisory Committee for the Share Market, provide a means for coordination between these two and other ministries which have roles in the stock market

Two major developments in the stock market took place after 1985; the first of these was that when the new regulations transferred share trading from unregulated brokers to the banks in 1985, the banks jointly formed the Saudi Shares Registration Company (SSRC) to be a clearing system for executed trades and to coordinate buy and sell orders among bank branches. The Saudi Shares Registration Company (SSRC) has been formed under the supervision of SAMA.

Because the SSRC served as a clearing system managing trades and purchases/sales, it became the source of all brokerage activities. Under the new regulation, banks established new shares departments. Buyers of a given stock first had to go to the branch and fill out an order. After that, the bank checked whether it had this stock in its own list; if not, then the bank contacted other banks. Under this system, different banks traded the stock at different prices. In addition, a delay of several days or weeks before orders were completed occurred frequently, indicating a lack of coordination among banks. Given this and the prohibition on banks from owning stock, a group of active investors became unofficial market makers. They traded for their own accounts and had their own ask-bid prices.

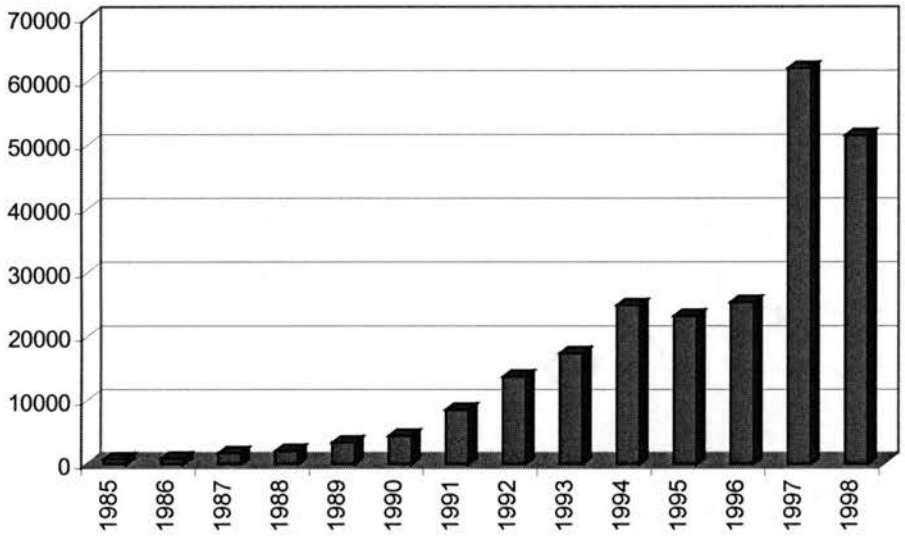
The second major development occurred in August, 1990, when SAMA introduced the Electronic Securities Information System (ESIS) to replace the old method of trading. After the introduction of ESIS, the banks established twelve Central Trading Units (CTUs) in Riyadh, where all of the CTUs are connected to the central system at SAMA, and each branch of each bank in various parts of the country is connected to the CTU in Riyadh. The only places in which buy-sell orders can be entered into the ESIS are the CTUs in each bank. In this system, all buy and sell orders placed at individual banks are transferred to a central system at SAMA for matching on an equitable basis. The introduction of the ESIS to the stock market is believed to have had a positive effect on trading.

Table 1 illustrates some indicators of Saudi stock market growth over the period of 1985-1998. For instance, the value of the transactions in 1998 jumps 6,677 percent from its value in 1985. Figure 1 shows the change in the value of the transactions during this period. This increase in the value of transactions in the market indicates that market liquidity has been increased during this period; however, the Saudi stock market is relatively small and thin by international standards. However, the change in the value of transactions experienced irregularities during this period. For instance, from 1986 to 1987, it increased by 103 percent, while from 1987 to 1988 the change did not exceed 21 percent. The number of transactions in the market shows an improvement when compared to the period before the regulation. While the number of transactions was 7,842 in 1985, it increased to 376,617 in 1998, as indicated by Figure 2. In addition, the size of the market has been augmented; the percentage increase in the market value of shares from 1985 to 1998 is 153 percent. 1997 was the peak for the market. In this year,

the market value of stocks was SR 222.7 billion. Figure 3 demonstrates the increase in the market value of shares.

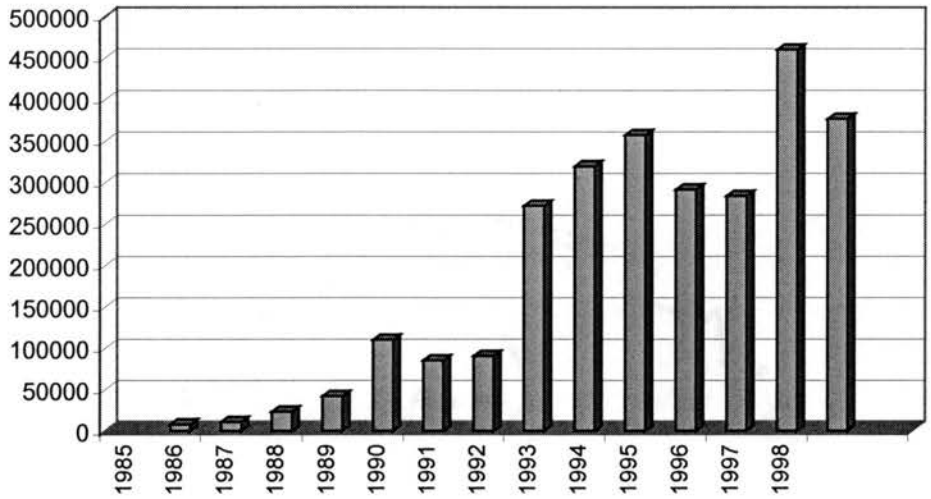
The Saudi stock market noticed an increase in its performance and size after regulation of the market occurred. Although the market experienced rapid growth during this period, it remains relatively thin and small, and continues to face several problems, as the next section discusses.

Figure (1)
Value of Transactions
(Millions S.R.)



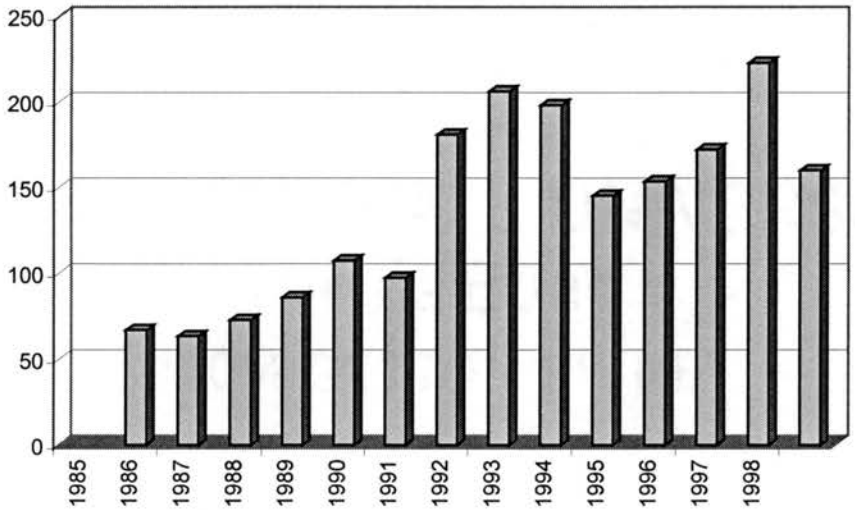
Source: Data is calculated from Table 1

Figure (2)
Number of Transactions



Source: Data is calculated from Table 1

Figure (3)
Market Value of Shares
(Billions S.R.)



Source: Data is calculated from Table 1

Table 1
Saudi Stock Market Growth During the Period 1985-1999

Year	Value of Transactions (Millions S.R.)	Change (Percent)	Quantity of Transaction (Millions S.R.)	Change (Percent)	No. of Transactions	Change (Percent)	Market Value of Shares (Billions S.R.)	Change (Percent)
1985	759.97		3.94		7,842	0	67	
1986	830.75	9	5.26	24	10,833	38	63.4	-5.4
1987	1,685.52	103	12.01	128	23,267	115	72.8	14.8
1988	2,036.79	21	14.64	22	41,960	80	85.9	17.9
1989	3,363.69	65	15.27	4	110,030	162	107.3	24.9
1990	4,403.24	31	16.94	11	85,298	-22	97.3	-9.3
1991	8,527.31	94	30.76	82	90,559	6	180.8	85.8
1992	13,698.83	61	35.2	14	272,075	200	206.1	13.9
1993	17,360.03	27	60.31	71	319,582	17	197.9	-3.9
1994	24,871.08	43	152.09	152	357,180	12	145.1	-26.7
1995	23,226.59	-7	116.62	-23	291,742	-18	153.39	5.7
1996	25,397.33	9.3	137.83	18.2	283,759	-2.7	171.98	12.1
1997	62,060.36	144.4	313.98	127.8	460,056	62	222.7	29.5
1998	51,509.16	-17	294.64	-6.2	376,617	-18	159.91	-28.2

The Ranking of the Saudi Arabian Stock Market

The stock market in Saudi Arabia is an emerging market. Although it is the largest in the Arabic world in capitalization (the capital value of the stock market in Saudi Arabia in 1998 was $42.563 billion), the number of firms listed in the market is 74 for the same year, which is one of the lowest numbers in emerging markets. The share of the Saudi stock market in the capitalization of emerging markets in 1998 is only 2.3%; there are 51 markets with a market capital equal to $1.868 trillion (*Emerging Stock Market Factbook*, 1999), and the Saudi market accounts for 33 percent of the total value of Arab share markets (SAMA, 1999).

The rank of the stock market in Saudi Arabia is relatively low in many aspects when judged by international standards. Using the data for 102 countries, the International Finance Corporation (IFC) compared the world's stock markets (*Emerging Stock Market Factbook*, 1999). Using the number of domestic companies listed, the market that ranked lowest in the IFC database is that of the Philippines, with 221 companies and a ranking of 40; the Saudi Arabian stock market has only 74 companies, a number which indicates the limitations of the stock market in Saudi Arabia. This relatively small number is caused by the restrictions that make entry into the market difficult. Initial Public Offerings (IPOs) are tightly regulated in terms of both initial share price and the size of the share blocks that can be sold. Most companies going public are either newly established corporations with large capital requirements or privatized companies. As the process of going public might take more than two years, and because the Ministry of Commerce sets initial prices lower than the company value, companies which might otherwise participate in the stock market are prevented from doing so. In

addition, evaluating the goodwill of already established corporations is an unsolved problem.

Finally, because the conditions to go public are slightly difficult for some companies to meet—although these conditions have been modified to encourage more companies to go public—fewer corporations are inclined to participate. For instance, a law requires that for a company to go public, it must have minimum net assets of SR 75 million ($20 million); these figures have been adjusted to SR 50 million ($13.333 million); similarly, the required return on equity of 10 percent or higher for all companies for the previous five years has been changed to a "high" level of profit; the term "high" is non-specific in order to allow the Ministry of Commerce to determine applicability on an individual basis, which may permit companies with a less than 10 percent profit to go public. In addition, the limitation demanding that the company must have been founded a minimum of 10 years prior to the time when it wants to go public has been adjusted to 5 years instead. And last, instead of the requirement that 51 percent of the company assets go public, the new law reduces this to 40 percent. This new law will help to increase the number of companies to go public. Despite this, however, there are some well-established family corporations which want to go public but cannot, due to the still-stringent number and level of the obstacles which block these corporations from going public.

Another problem the Saudi Arabian stock market faces is a low turnover ratio; in 1998, the turnover ratio in Saudi Arabia was 26%, which resulted in the country being ranked 47th. In comparison, the turnover ratio of the stock market in the U.S. was 106.2%, and in Germany, 167%. The turnover in the Saudi stock market (SSM) is even

less than the average of transition economies. For instance, on average, stock markets in transition economies have a turnover of 30 percent (Claessen, et al., 2000). The reasonable percentage for a turnover ratio falls in the range of 80 to 100. The lower the turnover ratio, the less liquid the market.

In 1998, the total value traded in the stock market was $13,712 million. While the SSM ranks 35th in terms of total value traded in the market, it occupies the 32nd position among the other markets in terms of total market capitalization, with total capital equal to $42.563 billion.

An Analysis of Saudi Arabia's Stock Market

The SSM is an over-the-counter market in which the commercial banks buy and sell shares by means of an electronic trading system, the Electronic Securities Information System (ESIS). In this system, banks act as the "brokers" for their customers' transactions. The details of all matched trades are passed to the clearing system on the evening of the trade date. The seller's position in the sold security is cancelled and a new position is created for the buyer in a Central Share Accounting system.

The SSM is composed of six sectors, namely banking, industrial, cement, service, electricity, and agriculture. Table 2 shows the total shares traded in each sector in the SSM. As illustrated in Table 2, all sectors have experienced an increase in the number of shares traded. Figure 4 compares the number of shares for the six sectors in the years 1990 and 1999; 1990 has been selected because it is the first year in which the ESIS was used for trading. Seventy-four companies with shares traded in the market are registered in the SSM.

Table 2

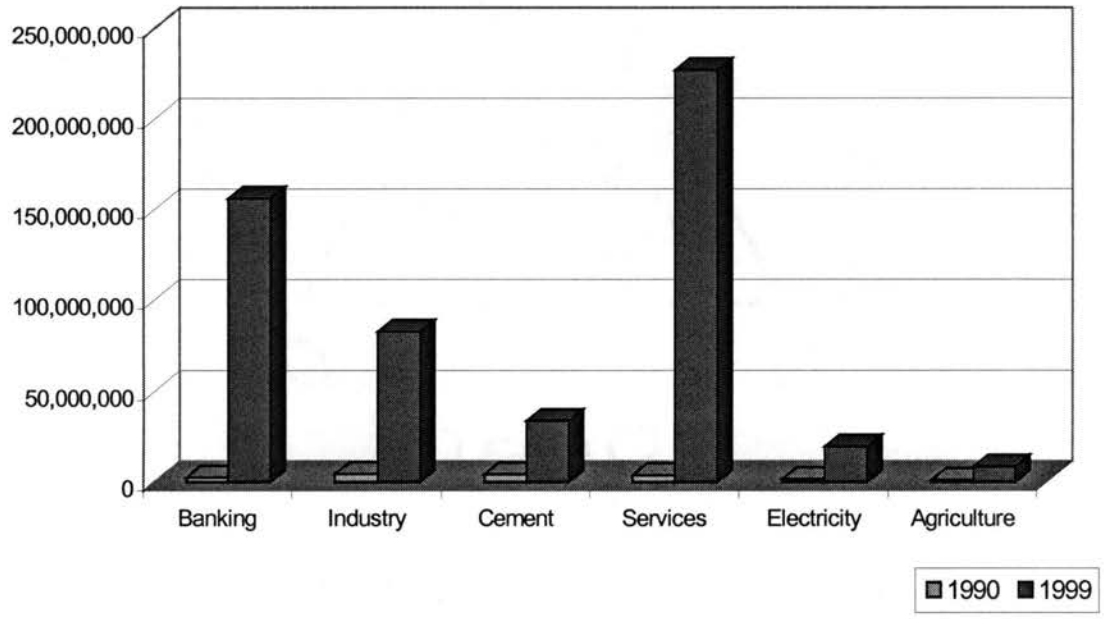
Number of Shares Traded by Sectors

Period	Banking	Industry	Cement	Services	Electricity	Agriculture	Total
1985	442,648	810,118	492,636	751,732	1,173,533	265,671	3,936,338
1986	781,420	422,116	422,116	1,386,350	1,084,384	788,226	5,263,001
1987	859,618	3,272,877	3,272,877	2,774,331	1,790,255	1,933,126	2,012,324
1988	1,209,975	4,949,985	2,799,759	2,506,681	1,583,858	1,591,069	14,641,327
1989	2,576,299	4,500,932	2,790,855	3,540,923	977,060	885,784	15,271,853
1990	2,453,089	4,236,573	4,126,478	3,660,715	1,518,901	942,630	16,938,386
1991	5,998,827	6,408,850	5,372,923	11,557,926	1,690,416	2,593,480	30,758,077
1992	5,998,827	7,654,973	2,951,953	11,987,312	1,588,252	4,053,495	35,199,907
1993	13,748,005	13,124,380	1,609,749	26,928,081	1,588,252	3,309,161	60,307,628
1994	15,096,764	47,802,100	5,580,357	73,336,053	1,184,523	9,088,637	152,088,434
1995	27,189,722	38,765,411	8,854,809	35,202,846	1,326,233	5,278,918	116,617,939
1996	31,860,296	19,924,784	29,804,145	48,010,923	2,309,169	5,923,243	137,832,560
1997	78,225,938	45,902,503	37,899,445	124,145,566	10,583,760	17,218,126	313,975,338
1998	129,699,957	56,893,625	21,137,344	71,654,808	8,066,767	7,184,703	294,637,204
1999	156,121,541	82,509,623	33,862,362	226,967,729	19,643,425	8,401,026	527,505,706

Source: SAMA, 2000; Internet Web page (www.sama-ksa.org)

Even though the system of trading, which has been developed by SAMA, meets the international standard, the stock market in Saudi Arabia faces many problems and is inefficient, as indicated by the results of several studies. Most of the studies analyzing the stock market (such as Medani, et al., 1987; Butler, et al., 1992; Alsayegh, et al., 1993; Albalat, 1996; Khbabah, 1998; and Khbabah, et al., 1998) concur that numerous problems exist in Saudi Arabia's market.

Figure (4)
Number of Shares Traded



These problems, or obstacles, have a negative impact on investors in the stock market. Therefore, some investors hold their money in checking accounts, according to Khbabah, et al., (1998); others put their wealth into real estate, which has led to the overpricing of real estate in Saudi Arabia. In addition, the outflow of capital is one of the problems facing Saudi Arabia's economy. Analysts estimate that from $500 to $600 billion of the private sector wealth flow abroad.

Butler and Malaikah's 1992 examination of the Saudi stock market finds it is inefficient. According to auto-correlation and run tests of serial independence, the Saudi stock market exhibits high serial dependence.

Six years later, Khababa (1998)'s auto-correlation and run tests conclude that the SSM is inefficient both informationally and operationally. The author attributes the inefficiency in the SSM to two main reasons: first, the absence of official markets traders and brokers; and second, the high concentration of the market, where in some economic sectors, shareholding is dominated by the government and/or a few investors.

Only about half of shares issued by the 74 traded companies in the stock market are available for trading. Shares held by the government, by quasi-government institutions, and by foreigners are out of the market because they are not traded. For example, in 1996, the outstanding number of shares of 71 companies was 756.364 million. Only 54 percent of these shares are owned by private sectors and are therefore available for trade (Bakheet Financial Advisors, 1996). However, the number of shares traded in the SSM in 1996 was 137.832 million, which is only 18 percent of the total shares issued, due to the fact that the ownership of market shares is concentrated among a few families. This concentration reduces the supply of shares in the market, resulting in slower trade, and, ultimately triggering a trading thinness which disturbs, to some extent, the price level in the SSM.

