Sources of Fluctuations: *The Case of MENA**

Hideaki Hirata
Faculty of Business Administration, Hosei University
Japan Center for Economic Research
Chiyoda, Tokyo, 102-8160, Japan
h-hirata@i.hosei.ac.jp

Sunghyun Henry Kim
Department of Economics, Tufts University
Medford, MA 02155
sunghyun.kim@tufts.edu

M. Ayhan Kose
International Monetary Fund, Research Department
Washington, D.C. 20431
akose@imf.org

Abstract: We analyze the sources of macroeconomic fluctuations in the emerging countries in the Middle East and North Africa (MENA) region using a dynamic stochastic general equilibrium model. The model economy captures some important structural characteristics of the MENA countries and is able to replicate the main properties of their business cycles. The results suggest that a substantial fraction of cyclical fluctuations in the MENA countries is explained by terms of trade shocks. In particular, these shocks account for more than 60 percent of the variation in aggregate output. They also explain the bulk of cyclical fluctuations in aggregate consumption. Domestic productivity shocks explain close to 40 percent of business cycle variation in aggregate output. While government spending shocks and world interest shocks are also important in accounting for the volatility of business cycles in certain macroeconomic variables, their overall impact on the dynamics of aggregate output appears to be relatively small.

Key Words: *MENA, business cycles, macroeconomic fluctuations, globalization, emerging markets..*
JEL Classification: *E32, F22.*

1. Introduction

In recent years, there has been a rapidly growing research program focusing on the dynamics of economic growth and stability in the Middle East and North Africa (MENA) region. Some studies in this research program concentrate on the determinants of economic growth (see Abed and Davoodi, 2003; and Hakura, 2004). Others consider how the forces of globalization, which are associated with increasing trade and financial linkages, affect various economic outcomes in the region (see Hirata, Kim, and Kose, 2004). There have also been some recent studies documenting the main features of business cycles in the MENA countries.[1] However, there has been no study analyzing the sources of business cycle fluctuations in the region using the methods of modern business cycle theory. The objective of this paper is to fill this gap by analyzing the main determinants of business cycle fluctuations in the emerging market countries of MENA using a dynamic stochastic general equilibrium (DSGE) model.

Our paper focuses on two major questions. First, what are the main driving forces of cyclical fluctuations in the MENA countries? Second, how do different types of shocks propagate through these economies? These questions have important policy implications as recent research shows that highly volatile business cycle fluctuations in the MENA countries could reduce long-term growth and result in large welfare costs.[2] For example, Makdisi, Fattah, and Limam (2003) note that "the effect of output volatility is more detrimental" in the MENA region than others.

As we briefly mention above, several recent studies consider how the MENA countries have been adapting to rapidly changing conditions in the global economic environment.[3] In Hirata, Kim, and Kose (2004), we examine the effects of global economic integration on the dynamics of growth and business cycles in the emerging economies of MENA. In that paper, our sample includes Egypt, Jordan, Morocco, and Tunisia as the emerging market economies in the region since they have undertaken comprehensive reform and liberalization programs since the mid-1980s (see Page, 2003). We also include more advanced emerging economies in the region, namely Israel and Turkey, to this group in order to provide a more comprehensive cross-country analysis.[4]

We document various stylized facts associated with growth and business cycles in these countries and compare their performance with the Asian emerging markets over the periods 1960-1985 and 1986-2000. While we conclude that business cycle fluctuations in the MENA

countries are much more volatile than in the Asian economies and provide some potential reasons for this result, we do not examine the sources of high volatility in the context of a business cycle model in our earlier paper.

This paper extends our earlier study by analyzing the sources of macroeconomic fluctuations in these countries in a fully specified, small open economy DSGE model[5]. Since the model economy is dynamic and involves endogenous labor-leisure choice, we are able to examine the link between a variety of exogenous shocks and fluctuations in aggregate consumption, investment, and foreign balances. The model employs imported capital goods and intermediate inputs in two sectors, namely exportable goods producing sector and non-traded goods producing sector. This production structure along with the differentiation in productive factors allows us to study the impact of various types of external and domestic shocks on different sectors of the economy.

Our model economy is able to capture several important features of the MENA countries documented in some earlier studies. First, the countries in the region have a narrow production base since a substantial fraction of aggregate output is produced by a small number of sectors.[6] For example, Tamberi (2005) finds that the extent of specialization in the MENA countries is quite high as these countries generally appear to have comparative advantage in producing "traditional" goods. While the countries in our sample are relatively more diversified, in some cases, a substantial fraction of aggregate output is produced by a few sectors. Our multi-sector model economy allows us to study how the main sectors in these economies respond to various shocks.

Second, these economies are quite vulnerable to exogenous shocks associated with terms of trade fluctuations as they heavily rely on export revenues from primary products. Makdisi, Fattah and Limam (2003) emphasize the importance of price shocks in accounting for the weak growth performance in the region. In Hirata, Kim, and Kose (2004), we argue that shocks stemming from terms of trade could be an important factor in explaining highly volatile macroeconomic fluctuations in the region. Our model features a terms of trade shock, which enables us to study the importance of price movements in world markets in driving business cycles in these countries.[7]

The third distinctive character of the region is limited integration of its domestic financial markets into the global markets. As documented in Hirata, Kim, and Kose (2004) and Nashashibi,

Elhage, and Fedelino (2001), the process of financial liberalization, which was initiated in the late 1980s and early 1990s, has led to a greater inflow of capital to the MENA region, but the volume of these flows is still very small. In order to account for the low degree of financial integration, our model economy features an incomplete asset market setting. We consider the importance of world interest rate shocks in driving business cycles in the model.

Fourth, the MENA countries have relatively large public sectors. In particular, government expenditure on average constitutes 17 percent of output in the emerging MENA countries while it is less than 10 percent in the emerging Asian economies. Page (1998) discusses the important role played by the public sector in the region and argues that the public sector behaves like an "entrepreneur" in most MENA economies.[8] He documents that a substantial fraction of public investment has been utilized in the non-traded goods sector. Our model also allows us to study the impact of government spending shocks on the non-traded goods sector.

Our paper closely related to some recent studies focusing on the dynamics of business cycles in developing countries. Mendoza (1995), Kose (2002), and Kim and Ahn (2005) examine the cyclical regularities observed in developing countries in the context of a small open economy model and find that the bulk of business cycle fluctuations in aggregate output is explained by external shocks. Hoffmaister and Roldos (1997) and Ahmed and Loungani (1998) study the sources of macroeconomic fluctuations in developing economies using VAR methods and conclude that external shocks, in particular foreign output shocks and oil price shocks, play an important role in inducing cyclical fluctuations in output in these countries.[9]

The rest of the paper is organized as follows: first, we explore the main regularities of business cycles in the MENA region. In section 3, we present the model. Model calibration is described in section 4. In section 5, we examine the ability of the model in replicating major features of business cycle dynamics in the MENA economies, analyze the model dynamics using impulse responses, and quantitatively evaluate the importance of different types of shocks with the help of variance decompositions. Section 6 concludes.

2. Stylized Features of Business Cycles

We first decompose the time series into secular and cyclical components to analyze the main features of business cycles. Since we want our results to be comparable with others in the literature, we employ a decomposition method that has been widely used. The method, which

was first proposed by Hodrick and Prescott (HP) (1997), decomposes a given time series into a trend component and a cyclical component by solving an optimization problem. We study the following features of the time series: volatility, as measured by the percentage standard deviation; comovement, as measured by the degree of contemporaneous correlation of a series with output; and persistence, as measured by the first-order autocorrelation coefficient.[10] We report our findings in Table 1. All statistics are based on logged and HP(100) detrended data deflated by the price of import goods.

INSERT TABLE 1 ABOUT HERE

Several interesting regularities regarding the volatility of national expenditure components emerge. In general, the MENA economies are more volatile than other groups of countries as the average volatility of each expenditure component in the region is larger than those in other groups. In particular, aggregate output in the MENA economies is approximately 28 % and 45 % more volatile than that in the Asian and G7 countries, respectively. The export goods producing sector is on average as volatile as the non-traded good sector.

Second, consumption is on average slightly more volatile than output. Our consumption series include consumption of durable goods, which is generally shown to be more volatile than non-durables consumption (see Baxter, 1996). Moreover, the MENA countries lack developed domestic financial markets and have only limited access to international financial markets. These in turn limit the scope of financial instruments that could be used for consumption smoothing purposes leading to a higher consumption variation in the region. Using the data of other developing country groups, some recent papers also document that the volatility of consumption is larger than that of output, and propose various theories to explain the lack of international consumption risk sharing.[11]

Third, investment is more volatile than output and consumption. The relative volatility of investment in the MENA countries (1.56) is higher than that of other regions (1.45 in the Asian countries and 1.22 in the G7 countries). Finally, exports and imports display much higher variation in the MENA region than they do in the Asian countries. One reason for highly volatile exports and imports is that export and import structures in the MENA countries are less diversified, thereby making them more vulnerable to external shocks. For example, exports of primary goods on average constitute more than half of total exports in the MENA countries while

manufacturing goods on average account for 35 % of exports.[12] In contrast, the share of manufacturing exports is much larger in the Asian and G7 countries than in the MENA region.

