Prospects for Arab Monetary Policy
in the International Financial System

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Abstract

The monetary/exchange rate policy nexus is in transition in many developing countries. Some of these countries, while recognizing the need for more realistic monetary policy management and related structural reforms, have maintained a fixed exchange rate system; some have adopted explicit inflation targeting frameworks as the nominal anchor for their macro-economic regimes; others are still looking for alternative approaches to the nominal anchor challenge in the context of managed floats.

While domestic considerations have played an important role in shaping these transitions, external factors have also been influential in determining the pace, smoothness, and timing of the transitions. As a result, policy management has been called upon to strike that delicate balance among sometimes conflicting domestic and external considerations that, at times, have also been impacted by the vagaries of market technicals.

In this context, the paper seeks to analyze recent developments in, and the outlook for monetary policy in select Arab economies. Specifically, after outlines of the prevailing emerging market context and the basic theoretical literature, the paper examines the main determinants of monetary policy in Arab countries in recent years, including the specification of instruments and the growing (albeit still relatively limited) influence of external and technical factors. The paper then discusses some of the medium-term policy issues facing Arab economies, detailing upside and downside risks.

Through an econometric analysis, the paper argues that, contrary to widespread perceptions, the management of the exchange/monetary policy nexus has incorporated in several countries systematic “rules” of the Taylor variety. The impact has been notable across countries in terms of inflation reduction; though trade-offs—and, consequently, the level and distribution of costs—have varied among countries reflecting varied domestic considerations. Looking forward, these systematic regimes can provide the basis for policy adaptations that would enable the exchange/monetary policy nexus to play an effective role in these countries’ stated objective to sustain high and well balanced economic growth.

ملخص

تمر سلسلة الربط بين السياسة النقدية وسياسة سعر الصرف فى الوقت الراهن بمرحلة تحول فى كثير من الدول النامية. فبينما تعترف بعض الدول بالحاجة إلى إدارة أكثر واقعية للسياسة النقدية وما يرتبط بها من إصلاحات هيكلية، إلا أنها حافظت على نظام سعر صرف ثابت. كما نجد أن بعض الدول إتبعت أسلوب تحديد أهداف للتضخم فى أطر واضحة مثل جعل سعر الصرف مرتكز إسمى لدعم السياسات الاقتصادية الكلية المتبعة. هذا بينما لا يزال البعض الآخر يبحث عن أنماط بديلة للمرتكز الإسمى فى إطار ما يعرف بالتعويم المدار (Managed Floats).

وبينما لعبت الأوضاع والإعتبارات الداخلية دوراً مهماً فى تشكيل هذه التحولات، كان للعوامل الخارجية تأثيرها أيضاً فى تحديد سرعة التحول ويسره وتوقيته. ونتيجة لذلك، تطلب الأمر أن يراعى فى إدارة السياسات التوازن الدقيق بين الإعتبارات المحلية والخارجية خاصة وأنها قد تكون متعارضة فى بعض الأحيان، ذلك التوازن الذى يتأثر أ حياناً بأمور فنية خاصة بالسوق.

وتتناول هذه الورقة تحليل التطورات الحديثة فى هذا المضمار، كما تبحث مستقبل السياسة النقدية فى إقتصادات عربية مختارة. وبوجه خاص، وبعد عرض مختصر للأطر الحالية فى الدول ذات الأسواق الصاعدة، وإستعراض الأدبيات النظرية الرئيسية، تفحص الورقة المحددات الأساسية للسياسة النقدية فى الدول العربية فى السنوات الأخيرة بما فى ذلك تحديد الأدوات ونمو تأثير العوامل الخارجية والفنية ولو أنه مازال محدود نسبياً. وتناقش الورقة بعد ذلك بعض القضايا فى السياسة النقدية والتى تواجه الاقتصادات العربية من منظور الأجل المتوسط، مع إيضاح المزايا والعيوب تفصيلاً.

ومن خلال التحليل القياسى، تنتهى الورقة إلى أنه، على العكس مما هو معتقد فيه بشكل واسع، تضمنت إدارة الربط بين السياسة النقدية وسعر الصرف فى الكثير من الدول قواعد نمطية من نوع قاعدة تايلور (Taylor Rule). وقد لوحظ هذا الوقع فى كافة الدول فيما يتعلق بتخفيض التضخم، رغم أن ذلك يعنى الإستغناء عن هدف آخر، وبالتالى إختلف مستوى وتوزيع التكلفة فيما بين الدول عاكساً فى ذلك الإختلافات فى الإعتبارات المحلية. وبالنظر إلى الإمام، نستطيع القول أن هذه النظم النمطية يمكنها توفير الأساس لتطويع السياسة بحيث تساعد على أن تلعب عملية الربط بين السياسة النقدية وسياسة سعر الصرف دوراً فعالاً فى وضع الأهداف فى هذه الدول بما يضمن مستوى مرتفع ومتوازن للنمو الاقتصادى.

I. Introduction

Developing countries as a group have gone through a roller-coaster experience in the last five years. Specifically, the recovery from the 1994/95 Mexican peso crisis was derailed in the second half of 1997 by a financial crisis that started in emerging East Asia, spread to Russia in the summer of 1998, and culminated in the disorderly Brazilian currency devaluation of January 1999. Since that time, most developing countries have regained their footing as the beneficial impact of improved domestic policies has been compounded by more favorable external demand and price conditions.

This roller-coaster ride has resulted in significant, and some would say permanent, changes in policy regimes around the developing world – some out of choice; others forced by the market in a rather disruptive fashion. These changes have impacted not only domestic policy variables but also the design of the international financial architecture (particularly, aspects related to "crisis prevention" and "crisis resolution" as pertaining to emerging economies).

The most visible changes in domestic policy regimes have been in the monetary/exchange rate policy nexus. In the context of the 1997-99 emerging market crisis, several economies abandoned their fixed exchange rate regimes (including Brazil, Colombia, Chile, Korea, and Thailand). Rather than relying solely on monetary aggregates as nominal anchors, some of these economies subsequently migrated to various styles of inflation-targeting regimes. They were joined in this process by countries that had previously adopted floating rate regimes (such as Mexico and Poland) and were still looking for effective nominal anchors. A third group of countries reinforced their commitment to fixed exchange rate regimes, with some either adopting or considering the possibility of outright dollarization (e.g., Argentina, Ecuador and El Salvador). For all these countries, there has been a related need to implement supportive fiscal policy stances and to strengthen the institutional basis of policies (including greater operational independence for central banks, greater coordination with fiscal agencies, improved regulatory and supervisory regimes, more transparent management, and better information dissemination).

Partly reflecting their lower exposure to the vagaries (positive and negative) of international capital movements, it appears on the surface that Arab economies have been less active in adapting their policy regimes. Thus, there has thankfully been no dramatic case of an exchange rate crisis; nor have we seen the explicit implementation of inflation-targeting frameworks or a flirtation with currency board regimes. However, behind the scenes, there have been some notable changes in the conduct of monetary policy and related structural aspects. Moreover, deliberation is increasing as to the outlook for macro policies in the context of stepped up *de jure* and *de facto* convergence with the international economic system.

The purpose of this paper is to shed light both on past adaptations to Arab monetary policy regimes and on the medium-term outlook. To this end, Section II reviews some of the key recent changes in the operational approach to monetary policy in emerging economies. This is followed in Section III by an overview of the theoretical and empirical literature on the costs and benefits of alternative regimes. These two sections provide the basis for Section IV's empirical study of a backward looking analysis of the determinants of monetary policy in Arab economies. Section V looks forward, identifying the key factors that will influence the effectiveness of Arab economies in the immediate period ahead. The paper's concluding remarks are contained in Section VI.

The main messages of the paper are fourfold.

- First, adaptations of monetary policy —direct or through changes in related macro and structural elements— are an inevitable consequence of the truly historic changes being experienced by the international economic and financial system.

- Second, there is no single monetary policy/exchange rate regime that is appropriate for all countries; nor is there one that ex-ante is advisable for a single country at all times.

- Third, while less visible and dramatic as compared to most other developing regions, several Arab economies have also been adapting the conduct of their monetary policy regimes, with some adhering to a *de facto* Taylor rule while others have fluctuated among different rules.

- Finally, such adaptation will need to be stepped up —supported by domestic structural reforms and made more responsive to international financial developments– – if the monetary/exchange rate policy nexus is to play its needed role in meeting governments' objectives of sustaining high and more balanced economic growth**.**

II. The Roller Coaster of Emerging Markets: Implications for the Monetary/Exchange Rate Policy Nexus

By any measure, the last few years have been truly remarkable for emerging economies. Widespread admiration of the “Asian economic miracle” and, more generally, of the exuberant outlook for emerging economies was replaced in 1997 and especially 1998 by an extremely negative sentiment. Indeed, there were not only concerns about a recurrence of the 1980's “debt crisis” and the related “lost decade” in which growth stagnated and poverty increased in many parts of the emerging world; but also worries that the international financial system was undergoing long-term structural damage.

This generalized gloom and doom was subsequently replaced by excitement that, in the context of improved domestic policies, favorable external developments led by historic U.S. “new era” growth were sufficient to allow for a sustained recovery in the emerging world’s economic growth while continuing to reduce domestic and external financial imbalances. This excitement spread as elements of the U.S. economic transformation spread to other industrial countries, fueling talk of a “global goldilocks” scenario characterized by the combination of high GDP growth and low inflation – all made possible by three factors: a massive IT-related favorable technological productivity shock; confidence that the main policy makers (led by the U.S. Federal Reserve) have the instruments and ability to counter inflationary pressures and “soft land” economies as needed; and massive availability of private funding, some of which share greater similarities with “lotteries” than traditional corporate finance.

In recent months, this exuberance has been tempered by concerns about the systemic impact of two price overshoots: first, international oil prices; and second, the sharp depreciation of the euro. The combination of these two overshoots, and the limited impact of the late-September G-7 currency/oil interventions, have raised concerns regarding the growth and inflation outlook for the global economy (especially the U.S.). Indeed, some advocates of the “global goldilocks” scenarios are now looking more seriously as to the possibility of “stagflation.”

Many summary pictures can be used to illustrate this remarkable roller coaster voyage. Our favorite one relates to developments in the average borrowing costs for emerging economies —a proxy for market comfort with the economic and financial outlook for these countries. As detailed in Figure 1, the average spread over U.S. treasuries for highly traded emerging market debt (EMBI+ adjusted for Russian restructuring) rose dramatically from a low of 473 basis points in mid 1998 to a high of 1,524 basis points in September 1998. The subsequent recovery was interrupted repeatedly during the periods November 1998 - March 1999, May—August 1999, and again in the spring of 2000. As of end-September 2000, the spread had stabilized for four months, ending the period at 675 basis points but widened thereafter as concerns re-surfaced regarding the growth and inflation outlook for the global economy.

Figure 1. Spread of J.P. Morgan's Emerging Market Bond Index Plus* (EMBI+) over U.S. Treasuries (weekly)

Note: *adjusted for Russian restructuring.

These fluctuations have reflected both internal and external factors. This is particularly the case for the periods of sharp and sudden movements in spreads. On the internal front, the main events have included the Asian financial crisis (December 1997), the Russian default (August 1998), the forced Brazilian devaluation (January 1999) and, on the more positive front, the Moody's upgrading of Mexico to investment grade (March 2000) and Brazil's march towards its upgrade (summer of 2000). On the external front, major events have included the U.S. Fed's signaling of an interest rate hiking cycle

(May 1999), increased market comfort with a successful "soft landing" of the U.S. economy (early summer of 2000), and subsequent concerns about the adverse global implications of the surge in oil prices and the debacle of the euro (September 2000).

Given the extent of the fluctuations in internal and external variables, it is not surprising that there have been significant adaptations —real and perceived— to the monetary/exchange rate policy nexus. The most visible and dramatic has been the forced abandonment of a fixed exchange rate regime in the context of massive losses in international reserves (e.g., Brazil, Korea, and Thailand). The subsequent stabilization of the newly-floating exchange rate inevitably required aggressive interest rate hikes which, in some countries, aggravated the fragility of the banking system. Such aggressive policies were also implemented by countries that already had floating regimes (e.g., Mexico), as they tried to minimize adverse contagion risk. Indeed, if we had to characterize an overall trend in emerging economies, this would consist of three elements: (a) a more generalized use of floating exchange rate regimes as shock absorbers in a fluid international environment; (b) a concurrent tightening of fiscal policy; and (c) more cautious debt management (for a more detailed discussion, see Mussa et al (2000); and Mussa (2000)).

Not all emerging economies followed this trend. Some remained passive, using a combination of international reserves, borrowing and moral suasion as the main shock absorbers. Other countries re-affirmed their market-based commitment to fixed rate regimes that, in some cases, required tolerance of significant deflationary/recessionary conditions (e.g., Argentina and Hong Kong). A third group resorted to *de facto* and *de jure* quantitative restrictions (e.g., Malaysia).

As the immediate crisis conditions receded, many policy makers have moved to reinforce policy regimes in order to better withstand future shocks and, thereby, be more effective in sustaining high economic growth. At the global level, this has involved actual and planned adaptations to modalities governing "crisis prevention" and "crisis resolution." At the national level, this has involved explicit restrictions on less cautious fiscal management (including "fiscal responsibility laws"), deeper structural reforms (including a deepening and widening of domestic financial markets and greater central bank independence), imparting greater instrument independence to monetary authorities, improved asset and liability management, and stepped-up investor relation efforts.

Where do Arab economies fit into all this? The conventional wisdom is that Arab economies adapted very little as, simply put, there was no need to do more. After all, their links with the international monetary system —the main channel for transmission of the above-cited changed in sentiment— were limited. As a result, negative contagion was not much of a concern, thereby allowing policy makers to focus just on domestic issues.

This conventional wisdom, while understandable, is too partial. Indeed, it may be misleading. There have been some important changes in the conduct of policies, especially pertaining to the interaction of the domestic financial system with the real economy. Moreover, the domestic financial systems have become increasingly sensitive to external developments, as reflected in greater strategic partnership at the level of the firm and, in some cases, international speculation directly impacting domestic exchange rate regimes.