Another of the major problems the stock market of Saudi Arabia faces is that most of the companies registered in the stock market do not publish financial statements on time (Almarkaz Alesteshary, 1999), despite the law's requirement that each firm must publish its financial statements quarterly. These publishing delays prevent the financial

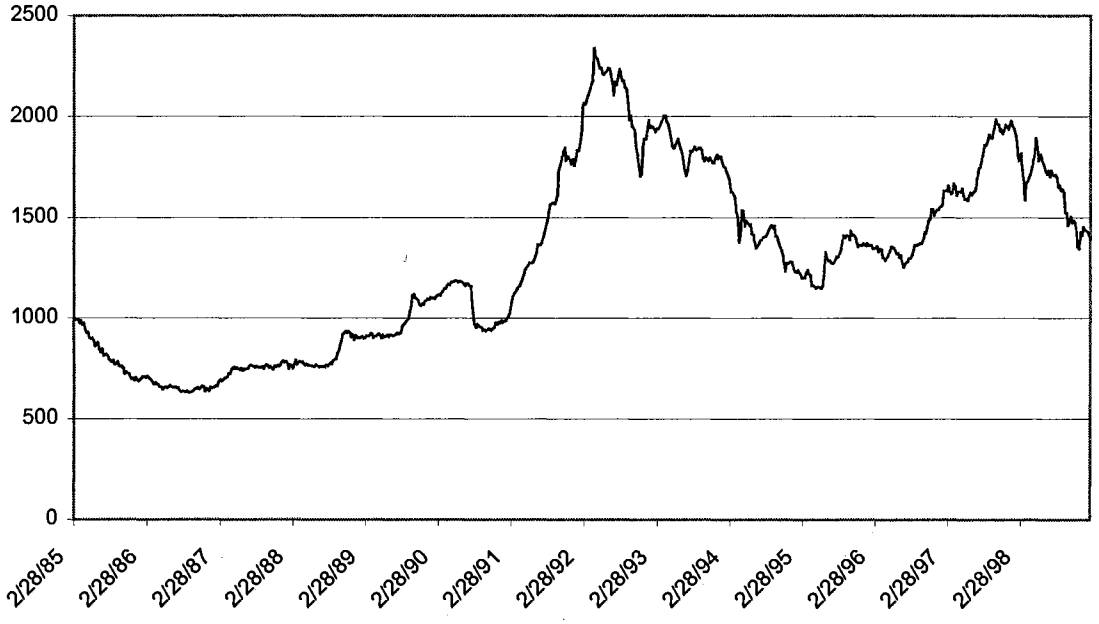
reports from serving as major sources of information for investors in the stock market. Khbabah, et al.'s 1998 survey shows that corporate financial reports are the last source of information for investors in the stock market.

A third obstacle the Saudi stock market must overcome is the absence of official market makers or specialists promoting liquidity. SAMA granted a brokerage monopoly to commercial banks to develop the market and offer mutual funds, but restricted them from buying or selling stocks for their own accounts. The result of these restrictions was to create a financial market parallel to the official market to sell and buy the shares through real estate offices. This parallel market has grown to the point that it is difficult to ignore (Khbabah, et al. 1998). On the other hand, it is not to the commercial banks' advantage to develop the market, as they might lose some of the profit from demand deposits, which account for about 43 percent of M_2, or non-interest bearing accounts for religious purposes. In a survey, Khbabah, et al., (1998) report that religion is a very important factor for people who put their money in checking accounts and for investors who invest in the stock market.

The Performance of the Market Index

The Ministry of Finance (MOF) has developed an index to measure changes in the market. The share index is a weekly index using Feb. 28, 1985, as a base year. The MOF used the average weight of shares prices to build the index, which was handled by the MOF until 1996, when SAMA took charge of preparing and publishing the index. Using ESIS, the investor can see the change in the index as trading in the market occurs. The index, shown below, consists of all the companies in the market.

Figure (5)
Chart for the Index of Saudi Stock Market



Source:SAMA, Share Control Division (SCD).

The share index of the Saudi stock market is a value-weighted figure calculated by dividing the current market value of all stocks by their value in the previous period, and multiplying the result by the value of the index in the previous period. The calculation for the share index for the Saudi stock market is shown in Equation 3.1:

$$I_t = \frac{\sum_{i=1}^{n}(P_{it}.Q_t)}{\sum_{i=1}^{n}(P_{it-1}.Q_t)}(I_{t-1}) \quad , \qquad 3.1$$

where:

I_t = the index value for period t,

$P_{i,t}$ = the price of the component stock *i* at time *t*,

$Q_{i,t}$ = the number of outstanding shares for company *i*,

$P_{i,t-1}$ = the price of component stock *i* at time (*t*-1), and

I_{t-1} = the value of the index at (*t*-1).

Using the data from SAMA covering the period from Feb. 28, 1985, to Feb. 11, 1999, Figure (5) shows the movement of the index during this period. The market experiences a drop in its value by about 37% in 1986 because of the drop in oil prices and the reduction in government expenditure, which reflect the decrease in the growth of the economy. After 1986, the index starts to take off with some volatility, but with an overall trend of increase. In May, 1990, the index was 1,183.77, which was the highest in the market since the index began. Then, in October, 1990, the index dropped to its lowest point—935.63—since mid-1989, due to the Gulf War. However, as the war ended and Kuwait was freed, investors regained confidence in the economy, and some of the money that had been invested in foreign markets during the war returned to the Saudi Arabian economy, resulting in a climb in the index until it reached the highest point ever on April 15, 1992, when the index value was 2,338.24. This rise was followed by a fall in the index as a result of a decrease in both the price of oil and government expenditure. By June, 1995, the share price index lost about 50% of its value. After June 1995, the volatility of the market continued its previous tendency towards increase, regaining much of its value by October 1997, when it reached 1,985.4 points. Then the market experienced another tumble in its value with some intermittent increases, but with an overall decrease as of February 1999.

As can be inferred from the above discussion, the Saudi stock market is heavily influenced by the oil market and by government consumption. All the attempts of the Saudi authorities to diversify the economy away from oil dependence have been unsuccessful so far. The most recent development plans focus on the role of the private sector in leading the economy and reducing the government's role in the economy. The

success of these efforts may have a negative impact on the economy in the short-run, but the long-run impact of these policies is promising. For this plan to succeed, the government must develop a stock market which can accommodate business needs and expansions.

Despite its problems, the Saudi stock market is an emerging market with the potential to play a future role in the economy. Although the Saudi stock market uses a highly advanced system for trading, the market remains inefficient; the lack of enforceable stock market regulations, the absence of official market makers, and the illiquidity, among other factors, contribute to the operational inefficiency of the Saudi stock market.

CHAPTER IV

METHODOLOGY

Introduction

This study determines the impact of the stock market on the Saudi Arabian economy using a dynamic computable general equilibrium model (CGE). In this model, financial and real sectors have been modeled to capture the effect of introducing the stock market to the economy.

A CGE simulates the working of a market economy in which prices and quantities adjust to clear markets for products and factors. The model specifies behavior for optimizing consumers and producers in the Saudi Arabian economy. The government is included in the model as an explicit agent and captures all transactions in the circular flow of income.

Although different types of quantitative tools, such as input-output models, linear programming, or econometric models, can be used to study the policy options, CGE models are more suitable for the Saudi Arabian economy because the central authority does not fully control the various quantity variables in the economy and "the economy has many agents independently maximizing their own welfare functions and jointly but inadvertently determining an outcome that can be affected only indirectly by the planner or the policy maker" (Dervis, et al., 1982, p. 131).

E models is to allow policy makers to use instrument here input-output and linear programming models at can be considered to be instruments controlled by omies. Although policy makers can benefit from the provided by the models, they cannot easily relate the olicy decisions" (Dervis, et al., 1982, 131). Moreover, is in partial equilibrium, the CGE is a general y using the CGE model, one can estimate the effect of the stock market on all related variables in the economy.

The majority of CGE models have been used to simulate comparative static results of change in a particular policy or group of policies where different states of the world are compared. Although this counterfactual approach is useful for policy analysis purposes, it is necessary to incorporate time paths of adjustment in analyzing particular policy or theoretical issues (Bandara, 1991).

CGE model can be static or dynamic; the static CGE is a model run for one period, while the dynamic model is run for several periods. Two types of dynamics are applicable in the CGE model: recursive dynamics and intertemporal dynamics.

The model used to formalize the theoretical relationship in this study is an intertemporal dynamic CGE model. In this model, we set a behavior equation for the agents in the economy, where each agent in the economy maximizes its own objective, giving us the data to solve our model for a base run. The CGE model assumes that the economy is in equilibrium in the base year. Thus the model should first reproduce the base-year data of the social accounting matrix (SAM); then the data will be updated. The

CGE model is designed to enable the simulation of short-term and long-term impacts; it derives the supply of and demand for commodities and factors in each sector, and then works to find a solution that provides a set of prices and wages that drive excess demands to zero in each period. To solve the model, parameters are either taken from previous studies or calibrated. Calibration requires some exogenously specified parameter values: for some equation sets, the number of parameters exceeds the number of equations.

In this study, two models have been developed. The first model is the base model, or reference run, which reproduces base-year data and uses the dynamic linkages to predict the economic future. In the second model, where the stock market is introduced, capital is mobilized with the aid of the stock market. The crucial assumptions introduced in this model are that all agents are rational and the stock market efficient. Given these assumptions, all companies will be evaluated in the stock market and correctly priced. Consequently, the stock market will favor the "good" projects, or those projects that will earn higher rates of return on capital, and use the dynamic linkages to move the economy forward. The comparison between these models will be made using some of the important variables in the economy. In this chapter, first the equations describing a dynamic CGE model are presented, then market clearing conditions and macroeconomic closure. Finally, the stock market's introduction to the model is explained.

EQUATIONS FOR THE DYNAMIC CGE MODEL

Production and Factor Markets

The Supply of Commodities

The production function for the Saudi Arabian economy is disaggregated into nine sectors producing a homogenous output (X_i), and each sectoral production system is characterized by a two-level nested production function. At level one, the Leontief functional form that implies no substitution among factors is adapted to represent a fixed coefficient for a composite of primary and a composite of intermediate inputs (4.1). The second level is the production technology for primary factors (labor and capital) and intermediate inputs, which are described by the neoclassical production function represented by the Cobb-Douglas (CD) functional form (4.2) to capture substitution among primary factors:

$$V_{it} = \sum_{j=1}^{n} V_{ijt} = \sum_{j=1}^{n} a_{ij} X_{it} \qquad 4.1$$

and

$$X_{it} = \Omega_{it} L_{it}^{\alpha_i} K_{it}^{(1-\alpha)_i} , \qquad 4.2$$

where

X_{it} = sectoral output,

Ω_{it} = a shift parameter,

L_{it} = aggregate sectoral labor,

K_{it} = aggregate sectoral capital,

α_I = output elasticity with respect to labor,

V_{it} = an aggregation of intermediate inputs, and

a_{ij} = the input-output coefficient.

The aggregate sectoral profit function is given in Equation 4.3:

$$\Pi_{it} = PN_{it} X_{it} - W_{it} L_{it} \qquad 4.3$$

The net price or value-added coefficient is represented in equation 4.4:

$$PN_{it} = PD_{it}(1-tau_i) - \Sigma_{j=1} P_{jt} a_{ji} \qquad 4.4$$

Firms in each sector are maximizing Equation 4.3 subject to Equation 4.2. By solving this constraint maximization, firms determine labor demand. The aggregate sectoral of labor demand is a result of summing up the labor demand of firms in each sector. Sectoral labor demands are given by equation 4.5:

$$PN_{it} \frac{\partial X_{it}}{\partial L_{it}} = W_{it} \qquad 4.5$$

Given the production technology and institutional assumption of competitive labor and product markets, profits are maximized by equating the value of the marginal product of each labor (VMP_L) to its nominal wage rate (W_i).

Normal wages in each sector are determined by equating the supply and demand of labor, as in Equation 4.6:

$$L_{it}^{d} = L_{it}^{S} \qquad 4.6$$

Income Generation and Demand for Commodities

The recipients of income in the Saudi Arabian economy are households, which demand consumer goods; the government, which also demands consumer goods; and the firms, which demand intermediate and capital goods. For the specifics of an oil-producing country, the last category is divided into two parts: non-oil capital income consists of the firms producing goods in all the sectors in the economy except the oil and mining sector (sector two), and oil capital income consists of the activities of all firms in the oil and mining sector.

Income:

1. Households receive wages as a compensation for labor services. To calculate the total income received by households, one should sum up wages across the sectors. Saudi Arabia does not tax income. The total income for labor is:

$$Y_{wt} = \sum_{i=1}^{n} W_{it} L_{it} \qquad 4.7$$

2. Non-oil-capital income is defined as the aggregate value added of all sectors excluding sector two, the crude oil and mining sector, subtracted from the wage incomes and the tax on non-oil-capital income. The Saudi government owns sector two; therefore, the value added from this sector is deducted from capital income:

$$Y_{kt}^{noil} = \left(\sum_{i=1}^{n} PN_{it} X_{it} - PN_{2t} X_{2t} - (Y_{wt} - W_{2t} L_{2t}) \right) \cdot (1 - t) \qquad 4.8$$

3. Oil-capital income consists of the value added of the crude oil and mining sector, less its wage income. Since this sector is owned by the government, there is no tax on it:

$$Y_{kt}^{oil} = PN_{2t}X_{2t} - W_{2t}L_{2t} \qquad 4.9$$

4. Government income is generated from direct tax, indirect tax, and crude oil and mining. The Saudi government owns the crude oil and mining sector, sector two. Therefore, the oil-capital income is added to government income. The government income is given in Equation 4.10:

$$\mathrm{Y_{gt}} = \frac{t}{1-t}Y_{kt}^{noil} + Y_{kt}^{oil} + \sum_{i=1}^{n} tau_i P_{it} X_{it} + \sum_{i=1}^{n} tm_i M_{it} + \overline{F}_t ER, \qquad 4.10$$

where

tau_i = indirect tax rates,

$\overline{F}$ = foreign capital inflow, and

tm_i = tariff rates.

Equation 4.11 computes the Gross Domestic Production (GDP) from the income side, which is the sum of all the above income equations minus the outflow of capital, at normal prices:

$$\mathrm{GDP_t} = \mathrm{Y_{wt}} + \mathrm{Y}_{kt}^{noil} + \mathrm{Y_{gt}} - ER * \overline{F}_t \qquad 4.11$$

Equation 4.12 defines real GDP. The General price index (CPI) has been used to calculate the GDP at constant prices, with 1997 as the base year:

$$RealGDP_t = \frac{GDP_t}{CPI_t} \qquad 4.12$$

Saving and Consumption:

Equations 4.13 and 4.14 represent savings equations for the agents in the economy. Since the assumption is that households and firms have the same saving rate, there is only one equation for private savings, Equation 4.13:

$$S_{pt} = s_p (Y_{wt} + Y_{kt}^{noil}) \qquad 4.13$$

Similarly, there is only one equation for government savings, Equation 4.14:

$$S_{gt} = s_g Y_{gt} , \qquad 4.14$$

where

s_p = private average saving rate, and

s_g = government average saving rate.

Equation 4.15 represents the total savings, which is the sum of Equations 4.13 and 4.14:

$$TS_t = S_{pt} + S_{gt} \qquad 4.15$$

The residual, or difference between the total income and the net savings of all economic agents, is spent on consumer goods. Equation 4.16 specifies the total consumption of goods by households and government:

$$TC_t = (1 - s_p)(Y_{wt} + Y_{kt}^{noil}) + (1 - s_g) Y_{gt} \qquad 4.16$$

Similarly, the sectoral allocation of consumption demand is defined in Equation 4.17:

$$C_{it} = fc_i \left(\frac{TC_t}{P_{it}} \right), \qquad 4.17$$

where

fc_i = sectoral consumption shares.

Dynamic Investment

Following the classical economy theory, the investment here is savings driven. Therefore, aggregate investment is the endogenous sum of savings components. Given this, we can distinguish between two types of investment: first, the investment demand by sector of destination, Equation 4.18, is the sectoral capital accumulations (dK_i), which is determined by the price system; and second, the investment demand by sector of origin, Equation 4.19, which is a function of the capital composition matrix and the investment demand by sector of destination:

$$dK_{it} = H_{i,t+1} \frac{TS_t}{U_{it}} \qquad 4.18$$

and

$$Z_{it} = \Sigma_j \, S_{ij} \, dK_{jt} \, , \qquad 4.19$$

where

S_{ij} = capital composition matrix.

The sectoral share of the investment for next period is a function of sector i's share of the aggregate profits in period t, and the profit rate differentials when μ is positive. Equation 4.20 defines these relations:

$$H_{i,t+1} = Sp_{it} + \mu \, Sp_{it} \left(\frac{R_{it} - AR_t}{AR_t} \right) , \qquad 4.20$$

where

μ = the mobility of the investable funds parameter.

When there is no stock market to help moving investable funds to a sector with a higher-than-average profit rate, then μ is very low, which is assumed in this model to be 0.2.

The sectoral shares in the aggregate profit are the ratio of profit in sector i to the total profit as stated in Equation 4.21:

$$Sp_{it} = \frac{Rk_{it}}{Rk_t} \tag{4.21}$$

Equation 4.22 states that sectoral profits are equal to the total value added for the factor of production multiplied by the share of capital in production, minus tax:

$$Rk_{it} = (1-\alpha_i)\, PN_{it}\, X_{it}\, (1-t_i) \tag{4.22}$$

Summing up the above sectoral profits gives total profit for all sectors in the economy:

$$Rk_t = \sum_i Rk_{it} \tag{4.23}$$

Equations 4.24 and 4.25 determine the profit rates at time t (R_{it}) and the average nominal profit rate, respectively. The profit rates consist of the returns to capital when the entire capital stock is valued in current prices and capital gains. The average nominal profit rate is the weighted average of sectoral shares in aggregate profits and of the profit rates:

$$R_{it} = \left(\frac{Rk_{it}}{U_{it} \cdot K_{it}}\right) + \left(\frac{U_{it} - U_{i,t-1}}{U_{i,t-1}}\right), \tag{4.24}$$

and

$$AR_t = \sum_{i=1}^{n} Sp_{it} \cdot R_{it} \tag{4.25}$$

Because the capital in each sector is fixed in the short run, the price of capital (U_{it}) is the weighted average of shares in the capital composition matrix (S_{ji}) and of the composite price (P_{it}):

$$U_{it} = \sum_{i=1}^{n} S_{ji} \cdot P_{jt} \qquad 4.26$$

Capital stock for sector *i* for the following period ($t+1$) defined in Equation 4.27:

$$K_{i,t+1} = K_{0it} + dK_{it} \,, \qquad 4.27$$

where

K_{0it} = initial capital stock for sector *i* at time *t*.

Foreign Trade

The assumption of a small and open economy is held in the case of the Saudi Arabian economy, except for the oil market, where Saudi Arabia has market power due to Saudi Arabian policy having a strong impact on the oil prices.