With regard to the correlations of expenditure components with output, both consumption and investment are highly positively correlated. Considering that business cycles are defined as fluctuations that simultaneously take place in various components of aggregate output, there are indeed business cycles in the MENA countries, and these cycles have some common features with those observed in the Asian emerging markets and G7 economies. National expenditure components of the MENA countries are fairly persistent, and, in most cases, the degree of persistence is quite close to that in the G7 countries.

Both exports and imports are procyclical. In other words, domestic economic activity has a positive impact on exports and imports, as one would expect. The correlation between exports and output is on average higher than that between imports and output in the MENA countries. While net exports are on average acyclical in the MENA countries, they are countercyclical in Jordan and Morocco and procyclical in Egypt, Tunisia and Turkey. Both exports and imports appear to be quite persistent, but the degree of persistence of net exports is low.

3. The Model Economy

3.1. Preferences

The economy is inhabited by a large number of infinitely lived, identical households. The representative household's objective function is given by

$$\max E_0 \sum_{t=0}^{\infty} \beta^t U_t, \quad \text{and} \quad U_t = \frac{\left(c_t - \frac{(1-l_t)^{\theta}}{\theta} \right)^{1-\sigma}}{1 - \sigma}, \qquad (1)$$

$$\sigma > 0, \quad \beta > 0, \quad \theta > 1$$

where β denotes the discount factor. σ is the risk aversion parameter and θ governs the intertemporal elasticity of substitution in labor supply. The formulation of instantaneous utility function, U_t, implies that the marginal rate of substitution between consumption and leisure is a function of the leisure only, so labor effort does not depend on the intertemporal consumption-saving choice (see Greenwood, Hercowitz and Huffman, 1988). l_t is leisure and c_t is a composite

of three types of consumption goods: exportable goods, c_{xt}, non-traded goods, c_{nt}, and importable goods, c_{mt}. The functional form of the composite good is represented by a CES aggregation

$$c_t = \left[b_x c_{xt}^{1-\gamma} + b_m c_{mt}^{1-\gamma} + b_n c_{nt}^{1-\gamma} \right]^{\frac{1}{1-\gamma}}$$

$$b_x + b_m + b_n = 1 \qquad (2)$$

$$0 < b_x, b_m, b_n < 1 \quad and \quad \gamma \geq 0$$

where $1/\gamma$ is the elasticity of substitution between the goods, and b_x, b_m, and b_n are the weights applied to the exportable, importable, and non-traded goods in the consumption basket, respectively. Total expenditure on consumption can be expressed as the sum of expenditure on each good:

$$p_t c_t = c_{mt} + p_{nt} c_{nt} + p_{xt} c_{xt} \qquad (3)$$

where p_t is the price of composite good c_t. Import goods are assumed to be the numeraire and p_{xt} denotes the price of exportable good in terms of importable good, i.e., terms of trade, and p_{nt} is the price of non-traded good in terms of importable good. The real exchange rate is equal to the general price level of the economy, p_t, because foreign price is assumed to be numeraire. This implies that a real appreciation of domestic currency is equivalent to an increase in the real exchange rate.

3.2. Technology

The economy produces exportable and non-traded goods. The production of exportable goods, y_{xt}, requires the use of capital, k_{xt}, labor, h_{xt}, and imported intermediate inputs, s_t. In order to analyze the impact of the degree of substitutability between capital goods and intermediate inputs on the dynamics of business cycles, the production function of this sector is assumed to be the CES type

$$y_{xt} = A_{xt} h_{xt}^{\omega} \left[a(k_{xt})^{1-z} + (1 - a) (s_t)^{1-z} \right]^{\frac{(1-\omega)}{1-z}} \qquad (4)$$

$$0 < a < 1, \ 0 < \omega < 1, \ z \geq 0$$

where A_{xt} denotes the exogenous productivity shock, a is the relative weight of capital, and ω is

the share of exportable good output earned by labor. The elasticity of substitution between intermediate inputs and capital is governed by *z*.

Non-traded goods sector employs labor, h_{nt}, capital, k_{nt}, and land, L_t, which is assumed to be inelastically supplied. The production function in the non-traded goods sector is

$$y_{nt} = A_{nt} h_{nt}^{\alpha_1} (L_t)^{\alpha_2} (k_{nt})^{1-\alpha_1-\alpha_2}$$
$$0 < \alpha_1 , \ \alpha_2 < 1 \qquad (5)$$

where A_{nt} is the productivity shock, α_1 and α_2 are the labor and land income shares respectively.

Following the standard practice in the international business cycle literature, capital accumulation is modeled as

$$k_{x,t+1} = (1-\delta_x)k_{xt} + k_{xt}\phi\left(\frac{i_{xt}}{k_{xt}}\right), \qquad (6)$$

$$k_{n,t+1} = (1-\delta_n)k_{nt} + k_{nt}\phi\left(\frac{i_{nt}}{k_{nt}}\right), \qquad (7)$$

where i_{xt} and i_{nt} are investment in capital goods in the exportable and non-traded goods sectors, respectively. δ denotes the rate of depreciation and $\phi(.)$ represents the concave adjustment cost function with $\phi(.) > 0$, $\phi(.)' > 0$, and $\phi(.)'' < 0$ (see Baxter and Crucini, 1993). The presence of adjustment costs helps prevent excess volatility of investment in these types of models.

3.3. Financial Markets

Although the MENA countries have been able to attract sizeable financial flows during the past fifteen years, their integration into the world financial markets has been far from complete (see Nashashibi, Elhage, and Fedelino (2001) and Hirata, Kim, and Kose (2004)). The model economy captures this feature of the MENA countries since it is assumed that the financial markets are incomplete in the sense that trade of financial assets is limited to one-period risk-free bonds and there are adjustment costs associated with financial transactions. In particular, the holdings of the bonds evolve according to the formula

$$B_{t+1} + \frac{\Phi}{2}(B_{t+1} - \overline{B})^2 = nx_t + f_t + (1+r_t)B_t \qquad (8)$$

where B_t denotes the net international bond holdings, $\overline{B}$ is the steady state value of these holdings, nx_t is the net exports, and r_t is the rate of return from period *t* to (*t+1*). f_t represents the

net exogenous transfers from abroad.

Since financial markets are incomplete, the households can only partially smooth consumption fluctuations by borrowing and lending international bonds. We also assume that households face adjustment costs of holding international assets, which are characterized by Φ and $\overline{B}$. In particular, households need to buy an additional amount of assets in the current period to receive the same interest income in the subsequent period because of the presence of these adjustment costs. With the presence of these costs in the model, it is possible to produce a well-defined stochastic steady state (see Kim and Kose (2003)). We eliminate the possibility of households accumulating an infinite amount of debt by imposing a no-Ponzi game condition.

3.4. Resource constraints

The resource constraint for the non-traded goods sector is given by

$$y_{nt} = c_{nt} + G_{nt} \qquad (9)$$

where G_{nt} is the exogenous government spending in non-traded goods. As we discussed earlier in the paper, the public sector plays an important role in the MENA countries as it accounts for a significant fraction of investment in the non-traded goods sector. Our model reflects this critical feature and allows us to study the impact of government spending shocks in driving business cycles. The resource constraint for the exportable sector is

$$p_{xt}c_{xt} + c_{mt} + i_{xt} + i_{nt} + s_t + nx_t = p_{xt}y_{xt} \qquad (10)$$

We assume that both exportable and non-traded goods sectors use imported capital goods implying that both i_{xt} and i_{nt} are imported since these countries heavily rely on foreign capital goods.

The representative household, who has a fixed time endowment normalized to one, faces the following labor-leisure allocation constraint

$$h_{xt} + h_{nt} + l_t = 1 \qquad (11)$$

3.5. Exogenous shocks

There are five shocks in the model: two sectoral productivity shocks, a world interest rate shock, a government spending shock, and a shock to the terms of trade. The vector of exogenous shocks is represented by $A_t = [A_{xt}, A_{nt}, r_t, G_{nt}, p_{xt}]'$. The evolution of A_t follows a first order Markov process

$$\ln A_{t+1} = \Pi \ln A_t + \varepsilon_{t+1} \qquad (12)$$

The vector of innovations is denoted by $\varepsilon_t = [\varepsilon_t^x, \varepsilon_t^n, \varepsilon_t^r, \varepsilon_t^g, \varepsilon_t^p]'$ where $\varepsilon_t \sim N(0, \Sigma)$.[13]

4. Model Calibration and Solution

Table 2 presents the parameters, steady state values and shock processes used to calibrate the model. We fix the value of β at 0.968 to match the annual steady state world real interest rate at roughly 3.3 % which is the average of the 6-month LIBOR rate deflated by import prices. θ, which governs the intertemporal elasticity of substitution in labor supply is set at 3 implying that the steady state labor share is equal to 0.35 (see Greenwood, Hercowitz and Huffman (1988)). The risk aversion parameter, σ, is equal to 2.61 which is the estimate from a panel study by Ostry and Reinhart (1992).