As argued elsewhere, the changes have appeared small when viewed in isolation. But, when considered as a group, they constitute a relatively large step forward—not a critical mass as yet, but an important progress nevertheless. Depending on which country we look at in the Arab region, changes have included modernizing regulatory and supervisory regimes; improving market infrastructure (particularly in the area of payments and settlement, information dissemination, and accounting practices); admission to various international financial indices; gradual relaxation of restrictions on foreign participation; and somewhat greater autonomy for central banks (for details, see El-Erian (2000)).

These are by far the most visible changes in policy regimes. The distributional relevance of their impact is over the medium-term, with rather thin short- and long-term tails. Moreover, they often constitute necessary though not sufficient measures to improve in a sustained manner the operation of the exchange/monetary policy nexus. For this reason, and as detailed econometrically below, it is important to analyze *de facto* adaptation to the way in which monetary policy has been conducted around the Arab worlds. For some countries, the outcome seemingly has been adherence to Taylor rule modalities. For others, it has involved shifts in underlying objective functions. For the rest, monetary policy is still held hostage to dated economic management ideas.

To provide the theoretical framework for discussing these changes, the next section contains a brief literature survey regarding the main elements of alternative monetary/exchange rate policy regimes.

III. Monetary/Exchange Rate Policies: What are the Options?

Economists agree that high inflation levels are disruptive for sustained economic growth (c.f. Andersen and Gruen (1995) for a survey of early results). Moreover, the effect of inflation on growth is economically substantial. For instance, Fischer (1993) estimated that every extra percentage point of inflation reduces the growth rate of an economy by one tenth of a percentage point, on average. This realization placed monetary and exchange rate policies center-stage in the battle against inflation and, by implications, in the ability of countries to sustain high and balanced economic growth.

In many, if not most instances, the conduct of an effective monetary policy requires establishing a nominal anchor to avoid “inflation scares” (c.f. Goodfriend (1993)), whereby inflationary expectations can become self-fulfilling. In the absence of a nominal anchor, the public may expect inflation to rise to undesirable levels. In such cases, the authorities will be faced with a choice of accommodating those expectations, and possibly igniting an inflationary spiral, or using tight monetary policy that may lead the economy into a recession. Thus, nominal anchors are desirable to stabilize inflationary expectations, and allow monetary policy to play a proactive macroeconomic role. In this regard, the best types of nominal anchors are those that are most transparent and best understood by the public whose inflationary expectations are to be “anchored”.

Fixed Nominal Exchange Rates

The most obvious nominal anchor that satisfies the above requirements of visibility and ease of understanding by the public is a fixed exchange rate policy. However, as shown by Frenkel (1983), a fixed exchange rate policy does not provide the promised monetary policy effectiveness in the face of increasingly mobile capital. For instance, an expansionary monetary policy in the presence of fixed exchange rates and high capital mobility would result in capital outflows and loss of international reserves. The expectation of continued depletion of international reserves thus undermines the role of fixed exchange rates as a nominal anchor, since the public would expect the government to abandon the policy at some future time.

In the presence of uncertainty about the rate at which the government creates credit, Flood and Garber (1984) and Obstfeld (1986) generalized the “speculative attacks” model of Krugman (1979) to show that a fixed exchange rate regime is destined to collapse at some unknown time. While constraints on capital mobility and other government policies can change the expected timing of such inevitable speculative attacks (c.f. Blackburn and Sola (1993) for the related literature), the fact remains that a *de facto* or *de jure* fixed exchange rate can only serve as a temporary nominal anchor. This view gained further momentum once the European Monetary System’s fixed exchange rates were altered during the early 1990s.

Inflation Targeting

As the practice of using fixed exchange rates as nominal anchors was increasingly abandoned during the 1990s, many countries shifted to “inflation targeting” policies. The process started essentially in industrial countries and is now spreading among developing economies. However, research to-date (c.f. Masson et al. (1997), Eichengreen et al. (1999) suggests that most developing countries lack the “pre-requisites” for implementing inflation targeting mechanisms.

Like fixed nominal exchange rates, inflation-targeting rules provide a commitment mechanism for long-term price stability, thus anchoring the public’s inflation expectations. The most rigid form of inflation targeting policy requires: (i) public announcement of the inflation target; (ii) definition of the variance of actual inflation around that target as the Central Bank’s objective function; and (iii) following a monetary policy “rule” to minimize that variance. More commonly, the central bank’s objective function is constructed to minimize a combination of the variance of inflation around its target, and the variance of output around its potential. Solving the minimization problem, a central bank can thus derive a monetary policy rule for interest rates as a function of the inflation rate and output. Such automated rules (usually setting real interest rates as a linear function of the inflation rate and the output gap – the difference between actual and potential log output) came to be known as Taylor rules, after the empirical discovery of such *de facto* rules in Taylor (1993).

In practice, Bernanke et al. (1999) argued based on their case studies that inflation targeting is better viewed as a policy framework rather than a rigid automated "rule." Thus, just as we may observe countries following *de facto* fixed exchange regimes (as was the case for the Arab countries we consider in this paper), it is also possible to observe them following a *de facto* inflation-targeting framework or unofficial rules. The degree of discipline imposed by a strict inflation targeting rule is analogous to that imposed by a strict fixed exchange rate policy (e.g. through a currency board, or dollarization). However, the discipline and resulting credibility are thus enhanced only through the institutional form that the nominal anchor may take. In the end, whether or not the public finds any particular institutional framework credible and then adjusts their inflationary expectations accordingly is a practical issue that varies from one country to another and from one time to another.

Some central banks —such as the European Central Bank (ECB) and that in Brazil— have opted for an explicit inflation target. Others, led by the U.S. Federal Reserve Bank, have not publicly committed to a specific target but, instead, made it widely understood that such a target exists in the internal corridors and, particularly, in the meetings of the FOMC (Federal Open Market Committee). This second approach has the advantage of accommodating more easily the impact of productivity shocks and other structural breaks. Indeed, the lack of an explicit inflation target has often been cited as one of the reasons why Chairman Greenspan was able to accommodate so skillfully the U.S. new era surge. Realistically, though, the implicit approach only works in cases where the monetary authority has already established its credibility – something that was lacking for the newly created ECB and for central banks in emerging economies.

Small Open Economies

The recent literature on inflation targeting (c.f. Ball (1999), Svensson (2000), and the references therein) stresses the sub-optimality of using simple Taylor rules (that ignore the effect of the real exchange rate on inflation) in small open economies. This result follows from the fact that "shocks originating in the rest of the world are important, and …the [real] exchange rate plays a prominent role in the transmission mechanism of monetary policy" (Svensson (2000), p.157). In this regard, real exchange rate movements contribute directly to domestic inflation (through the price of imports), as well as indirectly through the traditional aggregate demand and inflation expectation channels of monetary policy transmission.

Thus, ignoring or underestimating the importance of real exchange rate movements in setting real interest rates can have adverse consequences. For instance, Frenkel (1983, p.52) argued that a combination of high interest rates and an appreciating currency may indicate an increased demand for money and thus require an expansionary monetary stance. However, simple Taylor rules that do not allow real exchange rates to influence monetary policy may not accommodate such discretion. In turn, this may result in a monetary crunch and the possibility of a recession. In a calibration exercise, Ball (1999) showed that for a given level of inflation variability, the standard deviation of output (around its potential) can be reduced by 17 percentage points if a simple Taylor rule is augmented to include real exchange rates.

While we are considering the monetary/exchange rate nexus as a whole, we are mainly concerned with the monetary policy aspect. As we shall see in the following section, empirical evidence strongly suggests that most of the Arab countries under consideration *de facto* set both real exchange rates and real interest rates in an inflation-targeting manner. In those countries, we shall find that concentrating both policies on stabilizing prices has adversely affected their growth profiles. Moreover, the exchange rate profiles uncovered below have resulted in real exchange rate misalignment for some of those countries, with further adverse effects on growth (c.f. Domac and Shabsigh (1999), and Mongardini (1998)). Given the numerous difficulties with defining an appropriate measure of exchange rate misalignment (c.f. Hinkle and Montiel (1999, pp.14-27)), full treatment of the exchange rate misalignments in studied countries is beyond the scope of this paper.

IV. The Monetary/Exchange Rate Nexus in the Arab Economies

The majority of Arab economies have adopted fixed exchange rates as the official nominal anchor in their macro-economic policy arsenal. The reasons for this are varied.

They include historical inertia, deliberate policy choices in the context of their key economic characteristics and, in some case, "institutional pessimism."

As discussed in the previous section, the uniform choice of exchange rate regimes should, in theory, imply a certain degree of homogeneity in the conduct of monetary policy. Specifically, monetary policy becomes the most responsive of macro instruments, with fiscal policy providing a consistently supportive backdrop and central banks guided by an inflation objective. In practice, the conduct of monetary policy has varied both between countries and, in some cases, within an individual country over time. Consider, for example, the analysis of a sample of five Arab countries that includes the GCC economies of Kuwait and Saudi Arabia, as well as Egypt, Jordan and Tunisia.

Simple** de facto **Taylor Rules?

In an attempt to analyze in an *ex-post* fashion the modalities that governed policy measures, we first investigate the degree to which these five countries seemingly proxied a *de facto* simple Taylor rule. For this purpose, we specify a simple Taylor rule[1] as a real interest rate rule according to the following equation: $r_t = c + \alpha y_t + \beta \pi_t$, where r_t is the real interest rate in period t, y_t is the contemporaneous output gap (log real output less log potential output)[2], and π_t is the contemporaneous inflation rate. The estimated simple Taylor rules for the five countries are as follows (t-statistics in parentheses).

1. Egypt's Taylor rule: $\hat{r}_t = \underset{(7.69)}{12.05} + \underset{(1.45)}{0.34}\, y_t - \underset{(-8.06)}{0.63}\, \pi_t$, R^2=0.96.

2. Jordan's Taylor rule: $\hat{r}_t = \underset{(25.84)}{8.07} + \underset{(0.68)}{0.04}\, y_t - \underset{(-12.57)}{0.91}\, \pi_t$, R^2=0.97.

3. Kuwait's Taylor rule: $\hat{r}_t = \underset{(25.84)}{7.28} - \underset{(-1.96)}{0.03}\, y_t - \underset{(-12.31)}{1.06}\, \pi_t$, R^2=0.98.

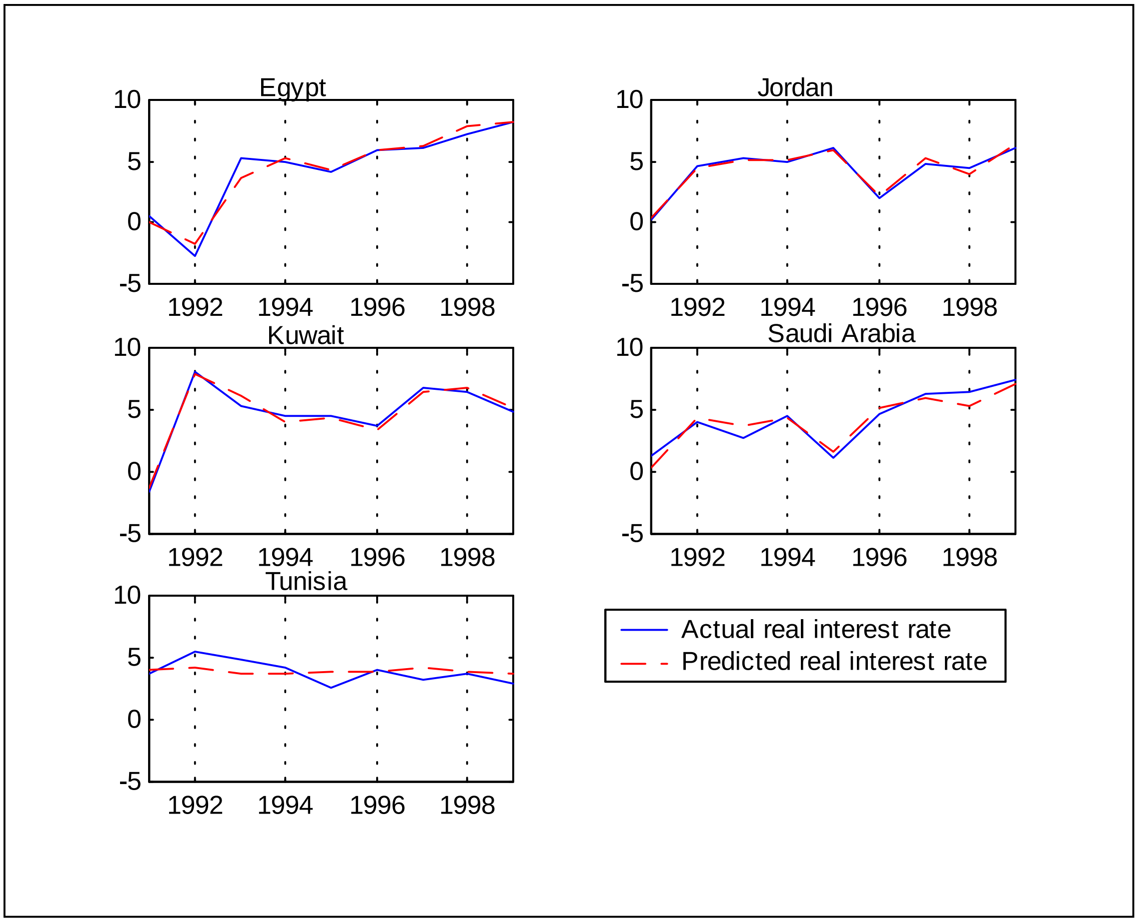
4. Saudi Arabia's Taylor rule: $\hat{r}_t = \underset{(10.80)}{6.62} - \underset{(-2.66)}{0.21}\, y_t - \underset{(-5.07)}{0.72}\, \pi_t$, R^2=0.90.