On the import side, the model treats domestic and foreign commodities as imperfect substitutes in domestic use. Consequently, the import composition of domestic demand is influenced by the ratio of domestic and import prices. Therefore, using CES aggregation, the model aggregates domestic and import goods into a composite good for each sector, Q_i, as represented in Equation 4.28:

$$Q_{it} = \overline{\beta}[\delta_i M_{it}^{-\rho_i} + (1-\delta_i) D_{it}^{-\rho_i}]^{\frac{-1}{\rho_i}} \qquad 4.28$$

The determination of Q_{it} depends on the relative price of imports to domestic production. Given Equation 4.28, the assumption of utility maximization, and the prices

of imported goods (PM_{it}) and domestic goods (PD_{it}), the problem facing domestic consumers is to maximize Q_i subject to their budget constraints:

$$P_{it}Q_{it} = PD_{it}\, D_{it} + PM_{it}\, M_{it} \qquad 4.29$$

Setting up the Lagrangian for this constrained maximization and solving for the first-order conditions yields the import demand Equation 4.30 as a function of relative price and elasticity of substitution:

$$m_{it} = \frac{M_{it}}{D_{it}} = \left(\frac{\delta_i}{1-\delta_i}\right)^{\sigma_i} \left(\frac{PD_{it}}{PM_{it}}\right)^{\sigma_i}, \qquad 4.30$$

where

$$\sigma_i = \frac{1}{1+\rho_i}$$

is the elasticity of technical substitution, which determines the adjustment in the import-domestic products demand ratio (M_{it}/D_{it}) as a response to changes in relative prices (PD_{it}/PM_{it}).

Equation 4.31 defines PM_{it} in domestic currency:

$$PM_{it} = \overline{PW_i}\,(1+tm_i)\, ER, \qquad 4.31$$

where

$\overline{PW_i}$ = import world \$ price indices,

tm_i = tariff rates, and

ER = exchange rate (SR/US \$).

Since the assumption of a small country is applied to Saudi Arabia, implying that Saudi Arabia is a price-taker, $\overline{PW_i}$ is exogenously determined. In addition, the exchange rate in Saudi Arabia is fixed.

Given M_{it}, D_{it}, and budget constraints, the composite price can be obtained by solving the budget constraint for P_{it}, as in Equation 4.32:

$$P_{it} = \frac{1}{\beta_i}\left[\delta_i PM_{it}^{(1-\sigma_i)} + (1-\delta_i)PD_{it}^{(1-\sigma_i)}\right]^{\frac{1}{1-\sigma_i}} \qquad 4.32$$

On the other hand, since the products in the international market are differentiated by the country of origin and by imperfect substitution, the demand function for exports is downward sloping, as defined in Equation 4.33:

$$E_{it} = \overline{E}_0\left(\frac{\Pi_i}{PWE_{it}}\right)^{\eta_i}, \qquad 4.33$$

where

$\overline{E}_0$ = a scaling constant,

Π_i = export world $ price indices, and

η_i = export demand elasticities.

The export price *(PWE_{it})* equation is given in Equation 4.34, expressed in foreign currency:

$$PWE_{it} = \frac{PD_{it}}{(1+te_i)ER}, \qquad 4.34$$

where

te_i = export subsidy rates.

Export-demand elasticities, η_i, play a major role in determining the demand by foreign buyers for products that are produced in Saudi Arabia. For all sectors, η_i should be greater than one (>1) to reflect the elasticity of demand, except for the oil sector. Since Saudi Arabia has some market power in the oil market, η_2 should be less than one

(<1) where the demand for Saudi's oil is inelastic, at least in the short run. The values of these parameters are given in Appendix (C).

Equation 4.35 represents the balance of payment constraints:

$$\overline{F_t} = \sum_{i=1}^{n} \overline{PW_i} M_{it} - \sum_{i=1}^{n} PWE_{it} E_{it} \qquad 4.35$$

The Monetary Sector

In a Walrasian CGE model with all prices flexible and with all excess-demand equations homogenous at degree zero, the choice of an aggregate price index is arbitrary. Any nominal magnitude, such as the nominal exchange rate, the nominal wage, or the nominal price of one of the domestically produced goods, could have been used as the numeraire with no effect on relative prices or real production and employment (Robinson, S., et al., 1984). Therefore, the inclusion of the monetary sector into the CGE enables the model to determine the overall price level instead of only relative price.

The demand for money in this model is a function of real GDP. The interest rate is assumed to have no effect on the demand for money in Saudi Arabia:

$$\frac{M_{dt}}{P_{at}} = mm\left(realGDP_t^{\beta_1}\right) \qquad 4.36$$

The magnitude of the real money balance multiplier (*mm*), which is obtained by calibration, is 0.495392. The elasticity of the real money balance to real income (β_1) is equal to one (= 1), which is the average in several estimation studies.

Money supply is a function of the money multiplier (mm_s), high-powered money (H_{0t}), and the inflow of capital. The value of the money multiplier determines the impacts of the change in high-powered money on the money supply. The value of mm_s is

the product of the required reserve ratio, the portfolio decisions of depositary institutions, the public, and the central bank in Saudi Arabia (SAMA). High-powered money consists of currency in circulation and bank reserves in SAMA. Since the exchange rate is fixed in the model, the money supply in Saudi Arabia is endogenous, which is a function of the inflow of capital. Equations 4.37 and 4.38 show the money supply in the model:

$$M_{st} = mm_s * H_{0t} - ER * \overline{F}_t \qquad 4.37$$

and

$$H_{0t} = (CD_t + R_t) * (msg^{tt}), \qquad 4.38$$

where

mm_s = the money multiplier,

CD_t = the currency in circulation, and

R_t = bank reserves,

msg = the growth of high-powered money, and

tt = time.

In an equilibrium, money demand should equal money supply. Equation 4.39 shows the equilibrium:

$$M_{st} = M_{dt} \qquad 4.39$$

The inflation rate is defined as a percentage change in the general price index (CPI):

$$\inf_t = 100\left(\frac{CPI_t - CPI_{t-1}}{CPI_{t-1}}\right), \qquad 4.40$$

where

$$CPI_t = \sum_{i=1}^{n} fc_i P_{it} \qquad 4.41$$

MARKET CLEARING CONDITIONS AND MACROECONOMIC CLOSURE

The model represented in this study is a general equilibrium system with all endogenous variables jointly determined. In this section, equations that defined the system constraints, which the model economy satisfies, are explained.

The market equilibrium condition for domestically produced goods in sector *i* at time *t* is:

$$X_{it}^{D} = d_{it}V_{it} + d_{it}C_{it} + d_{it}Z_{it} + E_{it} \ , \qquad 4.42$$

where the domestic use ratio (d_{it}) transfers these demands for composite commodities into demands for domestically produced goods. Equation 4.42 imposes the condition that the sectoral supply of domestically produced goods equals demand, and thus identifies a market-clearing equilibrium in domestically produced commodities. However, this equation can be stated differently to characterize the market-clearing equilibrium in the product markets. Equation 4.43 defines the equilibrium in composite commodities:

$$Q_{it} = V_{it} + C_{it} + Z_{it} + E_{it} \qquad 4.43$$

The demand for and supply of domestically produced commodities are a function of domestic prices and the exchange rate. Therefore, the demand and supply equations can be expressed as vector functions:

$$X_{it}^{D} = f(PD_{it}, ER) \qquad 4.44$$

and

$$X_{it}^{S} = f(PD_{it}, ER) \ , \qquad 4.45$$

and sectoral excess demands are given by Equation 4.46:

$$EX_{it} = X_{it}^{D} - X_{it}^{S} = 0 \qquad 4.46$$

Equilibrium will be reached in factor markets if the demand for labor equals the supply of labor in each sector, and the average factor prices (W_{it}) are the equilibrating variables. This equilibrium is given in Equation 4.47:

$$L_{it}^{D} = L_{it}^{S} \qquad 4.47$$

The macro-closure condition for the balance of payments is defined in Equation 4.48:

$$\sum_{i=1}^{n} \overline{PW_i} M_{it} - \sum_{i=1}^{n} PWE_{it} E_{it} - \overline{F_t} = 0 \qquad 4.48$$

Since the exchange rate is fixed, the flow of capital will adjust to compensate the deficit in current accounts.

The last macro-closure is the equilibrium in the capital market. In this condition, the total savings equal investments, which is known as a classical closure.

$$TS_t = \sum Z_{ti} \qquad 4.49$$

THE STOCK MARKET

Analyzing the impact of the stock market on the performance of the economy requires that the stock market be included in the model, which may be accomplished in different ways. The choice of inclusion methods depends on the data available to the modeler and on his/her views on the role of the stock market in the economy. This section will present the modifications made to the standard model described in "Equations for the CGE Model," section I of this chapter.

Metzler's 1951 measurement of the real value of the stock market is adapted in this model. Metzler states, "If real national income under conditions of full employment is y_o (real GDP), and if a proportion, *c* (*ps*), of this consists of business profits, the real

value of all common stock will be the capitalized value of these profits" (113). Equation 4.50 defines the real value of the stock market. Following Metzler's example to calculate the real value of the stock market, we need to multiply the proportion of real GDP which consists of the business profits for all sectors by real GDP, then divide the outcome by the rate of return on the stock market:

$$\mathrm{RVSM}_t = \frac{ps_t . realGDP_t}{rr}, \qquad 4.50$$

where

rr = average rate of return in the stock market, and

$$ps_{it} = \frac{RK_{it}}{realGDP_t} \qquad 4.51$$

Equation 4.51 states that a proportion of real GDP consists of business profits for each sector; a proportion of real GDP consists of business profit for *all* sectors in the entire economy is represented in Equation 4.52:

$$ps_t = \frac{RK_t}{realGDP_t} \qquad 4.52$$

Similarly, Equation 4.53 calculates the real value of common stock in each sectors of the economy:

$$q_{it} = \frac{ps_{it} . realGDP_t}{rr} \qquad 4.53$$

Equation 4.54 defines the total real value of common stock in the entire economy (TQ):

$$TQ = \sum_{i=1}^{n} q_{it} \qquad 4.54$$

Using q_{it} from Equation 4.53 and TQ from Equation 4.54, sectoral investment shares are calculated in Equation 4.55:

$$HH_{it} = \frac{q_{it}}{TQ} \qquad 4.55$$

Given the sectoral investment shares in Equation 4.55, the investment demand by sector of destination shown in Equation 4.18 should change to Equation 4.56:

$$dK_{it} = HH_{it} \frac{TS_t}{U_{it}} \qquad 4.56$$

Equation 4.56 states that the investment demand by sector of destination will be influenced by the sectoral profit. Therefore, the higher the profit in sector *i*, the higher the investment demand in such sectors, resulting in more funds going to such sectors. Although this is not a Tobin's "q theory of investment," there are some similarities to it. The stock market influences the future investment by a firm. The higher the future profit of the company, the higher the price of such a firm, and the higher the investment demands by this firm. In another words, the firm's profit is an important factor in each model affecting the firm's decision to invest. Moreover, a firm's decision to invest depends on the price of the firm in the stock market in both models

As indicated in the problem statement in Chapter I, Saudi Arabia faces the problem of an outflow of capital. A major part of the Saudis' wealth is invested abroad. Developing the stock market is assumed to encourage an inflow of capital to the Saudi economy. Therefore, household wealth is included in the model to reflect this feature.

Household total wealth can be calculated by adding the real value of the stock market to the real balance. The total wealth of the household is given in Equation 4.57:

$$WTH_t = RVSM_t + Md_t \quad 4.57$$

Since savings are flow and the household wealth is stock, the need is to create a flow of wealth which measures the change in wealth annually. Equation 4.58 defines the change in household wealth:

$$dWTH_t = WTH_t + WTH_{t-1} \quad 4.58$$

The change of household wealth has two effects: first, part of the increase in the household wealth will be saved (δ_1.dWTH) and find its way into the investment channel; second, the other part of the increase in wealth will increase the consumption of the household by ((1-δ_1)dWTH). Therefore, the total savings is defined in Equation 4.59, and Equation 4.60 defines total consumption:

$$TS_t = s_p (Y_{wt}) + s_g (Y_{gt} - Y_{kt}^{oil}) + (\delta_1.dWTH_t) \quad 4.59$$

and

$$TC_t = (Y_{wt} + Y_{kt}^{noil} + Y_{gt}) + ((1-\delta_1)\, dWT_t) - TS_t \quad 4.60$$

In the total saving (TS) equation, Equation 4.59, the savings of non-oil capital (spY_{kt}^{noil}) and oil capital (sgY_{kt}^{oil}) are subtracted from TS_t because they become a function of real value of stock market and, therefore, are included in the total wealth equation. Hence, TS_t in the stock market model depends on real value of the stock market, as opposed to the base-run model, where TS_t depends only on the propensity to save for household, government, and capital incomes, which are fixed parameters.

The capital market in this model is subject to three influences, as Metzler (1951) observes: "(1) the influence of current saving and investment, as in the classical or neoclassical theory; (2) the influence of decisions concerning the holding of cash or

securities, as in Keynes's doctrine of liquidity preference; and (3) the influence of wealth on current savings" (p. 98).

CHAPTER V

ANALYSIS

The dynamic CGE model, the formulation of which was presented in Chapter IV, formed the basis for the simulation analysis; the results of this simulation analysis are presented in this chapter. In particular, the impact of introducing the stock market and wealth effect into the Saudi Arabian economy will be analyzed. In order to ensure a realistic overview of the impact, the model runs for 20 years, with 1997 as the benchmark. This time span allows the complete effect of introducing the stock market into the economy to occur.

The plan for this chapter is as follows: first, the effect of the stock market on economic growth is analyzed using some of the important economic variables to compare an economy with no stock market to an economy into which the stock market has been introduced; second, investment allocation is investigated, based on the claim that the stock market will reallocate resources among sectors. The attempt in this later section is to analyze the impact of the stock market on investments.

The Effects of the Stock Market on Growth

In this experiment, the stock market is included in the model. The stock market is expected to improve the performance of the economy, to create an incentive for the

inflow of capital, to encourage households in Saudi Arabia to invest their savings in the stock market, and to raise the saving rate. Both models have been run using the same rates of growth for labor and for high-power money; these rates of growth assumed to be 3.5 percent and 5.5 percent, respectively. As expected, the result of the dynamic simulation shows that the economy, overall, does better when the stock market is included. Table 1 reports the results of some of the important variables in the economy. All the variables in the table show an improvement over the base-run figures. In 2016, real GDP is about 3.8 percent greater with the inclusion of the stock market when compared to the same year of the base-run. Figure 1 compares real GDP when the stock market is included to the base-run. During the 20 years, real GDP when the stock market is included is greater than real GDP of the base-run model for all years.

Before the inclusion of the stock market, the economy suffers from the outflow of capital; inclusion of the stock market opens more channels for agents to invest their savings and gives companies more options to raise capital. The extra money, which finds it ways into investments, pushes the growth of the economy to higher levels; consequently, the inclusion of the stock market is assumed to redirect new funds to projects that are more profitable. The ratios of the supply of money over real GDP are 0.56 for the base run model and 0.52 for the stock market model in the terminal year; despite this inequality, economic growth occurs. Surely, money supply influences the growth of the economy. If the ratio of money supply over real GDP in both models were equal, the stock market model would grow even higher. In reality, the policy makers would increase the money supply if a stock market economy were established, since the growth of real GDP would be higher than it is without the stock market. However, for

the sake of creating a comparison between these two models, the growth rate of high-powered money in both models is assumed to be similar; therefore, the ratios of the money supply over real GDP are unequal.

The total saving in the economy is, among other things, a function of the profit of firms through the real value of the stock market, which is determined by the profit generated by firms; hence total saving increases as the real value of the stock market rises. The money demand also influences total savings through its impact on the wealth effect. Therefore, the increase in real GDP will elevate both the demand for money and the real value of the stock market, since a proportion of real GDP consists of business profits. This increase will lead to higher savings, which, in turn, will be invested in the economy; thus the total output will increase, heading to higher real GDP.

Table 1

The Impact of the Inclusion of the Stock Market on Macroeconomic Variables.(Saudi Riyal)

	1997	2000	2003	2006	2009	2012	2014	2016
1. Real GDP								
Base Run	548,669.42	584,826.60	625,187.94	671,996.14	726,216.36	788,919.45	836,019.25	887,807.55
Stk Model	583,696.52	593,625.31	637,921.91	688,254.50	746,673.59	814,402.29	865,388.75	921,546.55
% Difference	6.38	1.50	2.04	2.42	2.82	3.23	3.51	3.80
2. Total Saving								
Base Run	108,175.85	135,173.04	149,489.84	166,453.54	186,544.53	210,337.71	228,589.69	249,022.60
Stk Model	351,713.77	159,432.10	190,807.34	217,706.18	249,450.08	286,955.40	315,694.91	347,849.88
% Difference	225.13	17.95	27.64	30.79	33.72	36.43	38.11	39.69
3. Investment								
Base Run	108,166.58	124,970.76	137,420.89	151,710.09	168,110.70	186,931.79	200,994.46	216,401.09
Stk Model	320,087.41	150,680.53	178,546.36	201,687.75	228,166.75	258,447.06	281,002.29	305,643.76
% Difference	195.92	20.57	29.93	32.94	35.72	38.26	39.81	41.24
4. Gross Output								
Base Run	756,814.03	812,859.60	885,066.21	964,921.37	1,053,436.93	1,151,758.98	1,223,388.41	1,300,373.35
Stk Model	756,814.03	857,327.43	939,524.90	1,032,523.12	1,137,027.23	1,254,563.96	1,340,999.72	1,434,540.92
% Difference	0.00	5.47	6.15	7.01	7.94	8.93	9.61	10.32
5. Labor Income								
Base Run	166,984.92	207,168.55	231,529.89	260,471.99	294,859.11	335,718.66	367,147.65	402,406.62
Stk Model	189,190.32	211,770.53	238,180.80	269,348.02	306,748.85	351,587.26	386,311.78	425,469.20
% Difference	13.30	2.22	2.87	3.41	4.03	4.73	5.22	5.73
6. Export								
Base Run	251,171.31	248,312.94	253,844.73	258,438.81	262,055.18	264,674.30	265,866.38	266,621.38
Stk Model	244,837.83	263,375.17	270,358.06	277,393.82	283,691.96	289,159.29	292,304.52	295,029.48
% Difference	-2.52	6.07	6.51	7.33	8.26	9.25	9.94	10.65

As a result of these dependences on the economy, the gap between real GDP in both models expands over time at an increasing rate. Figure 2 demonstrates the noticeable different paths of the total savings in both models. For example, by the end of the period, the total saving available to investment are 39.69 percent higher than the total saving of the base-run at the end of the period, indicating that more funds are available for investors than before. The first year depicts a huge jump in the total savings as well as in real GDP. Since the structure of the economy changes to reflect its dependence on the stock market, the first year is expected to have this huge jump as more money from outside the economy is injected into the economy. This increase reflects the wealth effect when the real value of the stock market and the real balance are part of it, as explained above.