INSERT TABLE 2 ABOUT HERE

Since we do not have reliable data series on the distribution of consumption across different groups of goods in the MENA countries, the share parameters b_m, b_n, and b_x in the composite consumption function are set to be close to those in some earlier studies on the dynamics of business in developing countries (see Kouparitsas (1997)). The value of γ is equal to 0.25. This matches the elasticity of substitution in the aggregate consumption function at 4 which is very close to the value used by Obstfeld and Rogoff (2001). As γ decreases, the response of consumption to changes in relative prices gets stronger. The parameter Φ describing adjustment costs associated with asset holdings is set to match the volatility of the net exports**.**

We set the annual depreciation rate at 10 %, which is commonly used in the literature. The share of labor income in the exportable goods sector, ω, is set at 0.429 following Mendoza (1995). The other parameters of this sector are very close to those used in Kose (2002). The share of capital, a, is set at 0.50. The elasticity of substitution between capital and imported intermediate good, z, is set at 1.35. Labor share in the non-traded goods sector, α_1, is set at 0.38 and the share of capital in the non-traded good production is equal to 0.4.

The adjustment cost parameters in the capital accumulation equations are chosen so that the steady state of the model is same as the one without adjustment costs. This implies that

$\phi(i/k) = i/k$ and $\phi'(i/k) = 1$. The steady state value of i/k is equal to the depreciation rate δ. The elasticity of the marginal adjustment cost function, $\eta = -(\phi'/\phi'')(i/k)^{-1}$, of the exportable and non-traded sectors is set at 10, to match the volatility of investment in the data. We set the ratio of government expenditure in non-traded output at 17 %, the share of foreign transfer in output at 6.9 %, and the share of net exports in aggregate output at -9 %. These shares are consistent with the averages of those observed in the MENA countries in our sample. We assume that the steady state land share in terms of non-traded output at 5 % (see Kouparitsas (1997) and Kose (2002)).

We estimate the shock processes employing the standard methodology in the literature. For the productivity measure in the exportable and non-traded goods sectors, we use the Solow residuals derived from the respective production functions. Since the sectoral labor data series are not available for the sample of countries we are interested in, we use aggregate employment series to proxy the fluctuations in the labor market. The shocks are assumed to follow AR(1) processes. The coefficients of these processes are estimated employing the OLS regressions. The variance-covariance matrix of innovations are computed by using the covariances between the residual terms of estimated processes for each country. Then, the average of these matrices over the sample is calculated. These averages are assumed to be the relevant parameters of exogenous shocks for the representative MENA economy. Since the data series are available only for Egypt, Morocco, Tunisia and Turkey, we estimate the shocks using the data of these countries.

The model is solved using the optimization problem of the representative household. This corresponds to a dynamic optimization problem which maximizes the expected lifetime utility, (1), subject to the constraints, (2)-(12). Since this problem cannot be solved analytically, we use log-linear approximations. The system is solved following Sims (2002), whose method is a generalization of the one by Blanchard and Khan (1980).

5. Results

We first study whether the model economy is able to replicate the main features of cyclical fluctuations in the MENA countries. Next, we analyze the dynamic effects of shocks using impulse responses. Then, we examine the importance of different types of shocks in explaining business cycle fluctuations. Following this, we provide a brief discussion about the sensitivity of our results to changes in various parameters of the model.

5.1. Features of Business Cycles

Is the model economy able to replicate the main features of business cycles observed in the MENA countries? To answer this question, the model is simulated and various business cycle moments are computed. Table 3 provides a summary of our findings. The statistics in this table correspond to the sample average of 1000 simulations each of which has 41 observations (1960-2000). We detrended the artificial series with the HP(100) filter to make the results comparable to our earlier data analysis. The moments of actual data refer to those moments calculated for the representative MENA country and correspond to the average moments reported in Table 1. We focus on the three main features of business cycles: volatility, comovement, and persistence.

INSERT TABLE 3 ABOUT HERE

The model is able to reproduce some important features of cyclical volatility in the MENA countries. For example, it is able to match the volatility of fluctuations in aggregate output, non-traded sector output, and investment quite closely. In particular, the success of the model in closely replicating the volatility of aggregate output is an encouraging result. The model predicts that the volatility of exportable sector output is larger than that in the data. This could be due to the presence of highly volatile and persistent terms of trade disturbances and productivity shocks in the export sector. In contrast, the volatility of output in the non-trade sector is much lower than that in the exportable sector as this sector is isolated from the effects of highly volatile terms of trade shocks.

The model slightly underestimates the volatility of consumption. This is an expected result since the model does not take into account the consumption of durable goods while the consumption data that are used to produce the moments in Tables 1 and 3 include both durable and nondurable consumption goods. As we already discussed, the volatility of durable consumption is 2-3 times higher than that of non-durables in general. If we used the consumption data including only non-durables consumption series, we could have shown that the model is able to mimic the volatility of consumption.[14]

The model is able to replicate the comovement properties of the data. In particular, the model captures the highly procyclical nature of output in both exportable and non-traded goods sectors as well as that of consumption. The correlation between the fluctuations in output and the

net exports produced by the model is larger than that in the data. This could be the result of highly persistent terms of trade and interest rate shocks as they could dampen the income effects associated with productivity shocks on demand for imported goods. In particular, while a decline in the terms of trade, i.e., an increase in the relative price of imports, reduces the demand for import goods, an increase in productivity leads to higher demand. The model is also able to reproduce some properties regarding the persistence of business cycles in the MENA countries. In particular, the model predicts that aggregate output is more persistent than investment while the net exports exhibit the least persistent business cycle fluctuations.

5.2. Dynamic Responses

We study propagation of business cycles in response to shocks employing impulse response analysis. In particular, we examine the impulse responses of model variables to a one percent increase in each shock. The results, presented in Figures 1-5, are plotted as percentage deviations from the initial steady state.

INSERT Figure 1, 2, 3, 4, and 5 ABOUT HERE (Each FIGURE has six graphs. Please put all six graphs (in each Figure) in a single page, for each figure there will be a page). Please do not separate them.)

We present the impulse responses of model variables to a one percent increase in productivity in the exportable good sector (A_x) in Figure 1. An increase in A_x naturally leads to an expansion in aggregate output, investment, labor input and consumption in the export sector. At impact, there is a slight decrease in the production of non-traded goods, which is also reflected in their consumption. Since the price of imported capital goods decreases with the appreciation of the real-exchange rate, there is also a small increase in investment in the non-traded goods sector. This leads to a reduction in labor employed in the non-traded sector since relatively cheaper capital substitutes for labor input. Both the net exports and current account register surpluses as households increase their savings by accumulating foreign bonds.

Figure 2 displays the impulse responses of model variables to a one percent increase in productivity in the non-traded goods sector (A_n). Output, investment, and consumption in the non-traded sector increase. As supply increases in the non-traded sector, price of non-traded goods decreases leading to a depreciation in the real-exchange rate. Output and investment in the

export sector increase since the production of non-traded goods requires imported capital goods, and in order to import these goods households need to increase the supply of exportable goods. This also leads to a reduction in the consumption of both exportable and importable goods. Aggregate output, however, decreases because of the decline in the price of non-traded goods (Note that aggregate output is defined as the value of the sum of export goods and non-traded goods produced in the economy). While labor input in the exportable sector goes up, labor input in the non-traded good sector decreases. This is due to the high elasticity of substitution between capital and labor in the non-traded sector. In the exportable sector, however, labor and capital are complementary, leading to concomitant increases in both factors of production. Both the net exports and current account register surpluses.

We present the impulse responses of model variables to a one percent increase in productivity in both sectors (A_x and A_n) in Figure 3. The dynamic responses in this figure are very similar to figure 2 because non-traded sector output constitutes a large fraction of total production in the representative MENA economy. A sudden increase in productivity results in an economy-wide boom as output increases in both sectors. Favorable productivity shocks also lead to an investment boom in both sectors as well as an increase in demand for intermediate inputs. Households work harder to take advantage of improved productivity. Aggregate consumption goes up, but the increase in consumption is less than that in output as there is a decline in consumption of exportable and importable. A decrease in consumption in these sectors results from the increased demand for imported capital and intermediate goods. Trade balance and current account improve as households become lenders in international financial markets. The results also suggest that productivity shocks lead to more pronounced effects on the dynamics of export sector than those of the non-traded sector.