5. Tunisia's Taylor rule: $\hat{r}_t = \underset{(2.03)}{4.61} - \underset{(-0.45)}{0.16}\, y_t + \underset{(0.12)}{0.03}\, \pi_t$, R^2=0.04.

[1] The original Taylor rule (1993) was specified in terms of nominal interest rates. However, later studies cited above treated the real interest rate as the monetary policy instrument.
[2] Potential GDP is estimated for each country in Appendix B. We use IFS and WEO data throughout.

In what may come as a surprise to some, the results indicate that the first four countries followed *de facto* simple Taylor rules. Moreover, it is interesting to note that the coefficient of the output gap is either insignificant, or has the wrong sign (for Kuwait and Saudi Arabia). As we shall see briefly, the negative coefficient of the output gap for Kuwait and Saudi Arabia will become less significant once we account for the real exchange rate in an extended Taylor rule. Therefore, those anomalous coefficients can be explained as a characteristic of those two oil-exporting economies' output gaps being heavily dependent on their terms of trade as captured by the real exchange rate. However, the inclusion of real exchange rates will not be sufficient to remove the anomalous coefficient sign for Kuwait. This is a consequence of the fact that the output gap for Kuwait is heavily influenced by the country's rebuilding efforts. The results are shown graphically in the following figure:

Figure 2. Observed Real Exchange Rates vs. Predictions Based on Simple Taylor Rules



Structural Model

In order to analyze the monetary policy behavior of our five countries more fully, we postulate a standard small open economy model. The model consists of two equations:

1. Aggregate supply or Phillips curve: $\pi_{t+1} = c_\pi + \alpha\pi_t + \beta y_t - \gamma(e_t - e_{t-1}) + \varepsilon_{t+1}$, and

2. Aggregate demand or IS curve: $y_{t+1} = c_y + \lambda y_t - \phi r_t - \theta e_t + \eta_{t+1}$,

where e_t is log of the real exchange rate, calculated as the log nominal exchange rate in terms of local currency per U.S.$, plus log U.S. CPI, less log domestic CPI. The estimated pairs of equations for the five countries are reported in Appendix A. The model is usually complemented with a third equation stipulating the relationship between the real exchange rate and the real interest rate[3]: $e_t = c_e + \psi r_t + \kappa r_t^* + \xi_t$.

This structural model and variations thereof can be generated from agent-optimization models, as shown in Svensson (2000) and the references therein. The advantage of the Ball (1999) specification is its simplicity and ease of estimation. Given the short time-series considered in this paper (1990s data), the use of forward looking and/or rational expectations models (a la Svensson (2000)) is not feasible.

For the sake of parsimony, we shall maintain the model of Ball (1999), hence obtaining an optimal policy rule (ibid., p.131):

$$wr_t + (1-w)e_t = ay_t + b(\pi_t + \gamma e_{t-1}),$$

where the weight w is determined by the preferences of the monetary authority. Following Taylor (1994), it is assumed that the monetary authorities choose (e_t, r_t) to minimize the objective function $U(\pi_{t+1}, y_{t+1}) = \text{var}(\pi_{t+1}) + \mu\,\text{var}(y_{t+1})$. The resulting policy rule is a small open economy version of the Taylor rule.

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[3] The version in Ball (1999) does not contain the foreign interest rate explicitly (i.e. puts it in the residual term). However, the estimated relationships were insignificant for all countries without that term, and hence we included it in the regressions reported in Appendix A.

Open Economy Taylor Rules

We may now proceed to specify a reduced form of the open economy Taylor rule:

$$r_t = c_r + \alpha y_t + \beta \pi_t + \gamma e_t + \varepsilon_t$$

The estimates of this extended rule for the five countries are as follows:

1. Egypt: $\hat{r}_t = \underset{(0.19)}{1.05} + \underset{(1.07)}{0.21}\, y_t - \underset{(-7.40)}{0.81}\, \pi_t + \underset{(2.00)}{9.69}\, e_t ,$ R^2=0.98.

2. Jordan: $\hat{r}_t = \underset{(1.53)}{5.51} + \underset{(0.94)}{0.06}\, y_t - \underset{(-11.03)}{0.89}\, \pi_t - \underset{(-0.72)}{6.60}\, e_t ,$ R^2=0.98.

3. Kuwait: $\hat{r}_t = \underset{(1.18)}{8.40} - \underset{(-1.65)}{0.04}\, y_t - \underset{(-10.56)}{1.06}\, \pi_t - \underset{(0.16)}{0.92}\, e_t ,$ R^2=0.98.

4. S. Arabia: $\hat{r}_t = -\underset{(-1.11)}{23.39} - \underset{(-0.35)}{0.05}\, y_t - \underset{(-3.41)}{0.57}\, \pi_t + \underset{(1.43)}{21.35}\, e_t ,$ R^2=0.93.

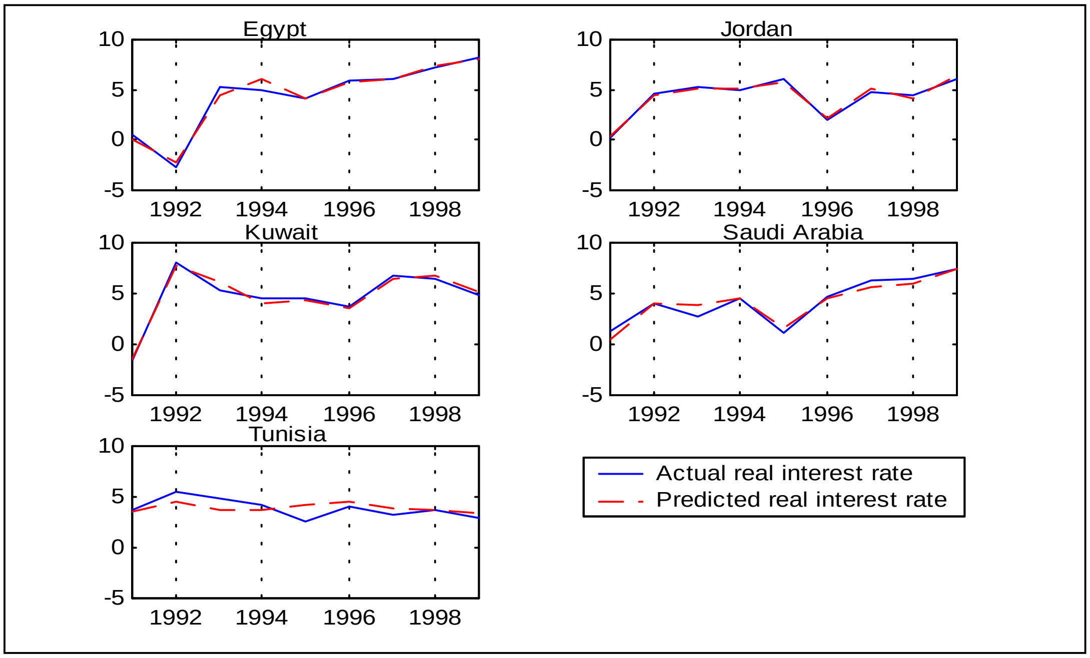
5. Tunisia: $\hat{r}_t = \underset{(2.17)}{5.14} - \underset{(-0.22)}{0.08}\, y_t - \underset{(-0.47)}{0.14}\, \pi_t - \underset{(-0.92)}{6.55}\, e_t ,$ R^2=0.17.

Studying the estimation results for simple and open economy Taylor rules, it seems that:

- Tunisia did not follow either type of rule in our sample.
- Jordan and Kuwait followed a simple Taylor rule, while minimizing the effect of the real exchange rate on domestic economic variables.
- Egypt and Saudi Arabia followed an open economy Taylor rule.

For the latter two economies, the significant positive coefficient for real exchange rates reflects the inflationary effects of a currency-depreciation as discussed in the previous section. With the exception of Kuwait, the coefficients of inflation are greater than –1, reflecting a positive relationship between inflation and *nominal* interest rates, as expected. The results are depicted graphically in the following figure:

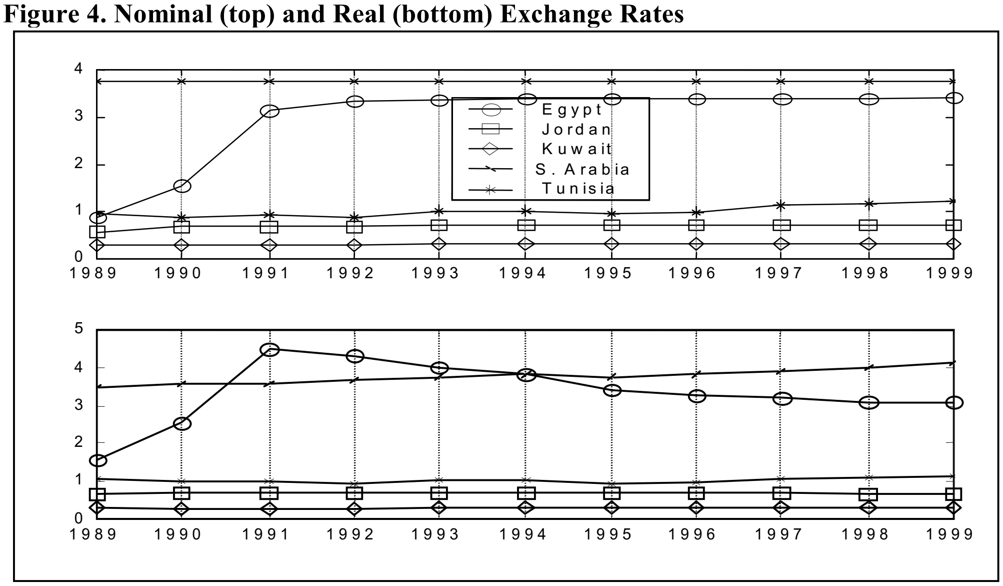
Figure 3. Observed Real Interest Rates vs. Predictions Based on Open Economy Taylor Rules



Exchange Rate Policies and Effective Nominal Anchors

As the following figure shows, all five countries have been following a *de facto* fixed nominal exchange rate vs. the U.S.$. The real exchange rates also seem to have been constant through that period, with the notable exception of Egypt (steadily appreciating after 1991), and Saudi Arabia (steadily depreciating through the 1990s)—though both results are particularly sensitive to the specification of the deflator.

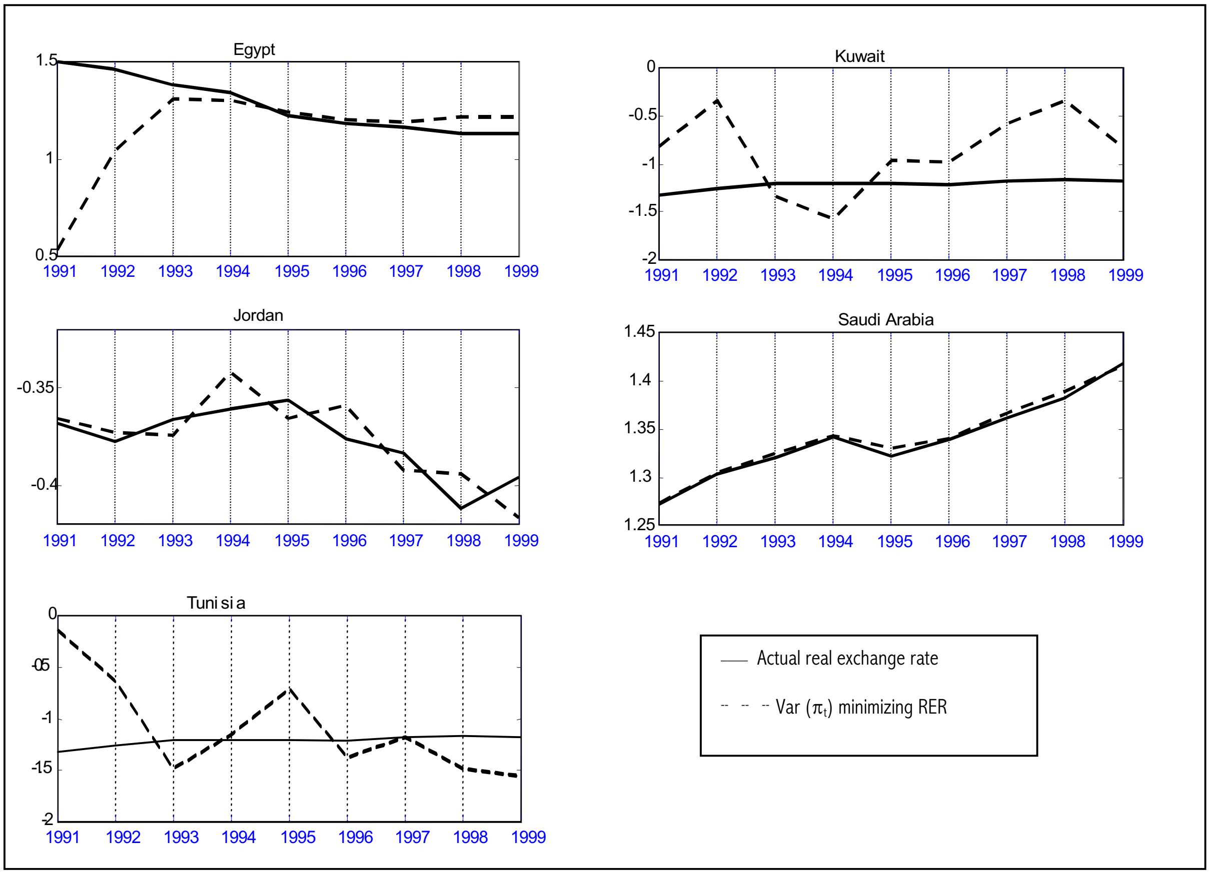
Figure 4. Nominal (top) and Real (bottom) Exchange Rates



We now consider the effectiveness of this fixed nominal exchange rate policy as a nominal anchor. We would say that the policy provides an effective nominal anchor if the resulting real exchange rate minimizes the variance of inflation around a target level. Given the Phillips curve: $\pi_{t+1} = c_\pi + \alpha\pi_t + \beta y_t - \gamma(e_t - e_{t-1}) + \varepsilon_{t+1}$, we can solve for the long-run average inflation level, which we interpret as the inflation target: $\bar{\pi} = \frac{c_\pi}{1-\alpha}$. Therefore, minimizing the variance of next period inflation around that mean would require setting $e_t = e_{t-1} + \frac{\alpha}{\gamma}\pi_t + \frac{\beta}{\gamma}y_t - \frac{\alpha c_\pi}{\gamma(1-\alpha)}$.