Figure (1)
real GDP

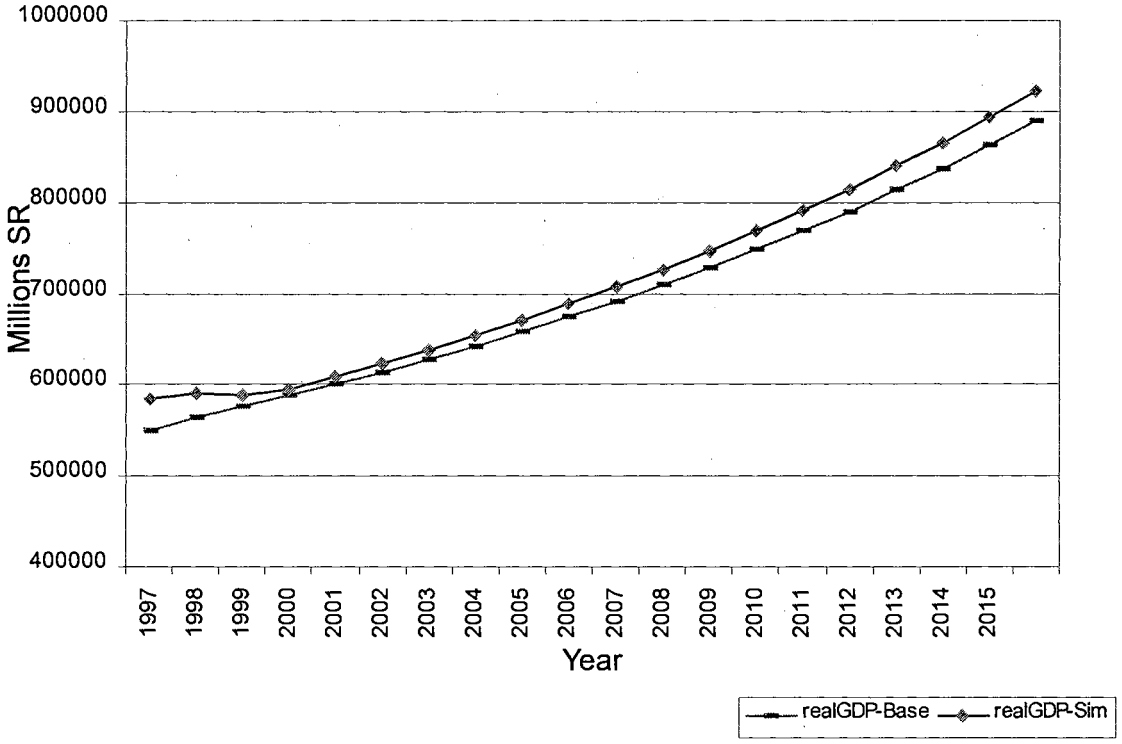
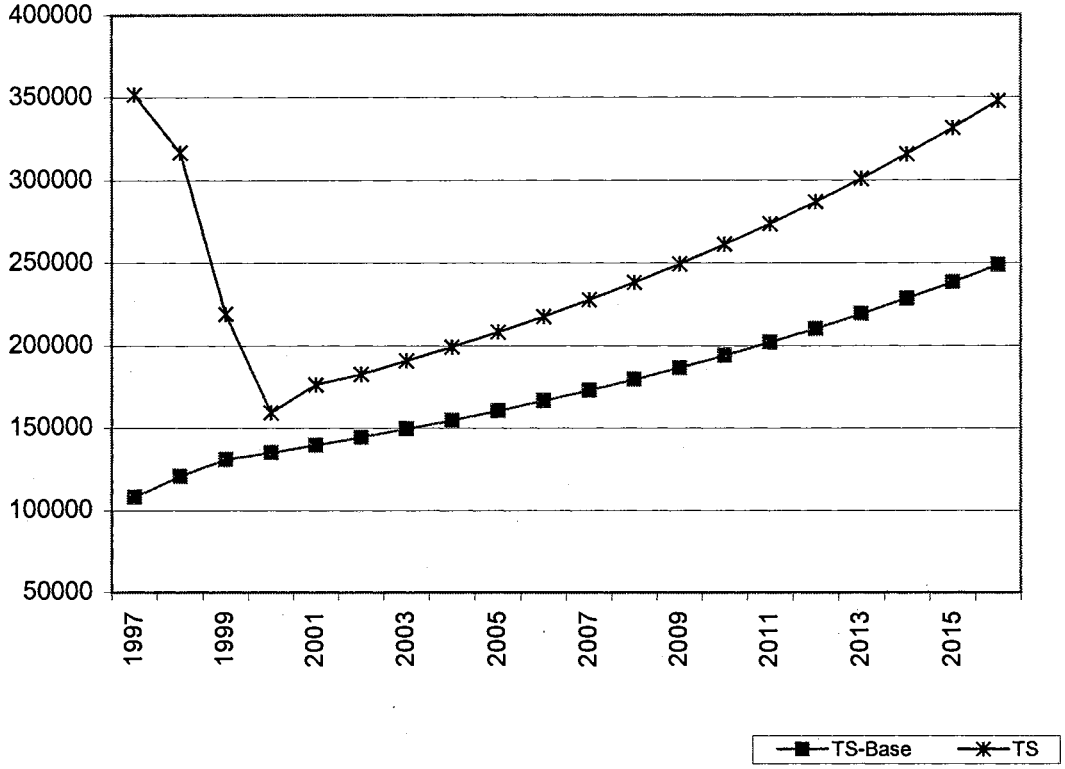


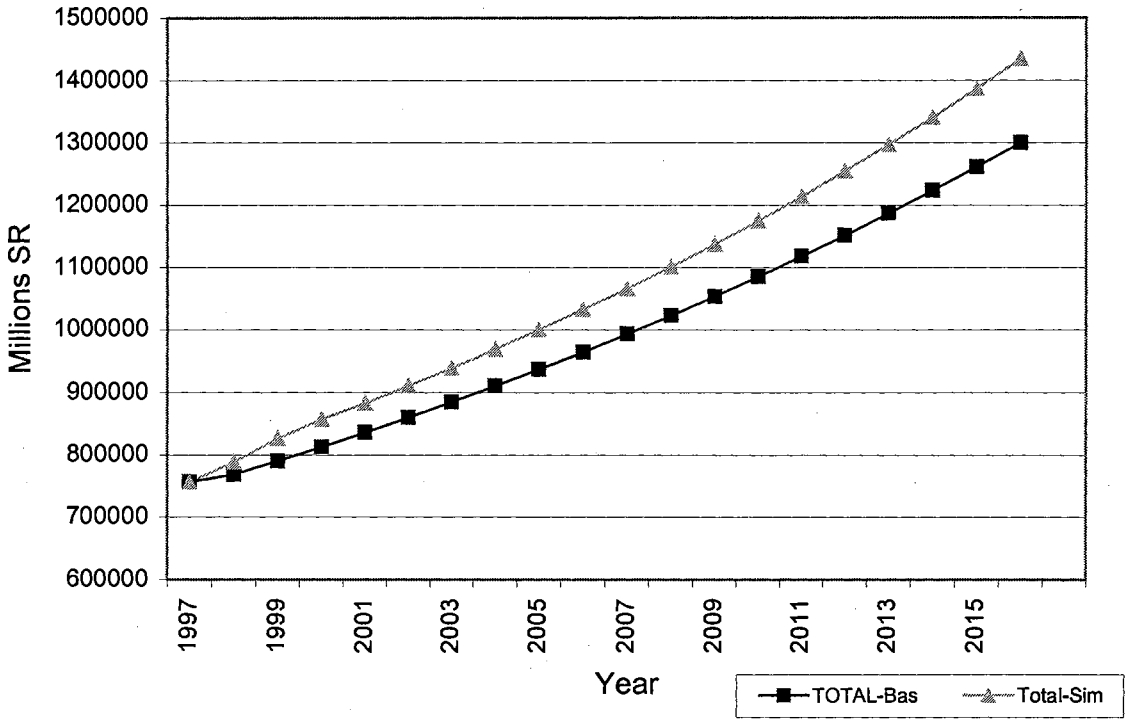
Figure (2)
Total Saving



Investment has been increased as well by about the same rate, 41.24 percent. Moreover, the total output of all sectors in the economy has increased 10.32 percent by the year 2016 when compared with the same year in the base model. This increase in the total output is caused by more capital becoming available in the economy as a result of the increase of the total savings, and since the derivative of the marginal value productivity of labor (MVP_L) with respect to capital is positive, then the MVP_L will increase when the capital increases. The paths of output when the stock market is included and for the base run are graphed in Figure 3. As is clear from Figure 3, the aggregate output of all sectors grows at an increasing rate; however, not each sector experiences an increase in its output compared to the base-run output. For instance, the

utility sector's output drops, albeit at a decreasing rate: the drop in 2016 is –11.77 percent, while it is -29.35 percent in 1998, compared to the same years in the base run. The transportation sector also experiences a small decrease in its output until the year 2010; the increase after that is negligible. On the other hand, the outputs of the other sectors grow at an increasing rate. Table 2 shows the percentage change in each sector as a result of including the stock market.

Figure(3)
Total Output for all Sectors



Labor income shows an increase after the inclusion of the stock market when compared to the base run. Figure 4 shows the labor income for both models. The distribution of income after including the stock market favors labor. The income for capital faces a decrease when the stock market is included, compared to the base-run level. Two factors contribute to this: first, wages increase as a result of the tight labor market. The growth rate of the population in both models is assumed to be equal, and full employment economies exist in both models. Hence, with more capital available for production, firms increase their demand for labor. This increase in labor demand creates strong pressure for high wages. The second reason is the decline which occurs in net prices (PNs) compared to the base-run net prices. The expansion of the total output increases the supply side, forcing general prices to fall. When PN falls with everything else constant, then the total profits of firms must decline. Therefore, the distribution of income must alter as a response to the change in the demand for labor and supply of output toward labor. Overall, the marginal productivity of labor increases, which sequentially increases labor wages. Thus, the labor income increases in the second model (the stock market model).

Table 2

The Percentage Change in Sectoral Output after the Inclusion of the Stock Market

Year	Agriculture	Min. & Oil	Manufacturing	Utility	Construction	Trade	Transportation	Finance	Service	Total
1997	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1998	1.23	5.34	2.00	-0.46	1.95	-0.47	0.41	0.46	0.57	2.55
1999	2.25	9.29	3.65	-0.45	4.80	-0.08	0.78	1.32	0.91	4.62
2000	2.75	10.76	4.44	-0.07	5.58	0.68	0.94	2.08	1.05	5.47
2001	2.93	11.02	4.67	0.17	5.42	1.00	0.98	2.28	1.08	5.62
2002	3.17	11.47	5.00	0.44	5.41	1.40	1.03	2.59	1.13	5.89
2003	3.40	11.92	5.33	0.70	5.42	1.79	1.09	2.88	1.17	6.15
2004	3.64	12.39	5.67	0.95	5.45	2.17	1.15	3.18	1.22	6.43
2005	3.88	12.89	6.02	1.19	5.51	2.55	1.22	3.48	1.27	6.71
2006	4.13	13.41	6.38	1.43	5.60	2.92	1.28	3.78	1.33	7.01
2007	4.38	13.95	6.75	1.66	5.71	3.29	1.35	4.08	1.38	7.31
2008	4.64	14.51	7.13	1.88	5.84	3.67	1.42	4.39	1.43	7.62
2009	4.90	15.09	7.52	2.09	5.98	4.04	1.50	4.71	1.49	7.94
2010	5.16	15.68	7.91	2.30	6.15	4.41	1.57	5.03	1.55	8.26
2011	5.43	16.29	8.31	2.51	6.34	4.79	1.65	5.36	1.61	8.59
2012	5.69	16.91	8.72	2.71	6.54	5.17	1.73	5.69	1.67	8.93
2013	5.96	17.55	9.13	2.91	6.76	5.55	1.81	6.04	1.73	9.27
2014	6.23	18.19	9.55	3.11	6.98	5.93	1.89	6.39	1.80	9.61
2015	6.51	18.85	9.97	3.30	7.22	6.31	1.98	6.76	1.87	9.96
2016	6.78	19.52	10.40	3.50	7.47	6.70	2.06	7.13	1.93	10.32

Figure (4)
Labor Income

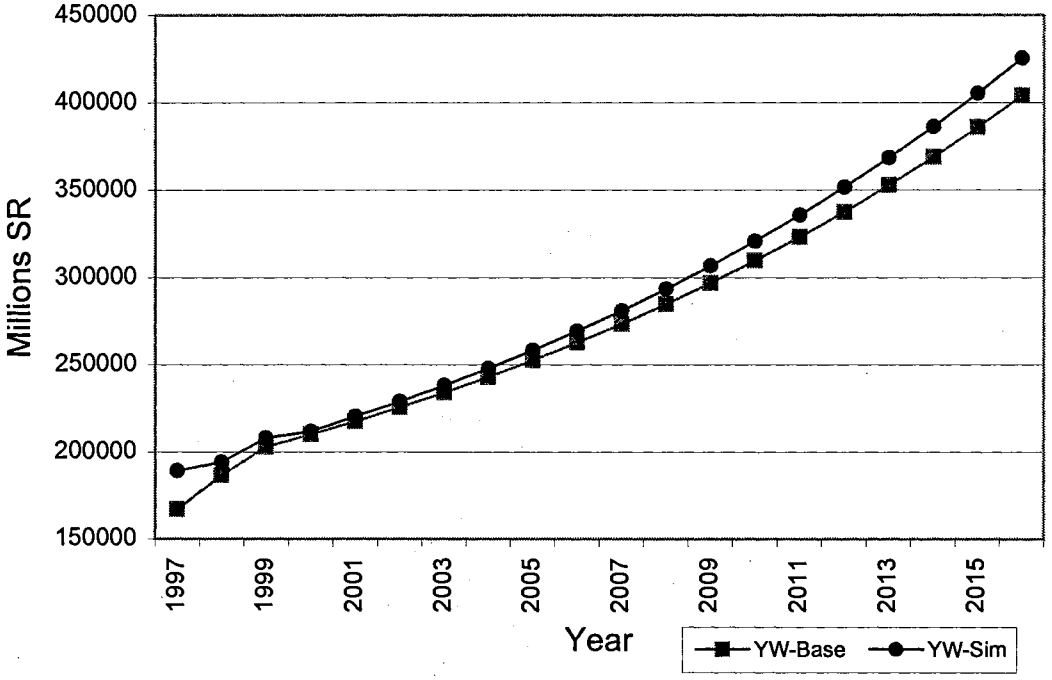
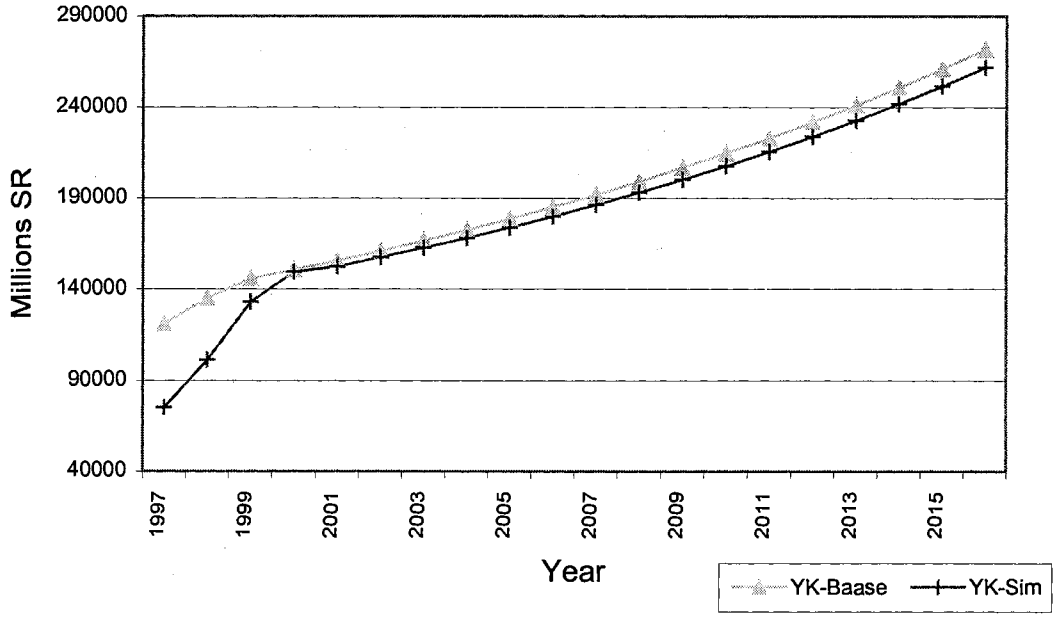
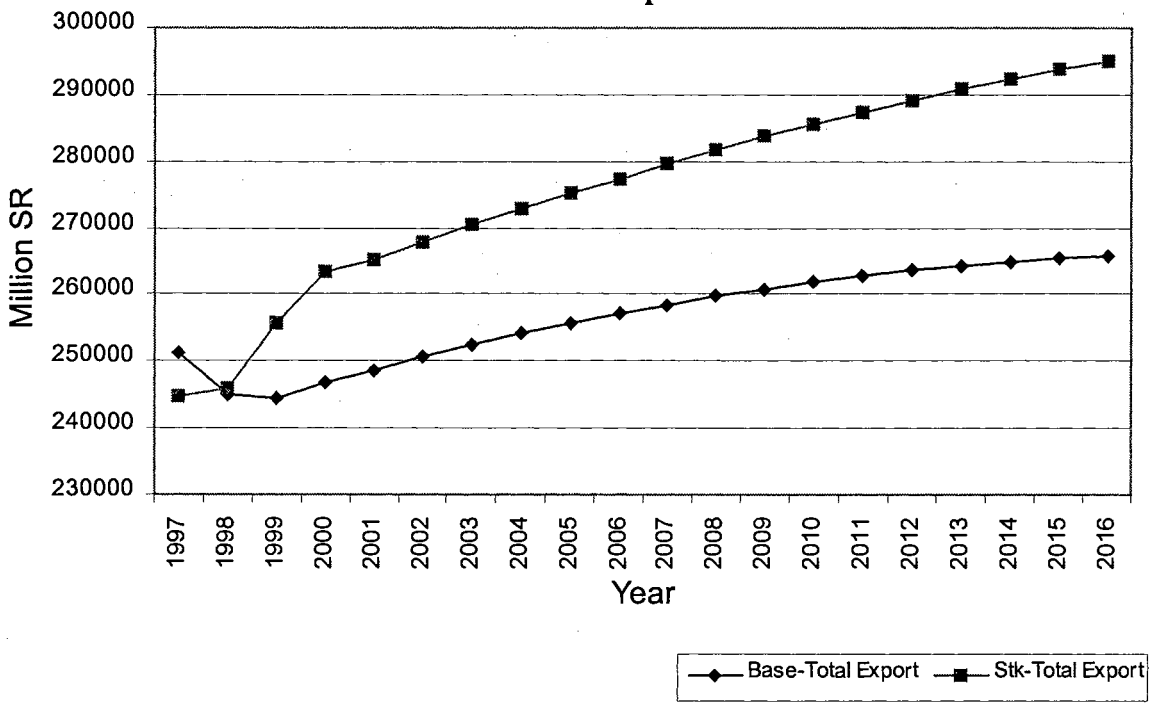


Figure (5)
Capital Income



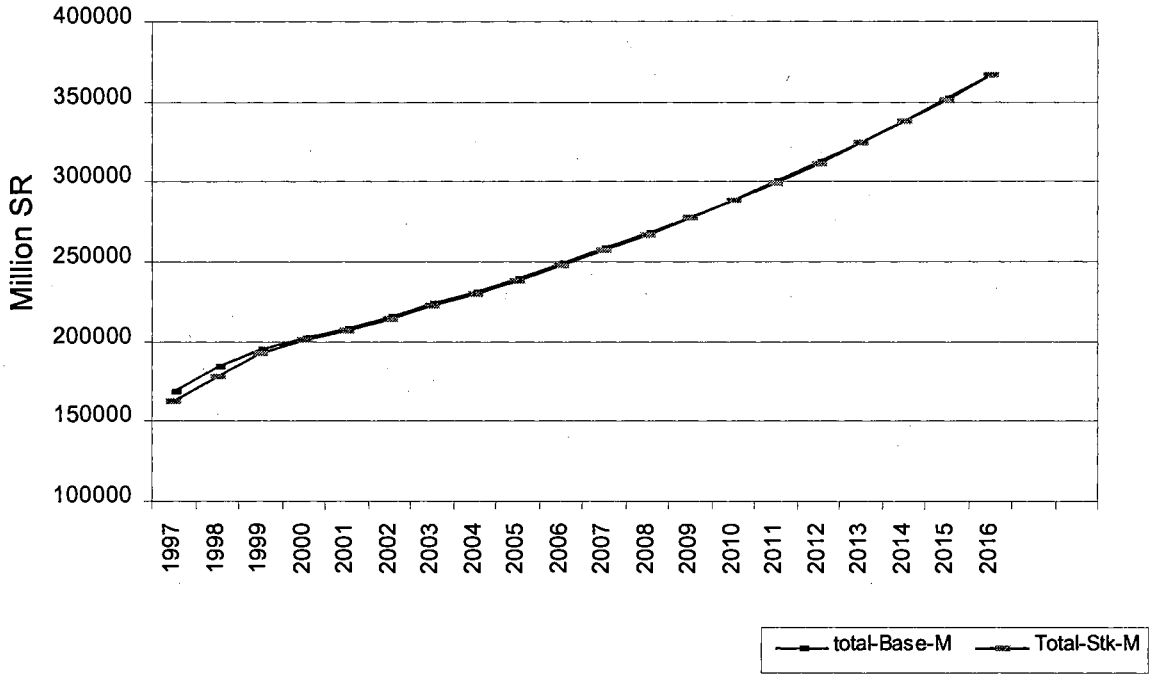
The expansion of the economy in the stock market model means a greater supply of domestic production. Part of the domestic output is consumed domestically, while the other part is exported for the rest of the world. As international consumers will consume a proportion of these products, total exports will increase. As expected, total export sees an expansion after the stock market has been included in the economy. Figure 6 illustrates this expansion in total exports. The increase in total export occurs at an increasing rate. In the terminal year, the total export has risen 10.65 percent compared to the base run for the same year. In the meantime, total import falls in the first year by –3.84 percent and in the terminal year by –0.10 percent in comparison to the base run for total import. The decline in domestic prices brought about by the expansion of domestic supply after the inclusion of the stock market changes the relative prices; therefore, the value shares of imports and domestically produced commodities in total domestic

Figure (6)
Total Export



expenditure change, favoring domestically produced commodities. Figure 7 demonstrates the decline in total import after the stock market has been included in the model.