Figure 4 presents the impulse responses to a one percent increase in the terms of trade. As the price of exportable goods rises, output, investment, intermediate good input and labor in the exportable sector also increase. There is a slight decrease in the production of non-traded goods. However, aggregate output increases by almost 1.4% because of the increase in the price of exported goods. While there is a fall in the supply of labor in the non-traded goods producing sector, the demand for capital (investment) in this sector rises following the fall in the price of imported capital goods. The relative increase in the price of non-traded goods leads to a slight decrease in the demand for non-traded consumption goods. However, consumption of both

exportable and importable goods increases leading to an increase in aggregate consumption. Although demand for imported capital increases in both sectors, trade balance registers a surplus due to the increase in the price of exported goods. This finding is consistent with the well-known Harberger-Laursen-Metzler effect that there is a positive correlation between trade balance and the terms-of-trade.

Figure 5 presents the impulse responses to a quarter percentage point increase in world interest rate. While the effects of world interest rate shocks on output, labor input and consumption are relatively small compared to other shocks, their impact on investment is quite large. There is a substantial decline in investment in both sectors leading to a surplus in trade balance and current account..

5.3. Sources of Business Cycles

We study the relative contribution of shocks to the volatility of business cycles in the MENA economies in this section. In particular, we apply the variance decomposition method, which is widely used in the vector autoregression (VAR) literature, to determine the relative importance of individual shocks in explaining business cycle fluctuations in our model. We decompose the variance of each macroeconomic variable into fractions explained by the exogenous shocks.[15] The results of the variance decompositions are reported in Table 4.

INSERT TABLE 4 ABOUT HERE

A substantial fraction of cyclical fluctuations in the MENA countries is explained by the terms of trade shocks. In particular, these shocks account for more than 60 percent of the variation in aggregate output in the short run (one-year forecast horizon). Since both sectors employ imported inputs as factors of production, terms-of-trade shocks have a direct effect on output fluctuations. Their impact on fluctuations in the components of aggregate output is much smaller. However, they still play an important role in explaining fluctuations in aggregate output because terms-of-trade shocks ultimately determine the value of aggregate output, Approximately 23 percent of the business cycle variation in the export sector is explained by shocks to terms of trade. Since terms of trade shocks mostly affect the price of exportable goods, they play a relatively smaller role in explaining the volatility of business cycles in non-traded

sector. Terms of trade shocks account for more than 60 percent of cyclical variation in aggregate consumption. The results also indicate that shocks to terms of trade have a large impact on business cycle fluctuations in the factors of production**.** For example, they explain approximately 30 percent of the variation in aggregate investment as imported capital and intermediate goods are directly affected by fluctuations in terms of trade.

Domestic productivity shocks account for roughly 38 percent of output variation. Moreover, these shocks play a larger role in explaining the dynamics of the components of aggregate output. Over a one-year forecast horizon, sectoral productivity shocks explain more than 70 percent of the variation of sectoral output. Sectoral productivity shocks have a smaller impact on aggregate output, since price and volume effects triggered by these shocks partially cancel out each other. For example, in response to a positive productivity shock, output in the non-traded sector increases while its price decreases as we discussed earlier.

As shown in impulses responses, the impact of world interest rate shocks on output and consumption is relatively minor. The world interest rate shocks do not have a direct effect on output fluctuations in our model. For example, a rise in the world interest rate leads to a shift of domestic savings to foreign assets and decreases domestic investment. The response of output to interest rate shocks, however, is delayed by at least one period because current investment affects capital stock and output only in the next period. However, world interest rate shocks play a significant role in driving cyclical fluctuations in investment. Moreover, dynamics of trade balance and foreign asset holdings are also heavily affected by interest rate fluctuations. More than 90 percent of the fluctuations in the net exports are accounted for by interest rate shocks. While government spending shocks have a minor role in explaining business cycles in aggregate output, they are able to explain almost 10 percent of fluctuations in the non-traded sector since it is assumed that government consumption takes place in the non-traded sector. Fluctuations in government spending have a small impact on the price of non-traded goods and the dynamics of trade balance. In our model, government spending shocks do not result in distortionary effects in production nor consumption since government spending does not change marginal conditions in agents' decision making.

As the forecast horizon increases, the impact of terms of trade shocks becomes more pronounced. For example, terms of trade shocks explain approximately 71 percent of output variation over a ten-year horizon whereas they account for roughly 61 percent over a one-year

horizon. Partly because their relatively low persistence, productivity shocks seem to be playing a less influential role in driving the dynamics of output and consumption over longer horizons.

5.4. Sensitivity Analysis

We analyze the sensitivity of our results to changes in the main parameters of the model in this section. Table 5 reports how the features of business cycles change. There are four main results. First, an increase in the volatility of shocks obviously increases the volatility of business cycles, but changes in the persistence of shocks do not have a significant effect on volatility. Second, changes in the risk aversion coefficient and consumption shares do not lead to any major change in the moments of business cycles. Third, changes in the elasticity of substitution of consumption (γ) lead to only minor changes. Fourth, when the adjustment costs of asset holdings decrease, both investment and net exports become more volatile since households increase the frequency of transactions involving assets. Table 5 also reports the results of sensitivity analysis regarding variance decompositions. Our results are quite robust to changes in the main parameters of the model, but they are sensitive to changes in the relative volatility of shocks as expected.

INSERT TABLE 5 ABOUT HERE

6. Conclusion

One of the major challenges facing the emerging market economies of the MENA region is to design economic policies that could help them to create a stable macroeconomic environment while achieving sustainable, long-term economic growth. Understanding the sources of macroeconomic fluctuations is an important step to meet this challenge as highly volatile macroeconomic fluctuations have been taking a heavy toll on economic growth in the region. This paper provides a fundamental analysis of the sources of business cycles fluctuations in the emerging MENA countries using a dynamic stochastic general equilibrium model.

We first document main features of business cycles in these countries. Our results indicate that aggregate output in the emerging MENA economies is more volatile than that in the Asian emerging markets. Second, while consumption is the least volatile aggregate among the national income expenditure terms, its volatility is slightly higher than that of output. Third, fluctuations in investment are more volatile that other aggregate variables. Both consumption

and investment are highly positively correlated with output. These findings suggest that while the amplitude of business cycles is relatively large in the emerging MENA economies, the main features of business cycles in the region are quite similar to those observed in other countries.

Our model economy captures several important structural properties of these countries as it features a multi-sector production base, incomplete financial markets, a large public sector, and a set of external and domestic shocks. The model is able to produce some key features of business cycles in the region. For example, the model is able to match the volatility of aggregate output, non-traded sector output, investment, and net exports quite closely. It also captures the highly procyclical nature of output in both exportable goods and non-traded goods sectors.

We attempt to answer two main questions using this model. First, what are the main driving forces of cyclical fluctuations in the MENA countries? We employ variance decompositions to study the sources of business cycles in these countries. Our findings suggest that a substantial fraction of cyclical fluctuations in the emerging economies of MENA is explained by terms of trade shocks. In particular, these shocks account for more than 60 percent of the variation in aggregate output. Since both sectors of the model economy use imported goods as factors of production, terms of trade shocks have a direct impact on output fluctuations. They also explain more than 60 percent of cyclical variation in aggregate consumption. As the forecast horizon gets longer, the impact of terms of trade shocks becomes more pronounced.

The other external shock in our model is associated with the movements in world interest rates. While the impact of world interest rate shocks is not substantial in explaining output fluctuations, they have a significant impact on external balances. We also study the impact of domestic shocks, including productivity and government spending shocks, in driving business cycles. Productivity shocks appear to be quite important: they explain close to 40 percent of output fluctuations and they account for more than 70 percent of variation in exportable and non-traded goods producing sectors. Government spending shocks have a minor impact on the dynamics of aggregate output, but they explain close to 10 percent of business cycle variation in the non-traded sector.

Second, how do different types of shocks propagate through these economies? We find that positive terms of trade shocks could lead to a substantial increase in output. Positive productivity shocks have differential effects on the sectoral dynamics depending on the sector

receiving the shock, but the changes in the non-traded goods producing sector appear to be quite important in driving aggregate output fluctuations in response to productivity shocks.

Our paper provides a set of benchmark stylized facts and a basic framework to analyze these facts. As the emerging MENA countries become more integrated into the global economy, there will be an increase in their exposition to shocks stemming from terms of trade and world interest rate fluctuations. More importantly, increased trade and financial linkages will change the nature of these shocks and will have a broader set of implications for economic activity in the region. For example, global trade and financial flows have been changing the features of cyclical fluctuations by affecting the dynamics of volatility and comovement as we document in Hirata, Kim, and Kose (2004). We plan to examine the implications of these changes for the MENA region in the context of a multi-country model in our future research.