The following figure illustrates how well this equation predicts the real exchange rate process for Egypt (esp. after 1993) and Jordan, where the estimated inflation targets are 6.56% and 4.02%, respectively. For Kuwait and Saudi Arabia, the inflation targets inferred from parameter estimates, which are –1.3 and 9.7, respectively, are very unreasonable from an operational perspective (both parameter sets are measured inaccurately in those data). Replacing the estimated asymptote with an exogenous target inflation level, the selected real exchange rate process would be: $e_t = e_{t-1} + \frac{\alpha}{\gamma}\pi_t + \frac{\beta}{\gamma}y_t + \frac{c_\pi - \bar{\pi}}{\gamma}$. If we postulate an inflation target equal to the unconditional average of inflation in those periods, which is 3.09 for Kuwait, and 1.2 for Saudi Arabia, we get excellent fits once again between the inflation-variance minimizing real exchange rate and the observed level. Finally, for the case of Tunisia, we have seen that our estimates are rather poor (perhaps due to using the wrong currency for the real exchange rate). For completeness, we report the same graph, using the estimated long-term inflation target of 6.48.

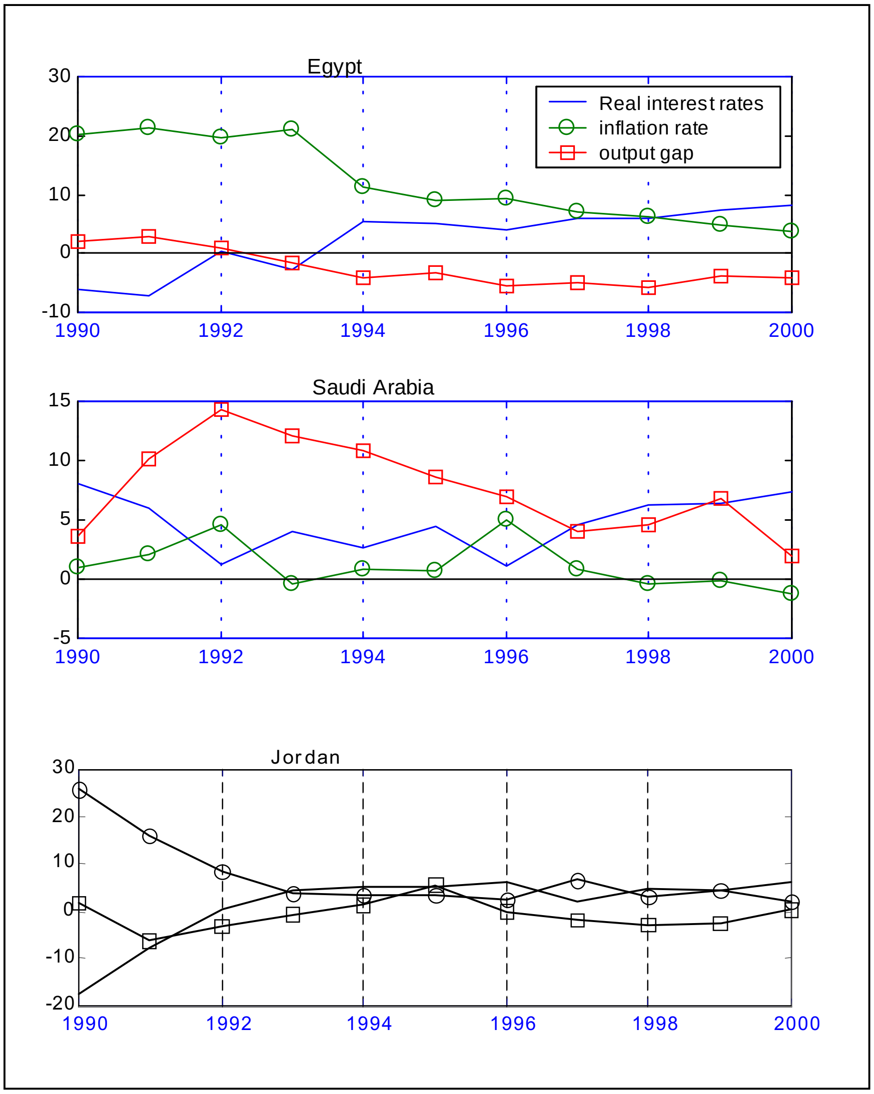
Figure 5. Log Real Exchange Rates vs. Inflation-Variance Minimizing Prediction



Uncovering Policy Profiles

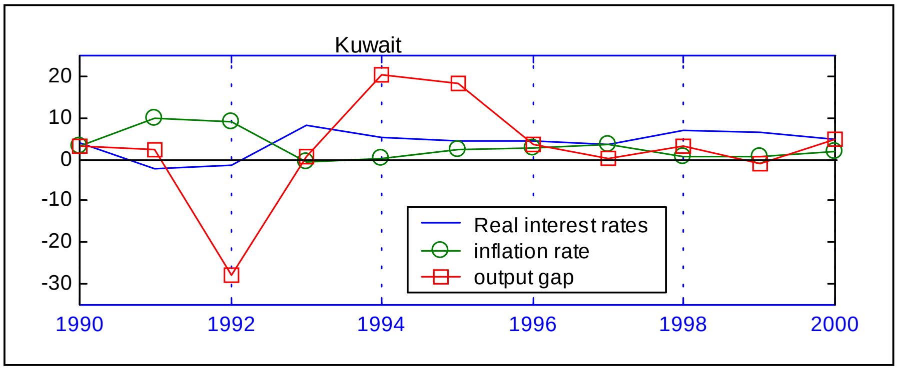
Those results suggest that Egypt, Jordan, and Saudi Arabia, followed *de facto* Taylor real interest rate rules, and also ended up with real exchange rates that essentially minimized the variation of inflation around the target level (with a lag in the case of Jordan). Moreover, since the output gap coefficients were insignificant for those countries, it appears that they were *de facto* using both the exchange rate policy and the interest rate policy as inflation targeting tools. As shown in the following figure, this two-sided (fixed nominal exchange rate, rising real interest rates) strategy has resulted in controlled inflation, at the expense of slower output growth (declining output gap). Our estimates earlier in this section point to real exchange rate misalignment (as seen in the poor third equation estimates in Appendix A) as a factor behind this phenomenon. In most cases, it reflected concerns about other aspects of policies, including the ability to fine tune, rather than purposely growth-ambivalent monetary policy (as could be misleadingly deduced from the insignificant coefficients of the output gap in estimated Taylor rules).

Figure 6. Summary Macroeconomic Variables for Egypt, Saudi Arabia and Jordan



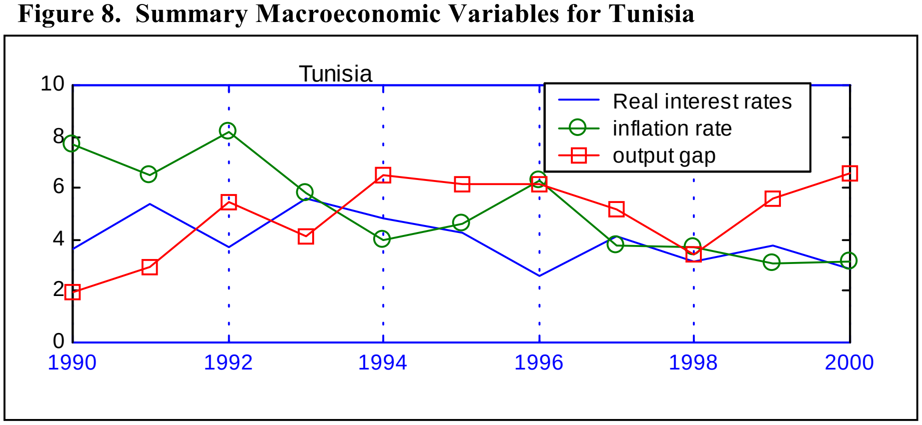
For Kuwait, as we have already mentioned, the output gap fluctuates wildly (negatively in the aftermath of the 1990 Iraqi invasion, and positively in the following rehabilitation/reconstruction phase). However, through all the turmoil, the inflation-targeting interest rate policy and fixed nominal exchange rate helped Kuwait keep inflation in check. The link with the output gap is clearly weak in this sample due to the aforementioned circumstances.

Figure 7. Summary Macroeconomic Variables for Kuwait



Finally, we consider Tunisia, where nominal exchange rates were fixed *de facto*, but neither the exchange rate policy nor the real interest rate policy seemed to be inflation-targeting. Unlike Egypt and Jordan, Tunisia did not suffer from double-digit inflation rates around 1990. Therefore, it seems that there was no need to impose monetary policy discipline through a *de facto* inflation-targeting rule. Instead, Tunisia seemed to follow a fully discretionary monetary policy, raising real interest rates moderately through the early to mid 1990s to bring inflation down, and then keeping interest rates low to fuel a faster-than-normal growth spurt. In 1992 and 1996, the country lowered interest rates too far, causing inflation to begin rising, but that was quickly fixed the following year. In fact, we can get an R^2 of 0.7 for a "reactive discretionary rule", where interest rates are regressed on last year's inflation. In the absence of inflationary expectations, this policy seemed to serve them well without any need to resort to inflation targeting as a secondary anchoring mechanism.

Figure 8. Summary Macroeconomic Variables for Tunisia



V. Some Implications for Medium-term Policy Approaches

The preceding section shed some light on the *de facto* operation of the exchange/monetary policy nexus in five Arab economies. It highlighted the proxies to the approaches being followed, including the implicit trade-offs in terms of ultimate objectives. Looking forward, a range of policy options is available to Arab countries in the medium term to enhance this nexus consistent with Arab governments' stated objectives to sustain high and balanced economic growth. Each option within this range has its advantages and disadvantages, and there can be no ideal solution that will serve all countries at any given time, or serve any given country all the time.

Recall the range of policy options discussed earlier in the paper. At one extreme, a country may adopt a rigid form of fixed exchange rates (e.g. dollarization or, as in the case of Argentina, the use of a currency board). Here, the monetary authorities have no discretion, and fiscal discipline and timely structural reforms become essential for avoiding harmful real exchange rate misalignments. Moreover, societies must be willing and able to tolerate the real output shocks (including sharp recessions) that result from limited policy instruments in the context of significant adverse external shocks (e.g., Hong Kong in 1998, and Argentina in 1999-2000). While this scenario may work in the short run, depending on the country's resolve to enforce its fixed exchange rate mechanism, it can have detrimental long-term effects. In particular, the threat of long-term unsustainability of the fixed exchange rate regime adds a level of uncertainty that is likely to limit the inflow of much-needed portfolio and direct foreign investment funds.

At the other extreme, a country may adopt a market-determined floating exchange rate, following the example of Mexico. In this case, an inflation-targeting monetary policy rule will need to be established credibly as a nominal anchor. The main drawback of a free float policy is the potential for excessive volatility in market exchange rates, which in turn can have an adverse effect on trade and international capital movements.

Our reading of internal considerations suggests that the most likely scenario for Arab countries is the continuation of "managed-pegged," with varying degrees of responsiveness to market forces. The advantages of allowing exchange rate policies to become more responsive to market conditions are twofold. First, countries can thus avoid prolonged periods of real exchange rate misalignment that have adverse effects on trade and economic growth. Second, the flexible exchange rate policy provides an excellent absorption mechanism for unanticipated international shocks.

As countries move to more flexible exchange rate regimes, an alternative nominal anchor can be found through appropriate inflation targeting regimes. Perhaps in a rather ironic fashion, such regimes have been *de facto* in operation as suggested by the analysis of the previous section. It is a question of making them explicit and robust.

In this regard, the credibility of the inflation targeting rule as a sustainable long-run policy profile also depends on three important factors: First, the government's ability to exercise fiscal discipline which, for some Latin American countries committed to inflation-targeting, has involved the legislative passage of tough "Fiscal Responsibility Laws." Second, greater central bank independence (particularly as pertaining to the use of instruments) combined with appropriate accountability and transparency procedures. Third, more developed domestic financial markets that are better regulated and supervised.

The main challenge in this scenario is the need to explain "inflation targeting rules" to the public. Whereas fixed exchange rates provide an easily understandable nominal anchor, the monetary discipline imposed by inflation targeting rules requires a more sophisticated understanding of monetary policy. It is for this purpose that certain central banks around the world have committed to greater information dissemination – in the most effective cases, this has been done through regularly scheduled "inflation reports" or testimonies to parliament; active use of the internet has also helped in a growing number of cases, especially with respect to communicating with international investors.

Moreover, the credibility of an inflation-targeting rule can only evolve gradually over time, as the monetary authorities build a track record of independence and discipline in following such rules. Therefore, an immediate or forced transition from a less flexible managed peg to a more flexible exchange rate regime can be disruptive in the short term, unless the track record of inflation targeting monetary policy is established beforehand.

In this regard, should the authorities decide to move to floating exchange rates or merely a more flexible managed peg, Egypt, Jordan, Saudi Arabia, and Kuwait may be well poised to expand on their well-established *de facto* Taylor rules, to adopt rules that are consistent with a flexible inflation targeting scheme. Thus, to exploit the medium-term benefits, each of these countries will need to determine the pace of policy transition according to the specific domestic economic conditions and the degree of exposure to international financial conditions. Even though the general trends followed by those countries are likely to be very similar, no single ex-ante transition recipe can be offered for all countries.