Figure (7)
Total Import



Investment Allocation

In the absence of the stock market, there is no intersectoral mobility of investment funds. However, when the stock market is included, then sectors with a higher-than-average profit rate will attract investment funds. In addition, the stock market helps to calculate sectoral investment shares, Equation 4.55, which in turn will determine the investment demand by sector of destination. It has been assumed that the sectoral share of the investments for the next period will be altered, compared to the base run, when the stock market is included. After calculating the real value of each sector in the stock

market, the market will favor a sector with higher profit. The sector with higher-than-average profits finds it easier to raise capital.

The real investment by sector of destination is endogenously determined by two main sources: first, sectoral investment shares, which determine how many funds should go to each sector; and second, total savings available for investment. Real investment by sector of destination is expected to follow the patterns of sectoral investment shares. In addition, when total savings increase, the real investment is expected to increase, even though sectoral investment shares decline. Table 3 demonstrates the influence of the stock market on sectoral investments. Investment by each sector in the economy has changed compared to the base run. Some sectors experience an immediate increase over investments in the base-run model, while others encounter a decrease in the first year. After that, all sectoral investments show a rise in investment when compared to the base run. However, the percentage increase in sectoral investments in each sector are dissimilar, as some sectors attract more funds than others do.

Table 3

Percentage Change in Sectoral Investment Shares Between Base-Run Model and Simulated Introduction of Stock Market.

Year	Agricultural Investment (%)	Min & Oil Investment (%)	Manufacturing Investment (%)	Utility Investment (%)	Construction Investment (%)	Trade Investment (%)	Transportation Investment (%)	Finance Investment (%)	Service Investment (%)
1997	223.02	245.37	161.15	-77.87	175.39	-24.51	187.72	23.66	387.48
1998	168.26	188.48	135.75	1.34	185.33	17.31	156.22	39.91	207.47
1999	82.31	77.72	69.08	41.51	54.57	32.43	73.50	33.51	85.23
2000	33.80	22.82	26.66	26.39	2.10	14.32	24.42	10.85	26.10
2001	41.45	32.37	34.72	27.99	10.87	17.78	33.27	14.80	34.52
2002	40.90	32.87	35.30	26.06	11.32	17.24	33.75	14.26	33.68
2003	41.46	34.62	36.89	24.81	12.91	17.31	35.37	14.41	34.19
2004	41.84	36.14	38.28	23.68	14.29	17.38	36.79	14.54	34.56
2005	42.23	37.65	39.66	22.74	15.65	17.51	38.20	14.73	34.99
2006	42.59	39.11	40.98	21.97	16.96	17.69	39.57	14.99	35.46
2007	42.95	40.53	42.27	21.36	18.23	17.92	40.91	15.29	35.97
2008	43.29	41.90	43.51	20.90	19.46	18.19	42.21	15.65	36.54
2009	43.61	43.23	44.71	20.58	20.65	18.50	43.49	16.05	37.15
2010	43.93	44.51	45.86	20.38	21.79	18.83	44.74	16.50	37.82
2011	44.24	45.75	46.96	20.29	22.90	19.18	45.96	16.97	38.53
2012	44.54	46.93	48.01	20.29	23.95	19.56	47.16	17.48	39.29
2013	44.83	48.07	49.02	20.38	24.97	19.95	48.34	18.00	40.09
2014	45.12	49.16	49.97	20.53	25.94	20.35	49.49	18.55	40.94
2015	45.39	50.21	50.88	20.74	26.86	20.75	50.62	19.11	41.82
2016	45.65	51.20	51.73	21.00	27.74	21.16	51.73	19.68	42.73

Including the stock market in the economy will ultimately improve the performance of the economy. As reported in this chapter, all the important variables will increase by a significant percent. For instance, real GDP is SR 887,807.5 in the terminal year for the base run, and SR 921,546.55 after including the stock market for the same year. In other words, real GDP for the Saudi Arabian economy increases by 3.8 percent after the inclusion of the stock market. The gap between real GDP in these two models expands each year in the favor of the second model, in which the stock market is included. In addition, the stock market helps to reallocate the resources available in the economy to their best use.

CHAPTER VI

CONCLUSIONS AND POLICY IMPLICATIONS

The accumulation of capital plays an important role in growth theories regarding the growth of the economy and the steady-state. The problem, which many developing countries face, is a deficiency of capital. The need for a well-developed financial sector to enable firms to receive necessary financing is clear. The stock market is one of the easiest ways to finance firms and enable savers to have access to their investments at any time. As the stock market gives investors higher returns than interest rates do, agents will be encouraged to save and invest in the stock market.

The importance of the stock market is widely recognized; this has been emphasized by several theoretical studies. However, theoretical disagreement exists among economists about the importance and impact of the stock market on economic growth. Although some empirical studies support its positive impact on the economy, other analysts view the stock market in developing countries as "casinos" that have little positive, and potentially a large negative, impact on economic growth. Using a dynamic CGE model, this study assists in determining the impact developing the stock market will have on economic growth in Saudi Arabia. To model the stock market in the dynamic CGE, savings, investment, and the stock market are interdependent. Moreover, savings in Saudi Arabia are assumed to be a function of income and stock market growth. Previous studies found that savings in Saudi Arabia do not depend on the interest rate.

As expected, the result of the dynamic simulation shows that, overall, the economy does better when the stock market is included. As reported in Chapter V, all the important variables have increased by a significant percent. In addition, the stock market helps to reallocate the resources available in the economy to their best use.

Using real GDP, total savings, investment, output, labor income, and export variables to appraise the impact of the stock market on the growth of the economy, the results of all these variables favor including the stock market.

As it has been described in Chapter V, the development of the stock market in Saudi Arabia alters the flow of capital in favor of the Saudi economy when compared to the situation when the stock market is thin and small, and total saving undergoes an increase in value. Consequently, more funds become available for companies to raise capital through the stock market. Additionally, the stock market changes sectoral investment shares among sectors; hence, the profitable sectors attract more funds.

Policy Implications

The private sector is crucial for sustainable growth in Saudi Arabia. Therefore, one of the goals of the Seventh Development Plan of Saudi Arabia is to increase the role of a private sector in the economy. Historically, the government in Saudi Arabia has acted to stimulate private sector development to increase its participation in the economy. In the last few plans, the government of Saudi Arabia focused on private sector-led growth. To promote private sector-led growth and sustainable development, the need among other things is to develop the capital market to meet the needs of entrepreneurs. Entrepreneurs raise a large amount of equity from themselves, family, and friends because raising equity in the local market is difficult, if not impossible. Even the Sixth

Development Plan (1995) notes this problem: "Most small enterprises are unable to satisfy the lending criteria of the commercial banks and the loan repayment guarantees required by the Government's specialized credit institutions; as a result, many sound investment initiatives are unable to proceed."

In light of this, this study suggests the following to develop the stock market:

1. Create a new agent responsible for handling market activity. To make this agent effective and powerful, it should be separate agent and connected directly to the highest rank in the country.
2. Encourage research in the market. Sometimes, in the first stage, research will not take place till the government funds these studies.
3. Give a license to market makers to provide liquidity to the market.
4. Open the market to foreign investors in a way that can provide liquidity to the market without creating a market crash.
5. Provide complete information about the companies traded in the market through a government agent.
6. Ensure that each company traded in the market must provide the market with quarterly financial reports, and for any company failing to do so, the government agent handling the market activity should stop trading the shares of such firms and impose some punishment to prevent such act to occur in the future.
7. Ease the entrance into the market for both well-established and new companies.

8. Gain government approval for five local stock exchanges and one national stock exchange, instead of only one. In the local stock exchange, small and newly established companies should be listed first. After they mature, such companies can be listed in the national market. This will allow more promising projects to have access to local funds, where agents of the region have more knowledge regarding the projects; thus, and the whole nation will not be exposed to the projects' risks.
9. Allow Islamic banks to open in order to offer additional means of investment to investors.

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APPENDIX A

Equations for the Dynamic CGE Model

1. Production and Factor Markets-Supply of commodities

$$V_{it} = \sum_{j=1}^{n} V_{ijt} = \sum_{j=1}^{n} a_{ij} X_{it} \quad 4.1$$

$$X_{it} = \Omega_{it} L_{it}^{\alpha_i} K_{it}^{(1-\alpha)_i} \quad 4.2$$

$$\Pi_{it} = PN_{it} X_{it} - W_{it} L_{it} \quad 4.3$$

$$PN_{it} = P_{it}(1-tau_i) - \Sigma_{j=1} P_{jt} a_{ji} \quad 4.4$$

$$PN_{it} \frac{\partial X_{it}}{\partial L_{it}} = W_{it} \quad 4.5$$

$$L_{it}^{d} = L_{it}^{S} \quad 4.6$$

Income generation and demand for commodities

Income:

$$Y_{wt} = \sum_{i=1}^{n} W_{it} L_{it} \quad 4.7$$

$$Y_{kt}^{noil} = \left(\sum_{i=1}^{n} PN_{it} X_{it} - PN_{2t} X_{2t} - (Y_{wt} - W_{2t} L_{2t}) \right) \cdot (1 - t) \quad 4.8$$

$$Y_{kt}^{oil} = PN_{2t} X_{2t} - W_{2t} L_{2t} \quad 4.9$$

$$Y_{gt} = \frac{t}{1-t} Y_{kt}^{noil} + Y_{kt}^{oil} + \sum_{i=1}^{n} tau_i P_{it} X_{it} + \sum_{i=1}^{n} tm_i M_{it} + \overline{F}_t ER \quad 4.10$$

$$GDP_t = Y_{wt} + Y_{kt}^{noil} + Y_{kt}^{oil} + Y_{gt} - ER * \overline{F} \quad 4.11$$

$$RealGDP_t = \frac{GDP_t}{CPI_t} \quad 4.12$$

Saving and Consumption:

$$S_{pt} = s_p\,(Y_{wt} + Y_{kt}^{noil}) \qquad 4.13$$

$$S_{gt} = s_g\,Y_{gt} \qquad 4.14$$

$$TS_t = S_{pt} + S_{gt} \qquad 4.15$$

$$TC_t = (1 - s_p)(Y_{wt} + Y_{kt}^{noil}) + (1 - s_g)Y_{gt} \qquad 4.16$$

$$C_{it} = fc_i \left(\frac{TC_t}{P_{it}} \right) \qquad 4.17$$

Dynamic Investment:

$$dK_{it} = H_{it} \frac{TS_t}{U_{it}} \qquad 4.18$$

$$Z_{it} = \Sigma_j\, S_{ij}\, dK_{jt} \qquad 4.19$$

$$H_{i,t+1} = Sp_{it} + \mu\, Sp_{it} \left(\frac{R_{it} - AR_t}{AR_t} \right) \qquad 4.20$$

$$Sp_{it} = \frac{Rk_{it}}{Rk_t} \qquad 4.21$$

$$Rk_{it} = (1-\alpha_i)\, PN_{it}\, X_{it}\, (1-t_i) \qquad 4.22$$

$$Rk_t = \sum_i Rk_{it} \qquad 4.23$$

$$R_{it} = \left(\frac{Rk_{it}}{U_{it} \cdot K_{it}} \right) + \left(\frac{U_{it} - U_{i,t-1}}{U_{i,t-1}} \right) \qquad 4.24$$

$$AR_t = \sum_{i=1}^{n} Sp_{it} \cdot R_{it} \qquad 4.25$$

$$U_{it} = \sum_{i=1}^{n} S_{ji} \cdot P_{jt} \qquad 4.26$$

$$K_{i,t+1} = K_{0it} + dK_{it} \quad 4.27$$

Foreign Trade:

$$Q_{it} = \overline{\beta}[\delta_i M_{it}^{-\rho_i} + (1-\delta_i) D_{it}^{-\rho_i}]^{\frac{-1}{\rho_i}} \quad 4.28$$

$$P_{it}Q_{it} = PD_{it}\, D_{it} + PM_{it}\, M_{it} \quad 4.29$$

$$m_{it} = \frac{M_{it}}{D_{it}} = \left(\frac{\delta_i}{1-\delta_i}\right)^{\sigma_i} \left(\frac{PD_{it}}{PM_{it}}\right)^{\sigma_i} \quad 4.30$$

$$PM_{it} = \overline{PW_i}\,(1+tm_i)\, ER \quad 4.31$$

$$P_{it} = \frac{1}{\overline{\beta_i}} \left[\delta_i PM_{it}^{(1-\sigma_i)} + (1-\delta_i) PD_{it}^{(1-\sigma_i)}\right]^{\frac{1}{1-\sigma_i}} \quad 4.32$$

$$E_{it} = \overline{E}_0 \left(\frac{\prod_i}{PWE_{it}}\right)^{\eta_i} \quad 4.33$$

$$PWE_{it} = \frac{PD_{it}}{(1+te_i)ER} \quad 4.34$$

$$\overline{F} = \sum_{i=1}^{n} \overline{PW_i} M_{it} - \sum_{i=1}^{n} PWE_{it} E_{it} \quad 4.35$$

Monetary Sector:

$$\frac{M_{dt}}{P_{at}} = mm\left(realGDP_t^{\beta_1}\right) \quad 4.36$$

$$M_{st} = mm_s * H_{0t} - ER * \overline{F}_t \quad 4.37$$

$$H_{0t} = CD_t + R_t \quad 4.38$$

$$M_{st} = M_{dt} \quad 4.39$$

$$\inf_t = 100\left(\frac{CPI_t - CPI_{t-1}}{CPI_{t-1}}\right) \quad 4.40$$

$$CPI_t = \sum_{i=1}^{n} fc_i P_{it} \quad 4.41$$

Market Clearing Conditions and Macroeconomic Closure

$$X_{it}^D = d_{it}V_{it} + d_{it}C_{it} + d_{it}Z_{it} + E_{it} \quad 4.42$$

$$Q_{it} = V_{it} + C_{it} + Z_{it} + E_{it} \quad 4.43$$

$$X_{it}^D = f(PD_{it}, ER) \quad 4.44$$

$$X_{it}^S = f(PD_{it}, ER) \quad 4.45$$

$$EX_{it} = X_{it}^D - X_{it}^S = 0 \quad 4.46$$

$$L_{it}^D = L_{it}^S \quad 4.47$$

$$\sum_{i=1}^{n} \overline{PW_i} M_{it} - \sum_{i=1}^{n} PWE_{it} E_{it} - \overline{F} = 0 \quad 4.48$$

$$TS_t = \sum Z_{ti} \quad 4.49$$

Stock Market

$$\mathrm{RVSM}_t = \frac{ps_t . realGDP_t}{rr} \quad 4.50$$

$$ps_{it} = \frac{RK_{it}}{realGDP_t} \quad 4.51$$

$$ps_t = \frac{RK_t}{realGDP_t} \quad 4.52$$

$$\mathrm{q}_{it} = \frac{ps_{it} . realGDP_t}{rr} \quad 4.53$$

$$TQ = \sum_{i=1}^{n} q_{it} \quad 4.54$$

$$HH_{it} = \frac{q_{it}}{TQ} \quad 4.55$$

$$dK_{it} = HH_{it} \frac{TS_t}{U_{it}} \quad 4.56$$

$$WTH_t = RVSM_t + Md_t \quad 4.57$$

$$dWTH_t = WTH_t + WTH_{t-1} \quad 4.58$$

$$TS_t = S_{pt} + S_{gt} + (\delta_1 . dWTH_t) \quad 4.59$$

$$TC_t = (1 - s_p)(Y_{wt} + Y_{kt}^{noil}) + (1 - s_g) Y_{gt} + ((1 - \delta_1)\, dWT_t) \quad 4.60$$

Exogenous

tau_i indirect tax rates

tm_i tariff rates

te_i export subsidy rates

s_p private average saving rate

s_g government average saving rate

fc_i sectoral consumption shares

S_{ij} capital composition matrix

$\overline{PW_i}$ import world $ price indices

ER exchange rate (SR/US $)

$\overline{E}_0$ a scaling constant

R_t bank reserves

rr average rate of return in the stock market

Π_i export world $ price indices

a_{ij} the input-output coefficient

Endogenous

X_{it} sectoral output

Ω_{it} a shift parameter

L_{it} aggregate sectoral labor

K_{it} aggregate sectoral capital

α_i output elasticity with respect to labor

V_{it} an aggregation of intermediate inputs

$\overline{F}$ foreign capital inflow

μ mobility of investable funds parameter

K_{0it} initial capital stock for sector i at time t

η_i export demand elasticities

mm_s money multiplier

CD_t currency in circulation

APPENDIX B

Staistical Data

Table B-1

Input-Output Table for Saudi Arabia (1997)
Interindustry Transactions
(Million of SR)

Sector	Agriculture	Min. &Oil	Manufacturing	Utility	Construction	Trade	Transportation	Finance	Service	Total Intermediate
Agriculture	986	0	259	0	2	0	0	0	0	1247
Min. &Oil	4323	5646	57674	230	68	25	2816	96	98	70976
Manufacturing	6909	1086	7789	319	17126	8965	8017	789	18297	69297
Utility	32	42	126	22	9	11	16	8	1130	1396
Construction	68	354	96	25	2	10	8	3	380	946
Trade	1957	49	8805	85	5863	208	2982	1505	619	22073
Transportation	998	823	316	134	6126	2585	10167	182	7602	28933
Finance	318	27	78	44	98	1184	8352	144	1860	12105
Service	0	412	86	2	233	299	57	42	90	1221
Total Intermediate	15591	8439	75229	861	29527	13287	32415	2769	30076	208194