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ENDNOTES

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1 Emerging Markets Finance & Trade allocated an entire issue (Vol: 40 No:6, November - December 2004, entitled "Nature and Transmission of Business Cycles: The Case of MENA and Europe") to six papers studying the major features of business cycles in the region and analyzing the transmission of shocks to these countries from Europe.

2 For recent surveys of the literature about the adverse impact of volatility on growth, see Kose, Prasad, and Terrones (2006) and Aizenman and Pinto (2005).

3 Iqbal (2001) provides a collection of papers focusing on a variety of issues ranging from demographic transition to financial liberalization process to sustainability of fiscal balances in the MENA countries. Shafik (1998) also presents a set of interesting studies on the dynamics of economic growth, transitional issues, poverty and environment in the MENA region.

4 We provide a detailed discussion about the choice of these countries and present an overview about the evolution of these economies since the 1960s in Hirata, Kim, and Kose (2004).

5 To the best of our knowledge, our paper is the first one analyzing the sources business cycles in the MENA countries using a DSGE model.

6 At a more disaggregated level, for example, tourism revenues account for a major share of foreign exchange reserves in Egypt, Israel, Morocco, and Tunisia (El-Erian, Eken, Sena, and Chauffour, 1996).

7 Some other papers also emphasize the vulnerability of these economies to international relative prices and the role of financial markets. For example, Domac and Shabsigh (2001) find that misalignment of real exchange rates has a significantly negative impact on the growth performance of some MENA countries. Nashashibi, Brown, and Fedelino (2001) claim that the appreciation of the real exchange rate in the 1990s was the major reason why exports have been slowly growing in some MENA economies in comparison with some other developing economies.

8 Jalali-Naini (2000) provides a detailed analysis of the dynamics of fiscal accounts in the MENA countries.

9 Kose, Prasad and Terrones (2003) examine how increasing global linkages affect the dynamics of volatility and Kose, Prasad, and Terrones (2004) study whether there has been an increase in the degree of synchronization of business cycles because of these rising linkages. Kim, Kim and Wang (2003) investigate how capital flows from financial market liberalization affect business cycle synchronization in the Asian countries. Kim, Kose, and Plummer (2003) document the main features of business cycle fluctuations in Asian emerging market economies. Agenor, McDermott, and Prasad (2000) compare business cycle characteristics of a group of developed economies with those of some developing countries.

10 Sussmuth and Woitek (2004) analyze business cycle characteristics of MENA and European

countries in the Mediterranean area. Zoubi and Maghyereh (2005) examine the Jordanian and Israeli Industrial Production to see the presence of complex unit roots in the business cycle frequencies. Lucke (2004) employs a dynamics small open economy model to examine the negative correlation between Jordanian business cycles and business cycles in the European Union.

11 Kose, Prasad, and Terrones (2003) discuss this issue in the context of a large number of developing countries. Kim, Kose, and Plummer (2003) document a similar result for the Asia-Pacific countries.

12 An appendix providing a detailed analysis of the structural characteristics of the MENA countries is available from the authors upon request.

13 We also consider shocks associated with the net exogenous transfers as a proxy for workers' remittances. Since their empirical impact is rather limited in our model, we do not discuss the implications of these shocks and assume that the net exogenous transfers remain constant Sayan (2004) reports that workers' remittances constitute a large share of output in the MENA countries.

14 See Backus, Kehoe and Kydland (1995) for a similar argument about the volatility of durable goods consumption. Baxter (1996) provides an extensive discussion about the differentiation between durables vs. nondurable goods and its business cycle implications.

15 This method requires us to impose a certain information ordering on the shocks because the relative contribution of each disturbance to macroeconomic fluctuations is sensitive to its place in the shock specification. Since our model represents a small open economy, there is a natural ordering of shocks. By construction, the small open economy does not have any control over the terms of trade and world interest rates shocks. This implies that domestic productivity and government spending shocks do not have any impact on terms of trade and world interest rates shocks, i.e. the shocks in the latter group precede sectoral productivity and government spending shocks.

Table 1. Properties of business cycles

	Volatility (%) / *Relative volatility*							
	y	y_x	y_n	*c*	*i*	*ex*	*im*	*nx*
Egypt	10.15	10.55	8.92	10.71	15.63	20.02	14.77	3.07
	1.00	*1.04*	*0.88*	*1.06*	*1.54*	*1.97*	*1.46*	*0.30*
Jordan	12.09	NA	NA	13.85	26.09	19.62	20.31	4.94
	1.00	*NA*	*NA*	*1.15*	*2.16*	*1.62*	*1.68*	*0.41*
Morocco	9.00	9.02	10.51	8.63	15.83	12.32	13.29	2.89
	1.00	*1.00*	*1.17*	*0.96*	*1.76*	*1.37*	*1.48*	*0.32*
Tunisia	11.34	11.3	11.4	10.47	16.45	11.97	11.48	2.7
	1.00	*1.00*	*1.01*	*0.92*	*1.45*	*1.06*	*1.01*	*0.24*
Israel	15.38	NA	NA	15.63	16.55	19.65	18.53	3.01
	1.00	*NA*	*NA*	*1.02*	*1.08*	*1.28*	*1.20*	*0.20*
Turkey	9.76	11.42	11.54	9.99	15.01	24.41	20.18	1.47
	1.00	*1.17*	*1.18*	*1.02*	*1.54*	*2.50*	*2.07*	*0.15*
MENA	**11.29**	**10.57**	**10.59**	**11.55**	**17.59**	**18.00**	**16.43**	**3.01**
	1.00	***0.94***	***0.94***	***1.02***	***1.56***	***1.59***	***1.46***	***0.27***
Asia	**8.85**	-	-	**9.35**	**12.83**	**11.95**	**9.89**	**3.52**
	1.00	-	-	***1.06***	***1.45***	***1.35***	***1.12***	***0.40***
G7	**7.80**	-	-	**7.72**	**9.49**	**8.74**	**8.72**	**0.97**
	1.00	-	-	***0.99***	***1.22***	***1.12***	***1.12***	***0.12***

	Comovement (NW standard error) / *Persistence*							
	y	y_x	y_n	*c*	*i*	*ex*	*im*	*nx*
Egypt	1.00	0.97	0.95	0.95	0.14	0.56	0.33	0.61
	-	(0.05)	(0.06)	(0.05)	(0.23)	(0.20)	(0.21)	(0.14)
	0.54	*0.55*	*0.27*	*0.62*	*0.64*	*0.75*	*0.64*	*0.34*
Jordan	1.00	-	-	0.93	0.86	0.79	0.89	-0.61
	-	-	-	(0.09)	(0.12)	(0.16)	(0.10)	(0.11)
	0.72	-	-	*0.69*	*0.72*	*0.67*	*0.73*	*0.30*
Morocco	1.00	0.93	0.95	0.96	0.81	0.52	0.61	-0.14
	-	(0.07)	(0.06)	(0.05)	(0.12)	(0.15)	(0.15)	(0.19)
	0.49	*0.38*	*0.56*	*0.52*	*0.41*	*0.32*	*0.44*	*0.48*
Tunisia	1.00	0.95	0.97	0.91	0.71	0.74	0.45	0.24
	-	(0.06)	(0.04)	(0.07)	(0.15)	(0.11)	(0.12)	(0.16)
	0.57	*0.46*	*0.48*	*0.47*	*0.50*	*0.37*	*0.01*	*0.27*
Israel	1.00	-	-	0.97	0.85	0.90	0.93	0.03
	-	-	-	(0.03)	(0.08)	(0.08)	(0.07)	(0.14)
	0.63	-	-	*0.57*	*0.56*	*0.61*	*0.64*	*0.13*
Turkey	1.00	0.97	0.97	0.95	0.62	0.62	0.41	0.40
	-	(0.06)	(0.06)	(0.06)	(0.13)	(0.17)	(0.19)	(0.10)
	0.49	*0.45*	*0.56*	*0.58*	*0.35*	*0.60*	*0.54*	*-0.04*
MENA	**1.00**	**0.95**	**0.96**	**0.95**	**0.66**	**0.69**	**0.60**	**0.09**
	0.57	***0.46***	***0.47***	***0.57***	***0.53***	***0.55***	***0.50***	***0.25***
Asia	**1.00**	**-**	**-**	**0.93**	**0.42**	**0.62**	**0.50**	**0.41**
	0.38	**-**	**-**	***0.43***	***0.39***	***0.45***	***0.21***	***0.24***
G7	**1.00**	-	-	**0.95**	**0.82**	**0.66**	**0.67**	**0.66**
	0.64	**-**	**-**	***0.60***	***0.54***	***0.58***	***0.58***	***0.48***

Notes: Statistics are based on logged and HP detrended data with smoothing parameter 100. Net exports refer to the HP detrended ratio of (exports - imports) to output. All variables in LCU are deflated by the price of importable good. The sample period is 1960-2000 with exceptions such as sectoral outputs. For details, see Appendix. Variables are output (y), output of exportable good sector (yx), output of non-traded good sector (yn), consumption (c), investment (i), exports (ex), imports (im), and net exports (nx). Statistics in bold correspond to the sample averages.