Should governments decide not to embark on such a transition, they would be well advised to take into account the trade-offs involved in their current policy regimes. Specifically, the Taylor rules they adopt in the medium to long term must continue to take the real exchange rate movements into account, but also balance the economic goals of meeting growth targets as well as taming inflation.

VI. Concluding Remarks

Arab countries face many of the same challenges confronting other emerging economies. Due to their relatively limited integration in international capital markets, they were fortunate in the past decade to have avoided the types of financial contagion that prompted drastic, and often disruptive, policy changes in other economies. However, as the degree of integration in the international goods and capital markets continues to increase, the need to face broader policy challenges continues to grow. It is no longer realistic or desirable to stand behind the argument of limited international integration. Nor is it appropriate to argue that the management of the exchange/monetary policy nexus does not already incorporate some of the more developed elements found elsewhere in the world.

In recent years, the fixed exchange rate policies adopted by Arab countries have come increasingly under analysis in terms of their welfare implications. Moreover, selected episodes in recent years have demonstrated that these regimes are becoming increasingly sensitive to developments in the international economy (and, ironically, in a rather asymmetric fashion that accentuates the relative importance of negative shocks). As a result, there is growing recognition among government as to the need to adopt more effective exchange/monetary policy regimes. As they progress in this regard, governments will need to establish the credibility of an inflation targeting mechanism as a monetary anchor for inflationary expectations. In this regard, the fact that many Arab countries have been following unannounced *de facto* Taylor rules sets the stage for a smooth transition between then two nominal anchor regimes. It is not a question of whether it is being done; it is. It is a question of how well to do it.

Two cautionary concluding remarks are in order: First, Arab countries should not wait for a crisis situation to force them into a hastened transition between regimes, since such crises would —by their very nature— undermine the confidence they wish to establish in the new exchange/monetary policy nexus. Second, should they embark more decisively on the policy adaptation route, there will be a transitory period where both types of nominal anchors will be used simultaneously. In that state of the world, Arab countries would need to be careful not to create significant real exchange rate misalignments and/or excess demands for money. Such monetary-crunches and misalignments of the exchange rate can lead to severe output variations that may in turn increase the probability of a hastened regime switch. In the game of anchoring inflationary expectations, credibility takes many years to build, but merely a few weeks to squander.

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Appendix A

Country-by-Country Macroeconomic Data Analysis

In what follows, we report the estimated Phillips curves and IS curves for the five countries in question: (t-statistics in parentheses)

1. Estimates for Egypt:

Phillips curve: $\hat{\pi}_{t+1} = \underset{(0.89)}{3.61} + \underset{(2.43)}{0.45}\pi_t - \underset{(-0.03)}{0.02} y_t + \underset{(2.76)}{14.34}(e_t - e_{t-1})$, R^2=0.95.

IS-curve: $\hat{y}_{t+1} = \underset{(0.48)}{1.51} - \underset{(-0.06)}{0.01} r_t - \underset{(-1.12)}{2.76} e_t + \underset{(1.89)}{0.57} y_t$, R^2=0.78.

Exchange rate determinants: $\hat{e}_t = \underset{(11.26)}{1.43} + \underset{(2.79)}{0.034} r_t - \underset{(-2.91)}{0.195} r_t^*$, R^2=0.61.

2. Estimates for Jordan:

Phillips curve: $\hat{\pi}_{t+1} = \underset{(5.83)}{5.00} - \underset{(-1.48)}{0.24}\pi_t - \underset{(-2.55)}{0.43} y_t + \underset{(3.87)}{89.93}(e_t - e_{t-1})$, R^2=0.85.

IS-curve: $\hat{y}_{t+1} = \underset{(-0.29)}{-7.89} + \underset{(0.22)}{0.09} r_t - \underset{(-0.26)}{20.21} e_t + \underset{(-0.64)}{0.35} y_t$, R^2=0.29.

Exchange rate determinants: $\hat{e}_t = \underset{(-32.66)}{-0.363} + \underset{(0.96)}{0.001} r_t - \underset{(-1.73)}{0.010} r_t^*$, R^2=0.35.

3. Estimates for Kuwait:

Phillips curve: $\hat{\pi}_{t+1} = \underset{(-0.19)}{-0.37} + \underset{(1.37)}{0.72}\pi_t + \underset{(2.64)}{0.17} y_t + \underset{(0.08)}{3.82}(e_t - e_{t-1})$, R^2=0.68.

IS-curve: $\hat{y}_{t+1} = \underset{(-1.55)}{-224.08} + \underset{(3.29)}{4.24} r_t - \underset{(-1.48)}{170.36} e_t + \underset{(0.33)}{0.11} y_t$, R^2=0.70.

Exchange rate determinants: $\hat{e}_t = \underset{(-56.74)}{-1.298} + \underset{(3.08)}{0.009} r_t + \underset{(2.01)}{0.020} r_t^*$, R^2=0.64.

4. Estimates for Saudi Arabia:

Phillips curve: $\hat{\pi}_{t+1} = \underset{(-0.98)}{-2.56} + \underset{(1.45)}{1.26}\pi_t - \underset{(-0.30)}{0.08} y_t + \underset{(1.67)}{166.54}(e_t - e_{t-1})$, R^2=0.38.

IS-curve: $\hat{y}_{t+1} = \underset{(4.69)}{133.95} + \underset{(3.47)}{0.96} r_t - \underset{(-4.84)}{100.41} e_t + \underset{(1.57)}{0.34} y_t$, R^2=0.93.

Exchange rate determinants: $\hat{e}_t = \underset{(32.37)}{1.286} + \underset{(0.23)}{0.002} r_t + \underset{(0.99)}{0.018} r_t^*$, R^2=0.16.

5. Estimates for Tunisia:

Phillips curve: $\hat{\pi}_{t+1} = \underset{(0.92)}{3.23} + \underset{(1.13)}{0.50}\pi_t - \underset{(-0.42)}{0.21} y_t - \underset{(-0.20)}{1.83}(e_t - e_{t-1})$, R^2=0.35.

IS-curve: $\hat{y}_{t+1} = \underset{(0.95)}{2.70} + \underset{(1.15)}{0.50} r_t + \underset{(1.26)}{8.73} e_t + \underset{(0.34)}{0.11} y_t$, R^2=0.33.

Exchange rate determinants: $\hat{e}_t = \underset{(0.367)}{0.062} - \underset{(-0.47)}{0.015} r_t + \underset{(0.54)}{0.016} r_t^*$, R^2=0.16.

Appendix B

Estimating Potential GDP

In this appendix, we discuss how we estimate potential GDP for the five countries in question. There are a number of alternative methods for estimating potential GDP, some utilizing univariate methods (e.g. Hodrick-Prescott Filters, Beveridge-Nelson, etc.), and others utilizing VAR technology. A consensus seems to have emerged in the 1990s that the multivariate methods are more appropriate (c.f. Dupasquier et al. (1999) and the references therein).

The methods of Cochrane (1994), and others, rely on theoretical foundations in the permanent income hypothesis, as well as the empirical fact that consumption and income tend to be highly cointegrated. Thus, deviations of the income pattern from the consumption pattern are attributed to transitory shocks, while other movements are considered part of the permanent data generating process, hence used to estimate potential GDP.

The process of estimating potential GDP thus proceeds in three steps:

1. Estimate a 3-variable VAR with log income, (log income – long consumption), and interest rates.
2. Orthogonalize the residuals to generate impulse response functions for the three variables. We are mainly interested in log income.
3. Use the calculated impulse response functions to compute long-term effects of shocks on income, thus estimating the permanent component of GDP, which we treat as the potential GDP.

In what follows, the variables we use are log real GDP, log real private consumption expenditure, and interest rates. The first step is to ascertain that log real GDP and log real private consumption expenditure each contains a unit root, and that they are cointegrated. In the remainder of this section, we report the results on a country-by-country basis.

1. Results for Egypt

a. Unit Roots:

The augmented Dickey-Fuller test for log real GDP with one lag produced an AR(1) estimate of 0.98134, with an ADF t-statistic of –1.247, which is insignificant even at the 10% level (critical value of –2.616). Therefore, we fail to reject the null hypothesis of unit roots in log real GDP. The test for log real consumption produced an AR(1) estimate of 0.9529, with an ADF t-statistic of -1.534, which is also insignificant at the 10% level.

ADF test for log real GDP

ADF t-statistic	# of lags	AR(1) estimate
-1.247526	1	0.981340

1% Crit Value	5% Crit Value	10% Crit Value
-3.640	-2.949	-2.616

ADF test for log real Consumption

ADF t-statistic	# of lags	AR(1) estimate
-1.534082	1	0.952875

1% Crit Value	5% Crit Value	10% Crit Value
-3.640	-2.949	-2.616

b. Cointegration

To determine the number of lags to include in the estimation, we run a Likelihood Ratio test with Sims correction, obtaining the following results that suggest using 7 lags in the analysis.

LR-ratio results with Sims Correction

nlag = 9 8, LR statistic = 7.7869, probability = 0.0997
nlag = 8 7, LR statistic = 4.6945, probability = 0.3201
nlag = 7 6, LR statistic = 26.5281, probability = 2.476e-005
nlag = 6 5, LR statistic = 12.8718, probability = 0.01192
nlag = 5 4, LR statistic = 6.3484, probability = 0.1746
nlag = 4 3, LR statistic = 12.1679, probability = 0.01615
nlag = 3 2, LR statistic = 4.4420, probability = 0.3495

Using the 7-lag specification, we conduct a Johansen test, which suggests that real GDP and real consumption are highly cointegrated (we strongly reject r<=0, but fail to reject r<=1).

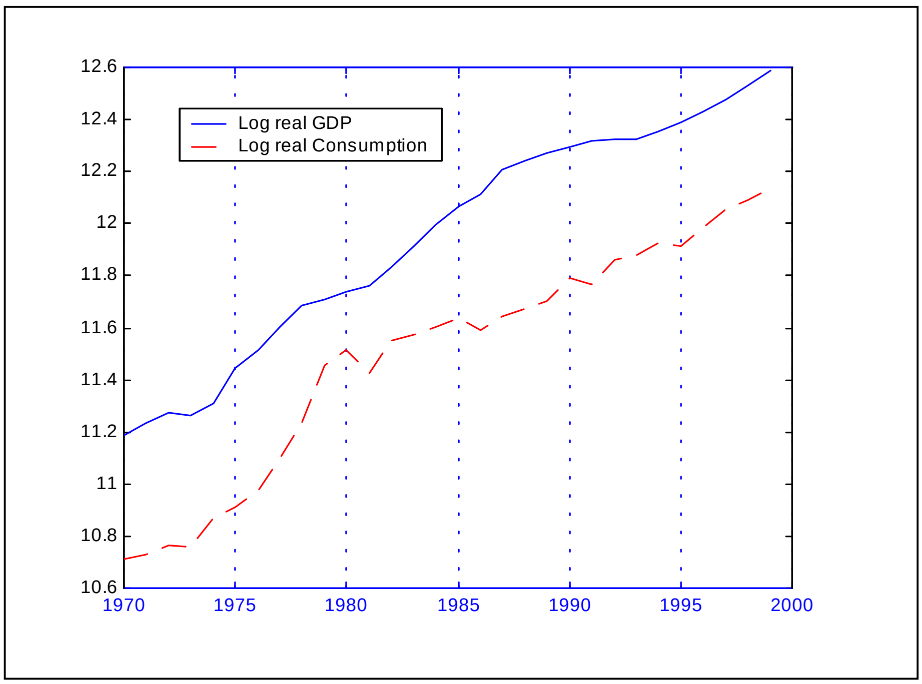
Johansen cointegration test based on MLE estimates

NULL:		Trace Statistic	Crit 90%	Crit 95%	Crit 99%
r <= 0	log Real GDP	27.678	13.429	15.494	19.935
r <= 1	log Real Consumption	2.197	2.705	3.841	6.635

NULL:		Eigen Statistic	Crit 90%	Crit 95%	Crit 99%
r <= 0	log Real GDP	25.480	12.297	14.264	18.520
r <= 1	log Real Consumption	2.197	2.705	3.841	6.635

This result can be viewed graphically in a plot of log real GDP and log real Consumption. This strong relationship supports the idea that the permanent and transitory components of real GDP can be distinguished by examining deviations of the real GDP trend from the consumption trend.

Figure B.1: Egypt: Log Real GDP and Log Real Consumption



c. VAR estimation

Following Cochrane (1994), we estimate a VAR model in its error correction representation, with two variables:

1. Dy = first differences of log real GDP,
2. Dc = first difference of log real consumption.

The number of lags we use is 7, as suggested both by the LR-tests reported above, as well as the strong evidence (c.f. De Serres and Guay (1995)) that having a small number of lags can bias the estimates of structural components. The results of the estimated reduced form VAR follow.