Source: Althomairy (2000)

Table B-2

Input-Output Table for Saudi Arabia (1997)
Structure of Final Demand
(Million of SR)

Sector	Government Consumption	Private Consumption	Fixed Capital	Change in Stock	Export	Import	Final Demand
Agriculture	23	40769	7950	164	11650	27156	33400
Min. &Oil	34016	0	29617	187	161785	22177	203428
Manufacturing	21785	67049	16525	3960	60385	119112	50592
Utility	240	584	0	36	0	1	859
Construction	19176	17318	10056	30	0	1	46579
Trade	2775	23563	0	657	10005	1	37000
Transportation	11317	9587	4232	623	6977	1	32735
Finance	5156	17756	51	0	383	0	23346
Service	57164	29558	33961	0	0	0	120683
Total	151652	206184	102392	5657	251185	168449	548622

Source: Althomairy (2000)

Table B-3

Input-Output Table for Saudi Arabia (1997)
Value Added
(Million of SR)

Sector	Agriculture	Min. &Oil	Manufacturing	Utility	Construction	Trade	Transportation	Finance	Service	Total
Wages	12683	9621	19610	689	8930	6719	22999	4221	81386	166858
Capital	8693	256344	25182	534	9044	38735	2607	27035	9330	377504
Subsidies	-3380	0	-250	-210	-72	-96	-56	0	-3068	-7132
Indirect Tax	1060	0	118	382	96	428	3704	1420	4180	11388
Total Value Add	19056	265965	44660	1395	17998	45786	29254	32676	91828	

Source: Althomairy (2000)

Table B-4
Total Labor Force by Sector (1997)

Sector	Number
Agriculture	541,790
Min. &Oil	108,810
Manufacturing	572,870
Utility	84,910
Construct	1,025,540
Trade	1,005,800
Transport	288,640
Finance	334,000
Service	3,026,590
Total	6,988,950

Source: Ministry of Planning

APPENDIX C

Estimated Data and Parameters

Table C-1
Production Function Parameters (1997)

Sector	Ω	α	β
Agriculture	0.10754	0.59333	0.40667
Min. &Oil	0.09678	0.03617	0.96383
Manufacturing	0.29142	0.4378	0.5622
Utility	0.06978	0.56337	0.43663
Construction	0.14001	0.4968	0.5032
Trade	0.10928	0.14782	0.85218
Transportation	0.26621	0.89818	0.10182
Finance	0.10505	0.13505	0.86495
Service	0.05468	0.89715	0.10285

Table C-2
Sectoral Import Tariff and Export Subsidy Rates (1997)

Sector	tm_i	te_i
Agriculture	0.0003	0
Min. &Oil	0.002	0
Manufacturing	0.0002	0
Utility	0.12	0
Construction	0.12	0
Trade	0.12	0
Transportation	0.12	0
Finance	0.1	0
Service	0.15	0

Table C-3
Estimated Values of η_i, σ_i, and δ_i (1997)

Sector	η_i	σ_i	δ_i
Agriculture	2	0.78262016	2.5
Min. &Oil	0.7	0.48680295	2.5
Manufacturing	1.25	0.85054324	2.5
Utility	0	0	0.5
Construction	0	0	0.5
Trade	0	0	0.5
Transportation	2	0.014257545	2.5
Finance	2	0	2
Service	0	0	2

APPENDIX D

Gauss Computer Program for Dynamic CGE (Base Model)

```
/*A CGE modelUsing Input-Output data for Saudi Arabia 1997,(million
                                    SR)
                                      (Base Run)
                        Growth in L start in 3P
=================================================================
=================================================================*/

/*======================== The CGE Model ========================*/
eqsolveset;


let x0[192,1] =
   34647   274404   119889     2256    47526  59073.2    61669    35445   121904  @       O  @
   0.617    0.969    0.373    0.542    0.378     0.77    0.415    0.882    0.745  @      PN  @
  541790   108810   572870    84910  1025540  1005800   288640   334000  3026590  @       L  @
 23407.3  88378.5    34211   8110.9  8711.97  6682.25    79696    12644  26933.7  @       W  @
  166985   120922   178206                                                        @ Yw Yk Yg  @
  108176   357937                                                                @   TS TC  @
 40803.4  34027.8    88859   824.03  36495.7  26338.8    20907    22913  86726.9  @       C  @
       1        1        1        1        1        1        1        1        1  @       U  @
 7950.22  29617.8    16525        0  10056.3        0   4232.1   51.001  33961.9  @       Z  @
       1        1        1        1        1        1        1        1    1.001  @      PD  @
       1    1.002        1     1.12     1.12     1.12     1.12      1.1     1.15  @      Pm  @
       1        1        1        1        1        1        1        1    1.001  @     PWE  @
 27161.5  22174.9   119126        1        1        1        1        0        0  @       M  @
       1        1        1        1        1        1        1        1        1  @       P  @
 11650.9   161772    60384        0        0    10005   6975.8   383.65        0  @       E  @
  -82620                                                                        @    Fbar  @
       1                                                                        @     CPI  @
   0.012                                                                        @  expinf  @
   5.778                                                                        @       r  @
    5.79                                                                        @  nomint  @
  548733                                                                        @     GDP  @
  548669                                                                        @ realGDP  @
  271940                                                                        @      Md  @
       1                                                                        @      Pa  @
  271940                                                                        @      Ms  @
   58378                                                                        @      Mo  @
   13499                                                                        @     dDC  @
   11801   11333.7    11520    11370  11358.7  11369.9    11370    11370  10902.1  @      dk  @
 8672.92   255654    25112   532.58  9029.45  38660.7   2601.9    26988  9324.32  @     Rki  @
  376576                                                                        @      RK  @
    0.11    0.132    0.132     0.11    0.132    0.132    0.131    0.133    0.113  @      ri  @
   0.023    0.679    0.067    0.001    0.024    0.103    0.007    0.072    0.025  @     Spi  @
   0.131                                                                        @      AR  @
   0.019    0.685    0.067    0.001    0.024    0.103    0.007    0.072    0.021  @  Hplus1  @
  162713  3215634   329420    20670   125309   496757    44657   349307   165877  @  Kplus1  @
   3.669                                                                        @ GROWTH  @
  256223                                                                        @    YOIL  @
```

```
;

vf=zeros(rows(x0),1);    @ size of this vector is determined from x0 @

proc f(x);


        @ Set-Up Variables of Model @
Local
o, PN, L, W, Yw, Yk, Yg, TS,TC, C, U, Z, PD, Pm, PWE, M, P, E, Fbar, CPI, expinf, r,
nomint, GDP, realGDP, Md, Pa, Ms, Mo, dDC,dK, Rki, RK, ri, Spi, AR, Hplus1, Kplus1,
Growth, Yoil ;

o=x[1:9,1];          PN=x[10:18,1];       L=x[19:27,1];        W=x[28:36,1];
Yw=x[37,1];          Yk=x[38,1];          Yg=x[39,1];          TS = x[40,1];
TC=x[41,1];          C = x[42:50, 1];     U= x[51:59, 1];      Z=x[60:68,1];
PD=x[69:77,1];       Pm=x[78:86,1];       PWE=x[87:95,1];      M=x[96:104,1];
P=x[105:113,1];      E = x[114:122,1];    Fbar= x[123,1];      CPI=x[124,1];
expinf=x[125,1];     r=x[126,1];          nomint=x[127,1];     GDP=x[128,1];
realGDP=x[129,1];    Md=x[130,1];         Pa=x[131,1];         Ms=x[132,1];
Mo=x[133,1];         dDC=x[134,1];        dK=x[135:143,1];     Rki=x[144:152,1];
RK=x[153,1];         ri=x[154:162,1];     Spi=x[163:171,1];    AR=x[172,1];
Hplus1=x[173:181,1];
Kplus1=x[182:190,1];                      Growth=x[191,1];     Yoil=x[210,1];


                    @ Set-Up Equations of Model @

 /*---------------------------------- Production Function ----------------------------------------*/

vf[1:9,1]=O-omega.*(L.^alpha).*(K.^(1-alpha));

/*------------------------------------- Net Prices-------------------------------------------------*/

vf[10:18,1]=PN-(PD-tau.*PD-A'*P);

/*------------------------------- Labor Market Equilibrium-----------------------------------*/

vf[19:27,1]=PN.*alpha.*O-L.*W./1000000;          /* Wages in Millions RS*/

vf[28:36,1]=L-LS;
```

```
/*----------Income Generation and Demand for Commodities----------*/

vf[37,1] =Yw-(W'L./1000000) ;       @Disposable Labor income, Millions SR @

vf[38,1] = Yk-((PN'*O-PN[2,1]*O[2,1]) - (W'*L-W[2,1]*L[2,1])./1000000).*(1-t) ;
                                    @Disposable Non-Oil Capital Income, Millions SR@

vf[39,1]=  Yg-(Yk)*(t/(1-t)) -tau'(P.*O)-tm'M-Fbar*ER+te'(PWE.*ER.*E)-Yoil ;
                                                    @ Gov. income, millions SR@

vf[40,1] = TS-sp*(Yw+Yk)-sg*Yg;
                                                    @total savings,millions SR@

vf[41,1] = TC-(Yw+Yk+Yg)+TS ;
                                                    @totalconsumption, millions SR@

vf[42:50,1] = C-fc.*TC./P ;
                                    @sectoral consumption, constant prices, Millions SR@

vf[51:59,1] = U-Sij'*P ;
                                                    @vector of capital prices@

vf[60:68,1] = Z-Sij*(H.*TS./U);
                                                    @sectoral investment demand by origin,
                                                    constant prices, millions SR@

 /*---------- Production Market Equilibrium----------*/

vf[69:76,1] =df*(PD.*O-(P.*A*O+P.*C+P.*Z+P.*CHS-Pm.*M)-PD.*E) ;
                                                    @ sectoral supply=demand @

/*---------- Average Price Eqaution ----------*/

 vf[77,1]=(O./sumc(O))'*P - Pa ;
 /*----------Import Price Equations ----------*/

vf[78:86,1] =Pm-Pwbar.*(1+tm).*ER ;
                                                    @import price in domestic currency @

/*---------- Export Price Equations ----------*/

vf[87:95,1] = PWE-PD./((1+te)*ER) ;
```

```
                                                    @supply price index of domestic exports in RS@

/*-------------------------------- Import Demand Equations --------------------------------*/

vf[96:104,1] = M-(delta.^sigma).*((P./Pm).^sigma).*(C+Z+CHS+A*O) ;


@vf[96:104,1]=delta-(M./(((P./Pm).^sigma).*(C+Z+CHS+A*O))).^(1/sigma); @

/*-----------------------------------Composite Price Equations-------------------------------*/

vf[105:113,1] =P-epsilon.*((delta.^sigma).*Pm.^(1-sigma)+
((1-delta).^sigma).*(PD.^(1-sigma))).^(1./(1-sigma));
                                          @assumes a CES composite aggregation function @

@vf[105:113,1] = epsilon- (((delta.^sigma).*Pm.^(1-sigma)+
((1-delta).^sigma).*(PD.^(1-sigma))).^(1./(1-sigma)))^(-1).*P;@

 /*-----------------------------------------Export Demand Functions-------------------------*/

vf[114:122,1] = E - Ebar.*(phi./PWE).^eta ;

 /*-----------------------------------Balance of Payments Equilbrium-----------------------*/

vf[123,1]=PWbar'*M-PWE'*E-Fbar;

/*-------------------------- ------Monetary Equations ----------------------------------------*/

vf[124,1] = CPI - fc'*P;
                                                    @consumer price index @

vf[125,1] = expinf - 100*(CPI-CPIlag)/CPIlag ;
                                                      @expected inflation @

vf[126,1] = r-0 ;
                                                    @ real rate of interest @

vf[127,1] = nomint - 0;
 @ nominal rate of interest@

vf[128,1] = GDP -(Yw+Yk+Yg)+Fbar*ER ;
                                                        @nominal GDP@

vf[129,1] = realGDP-GDP/CPI ;
                                                        @real GDP@
```

```
vf[130,1]=Md/Pa - .4956 *(realGDP.^1.0)  ;
                                                    @ real money balance@

vf[131,1]=Ms-(mm*Ho-ER*Fbar);
                                                    @ money supply  @

vf[132,1]=Ho -(CD + R)*(msg^tt);
                                                    @ High-power money , Millions SR@

vf[133,1]=dDC- 13499;
                                                    @ changes in domestic credit, Millions SR@

vf[134,1]=Md-Ms;
                                                    @ money market equilibrium@

/*------------------------------ Sectoral Investment Equations ------- ----------------------*/

vf[135:143,1]=dK-Hplus1.*TS./U;
                                                    @ real investment by sector of destination@

vf[144:152,1]=Rki - ((1-alpha).*PN.*o.*(1-t)) ;
                                                    @ after tax sectoral profits @

vf[153,1]=Rk - sumc(Rki) ;
                                                    @ after tax profits@

vf[154:162,1]=ri-(Rki./(U.*k)+(U-Ulag)./Ulag) ;
                                                    @ nominal sectoral profit rates defined as returns to
                                                    capital valued in current prices plus capital gains @

vf[163:171,1]=Spi-Rki./Rk ;
                                                    @ sectoral share in aggregate profits@

vf[172,1]=AR-Spi'*ri ;
                                                    @ average nominal profit rate @

vf[173:181,1]=Hplus1 - (Spi+ u.*Spi.*(Ri-AR)./AR) ;
                                                    @ sectoral shares of investment for following time period@

vf[182:190,1]=Kplus1-(K+dK) ;
                                                    @ sectoral capital stock for following time period @

/*---------------------------------- -------- Growth ---------------------- ----------------------*/

Vf[191,1]=Growth-100*(realGDP-RealGDPlag)/realGDPlag;
```

```
/*---------------------------------------------------------- ----------------------------*/

 vf[192,1]=Yoil-(PN[2,1]*O[2,1]-(L[2,1]*W[2,1]/1000000));
                                        @Disposable Oil Capital Income, Millions  SR@

/*==========================================================================================*/


retp(vf);
endp;

__altnam=
{O1, O2, O3, O4, O5, O6, O7, O8, O9,
PN1, PN2, PN3, PN4, PN5, PN6,  PN7,
PN8, PN9,
L1, L2, L3, L4, L5, L6, L7, L8, L9,
W1, W2, W3, W4, W5, W6, W7, W8, W9,
Yw, Yk, Yg, TS, TC,
C1, C2, C3, C4, C5, C6, C7, C8, C9,
U1, U2, U3, U4, U5, U6, U7, U8, U9,
Z1, Z2, Z3, Z4, Z5, Z6, Z7, Z8, Z9,
PD1,PD2, PD3, PD4, PD5, PD6, PD7,PD8,
PD9,
Pm1, Pm2, Pm3, Pm4, Pm5, Pm6,  Pm7,
Pm8,Pm9,
PWE1, PWE2, PWE3, PWE4, PWE5, PWE6,
PWE7, PWE8, PWE9,
M1, M2, M3, M4, M5, M6, M7, M8, M9,
P1, P2, P3, P4, P5, P6, P7, P8, P9,
E1, E2, E3, E4, E5, E6, E7, E8, E9,
Fbar, CPI, "expinf", "r", "nomint",
GDP, "realGDP",
"Md", "Pa", "Ms", "Mo", "dDC",
"dK1", "dK2", "dK3", "dK4", "dK5",
"dK6", "dK7", "dK8", "dK9",
"Rki1", "Rki2", "Rki3", "Rki4", "Rki5",
"Rki6", "Rki7",  "Rki8",  "Rki9",
RK, "ri1", "ri2", "ri3", "ri4", "ri5",
"ri6", "ri7",  "ri8", "ri9",
"SPi1", "SPi2", "SPi3", "SPi4", "SPi5",
"SPi6", "SPi7", "SPi8", "SPi9",
AR,
"Hplus1", "Hplus2", "Hplus3", "Hplus4",
"Hplus5","Hplus6", "Hplus7", "Hplus8",
"Hplus9",
```

```
"Kplus1", "Kplus2", "Kplus3", "Kplus4",
"Kplus5", "Kplus6",
"Kplus7", "Kplus8", "Kplus9",
Growth,
Yoil };


_nlagr = 1;
__title= " Solution of  CGE Model for Saudi Arabia" ;
start=x0;
output file = a:eqsolve1.out reset;
{x,tcode} = eqSolve (&f,start);


period1 = x;



/*==========================period 2==========================*/

        /*update of exogenous variables*/

x0=period1;

K = x[182:190,1];
H = x[173:181,1];
Ho=(1+.168)*58378;

let L[9,1]= 541790 108810 572870 84910 1025540 1005800 288640 334000 3026590
;

Ls=L.*(1.005);

CPIlag = x[124,1] ;
realGDPlag=x[129,1];
WTHlag=x[203,1];



_nlagr = 1 ;
__title ="Saudi Arabia CGE Model, Period 2";
start = x;
{ x,tcode }  = eqSolve(&f,start);

period2 = x;
```

```
/*=========================period 3=================================*/

        /*update of exogenous variables*/

x0=period2;

K = x[182:190,1];
H = x[173:181,1];
msg=1.055;
tt=2;
let L[9,1]= 541790 108810 572870 84910 1025540 1005800 288640 334000 3026590
;

Ls=L.*(1.035)^(tt-1);

CPIlag = x[124,1] ;
 realGDPlag=x[129,1];
WTHlag=x[203,1];

output file=a:results reset;

_nlagr = 1 ;
@_nlchpF = 1;@
_nltypx = x0;
__title =" Saudi Arabia CGE Model, Period 3";
start = x;
{ x,tcode }  = eqSolve(&f,start);

period3 = x;

/*=========================period 4=================================*/

        /*update of exogenous variables*/

x0=period3;

 K = x[182:190,1];
H = x[173:181,1];
msg=1.055;
tt=3;
let L[9,1]= 541790 108810 572870 84910 1025540 1005800 288640 334000 3026590
;
Ls=L.*(1.035)^(tt-1);

CPIlag = x[124,1] ;
```

```
 realGDPlag=x[129,1];
WTHlag=x[203,1];

output file=a:results reset;

_nlagr = 1 ;
@_nlchpF = 1;@
__title =" Saudi Arabia CGE Model, Period 4";
start = x;
{ x,tcode }  = eqSolve(&f,start);

period4 = x;

/*=======================period 5=============================*/

        /*update of exogenous variables*/

x0=period4;

 K = x[182:190,1];
H = x[173:181,1];
msg=1.055;
tt=4;
let L[9,1]= 541790 108810 572870 84910 1025540 1005800 288640 334000 3026590
;
Ls=L.*(1.035)^(tt-1);

CPIlag = x[124,1] ;
 realGDPlag=x[129,1];
WTHlag=x[203,1];

output file=a:results reset;
_nlagr = 1 ;
@_nlchpF = 1;@
__title =" Saudi Arabia CGE Model, Period 5";
start = x;
{ x,tcode }  = eqSolve(&f,start);

period5 = x;

/*=======================period 6=============================*/

        /*update of exogenous variables*/

x0=period5;
```

```
K = x[182:190,1];
H = x[173:181,1];
msg=1.055;
tt=5;
let L[9,1]= 541790 108810 572870 84910 1025540 1005800 288640 334000 3026590
;

Ls=L.*(1.035)^(tt-1);

CPIlag = x[124,1] ;
realGDPlag=x[129,1];
WTHlag=x[203,1];

output file=a:results reset;
_nlagr = 1 ;
__title =" Saudi Arabia CGE Model, Period 6";
start = x;
{ x,tcode }  = eqSolve(&f,start);

period6 = x;



/*==========================period 7==================================*/

        /*update of exogenous variables*/

x0=period6;

K = x[182:190,1];
H = x[173:181,1];
msg=1.055;
tt=6;
let L[9,1]= 541790 108810 572870 84910 1025540 1005800 288640 334000 3026590
;

Ls=L.*(1.035)^(tt-1);

CPIlag = x[124,1] ;
realGDPlag=x[129,1];
WTHlag=x[203,1];

output file=a:results reset;
_nlagr = 1 ;
__title =" Saudi Arabia CGE Model, Period 6";
start = x;
```

```
{ x,tcode }  = eqSolve(&f,start);

period7 = x;


/*=======================period 8=================================*/

        /*update of exogenous variables*/

x0=period7;

K = x[182:190,1];
H = x[173:181,1];
msg=1.055;
tt=7;
let L[9,1]= 541790 108810 572870 84910 1025540 1005800 288640 334000 3026590
;

Ls=L.*(1.035)^(tt-1);
CPIlag = x[124,1] ;
realGDPlag=x[129,1];
WTHlag=x[203,1];

output file=a:results reset;
_nlagr = 1 ;
__title =" Saudi Arabia CGE Model, Period 6";
start = x;
{ x,tcode }  = eqSolve(&f,start);

period8 = x;


/*=======================period 9=================================*/

        /*update of exogenous variables*/

x0=period8;

K = x[182:190,1];
H = x[173:181,1];
msg=1.055;
tt=8;
let L[9,1]= 541790 108810 572870 84910 1025540 1005800 288640 334000 3026590
;

Ls=L.*(1.035)^(tt-1);
```

```
CPIlag = x[124,1] ;
realGDPlag=x[129,1];
WTHlag=x[203,1];

output file=a:results reset;
_nlagr = 1 ;
__title =" Saudi Arabia CGE Model, Period 9";
start = x;
{ x,tcode }  = eqSolve(&f,start);

period9 = x;


/*=======================period 10=================================*/

        /*update of exogenous variables*/

x0=period9;

K = x[182:190,1];
H = x[173:181,1];
msg=1.055;
tt=9;
let L[9,1]= 541790 108810 572870 84910 1025540 1005800 288640 334000 3026590
;
Ls=L.*(1.035)^(tt-1);

CPIlag = x[124,1] ;
realGDPlag=x[129,1];
WTHlag=x[203,1];

output file=a:results reset;
_nlagr = 1 ;
__title =" Saudi Arabia CGE Model, Period 6";
start = x;
{ x,tcode }  = eqSolve(&f,start);

period10 = x;

/*=======================period 11=================================*/

        /*update of exogenous variables*/

x0=period10;
```

```
K = x[182:190,1];
H = x[173:181,1];
msg=1.055;
tt=10;
let L[9,1]= 541790 108810 572870 84910 1025540 1005800 288640 334000 3026590
;
Ls=L.*(1.035)^(tt-1);

CPIlag = x[124,1] ;
realGDPlag=x[129,1];
WTHlag=x[203,1];

output file=a:results reset;
_nlagr = 1 ;
__title =" Saudi Arabia CGE Model, Period 11";
start = x;
{ x,tcode }  = eqSolve(&f,start);

period11 = x;
/*==========================period 12==============================*/

        /*update of exogenous variables*/

x0=period11;

K = x[182:190,1];
H = x[173:181,1];
msg=1.055;
tt=11;
let L[9,1]= 541790 108810 572870 84910 1025540 1005800 288640 334000 3026590
;
Ls=L.*(1.035)^(tt-1);

CPIlag = x[124,1] ;
realGDPlag=x[129,1];
WTHlag=x[203,1];

output file=a:results reset;
_nlagr = 1 ;
__title =" Saudi Arabia CGE Model, Period 12";
start = x;
{ x,tcode }  = eqSolve(&f,start);

period12 = x;
/*==========================period 13==============================*/
```

```
        /*update of exogenous variables*/

x0=period12;

K = x[182:190,1];
H = x[173:181,1];
msg=1.055;
tt=12;
let L[9,1]= 541790 108810 572870 84910 1025540 1005800 288640 334000 3026590
;
Ls=L.*(1.035)^(tt-1);

CPIlag = x[124,1] ;
realGDPlag=x[129,1];
WTHlag=x[203,1];

output file=a:results reset;
_nlagr = 1 ;
__title =" Saudi Arabia CGE Model, Period 13";
start = x;
{ x,tcode }  = eqSolve(&f,start);

period13 = x;
/*=========================period 14=================================*/

        /*update of exogenous variables*/

x0=period13;

K = x[182:190,1];
H = x[173:181,1];
msg=1.055;
tt=13;
let L[9,1]= 541790 108810 572870 84910 1025540 1005800 288640 334000 3026590
;
Ls=L.*(1.035)^(tt-1);

CPIlag = x[124,1] ;
realGDPlag=x[129,1];
WTHlag=x[203,1];

output file=a:results reset;
_nlagr = 1 ;
__title =" Saudi Arabia CGE Model, Period 14";
start = x;
{ x,tcode }  = eqSolve(&f,start);
```

```
period14 = x;
/*==========================period 15==============================*/

        /*update of exogenous variables*/

x0=period14;

K = x[182:190,1];
H = x[173:181,1];
msg=1.055;
tt=14;
let L[9,1]= 541790 108810 572870 84910 1025540 1005800 288640 334000 3026590
;
Ls=L.*(1.035)^(tt-1);

CPIlag = x[124,1] ;
realGDPlag=x[129,1];
WTHlag=x[203,1];

output file=a:results reset;
_nlagr = 1 ;
__title =" Saudi Arabia CGE Model, Period 15";
start = x;
{ x,tcode }  = eqSolve(&f,start);

period15 = x;
/*==========================period 16==============================*/

        /*update of exogenous variables*/

x0=period15;

K = x[182:190,1];
H = x[173:181,1];
msg=1.055;
tt=15;
let L[9,1]= 541790 108810 572870 84910 1025540 1005800 288640 334000 3026590
;
Ls=L.*(1.035)^(tt-1);

CPIlag = x[124,1] ;
realGDPlag=x[129,1];
WTHlag=x[203,1];

output file=a:results reset;
```

```
_nlagr = 1 ;
__title =" Saudi Arabia CGE Model, Period 16";
start = x;
{ x,tcode }  = eqSolve(&f,start);

period16 = x;
/*=========================period 17=================================*/

        /*update of exogenous variables*/

x0=period16;

K = x[182:190,1];
H = x[173:181,1];
msg=1.055;
tt=16;
let L[9,1]= 541790 108810 572870 84910 1025540 1005800 288640 334000 3026590
;
Ls=L.*(1.035)^(tt-1);

CPIlag = x[124,1] ;
realGDPlag=x[129,1];
WTHlag=x[203,1];

output file=a:results reset;
_nlagr = 1 ;
__title =" Saudi Arabia CGE Model, Period 17";
start = x;
{ x,tcode }  = eqSolve(&f,start);

period17 = x;

/*=========================period 18=================================*/

        /*update of exogenous variables*/

x0=period17;

K = x[182:190,1];
H = x[173:181,1];
msg=1.055;
tt=17;
let L[9,1]= 541790 108810 572870 84910 1025540 1005800 288640 334000 3026590
;
Ls=L.*(1.035)^(tt-1);
```

```
CPIlag = x[124,1] ;
realGDPlag=x[129,1];
WTHlag=x[203,1];

output file=a:results reset;
_nlagr = 1 ;
__title =" Saudi Arabia CGE Model, Period 18";
start = x;
{ x,tcode }  = eqSolve(&f,start);

period18 = x;

/*==========================period 19==========================*/

        /*update of exogenous variables*/

x0=period18;

K = x[182:190,1];
H = x[173:181,1];
msg=1.055;
tt=18;
let L[9,1]= 541790 108810 572870 84910 1025540 1005800 288640 334000 3026590
;
Ls=L.*(1.035)^(tt-1);

CPIlag = x[124,1] ;
realGDPlag=x[129,1];
WTHlag=x[203,1];

output file=a:results reset;
_nlagr = 1 ;
__title =" Saudi Arabia CGE Model, Period 19";
start = x;
{ x,tcode }  = eqSolve(&f,start);

period19 = x;
/*==========================period 20==========================*/

        /*update of exogenous variables*/

x0=period19;

K = x[182:190,1];
H = x[173:181,1];
msg=1.055;
```

```
tt=19;
let L[9,1]= 541790 108810 572870 84910 1025540 1005800 288640 334000 3026590
;
Ls=L.*(1.035)^(tt-1);

CPIlag = x[124,1] ;
realGDPlag=x[129,1];
WTHlag=x[203,1];


output file=a:results reset;
_nlagr = 1 ;
__title =" Saudi Arabia CGE Model, Period 20";
start = x;
{ x,tcode }  = eqSolve(&f,start);

period20 = x;

/*==========================================================================*/
names = __altnam;

Y =
names~period1~period2~period3~period4~period5~period6~period7~period8~period9~p
eriod10~period11~period12~period13~period14~period15~period16~period17~period18
~period19~period20;

let mask[1,21] = 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1;

let fmt[21,3] =
"-*.*s "  7 7
"*.*lf"  12 3
"*.*lf"  12 3
"*.*lf"  12 3
"*.*lf"  12 3
"*.*lf"  12 3
"*.*lf"  12 3
"*.*lf"  12 3
"*.*lf"  12 3
"*.*lf"  12 3
"*.*lf"  12 3
"*.*lf"  12 3
"*.*lf"  12 3
"*.*lf"  12 3
"*.*lf"  12 3
"*.*lf"  12 3
"*.*lf"  12 3
"*.*lf"  12 3
"*.*lf"  12 3
```

```
"*.*lf"  12 3
"*.*lf"  12 3
"*.*lf"  12 3
"*.*lf"  12 3;


d = printfm(Y,mask,fmt);

library pgraph;
external proc xy;
M =
period1~period2~period3~period4~period5~period6~period7~period8~period9~period10
~period11~period12~period13~period14~period15~period16~period17~period18~period
19~period20;
x = seqa(1997,1,20);
y =M[191,.]'~M[153,.]'~M[130,.]';
xy(x,y);
```