Table 2. Parameters of the model

Parameter	Description	Parameter
Preferences		
β	Discount factor, $r = \beta^{-1}-1$	0.968
r	Real interest rate, annual	3.27%
$1/\gamma$	Coefficient of intratemporal elasticity of substitution between consumption goods	4.00
σ	Coefficient of relative risk aversion	2.61
θ	Intertemporal elasticity of substitution in labor supply	3.00
b_m	Weight of importable goods (in consumption)	0.15
b_x	Weight of exportable goods (in consumption)	0.10
b_n	Weight of nontraded goods (in consumption)	0.75
Technology		
Exportable Goods Sector		
ω	Share of labor income	0.429
z	Coefficient of intratemporal elasticity of substitution between capital and importable intermediate inputs	1.350
a	Weight of capital input in the CES composite	0.500
δ_x	Depreciation rate, annual	0.100
η_x	Elasticity of marginal adjustment cost function, $\eta_x = -(\phi'/\phi'')/(i_x/k_x)$	10
Nontraded Goods Sector		
α_1	Share of labor income	0.380
α_2	Share of land income	0.220
α_3	Share of capital income	0.400
δ_n	Depreciation rate, annual	0.100
η_n	Elasticity of marginal adjustment cost function, $\eta_n = -(\phi'/\phi'')/(i_n/k_n)$	10
Other steady state values		
l_{yn}	Share of land in y_n	0.050
g_{yn}	Share of government expenditure in y_n	0.170
f_y	Share of foreign transfers in y	0.069
nx_y	Share of net exports in y	-0.091
p_x	Initial terms of trade (index)	1.000
Φ	Adjustment cost of asset holdings	0.600
Exogenous shocks		

$ln\,A_{t+1} = \Pi\, ln\,A_t + \varepsilon_{t+1}$ where ε_t follows $N(0, \Sigma)$

$$\Pi = \begin{bmatrix} 0.60 & 0 & 0 & 0 & 0 \\ 0 & 0.80 & 0 & 0 & 0 \\ 0 & 0 & 0.81 & 0 & 0 \\ 0 & 0 & 0 & 0.84 & 0 \\ 0 & 0 & 0 & 0 & 0.75 \end{bmatrix}$$

$$\Sigma = \begin{bmatrix} 0.06\text{^}2 & & & & \\ 0.162 & 0.02\text{^}2 & & & \\ 0.150 & -0.020 & 0.018\text{^}2 & & \\ 0.145 & -0.033 & 0.01 & 0.15\text{^}2 & \\ -0.021 & -0.148 & -0.05 & 0.034 & 0.08\text{^}2 \end{bmatrix}$$

The ordering of shocks is Ax, An, r, Gn, and px. Off-diagonal represents innovations' correlation.

Table 3. Business cycle properties

	y	y_x	y_n	c	i	nx
Volatility (%)						
Model	12.10	17.06	10.45	9.48	16.77	4.27
Data	11.29	10.57	10.59	11.55	17.59	3.01
Relative volatility						
Model	-	1.41	0.86	0.78	1.39	0.35
Data	-	0.94	0.94	1.02	1.56	0.27
Comovement with output						
Model	-	0.94	0.95	0.98	0.60	0.42
Data	-	0.95	0.96	0.95	0.66	0.09
Persistence						
Model	0.68	0.68	0.70	0.71	0.54	0.48
Data	0.57	0.46	0.47	0.57	0.53	0.25

Notes: The data are the average moments over the sample MENA countries. See Table 1. The data and the simulated data are constant at importable good prices. All moments are computed from the logged and HP detrended time series except moments of net exports. Smoothing parameter is 100. All model moments are averages over the 1,000 simulations of the model each with 41 observations. The simulated data are also HP detrended with smoothing parameter 100.

Table 4. Variance decomposition (%)

	y	y_x	y_n	c	i	nx
One-year forecast horizon						
Productivity shocks	37.69	74.82	82.83	37.31	22.95	3.56
A_x	37.59	71.32	7.06	34.62	20.29	0.84
A_n	0.10	3.50	75.77	2.69	2.66	2.72
World price shocks	61.28	20.81	7.92	61.98	75.77	91.96
P_x	61.28	20.81	7.92	61.98	29.72	0.87
r	0.00	0.00	0.00	0.00	46.05	91.09
Government spending shock	1.03	4.37	9.24	0.70	1.28	4.48
Five-year forecast horizon						
Productivity shocks	30.05	59.04	84.54	29.82	25.04	7.84
A_x	29.98	53.91	5.23	27.87	21.71	0.68
A_n	0.07	5.13	79.31	1.95	3.33	7.16
World price shocks	69.33	33.73	6.46	69.77	71.43	86.28
P_x	69.28	29.19	5.99	68.62	40.72	2.80
r	0.05	4.54	0.47	1.15	30.71	83.48
Government spending shock	0.61	7.23	9.00	0.40	3.53	5.89
Ten-year forecast horizon						
Productivity shocks	28.14	53.56	72.54	27.41	23.58	7.31
A_x	27.94	47.92	10.83	25.74	20.19	0.55
A_n	0.20	5.64	61.71	1.67	3.39	6.76
World price shocks	71.13	37.47	21.44	71.72	71.86	87.57
P_x	71.08	32.21	18.59	70.00	41.15	2.74
r	0.05	5.26	2.85	1.72	30.71	84.83
Government spending shock	0.73	8.98	6.02	0.88	4.57	5.13

Notes: See Table 3 for explanations.

Table 5. Sensitivity analysis

	y	y_x	y_n	c	i	nx
Volatility (%)						
Benchmark	12.10	17.06	10.45	9.48	16.77	4.27
Only A_x and A_n drive the economy	7.20	11.27	5.49	5.41	8.18	1.24
Only p_x drives the economy	9.57	13.26	7.60	7.49	9.01	1.93
Volatility of A_x and A_n rise by 20%	13.01	18.50	11.14	10.17	17.42	4.35
Persistence of A_x and A_n rise by 20%	12.25	16.88	10.62	9.69	17.26	4.23
Volatility of p_x rises by 20%	13.65	19.10	11.63	10.72	17.79	4.45
Persistence of p_x rises by 20%	12.61	16.15	11.75	10.95	17.17	4.50
Volatility of r rises by 20%	12.10	17.14	10.47	9.50	18.63	4.88
Persistence of r rises by 20%	12.14	17.20	10.52	9.55	17.78	5.09
η_x rises by 20%	12.13	17.12	10.46	9.49	17.42	4.33
η_n rises by 20%	12.09	17.10	10.42	9.45	17.40	4.39
nx/y = -1.2%	12.10	17.06	10.45	9.48	16.77	4.27
nx/y = -33.7%	12.10	17.06	10.45	9.48	16.77	4.27
σ rises by 20%	12.33	16.67	11.14	10.17	16.66	4.22
$1/\gamma$ = 1.07	11.84	18.44	9.08	8.15	19.51	4.78
$1/\gamma$ = 0.5	12.71	18.02	10.83	8.83	21.52	5.34
Φ = 0.001	11.94	19.40	9.93	8.79	31.58	11.35
b_x rises by 20%	12.06	17.13	10.33	9.44	16.78	4.25
b_m rises by 20%	12.09	17.09	10.40	9.47	16.76	4.26
z = 1	11.38	16.15	9.85	8.92	15.75	4.03
z = 2	12.50	17.51	10.83	9.85	17.58	4.55
l_{yn} = 0	10.29	21.71	5.75	5.97	42.96	3.87

One-year forecast horizon (variance decomposition of output (y), %)