VAR estimates for Egypt's first differences of log GDP and log consumption

Dependent Variable = Dy
R-squared = 0.8533
Rbar-squared = 0.5599
sige = 0.0003
Q-statistic = 3.7854
Nobs, Nvars = 22, 15
****

Variable		Coefficient	t-statistic	t-probability
Dy	lag1	-0.424776	-1.129414	0.295935
Dy	lag2	0.151579	0.507168	0.627620
Dy	lag3	0.607990	2.378248	0.049008
Dy	lag4	0.025380	0.103241	0.920667
Dy	lag5	-0.259881	-1.504577	0.176146
Dy	lag6	-0.261523	-1.511601	0.174391
Dy	lag7	-0.210982	-1.137413	0.292796
Dc	lag1	-0.216575	-2.567316	0.037153
Dc	lag2	-0.172388	-2.064671	0.077827
Dc	lag3	-0.037161	-0.416853	0.689272
Dc	lag4	0.208566	3.120280	0.016837
Dc	lag5	0.313430	2.987699	0.020292
Dc	lag6	0.200643	1.651326	0.142655
Dc	lag7	0.022860	0.293122	0.777928
constant		0.044442	2.608488	0.034990

****** Granger Causality Tests *******

Variable	F-value	Probability
Dy	3.026511	0.083611
Dc	2.819925	0.097390

===

Dependent Variable = Dc
R-squared = 0.8861
Rbar-squared = 0.6582
sige = 0.0015
Q-statistic = 4.8335
Nobs, Nvars = 22, 15
****

Variable		Coefficient	t-statistic	t-probability
Dy	lag1	1.358324	1.634618	0.146145
Dy	lag2	1.710561	2.590424	0.035923
Dy	lag3	-0.480245	-0.850243	0.423315
Dy	lag4	-1.245026	-2.292235	0.055624
Dy	lag5	0.387375	1.015057	0.343872
Dy	lag6	-0.952005	-2.490502	0.041566
Dy	lag7	1.644707	4.013105	0.005104
Dc	lag1	0.283123	1.519032	0.172551
Dc	lag2	0.292017	1.582970	0.157444
Dc	lag3	0.358170	1.818449	0.111822
Dc	lag4	0.176554	1.195492	0.270818
Dc	lag5	-0.157685	-0.680306	0.518171
Dc	lag6	-0.737233	-2.746200	0.028661
Dc	lag7	-0.684637	-3.973302	0.005370
constant		-0.038633	-1.026291	0.338906

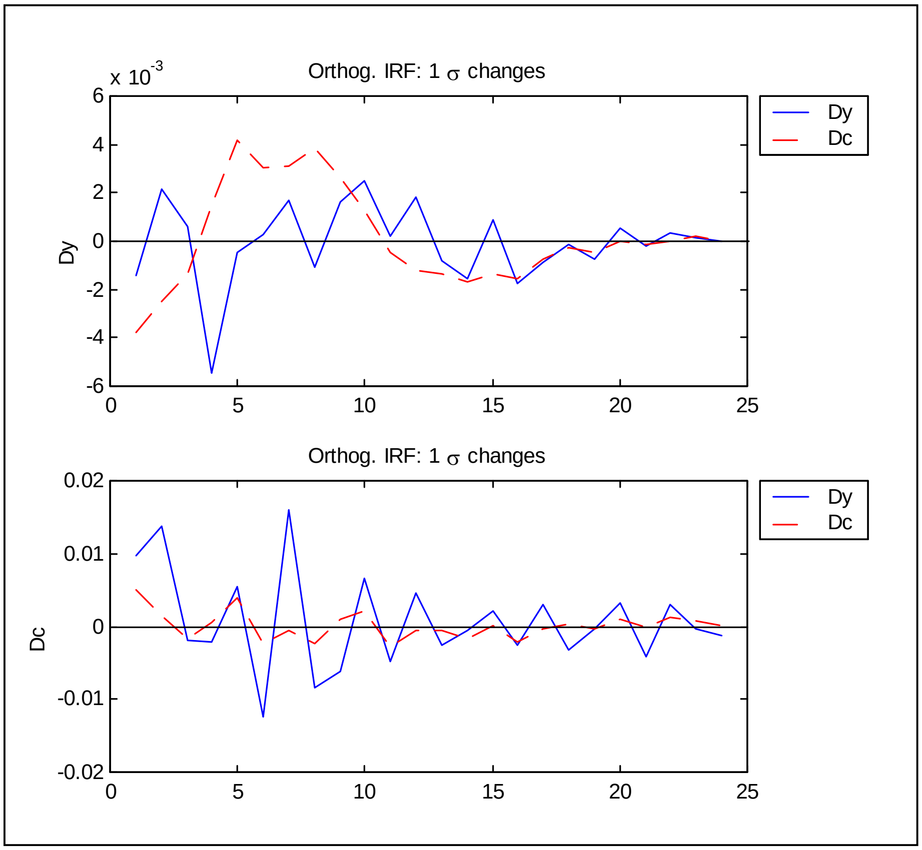
****** Granger Causality Tests *******

Variable	F-value	Probability
Dy	5.856237	0.016360
Dc	3.431710	0.063025

d. Impulse Response Functions

We then use the estimated VAR parameters and residuals, and employ a Cholesky decomposition to orthogonalize the residuals and obtain impulse response functions. The results are plotted in the following figure:

Figure B.2: Egypt: Impulse Response Functions for Real GDP and Real Consumption Growth Rates

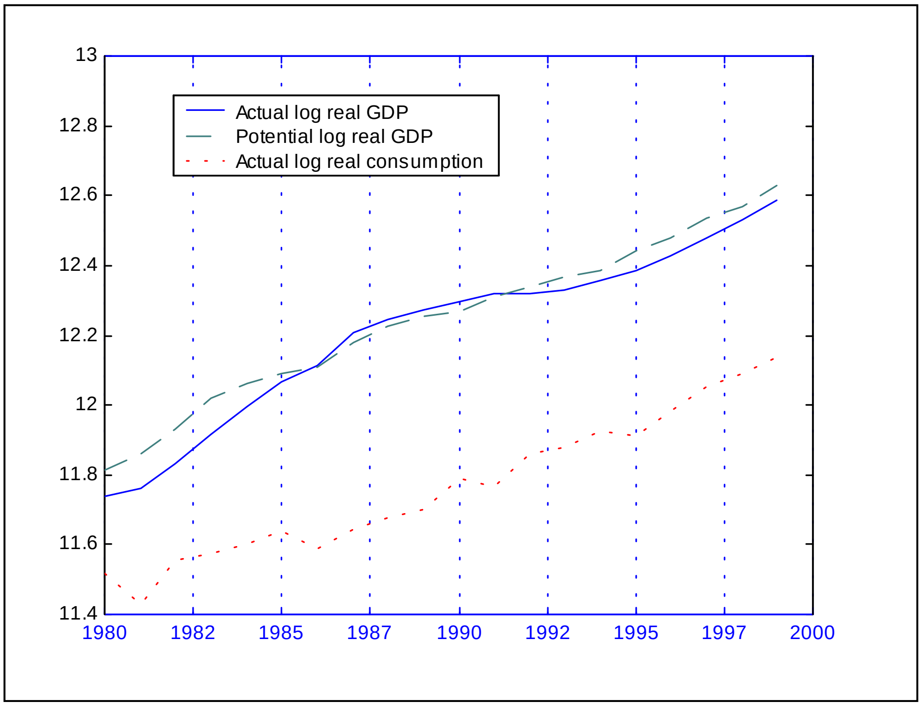


e. Estimated potential GDP

Using our estimated VAR parameters, we can generate a potential GDP via a multivariate version of the Beveridge and Nelson (1981) decomposition of output into permanent and transitory components. This method is tantamount to estimating potential output (the permanent component) as that level that would be reached after all transitory dynamics have worked themselves out. By rewriting the VAR in first order form (with appropriate identity restrictions on lagged Dy and Dc), the output gap can be calculated from the augmented matrix of estimated parameters (c.f. Cochran (1994) for a derivation in the 2-lag case, we save space by not writing the 7-lag analog here). Since we have seen that both log real GDP and log real consumption have unit roots, and they are cointegrated, the three methods surveyed in Dupasquier et al (1999) (Cochrane's, the multivariate Beveridge Nelson method, and the long-run restrictions method) are virtually identical.

We plot the actual and potential levels of log real GDP for the period 1980-1999. We also plot log real consumption on the same graph to illustrate that the "output gap" (in the sense of deviation from potential output) is mainly explained by a widening gap between the consumption and income patterns of growth.

Figure B.3: Egypt: Actual and Potential Log Real GDP, with Log Real Consumption



2. Results for Jordan

a. Unit Roots:

Unfortunately, the available CPI for Jordan (from IFS) seems to be inconsistent with the GDP deflator. If we use the CPI, real consumption amounts to more than real GDP, which seems nonsensical. Therefore, we opt in this case to use the GDP deflator for deflating both GDP and consumption. The results in the remainder of this section and throughout the paper will use this notion of real consumption. We fail to reject the null hypotheses of unit roots for log real GDP and log real consumption. In both cases, the ADF t-statistic is not significant at the 10% level.

ADF test for log real GDP

Augmented DF test for unit root variable: variable 1

ADF t-statistic	# of lags	AR(1) estimate
-1.075979	1	0.963245

1% Crit Value	5% Crit Value	10% Crit Value
-3.640	-2.949	-2.616

ADF test for log real Consumption

Augmented DF test for unit root variable: variable 1

ADF t-statistic	# of lags	AR(1) estimate
-1.194333	1	0.945120

1% Crit Value	5% Crit Value	10% Crit Value
-3.640	-2.949	-2.616

b. Cointegration

To determine the number of lags to include in the estimation, we run a Likelihood Ratio test with Sims correction, obtaining the following results that suggest using 5 lags in the analysis.

LR-ratio results with Sims Correction

nlag = 8 7, LR statistic = 8.4137, probability = 0.07755
nlag = 7 6, LR statistic = 5.8948, probability = 0.2071
nlag = 6 5, LR statistic = 1.5058, probability = 0.8256
nlag = 5 4, LR statistic = 10.5026, probability = 0.03276
nlag = 4 3, LR statistic = 8.8255, probability = 0.06561
nlag = 3 2, LR statistic = 0.3175, probability = 0.9887

Using the 5-lag specification, we conduct a Johansen test, which suggests that real GDP and real consumption are highly cointegrated (at the 95% level, we reject r<=0, but fail to reject r<=1).

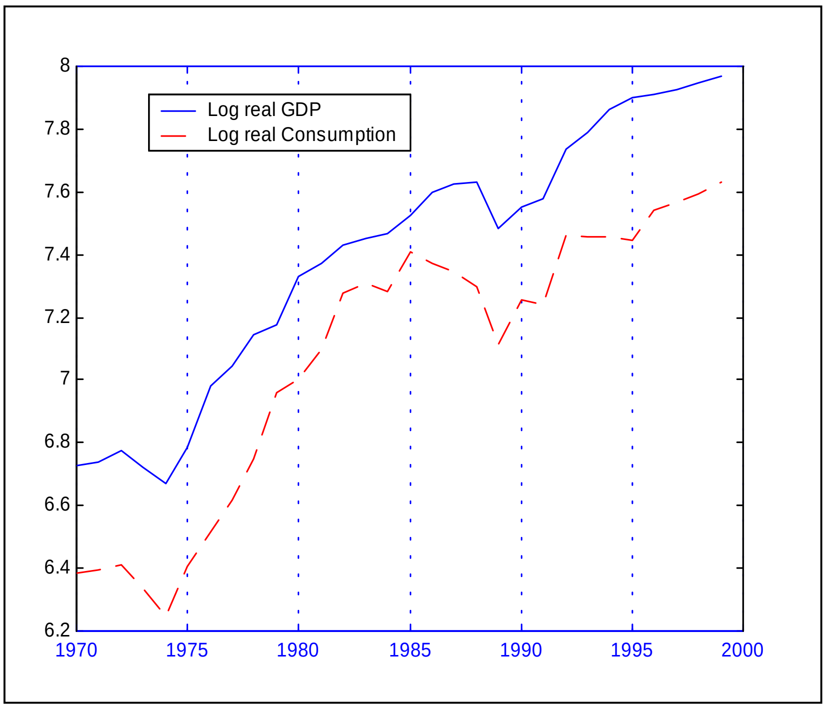
Johansen MLE estimates

NULL:		Trace Statistic	Crit 90%	Crit 95%	Crit 99%
r <= 0	log Real GDP	16.365	13.429	15.494	19.935
r <= 1	log Real Consumption	0.364	2.705	3.841	6.635

NULL:		Eigen Statistic	Crit 90%	Crit 95%	Crit 99%
r <= 0	log Real GDP	16.001	12.297	14.264	18.520
r <= 1	log Real Consumption	0.364	2.705	3.841	6.635

This result can be viewed graphically in a plot of log real GDP and log real Consumption (Figure B.4). This relationship supports the idea that the permanent and transitory components of real GDP can be distinguished by examining deviations of the real GDP trend from the consumption trend.