APPENDIX E

Gauss Computer Program for
Dynamic CGE (Stock Market Model)

/*A CGE modelUsing Input-Output data for Saudi Arabia, 1997(million SR)
(Stock Market included)

==========*/

/*========== The CGE Model==========*/
eqsolveset;

let x0[225,1] =

34647	274404	119889	2256	47526	59073.2	61669	35445	121904	@	O	@
0.617	0.969	0.373	0.542	0.378	0.77	0.415	0.882	0.745	@	PN	@
541790	108810	572870	84910	1025540	1005800	288640	334000	3026590	@	L	@
23407.3	88378.5	34211	8110.9	8711.97	6682.25	79696	12644	26933.7	@	W	@
166985	120922	178206							@	Yw Yk Yg	@
108176	357937								@	TS TC	@
40803.4	34027.8	88859	824.03	36495.7	26338.8	20907	22913	86726.9	@	C	@
1	1	1	1	1	1	1	1	1	@	U	@
7950.22	29617.8	16525	0	10056.3	0	4232.1	51.001	33961.9	@	Z	@
1	1	1	1	1	1	1	1	1.001	@	PD	@
1	1.002	1	1.12	1.12	1.12	1.12	1.1	1.15	@	Pm	@
1	1	1	1	1	1	1	1	1.001	@	PWE	@
27161.5	22174.9	119126	1	1	1	1	0	0	@	M	@
1	1	1	1	1	1	1	1	1	@	P	@
11650.9	161772	60384	0	0	10005	6975.8	383.65	0	@	E	@
-82620									@	Fbar	@
1									@	CPI	@
0.012									@	expinf	@
5.778									@	r	@
5.79									@	nomint	@
548733									@	GDP	@
548669									@	realGDP	@
271940									@	Md	@
1									@	Pa	@
271940									@	Ms	@
58378									@	Mo	@
13499	2-9 2-4 e								@	dDC	@
11801	11333.7	11520	11370	11358.7	11369.9	11370	11370	10902.1	@	dk	@
8672.92	255654	25112	532.58	9029.45	38660.7	2601.9	26988	9324.32	@	Rki	@
376576									@	RK	@
0.11	0.132	0.132	0.11	0.132	0.132	0.131	0.133	0.113	@	ri	@
0.023	0.679	0.067	0.001	0.024	0.103	0.007	0.072	0.025	@	Spi	@
0.131									@	AR	@
0.019	0.685	0.067	0.001	0.024	0.103	0.007	0.072	0.021	@	Hplus1	@
162713	3215634	329420	20670	125309	496757	44657	349307	165877	@	Kplus1	@
3.669									@	GROWTH	@
0.014	0.514	0.038	0	0.014	0.017	0.004	0.019	0.023	@	psi	@

```
  0.643                                                                  @   ps    @
3753171                                                                  @   RVSM  @
4036916                                                                  @   WTH   @
 286916                                                                  @   dWTH  @
79132.3 2999078 221417 332.34 84114.4 99025.4 25116 113425 131531        @   q     @
  1.099                                                                  @   AU    @
3753171                                                                  @   TQ    @
  0.021   0.799  0.059      0  0.022   0.026  0.007  0.03   0.035       @   HH    @
 256223                                                                  @   Yoil  @
```

vf=zeros(rows(x0),1); @ size of this vector is determined from x0 @

proc f(x);

@ Set-Up Variables of Model @
Local
o, PN, L, W, Yw, Yk, Yg, TS, TC, C, U, Z, PD, Pm, PWE, M, P, E, Fbar,CPI, expinf, r, nomint,GDP,realGDP, Md, Pa, Ms, Mo, dDC, dK, Rki, RK, ri, Spi, AR, Hplus1, Kplus1, Growth, psi, ps, RVSM, WTH, dWTH, q, AU, TQ, HH, Yoil ;

```
o=x[1:9,1];              PN=x[10:18,1];          L=x[19:27,1];          W=x[28:36,1];
Yw=x[37,1];              Yk=x[38,1];             Yg=x[39,1];            TS =x[40,1];
TC=x[41,1];              C = x[42:50, 1];        U= x[51:59, 1];        Z=x[60:68,1];
PD=x[69:77,1];           Pm=x[78:86,1];          PWE=x[87:95,1];        M=x[96:104,1];
P=x[105:113,1];          E= x[114:122,1];        Fbar=x[123,1];         CPI=x[124,1];
expinf=x[125,1];         r=x[126,1];             nomint=x[127,1];       GDP=x[128,1];
realGDP=x[129,1];        Md=x[130,1];            Pa=x[131,1];           Ms=x[132,1];
Mo=x[133,1];             dDC=x[134,1];           dK=x[135:143,1];       Rki=x[144:152,1];
RK=x[153,1];             ri=x[154:162,1];        Spi=x[163:171,1];      AR=x[172,1];
Hplus1=x[173:181,1];     Kplus1=x[182:190,1];    Growth=x[191,1];       psi=x[192:200,1];
ps=x[201,1];             RVSM=x[202,1];          WTH=x[203,1];          dWTH=x[204,1];
q=x[205:213,1];          AU=x[214,1];            TQ=x[215,1];           HH=x[216:224,1];
Yoil=x[225,1];
```

@ Set-Up Equations of Model @

/*---------- Production Function ----------*/

vf[1:9,1]=O-omega.*(L.^alpha).*(K.^(1-alpha));