	Productivity shocks			World price shocks			Policy shock
	A_x	A_n	*Total*	P_x	r	*Total*	G_n
Benchmark	37.59	0.10	37.69	61.28	0.00	61.28	1.03
Only A_x and A_n drive the economy	99.74	0.26	100	0.00	0.00	0.00	0.00
Only p_x drives the economy	0.00	0.00	0.00	100.00	0.00	100.00	0.00
Volatility of A_x and A_n rise by 20%	46.43	0.12	46.55	52.56	0.00	52.56	0.88
Persistence of A_x and A_n rise by 20%	38.57	0.02	38.59	60.39	0.00	60.39	1.01
Volatility of p_x rises by 20%	29.61	0.08	29.69	69.50	0.00	69.50	0.81
Persistence of p_x rises by 20%	34.60	0.09	34.69	64.36	0.00	64.36	0.95
Volatility of r rises by 20%	37.59	0.10	37.69	61.28	0.00	61.28	1.03
Persistence of r rises by 20%	37.57	0.10	37.67	61.24	0.06	61.30	1.03
η_x rises by 20%	37.59	0.10	37.69	61.28	0.00	61.28	1.03
η_n rises by 20%	37.59	0.10	37.69	61.28	0.00	61.28	1.03
nx/y = -1.2%	37.59	0.10	37.69	61.28	0.00	61.28	1.03
nx/y = -33.7%	37.59	0.10	37.69	61.28	0.00	61.28	1.03
σ rises by 20%	37.57	0.15	37.72	61.11	0.00	61.11	1.17
$1/\gamma$ = 1.07	37.37	0.04	37.41	61.69	0.01	61.70	0.89
$1/\gamma$ = 0.5	39.39	0.23	39.62	59.14	0.03	59.17	1.22
Φ = 0.001	37.36	0.14	37.50	60.47	0.55	61.02	1.47
b_x rises by 20%	37.38	0.09	37.47	61.53	0.00	61.53	1.00
b_m rises by 20%	37.60	0.10	37.70	61.28	0.00	61.28	1.02
z = 1	37.37	0.16	37.53	61.13	0.00	61.13	1.34
z = 2	37.60	0.08	37.68	61.42	0.00	61.42	0.90
l_{yn} = 0	27.63	0.60	28.23	71.62	0.01	71.63	0.13

Notes: See Table 3 for explanations.

Figure 1. Impulse responses to 1% increase in productivity shock

(Exportable goods sector, A_x)

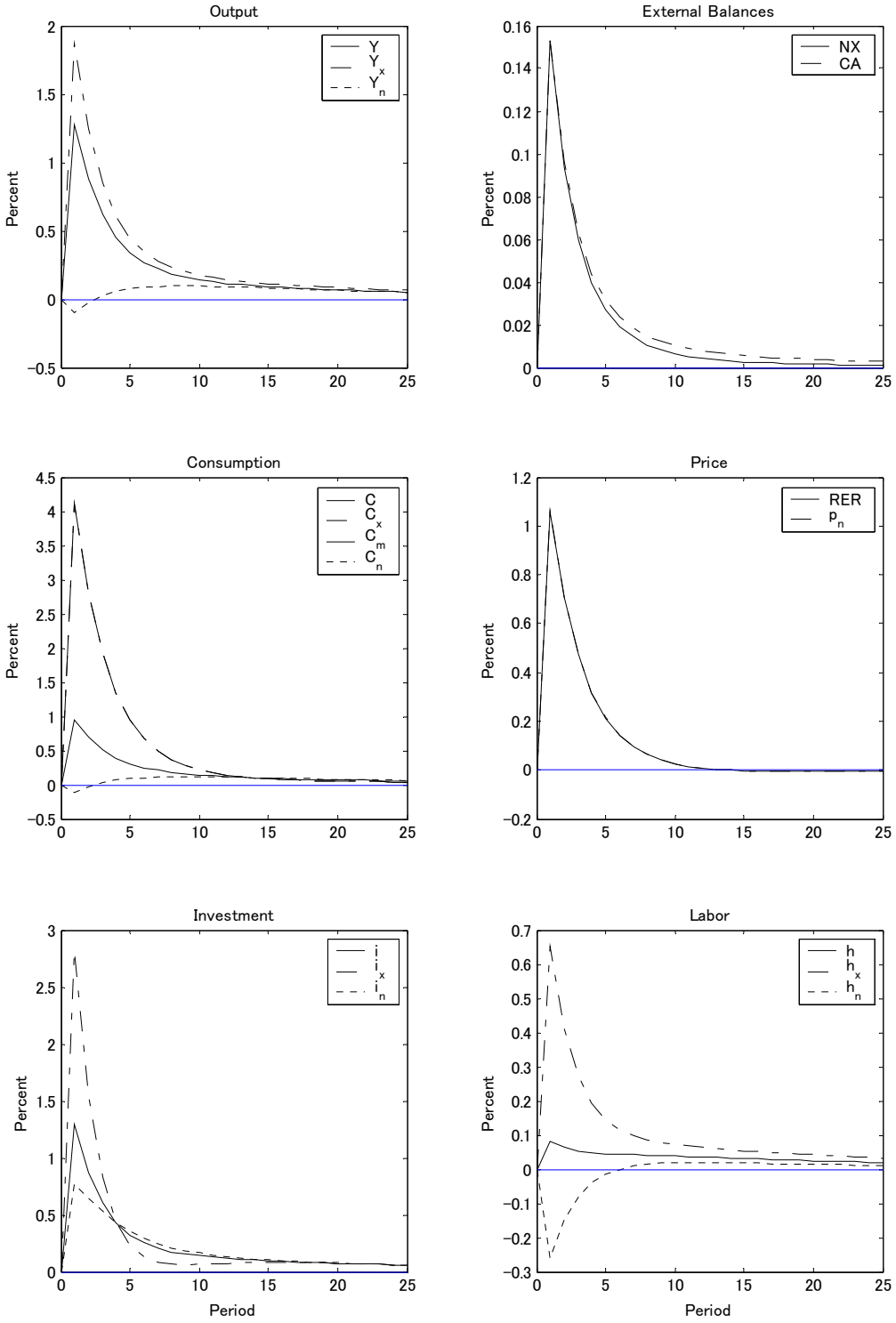

Figure 2. Impulse responses to 1% increase in productivity shock

(Nontraded goods sector, A_n)

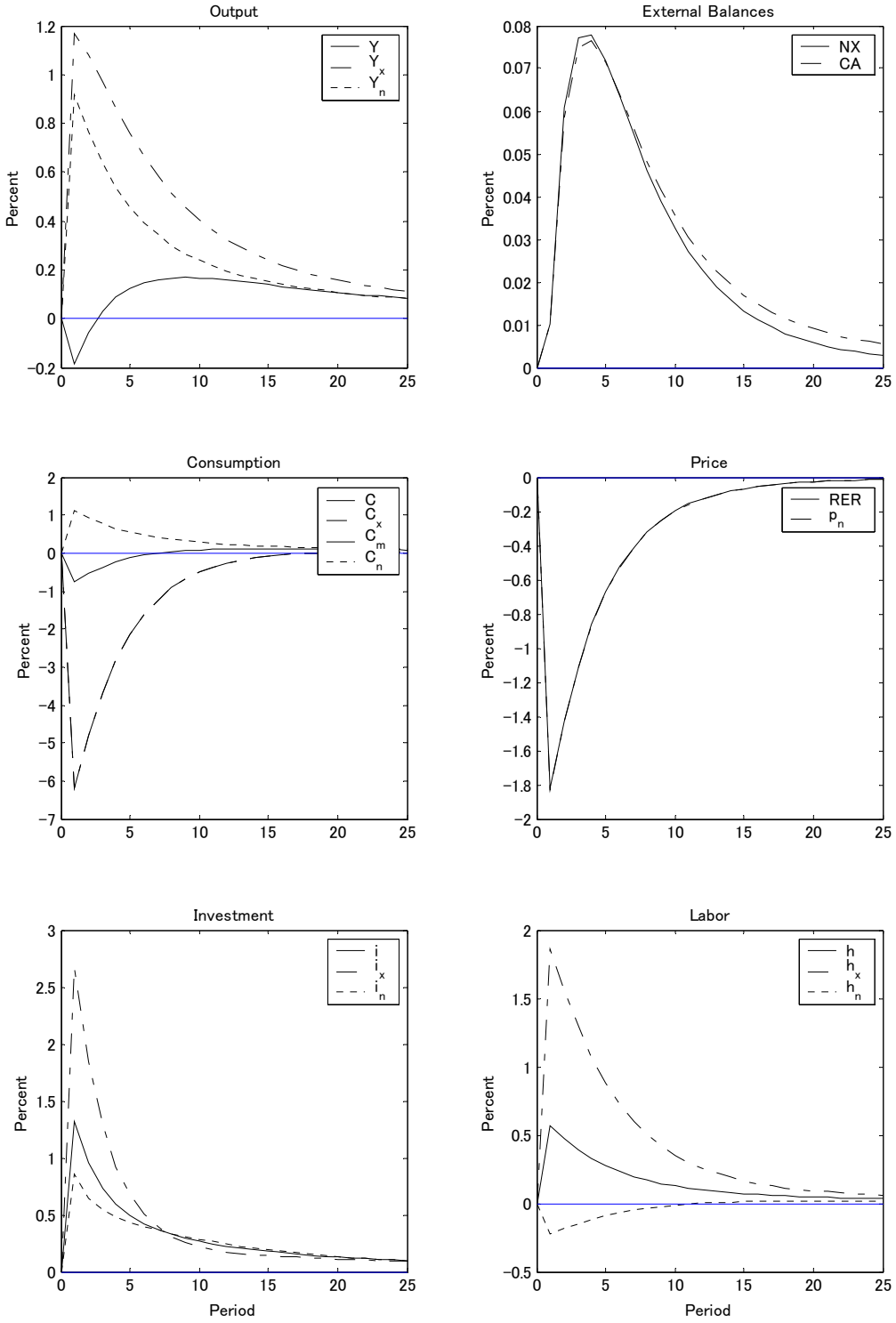

Figure 3. Impulse responses to 1% increase in productivity shock

(Exportable and Nontraded goods sectors, A_x and A_n)