Figure B.4: Jordan: Log Real GDP and Log Real Consumption



c. VAR estimation:
We now proceed to the VAR estimation with 5 lags, in analogy to the 7-lag procedure for Egypt:

VAR estimates for Jordan
Dependent Variable = Dy
R-squared = 0.4318
Rbar-squared = -0.0053
sige = 0.0041
Q-statistic = 2.9751
Nobs, Nvars = 24, 11
****

Variable		Coefficient	t-statistic	t-probability
Dy	lag1	-0.179281	-0.516332	0.614293
Dy	lag2	0.026913	0.077040	0.939765
Dy	lag3	-0.567813	-1.942189	0.074098
Dy	lag4	0.109887	0.318564	0.755117
Dy	lag5	-0.064466	-0.199654	0.844840
Dc	lag1	0.353097	1.809403	0.093560
Dc	lag2	0.132834	0.605194	0.555468
Dc	lag3	0.159029	0.735187	0.475281
Dc	lag4	-0.099264	-0.458420	0.654220
Dc	lag5	-0.004275	-0.020483	0.983969
constant		0.052349	1.603453	0.132843

****** Granger Causality Tests *******

Variable	F-value	Probability
Dy	0.999934	0.455458
Dc	0.894257	0.512962

===

Dependent Variable = Dc
R-squared = 0.2314
Rbar-squared = -0.3599
sige = 0.0118
Q-statistic = 0.2071
Nobs, Nvars = 24, 11
****

Variable		Coefficient	t-statistic	t-probability
Dy	lag1	-0.076727	-0.130651	0.898051
Dy	lag2	0.498338	0.843420	0.414244
Dy	lag3	-0.250847	-0.507298	0.620442
Dy	lag4	0.399963	0.685545	0.505042
Dy	lag5	0.604954	1.107732	0.288052
Dc	lag1	0.130304	0.394791	0.699398
Dc	lag2	0.062276	0.167754	0.869358
Dc	lag3	0.021032	0.057487	0.955031
Dc	lag4	-0.206997	-0.565203	0.581559
Dc	lag5	-0.454694	-1.287981	0.220207
constant		0.011762	0.213017	0.834618

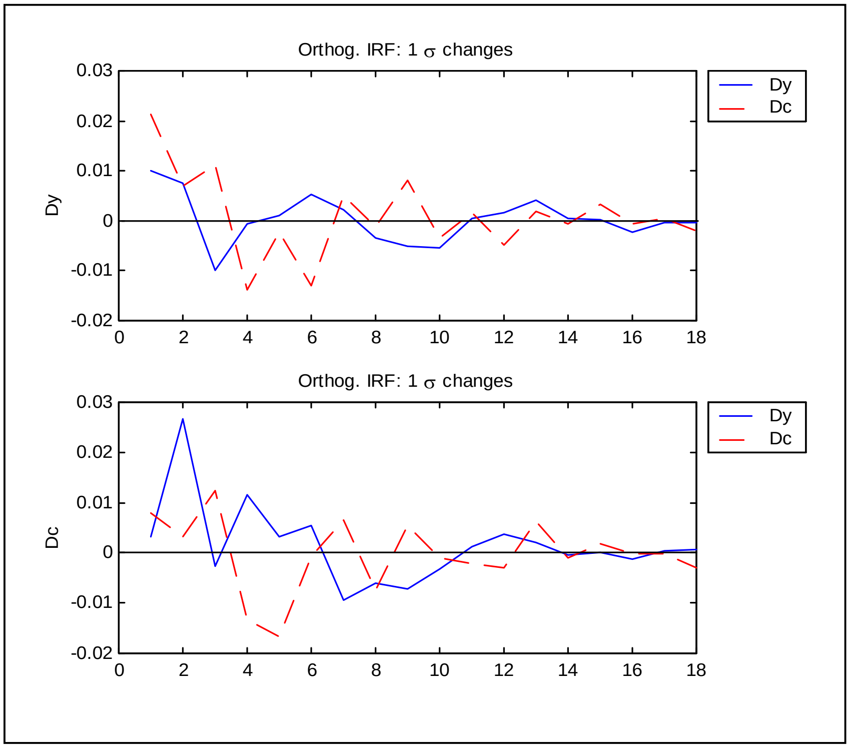
****** Granger Causality Tests *******

Variable	F-value	Probability
Dy	0.514173	0.761127
Dc	0.392069	0.845590

d. Impulse Response Functions

We then use the estimated VAR parameters and residuals, and employ a Cholesky decomposition to orthogonalize the residuals and obtain impulse response functions. The results are plotted in the following figure:

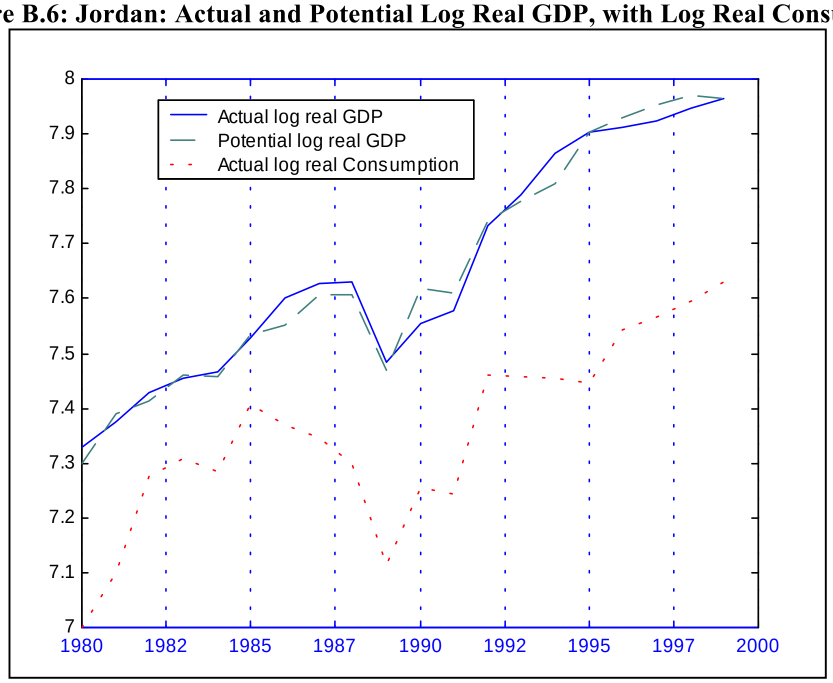
Figure B.5: Jordan: Impulse Response Functions for Real GDP and Real Consumption Growth Rates



e. Estimated potential GDP

Using our estimated VAR parameters, we can generate a potential GDP series in the same manner as for Egypt:

Figure B.6: Jordan: Actual and Potential Log Real GDP, with Log Real Consumption



3. Results for Kuwait

a. Unit Roots:
Unfortunately, the available CPI for Kuwait (from IFS) is missing a number of observations. Therefore, we opt in this case to use the GDP deflator for deflating both GDP and consumption. We fail to reject the null hypotheses of unit roots for log real GDP and log real consumption. In both cases, the ADF t-statistic is not significant at the 10% level.

ADF test for log real GDP

Augmented DF test for unit root variable: variable 1

ADF t-statistic	# of lags	AR(1) estimate
-2.635760	1	0.533925

1% Crit Value	5% Crit Value	10% Crit Value
-3.640	-2.949	-2.616

ADF test for log real Consumption

Augmented DF test for unit root variable: variable 1

ADF t-statistic	# of lags	AR(1) estimate
-1.771521	1	0.844974

1% Crit Value	5% Crit Value	10% Crit Value
-3.640	-2.949	-2.616

b. Cointegration
To determine the number of lags to include in the estimation, we run a Likelihood Ratio test with Sims correction, obtaining the following results that suggest using 5 lags in the analysis. If we follow the rule, we would use 7 lags. However, due to the unusual nature of the Kuwaiti data for this period (due to the Gulf war), such long lag structures are unwise. In fact, when we ran the cointegration tests with lags of 7, 5, and 2, we failed always to find any cointegration structure between consumption and GDP, mainly because of the behavior of the two series around 1990.

LR-ratio results with Sims Correction

nlag = 8 7, LR statistic = 3.0084, probability = 0.5564
nlag = 7 6, LR statistic = 10.1157, probability = 0.03852
nlag = 6 5, LR statistic = 3.7270, probability = 0.4442
nlag = 5 4, LR statistic = 4.8273, probability = 0.3055
nlag = 4 3, LR statistic = 8.0769, probability = 0.0888
nlag = 3 2, LR statistic = 2.1505, probability = 0.7081

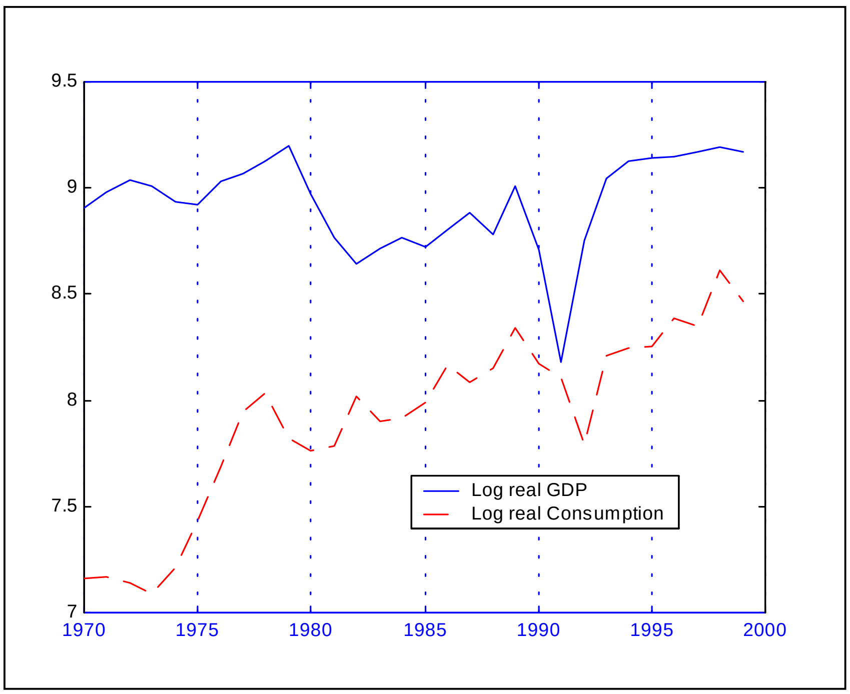
The lack of cointegration is shown here for the test with 2 lags, but the result is obvious by inspecting Figure B.7 below.

Johansen MLE estimates

NULL:		Trace Statistic	Crit 90%	Crit 95%	Crit 99%
r <= 0	Real GDP	7.534	13.429	15.494	19.935
r <= 1	Real Consumption	2.381	2.705	3.841	6.635

NULL:		Eigen Statistic	Crit 90%	Crit 95%	Crit 99%
r <= 0	Real GDP	5.153	12.297	14.264	18.520
r <= 1	Real Consumption	2.381	2.705	3.841	6.635

Figure B.7: Kuwait: Log Real GDP and LogReal Consumption



c. VAR estimation:

Given the obvious short lag structure in the data dictated by the quick recovery after the gulf war, we use 2 lags in the VAR estimation and the resulting estimates of impulse response functions and potential GDP.

VAR estimates for Kuwait

Dependent Variable = Dy
R-squared = 0.2449
Rbar-squared = 0.1076
sige = 0.0351
Q-statistic = 1.9025
Nobs, Nvars = 27, 5
****

Variable	Coefficient	t-statistic	t-probability
Dy lag1	0.019272	0.103064	0.918846
Dy lag2	-0.467861	-2.351430	0.028069
Dc lag1	0.314695	1.332733	0.196259
Dc lag2	-0.204657	-0.894959	0.380497
constant	0.001525	0.038510	0.969628

****** Granger Causality Tests *******

Variable	F-value	Probability
Dy	2.776257	0.084115
Dc	1.444515	0.257372

===

Dependent Variable = Dc
R-squared = 0.1659
Rbar-squared = 0.0142
sige = 0.0291
Q-statistic = 0.0179
Nobs, Nvars = 27, 5
****

Variable	Coefficient	t-statistic	t-probability
Dy lag1	0.325199	1.907643	0.069576
Dy lag2	-0.077489	-0.427181	0.673399
Dc lag1	-0.134858	-0.626454	0.537464
Dc lag2	-0.075058	-0.360026	0.722261
constant	0.057928	1.605000	0.122754

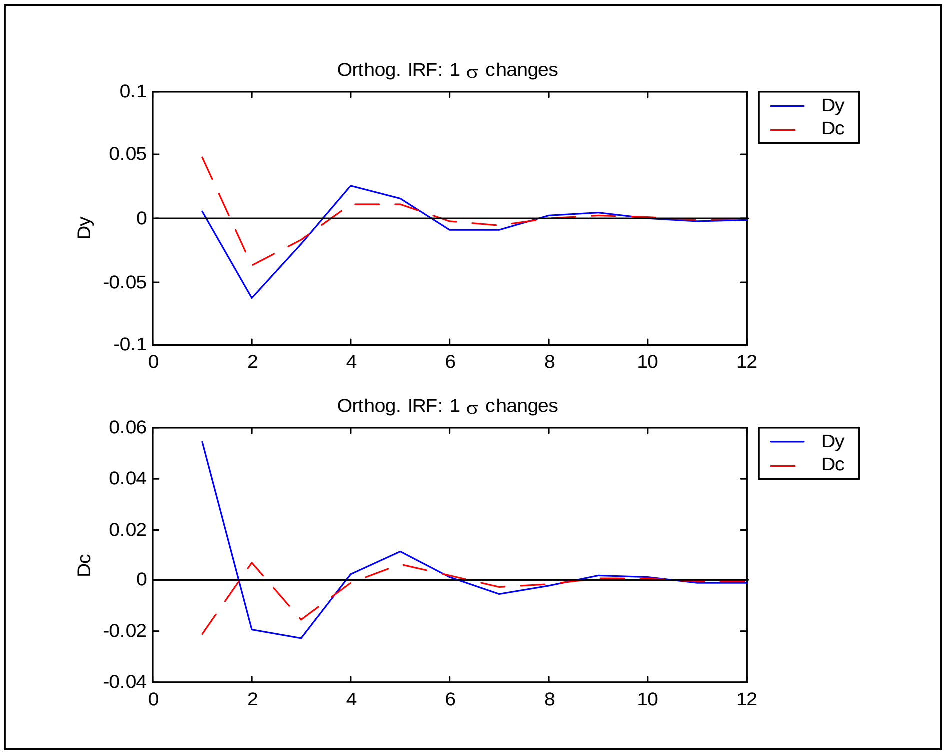
****** Granger Causality Tests *******

Variable	F-value	Probability
Dy	1.928807	0.169113
Dc	0.238282	0.789988

d. Impulse Response Functions

We then use the estimated VAR parameters and residuals, and employ a Cholesky decomposition to orthogonalize the residuals and obtain impulse response functions. The results are plotted in the following figure:

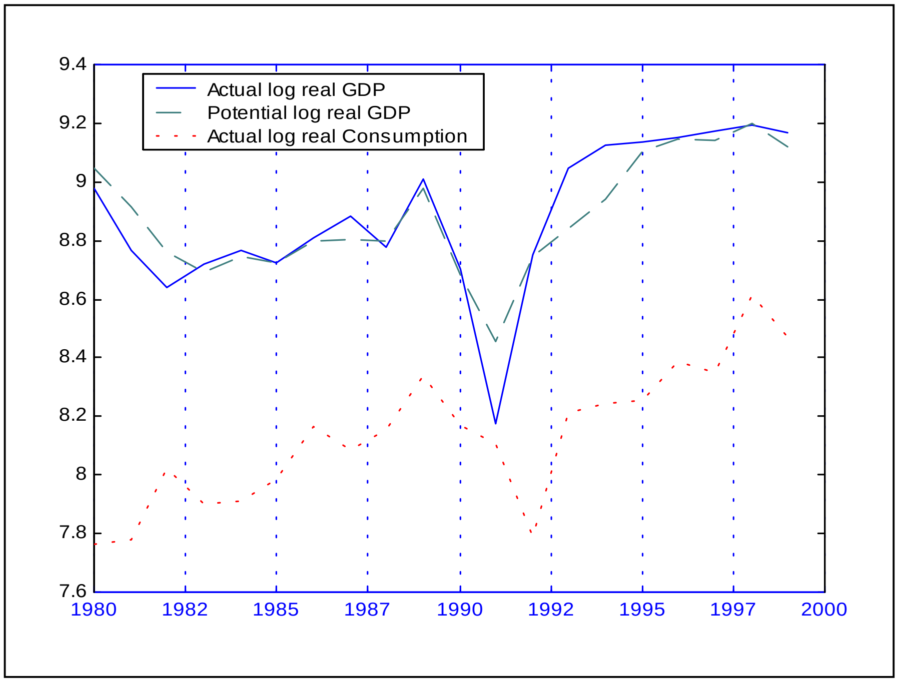
Figure B.8: Kuwait: Impulse Response Functions for Real GDP and Real Consumption Growth Rates



e. Estimated potential GDP

Using our estimated VAR parameters, we can generate a potential GDP series in the same manner as for Egypt:

Figure B.9: Kuwait: Potential and Actual Log Real GDP, with Log Real Consmption



4. Results for Saudi Arabia

a. Unit Roots:

The augmented Dickey-Fuller tests fail to reject the null hypothesis of unit roots at the 1% level for the model with 1 lag (failure to reject at lower significance levels is attained with more lags).