/*---------- Net Prices----------*/

```
vf[10:18,1]=PN-(PD-tau.*PD-A'*P);

/*---------------------- ------- Labor Market Equilibrium------- ------------------------*/

vf[19:27,1]=PN.*alpha.*O-L.*W./1000000;
                                                    /* Wages in Millions RS*/

vf[28:36,1]=L-LS;

/*--------------------Income Generation and Demand for Commodities---------------------*/

vf[37,1] =Yw-(W'L./1000000) ;
                                          @Disposable Labor income, Millions SR @

vf[38,1] = Yk-((PN'*O-PN[2,1]*O[2,1]) - (W'*L-W[2,1]*L[2,1])./1000000).*(1-t) ;
                                    @Disposable Non-Oil Capital Income, Millions  SR@

vf[39,1]=  Yg-(Yk)*(t/(1-t)) -tau'(P.*O)-tm'M-Fbar*ER+te'(PWE.*ER.*E)-Yoil  ;
                                                    @ Gov. income, millions SR@

vf[40,1] = TS-sp*(Yw)-a1*dWTH- sg*(Yg-Yoil);          @total savings,millions SR@

vf[41,1] = TC-(Yw+Yk+Yg)+TS-(1-a1)*dWTH ;
                                          @total consumption, millions  SR@


vf[42:50,1] = C-fc.*TC./P ;
                                    @sectoral consumption, constant prices, Millions SR@

vf[51:59,1] = U-Sij'*P ;
                                                    @vector of capital prices@

vf[60:68,1] = Z-Sij*(H.*TS./U);
              @sectoral investment demand by origin, constant  prices, millions  SR@

/*----------------- ---------- Production Market Equilibrium--------------------------------*/


vf[69:76,1] =df*(PD.*O-(P.*A*O+P.*C+P.*Z+P.*CHS-Pm.*M)-PD.*E) ;
                                                    @ sectoral supply=demand @
/*------------------------------ Average Price Eqaution ----------------------------------------*/


 vf[77,1]=(O./sumc(O))'*P - Pa ;

 /*-----------------------------Import Price Equations ----------------------------------------*/
```

```
vf[78:86,1] =Pm-Pwbar.*(1+tm).*ER ;
                                        @import price in domestic currency @

/*-------------------------- Export Price Equations ----------------------------------------*/


vf[87:95,1] = PWE-PD./((1+te)*ER) ;
                                        @supply price index of domestic exports in RS@

/*-------------------------------- Import Demand Equations ----- --------------------------*/

vf[96:104,1] = M-(delta.^sigma).*((P./Pm).^sigma).*(C+Z+CHS+A*O) ;


@vf[96:104,1]=delta-(M./(((P./Pm).^sigma).*(C+Z+CHS+A*O))).^(1/sigma); @

/*------------------------ --Composite Price Equations---- ------------------------------*/

vf[105:113,1] =P-epsilon.*((delta.^sigma).*Pm.^(1-sigma)+
((1-delta).^sigma).*(PD.^(1-sigma))).^(1./(1-sigma));
                                        @assumes a CES composite aggregation function @

@vf[105:113,1] = epsilon- (((delta.^sigma).*Pm.^(1-sigma)+
((1-delta).^sigma).*(PD.^(1-sigma))).^(1./(1-sigma)))^(-1).*P;@

/*-----------------------------------Export Demand Functions ------------------------------*/

vf[114:122,1] = E - Ebar.*(phi./PWE).^eta ;

/*-----------------------------------Balance of Payments Equilbrium----------------------*/

vf[123,1]=PWbar'*M-PWE'*E-Fbar;

/*---------------------------------Monetary Equations ----------- --------------------------*/

vf[124,1] = CPI - fc'*P;
                                        @consumer price index @

vf[125,1] = expinf - 100*(CPI-CPIlag)/CPIlag ;
                                        @expected inflation @

vf[126,1] = r-0 ;
                                        @ real rate of interest @
```

```
vf[127,1] = nomint - 0;
                                                    @ nominal rate of interest@

vf[128,1] = GDP -(Yw+Yk+Yg)+Fbar*ER ;
                                                    @nominal GDP@

vf[129,1] = realGDP-GDP/CPI ;
                                                    @real GDP@

vf[130,1]=Md/Pa -  .4956 *(realGDP.^1.0)   ;
                                                    @ real money balance@

vf[131,1]=Ms-(mm*Ho-ER*Fbar);
                                                    @ money supply  @

vf[132,1]=Ho -(CD + R)*(msg^tt);
                                                    @ High-power money , Millions SR@

vf[133,1]=dDC- 13499;
                                                    @ changes in domestic credit, Millions SR@

vf[134,1]=Md-Ms;
                                                    @ money market equilibrium@

/*-------------------------- ---- Sectoral Investment Equations ---------- ----------*/

vf[135:143,1]=dK-HH.*TS./U;
                                                    @ real investment by sector of destination@

vf[144:152,1]=Rki - ((1-alpha).*PN.*o.*(1-t)) ;
                                                    @ after tax sectoral profits @

vf[153,1]=Rk - sumc(Rki) ;
                                                    @ after tax profits@

vf[154:162,1]=ri-(Rki./(U.*k)+(U-Ulag)./Ulag) ;
                                                    @ nominal sectoral profit rates defined as returns to
                                                    capital valued in current prices plus capital gains @

vf[163:171,1]=Spi-Rki./Rk ;
                                                    @ sectoral share in aggregate profits@

vf[172,1]=AR-Spi'*ri ;
                                                    @ average nominal profit rate @

vf[173:181,1]=Hplus1 - (Spi+ u.*Spi.*(Ri-AR)./AR) ;
```

```
                                        @ sectoral shares of investment for following time period@

vf[182:190,1]=Kplus1-(K+dK) ;
                                              @ sectoral capital stock for following time period @

/*------------------------------ ------- Growth ----------------------------------------------*/


Vf[191,1]=Growth-100*(realGDP-RealGDPlag)/realGDPlag;

/*---------------------------Real Value of Stock Market-------------------------------------*/

vf[192:200,1]=psi-(RKi./realGDP);
                    @a proportion of    real GDP consists of Buseness profit for each sector@

vf[201,1]=ps-(RK/realGDP);
                                    @a proportion of real GDP consists of Buseness profit @

vf[202,1]=RVSM-(ps*realGDP/rr);
                                                    @real value of all common stocks@

vf[203,1]=WTH-RVSM-Md;
@Wealth of HH@

vf[204,1]=dWTH-WTH+WTHlag;
                                                          @change in Wealth@

vf[205:213,1]=q-(psi.*realGDP./rr);
                                                  @real value of common stock by sector@

vf[214,1]=AU-sumc(u)/9;
                                                       @Average of capital prices @

vf[215,1]=TQ-sumc(q);
@Total q's@

vf[216:224,1]=HH-q./TQ;
                                        @ sectoral shares of investment for following time period@

 /*---------------------------------------------------- ----------------------------------------*/

vf[225,1]=Yoil-(PN[2,1]*O[2,1]-(L[2,1]*W[2,1]/1000000));
@Disposable Oil Capital Income, Millions  SR@
/*=============================================================================*/

retp(vf);
```

```
endp;

__altnam=
{ O1, O2, O3, O4, O5, O6, O7, O8, O9,
PN1, PN2, PN3, PN4, PN5, PN6, PN7, PN8, PN9,
L1, L2, L3, L4, L5, L6, L7, L8, L9,
W1, W2, W3, W4, W5, W6, W7, W8, W9,
Yw, Yk, Yg, TS, TC,
C1, C2, C3, C4, C5, C6,C7,C8,C9,
U1, U2, U3, U4, U5, U6, U7, U8, U9,
Z1, Z2, Z3, Z4, Z5, Z6, Z7, Z8, Z9,
PD1,PD2, PD3, PD4, PD5, PD6, PD7, PD8, PD9,
Pm1,Pm2, Pm3, Pm4, Pm5, Pm6, Pm7,Pm8, Pm9,
PWE1, PWE2, PWE3, PWE4, PWE5, PWE6, PWE7, PWE8, PWE9,
M1, M2, M3, M4, M5, M6, M7, M8, M9,
P1, P2, P3, P4, P5, P6, P7, P8, P9,
E1, E2, E3, E4, E5, E6, E7, E8, E9,
Fbar, CPI, "expinf", "r", "nomint", GDP, "realGDP",
"Md", "Pa", "Ms", "Mo", "dDC",
"dK1", "dK2", "dK3", "dK4", "dK5", "dK6", "dK7", "dK8", "dK9",
"Rki1", "Rki2", "Rki3", "Rki4", "Rki5", "Rki6", "Rki7",  "Rki8",  "Rki9",
RK, "ri1", "ri2", "ri3", "ri4", "ri5", "ri6", "ri7",  "ri8", "ri9",
"SPi1", "SPi2", "SPi3", "SPi4", "SPi5", "SPi6", "SPi7", "SPi8", "SPi9",
AR, "Hplus1", "Hplus2", "Hplus3", "Hplus4", "Hplus5",
"Hplus6", "Hplus7", "Hplus8", "Hplus9",
"Kplus1", "Kplus2", "Kplus3", "Kplus4", "Kplus5", "Kplus6",
"Kplus7", "Kplus8", "Kplus9", Growth,
ps1,ps2,ps3,ps4,ps5,ps6,ps7,ps8,ps9,ps,
RVSM, WTH, dWTH,
q1, q2,q3, q4, q5, q6, q7, q8, q9,
AU, TQ,
HH1, HH2, HH3, HH4, HH5, HH6, HH7, HH8, HH9, Yoil };

_nlagr = 1;
__title= " Solution of  CGE Model for Saudi Arabia" ;
start=x0;
output file = a:eqsolve1.out reset;
{x,tcode} = eqSolve (&f,start);

period1 = x;



/*==========================period 2==============================*/

        /*update of exogenous variables*/
```

```
x0=period1;

K = x[182:190,1];
H = x[173:181,1];
Ho=(1+.168)*58378;

let L[9,1]= 541790 108810 572870 84910 1025540 1005800 288640 334000 3026590
;

Ls=L.*(1.005);

CPIlag = x[124,1] ;
realGDPlag=x[129,1];
WTHlag=x[203,1];



_nlagr = 1 ;
__title ="Saudi Arabia CGE Model, Period 2";
start = x;
{ x,tcode }  = eqSolve(&f,start);

period2 = x;


/*=======================period 3=================================*/

        /*update of exogenous variables*/

x0=period2;

K = x[182:190,1];
H = x[173:181,1];
msg=1.055;
tt=2;
let L[9,1]= 541790 108810 572870 84910 1025540 1005800 288640 334000 3026590
;

Ls=L.*(1.035)^(tt-1);

CPIlag = x[124,1] ;
 realGDPlag=x[129,1];
WTHlag=x[203,1];

output file=a:results reset;
```

```
_nlagr = 1 ;
@_nlchpF = 1;@
_nltypx = x0;
__title =" Saudi Arabia CGE Model, Period 3";
start = x;
{ x,tcode }  = eqSolve(&f,start);

period3 = x;

/*==========================period 4==================================*/

        /*update of exogenous variables*/

x0=period3;

 K = x[182:190,1];
H = x[173:181,1];
msg=1.055;
tt=3;
let L[9,1]= 541790 108810 572870 84910 1025540 1005800 288640 334000 3026590
;
Ls=L.*(1.035)^(tt-1);

CPIlag = x[124,1] ;
 realGDPlag=x[129,1];
WTHlag=x[203,1];

output file=a:results reset;

_nlagr = 1 ;
@_nlchpF = 1;@
__title =" Saudi Arabia CGE Model, Period 4";
start = x;
{ x,tcode }  = eqSolve(&f,start);

period4 = x;

/*==========================period 5==================================*/

        /*update of exogenous variables*/

x0=period4;

 K = x[182:190,1];
H = x[173:181,1];
msg=1.055;
```

```
tt=4;
let L[9,1]= 541790 108810 572870 84910 1025540 1005800 288640 334000 3026590
;
Ls=L.*(1.035)^(tt-1);

CPIlag = x[124,1] ;
 realGDPlag=x[129,1];
WTHlag=x[203,1];

output file=a:results reset;
_nlagr = 1 ;
@_nlchpF = 1;@
__title =" Saudi Arabia CGE Model, Period 5";
start = x;
{ x,tcode }  = eqSolve(&f,start);

period5 = x;

/*==========period 6==========*/

        /*update of exogenous variables*/

x0=period5;

K = x[182:190,1];
H = x[173:181,1];
msg=1.055;
tt=5;
let L[9,1]= 541790 108810 572870 84910 1025540 1005800 288640 334000 3026590
;

Ls=L.*(1.035)^(tt-1);

CPIlag = x[124,1] ;
realGDPlag=x[129,1];
WTHlag=x[203,1];

output file=a:results reset;
_nlagr = 1 ;
__title =" Saudi Arabia CGE Model, Period 6";
start = x;
{ x,tcode }  = eqSolve(&f,start);

period6 = x;
```

```
/*==========================period 7==================================*/

        /*update of exogenous variables*/

x0=period6;

K = x[182:190,1];
H = x[173:181,1];
msg=1.055;
tt=6;
let L[9,1]= 541790 108810 572870 84910 1025540 1005800 288640 334000 3026590
;

Ls=L.*(1.035)^(tt-1);

CPIlag = x[124,1] ;
realGDPlag=x[129,1];
WTHlag=x[203,1];

output file=a:results reset;
_nlagr = 1 ;
__title =" Saudi Arabia CGE Model, Period 6";
start = x;
{ x,tcode }  = eqSolve(&f,start);

period7 = x;


/*==========================period 8==================================*/

        /*update of exogenous variables*/

x0=period7;

K = x[182:190,1];
H = x[173:181,1];
msg=1.055;
tt=7;
let L[9,1]= 541790 108810 572870 84910 1025540 1005800 288640 334000 3026590
;

Ls=L.*(1.035)^(tt-1);
CPIlag = x[124,1] ;
realGDPlag=x[129,1];
WTHlag=x[203,1];
```

```
output file=a:results reset;
_nlagr = 1 ;
__title =" Saudi Arabia CGE Model, Period 6";
start = x;
{ x,tcode }  = eqSolve(&f,start);

period8 = x;


/*==========================period 9==================================*/

        /*update of exogenous variables*/

x0=period8;

K = x[182:190,1];
H = x[173:181,1];
msg=1.055;
tt=8;
let L[9,1]= 541790 108810 572870 84910 1025540 1005800 288640 334000 3026590
;

Ls=L.*(1.035)^(tt-1);

CPIlag = x[124,1] ;
realGDPlag=x[129,1];
WTHlag=x[203,1];

output file=a:results reset;
_nlagr = 1 ;
__title =" Saudi Arabia CGE Model, Period 9";
start = x;
{ x,tcode }  = eqSolve(&f,start);

period9 = x;


/*==========================period 10==================================*/

        /*update of exogenous variables*/

x0=period9;

K = x[182:190,1];
H = x[173:181,1];
```

```
msg=1.055;
tt=9;
let L[9,1]= 541790 108810 572870 84910 1025540 1005800 288640 334000 3026590
;
Ls=L.*(1.035)^(tt-1);

CPIlag = x[124,1] ;
realGDPlag=x[129,1];
WTHlag=x[203,1];

output file=a:results reset;
_nlagr = 1 ;
__title =" Saudi Arabia CGE Model, Period 6";
start = x;
{ x,tcode }  = eqSolve(&f,start);

period10 = x;

/*==========================period 11==================================*/

        /*update of exogenous variables*/

x0=period10;

K = x[182:190,1];
H = x[173:181,1];
msg=1.055;
tt=10;
let L[9,1]= 541790 108810 572870 84910 1025540 1005800 288640 334000 3026590
;
Ls=L.*(1.035)^(tt-1);

CPIlag = x[124,1] ;
realGDPlag=x[129,1];
WTHlag=x[203,1];

output file=a:results reset;
_nlagr = 1 ;
__title =" Saudi Arabia CGE Model, Period 11";
start = x;
{ x,tcode }  = eqSolve(&f,start);

period11 = x;
/*==========================period 12==================================*/

        /*update of exogenous variables*/
```

```
x0=period11;

K = x[182:190,1];
H = x[173:181,1];
msg=1.055;
tt=11;
let L[9,1]= 541790 108810 572870 84910 1025540 1005800 288640 334000 3026590
;
Ls=L.*(1.035)^(tt-1);

CPIlag = x[124,1] ;
realGDPlag=x[129,1];
WTHlag=x[203,1];

output file=a:results reset;
_nlagr = 1 ;
__title =" Saudi Arabia CGE Model, Period 12";
start = x;
{ x,tcode }  = eqSolve(&f,start);

period12 = x;
/*=========================period 13=================================*/

        /*update of exogenous variables*/

x0=period12;

K = x[182:190,1];
H = x[173:181,1];
msg=1.055;
tt=12;
let L[9,1]= 541790 108810 572870 84910 1025540 1005800 288640 334000 3026590
;
Ls=L.*(1.035)^(tt-1);

CPIlag = x[124,1] ;
realGDPlag=x[129,1];
WTHlag=x[203,1];

output file=a:results reset;
_nlagr = 1 ;
__title =" Saudi Arabia CGE Model, Period 13";
start = x;
{ x,tcode }  = eqSolve(&f,start);
```

```
period13 = x;
/*==========================period 14==============================*/

        /*update of exogenous variables*/

x0=period13;

K = x[182:190,1];
H = x[173:181,1];
msg=1.055;
tt=13;
let L[9,1]= 541790 108810 572870 84910 1025540 1005800 288640 334000 3026590
;
Ls=L.*(1.035)^(tt-1);

CPIlag = x[124,1] ;
realGDPlag=x[129,1];
WTHlag=x[203,1];

output file=a:results reset;
_nlagr = 1 ;
__title =" Saudi Arabia CGE Model, Period 14";
start = x;
{ x,tcode }  = eqSolve(&f,start);

period14 = x;
/*==========================period 15==============================*/

        /*update of exogenous variables*/

x0=period14;

K = x[182:190,1];
H = x[173:181,1];
msg=1.055;
tt=14;
let L[9,1]= 541790 108810 572870 84910 1025540 1005800 288640 334000 3026590
;
Ls=L.*(1.035)^(tt-1);

CPIlag = x[124,1] ;
realGDPlag=x[129,1];
WTHlag=x[203,1];

output file=a:results reset;
_nlagr = 1 ;
```

```
__title =" Saudi Arabia CGE Model, Period 15";
start = x;
{ x,tcode }  = eqSolve(&f,start);

period15 = x;
/*=========================period 16=================================*/

        /*update of exogenous variables*/

x0=period15;

K = x[182:190,1];
H = x[173:181,1];
msg=1.055;
tt=15;
let L[9,1]= 541790 108810 572870 84910 1025540 1005800 288640 334000 3026590
;
Ls=L.*(1.035)^(tt-1);

CPIlag = x[124,1] ;
realGDPlag=x[129,1];
WTHlag=x[203,1];

output file=a:results reset;
_nlagr = 1 ;
__title =" Saudi Arabia CGE Model, Period 16";
start = x;
{ x,tcode }  = eqSolve(&f,start);

period16 = x;
/*=========================period 17=================================*/

        /*update of exogenous variables*/

x0=period16;

K = x[182:190,1];
H = x[173:181,1];
msg=1.055;
tt=16;
let L[9,1]= 541790 108810 572870 84910 1025540 1005800 288640 334000 3026590
;
Ls=L.*(1.035)^(tt-1);

CPIlag = x[124,1] ;
realGDPlag=x[129,1];
```

```
WTHlag=x[203,1];

output file=a:results reset;
_nlagr = 1 ;
__title =" Saudi Arabia CGE Model, Period 17";
start = x;
{ x,tcode }  = eqSolve(&f,start);

period17 = x;

/*==========================period 18==================================*/

        /*update of exogenous variables*/

x0=period17;

K = x[182:190,1];
H = x[173:181,1];
msg=1.055;
tt=17;
let L[9,1]= 541790 108810 572870 84910 1025540 1005800 288640 334000 3026590
;
Ls=L.*(1.035)^(tt-1);

CPIlag = x[124,1] ;
realGDPlag=x[129,1];
WTHlag=x[203,1];

output file=a:results reset;
_nlagr = 1 ;
__title =" Saudi Arabia CGE Model, Period 18";
start = x;
{ x,tcode }  = eqSolve(&f,start);

period18 = x;

/*==========================period 19==================================*/

        /*update of exogenous variables*/

x0=period18;

K = x[182:190,1];
H = x[173:181,1];
msg=1.055;
tt=18;
```

```
let L[9,1]= 541790 108810 572870 84910 1025540 1005800 288640 334000 3026590
;
Ls=L.*(1.035)^(tt-1);

CPIlag = x[124,1] ;
realGDPlag=x[129,1];
WTHlag=x[203,1];

output file=a:results reset;
_nlagr = 1 ;
__title =" Saudi Arabia CGE Model, Period 19";
start = x;
{ x,tcode }  = eqSolve(&f,start);

period19 = x;
/*==========================period 20==============================*/

        /*update of exogenous variables*/

x0=period19;

K = x[182:190,1];
H = x[173:181,1];
msg=1.055;
tt=19;
let L[9,1]= 541790 108810 572870 84910 1025540 1005800 288640 334000 3026590
;
Ls=L.*(1.035)^(tt-1);

CPIlag = x[124,1] ;
realGDPlag=x[129,1];
WTHlag=x[203,1];


output file=a:results reset;
_nlagr = 1 ;
__title =" Saudi Arabia CGE Model, Period 20";
start = x;
{ x,tcode }  = eqSolve(&f,start);

period20 = x;

/*=================================================================*/

names = __altnam;
```

```
Y =
names~period1~period2~period3~period4~period5~period6~period7~period8~period9~p
eriod10~period11~period12~period13~period14~period15~period16~period17~period18
~period19~period20;

let mask[1,21] = 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1;

let fmt[21,3] =
"-*.*s "  7 7
"*.*lf"  12 3
"*.*lf"  12 3
"*.*lf"  12 3
"*.*lf"  12 3
"*.*lf"  12 3
"*.*lf"  12 3
"*.*lf"  12 3
"*.*lf"  12 3
"*.*lf"  12 3
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"*.*lf"  12 3
"*.*lf"  12 3
"*.*lf"  12 3
"*.*lf"  12 3
"*.*lf"  12 3
"*.*lf"  12 3
"*.*lf"  12 3
"*.*lf"  12 3;

d = printfm(Y,mask,fmt);

library pgraph;
external proc xy;
M =
period1~period2~period3~period4~period5~period6~period7~period8~period9~period10
~period11~period12~period13~period14~period15~period16~period17~period18~period
19~period20;
x = seqa(1995,1,20);
y =M[191,.]'~M[202,.]';
xy(x,y);


/*==========================================================*/
```

VITA

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Doctor of Philosophy

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