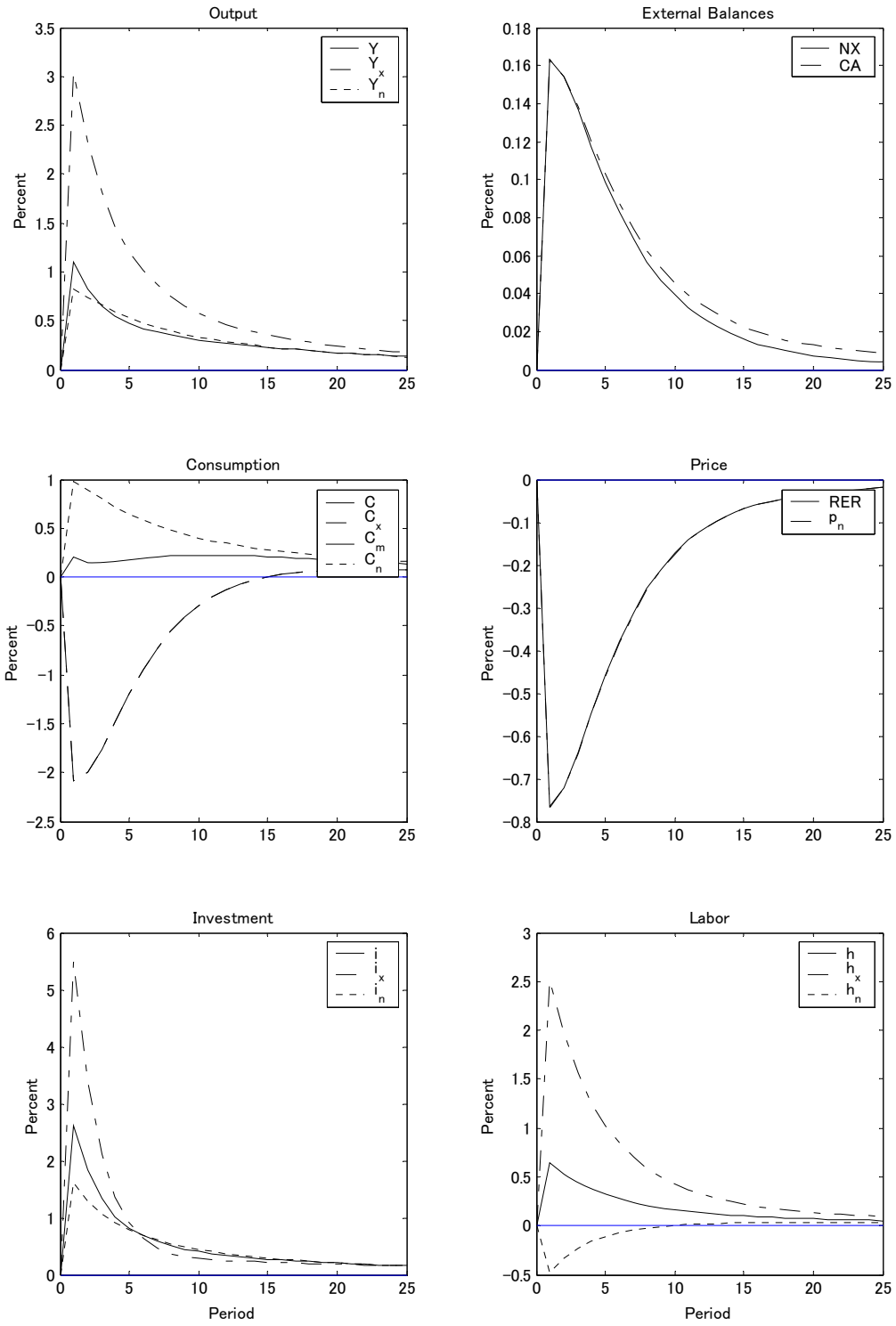

Figure 4. Impulse responses to 1% increase in the terms of trade (P_x)

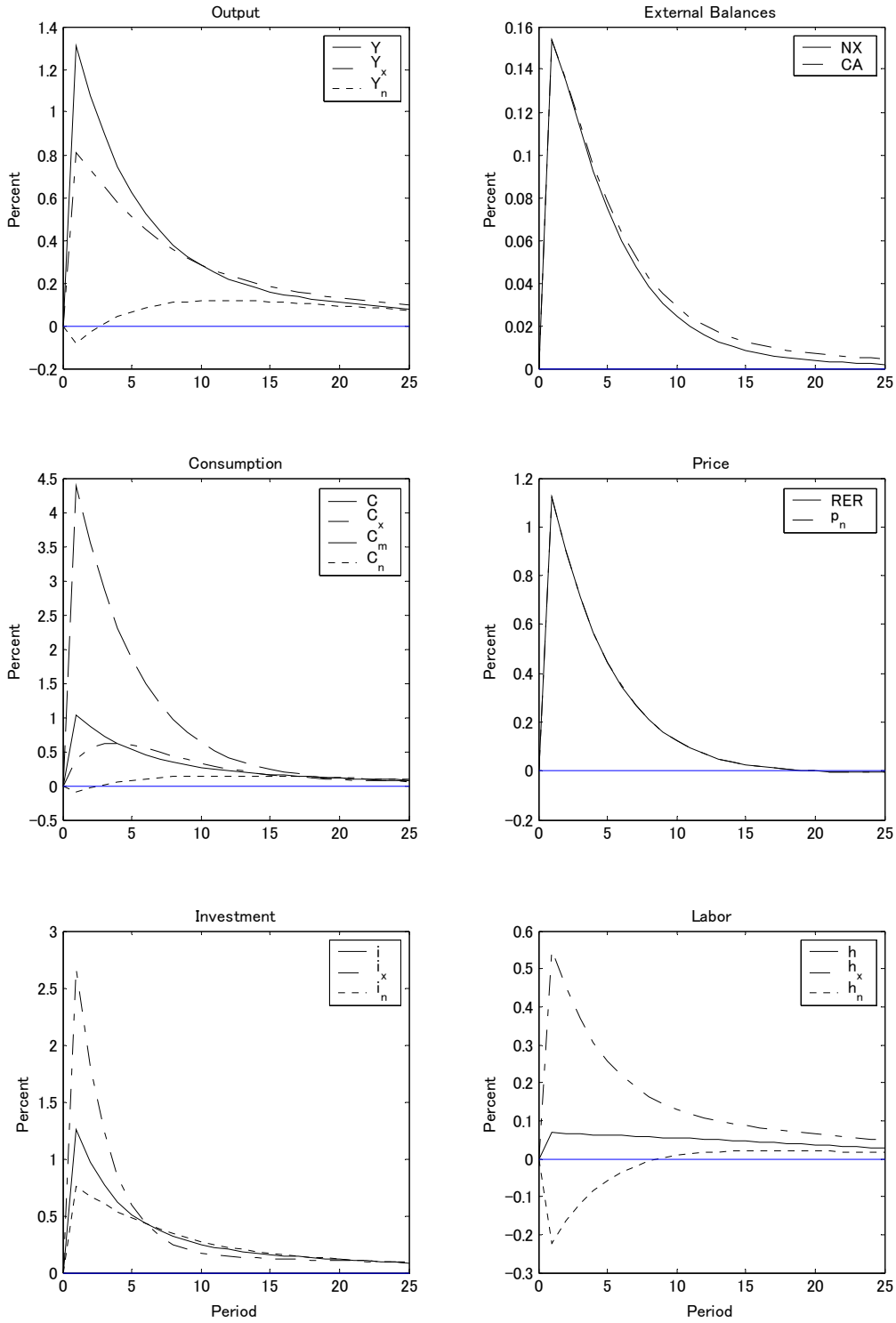

Figure 5. Impulse responses to 0.25% increase in world interest rate (r)