ADF test for log real GDP

Augmented DF test for unit root variable: variable 1

ADF t-statistic	# of lags	AR(1) estimate
-3.042419	1	0.860548

1% Crit Value	5% Crit Value	10% Crit Value
-3.640	-2.949	-2.616

ADF test for log real Consumption

Augmented DF test for unit root variable: variable 1

ADF t-statistic	# of lags	AR(1) estimate
-3.251105	1	0.889268

1% Crit Value	5% Crit Value	10% Crit Value
-3.640	-2.949	-2.616

b. Cointegration

To determine the number of lags to include in the estimation, we run a Likelihood Ratio test with Sims correction, obtaining the following results that suggest using 7 lags in the analysis.

LR-ratio results with Sims Correction

nlag = 9 8, LR statistic = 7.7800, probability = 0.09998
nlag = 8 7, LR statistic = 3.8799, probability = 0.4225
nlag = 7 6, LR statistic = 10.9290, probability = 0.02737
nlag = 6 5, LR statistic = 33.7256, probability = 8.483e-007
nlag = 5 4, LR statistic = 4.9802, probability = 0.2893
nlag = 4 3, LR statistic = 7.0933, probability = 0.131
nlag = 3 2, LR statistic = 1.7676, probability = 0.7784

Using the 7-lag specification, we conduct a Johansen test, which suggests that real GDP and real consumption are highly cointegrated (we reject r<=0, but fail to reject r<=1 at the 90% level).

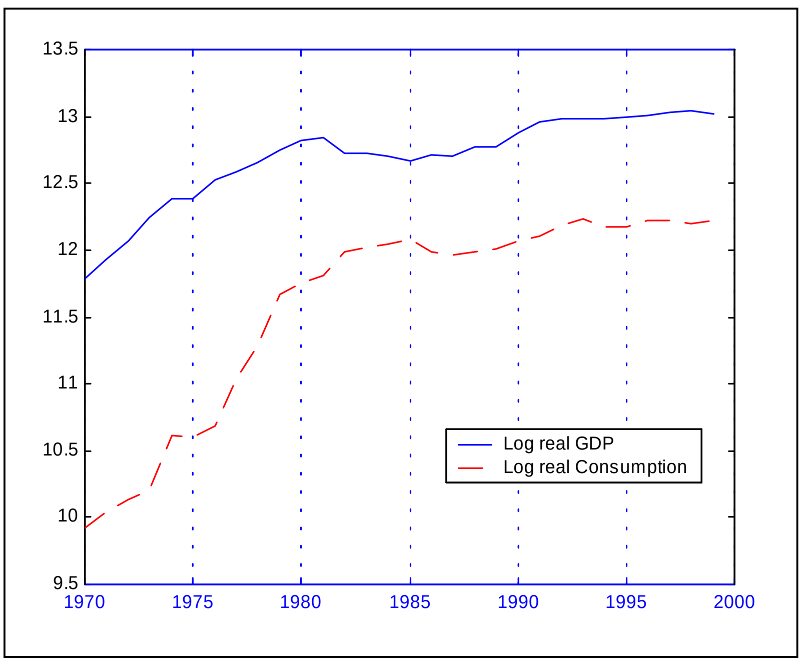
Johansen cointegration test based on MLE estimates

NULL:		Trace Statistic	Crit 90%	Crit 95%	Crit 99%
r <= 0	log Real GDP	13.973	13.429	15.494	19.935
r <= 1	log Real Consumption	0.937	2.705	3.841	6.635

NULL:		Eigen Statistic	Crit 90%	Crit 95%	Crit 99%
r <= 0	log Real GDP	13.036	12.297	14.264	18.520
r <= 1	log Real Consumption	0.937	2.705	3.841	6.635

This result can be viewed graphically in a plot of log real GDP and log real Consumption (Figure B.10). This strong relationship supports the idea that the permanent and transitory components of real GDP can be distinguished by examining deviations of the real GDP trend from the consumption trend.

Figure B.10: Saudi Arabia: LogReal GDP and Log Real Consumption



c. VAR estimates for Saudi Arabia

Dependent Variable = Dy
R-squared = 0.8362
Rbar-squared = 0.5085
sige = 0.0013
Q-statistic = 4.7269
Nobs, Nvars = 22, 15
****

Variable		Coefficient	t-statistic	t-probability
Dy	lag1	-1.176551	-2.111406	0.072637
Dy	lag2	-1.588256	-1.853309	0.106250
Dy	lag3	-1.982369	-2.072282	0.076957
Dy	lag4	-0.834884	-1.888528	0.100893
Dy	lag5	-0.140905	-0.879482	0.408316
Dy	lag6	-0.912079	-2.523860	0.039587
Dy	lag7	-0.624369	-1.469945	0.185038
Dc	lag1	1.480969	2.705811	0.030383
Dc	lag2	1.001277	1.928256	0.095166
Dc	lag3	0.204830	1.012326	0.345088
Dc	lag4	0.144455	0.697718	0.507859
Dc	lag5	-0.080458	-0.859257	0.418649
Dc	lag6	-0.731040	-2.184932	0.065164
Dc	lag7	-0.633030	-1.638082	0.145415
constant		0.203305	2.340808	0.051783

****** Granger Causality Tests *******

Variable	F-value	Probability
Dy	1.300643	0.368772
Dc	3.595158	0.056557

===

Dependent Variable = Dc
R-squared = 0.9208
Rbar-squared = 0.7624
sige = 0.0024
Q-statistic = 7.7701
Nobs, Nvars = 22, 15
****

Variable		Coefficient	t-statistic	t-probability
Dy	lag1	1.199860	1.552824	0.164408
Dy	lag2	1.784884	1.501991	0.176796
Dy	lag3	0.683873	0.515549	0.622047
Dy	lag4	0.120736	0.196953	0.849461
Dy	lag5	0.544019	2.448758	0.044188
Dy	lag6	0.432540	0.863156	0.416642
Dy	lag7	0.128214	0.217684	0.833885
Dc	lag1	-0.373250	-0.491792	0.637912
Dc	lag2	-0.364417	-0.506103	0.628330
Dc	lag3	-0.340880	-1.214949	0.263772
Dc	lag4	-0.246987	-0.860305	0.418109
Dc	lag5	0.506943	3.904293	0.005866
Dc	lag6	0.460936	0.993500	0.353560
Dc	lag7	0.200049	0.373317	0.719961
constant		-0.114105	-0.947443	0.374964

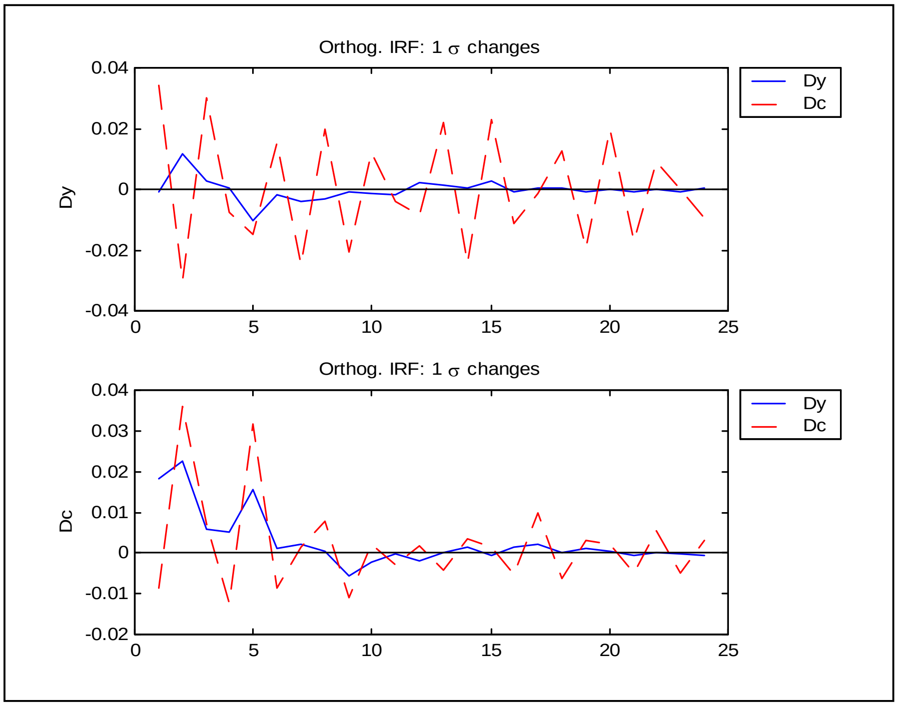
****** Granger Causality Tests *******

Variable	F-value	Probability
Dy	2.597100	0.115611
Dc	3.361182	0.066104

d. Impulse Response Functions

We then use the estimated VAR parameters and residuals, and employ a Cholesky decomposition to orthogonalize the residuals and obtain impulse response functions. The results are plotted in the following figure:

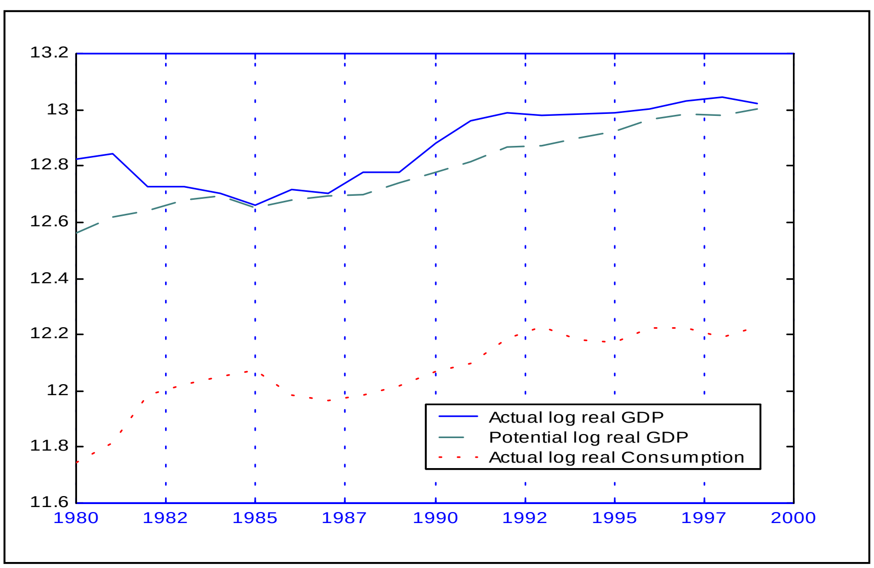
Figure B.11: Saudi Arabia: Impulse Response Functions for Real GDP and Real Consumption Growth Rates



e. Estimated potential GDP

Using the estimated VAR parameters and IRFs, we can estimate potential log real GDP:

Figure B.12: Saudi Arabia: Actual and Potential Log Real GDP, with Log Real Consumption



5. Results for Tunisia

a. Unit Roots:

The augmented Dickey-Fuller tests fail to reject the null hypothesis of unit roots at the 5% level for the model with 1 lag (failure to reject at lower significance levels is attained with more lags).

ADF test for log real GDP

Augmented DF test for unit root variable: variable 1

ADF t-statistic	# of lags	AR(1) estimate
-0.908031	1	0.986387

1% Crit Value	5% Crit Value	10% Crit Value
-3.640	-2.949	-2.616

ADF test for log real Consumption

Augmented DF test for unit root variable: variable 1

ADF t-statistic	# of lags	AR(1) estimate
-2.832774	1	0.943070

1% Crit Value	5% Crit Value	10% Crit Value
-3.640	-2.949	-2.616

b. Cointegration

To determine the number of lags to include in the estimation, we run a Likelihood Ratio test with Sims correction, obtaining the following results that suggest using 5 lags in the analysis.

LR-ratio results with Sims Correction

nlag = 8 7, LR statistic = 7.5649, probability = 0.1089
nlag = 7 6, LR statistic = 5.8581, probability = 0.21
nlag = 6 5, LR statistic = 4.0584, probability = 0.3982
nlag = 5 4, LR statistic = 19.8246, probability = 0.0005408
nlag = 4 3, LR statistic = 0.4715, probability = 0.9762
nlag = 3 2, LR statistic = 12.4827, probability = 0.0141

Using the 5-lag specification, we conduct a Johansen test, which suggests that real GDP and real consumption are not cointegrated (we fail to reject r<=0).

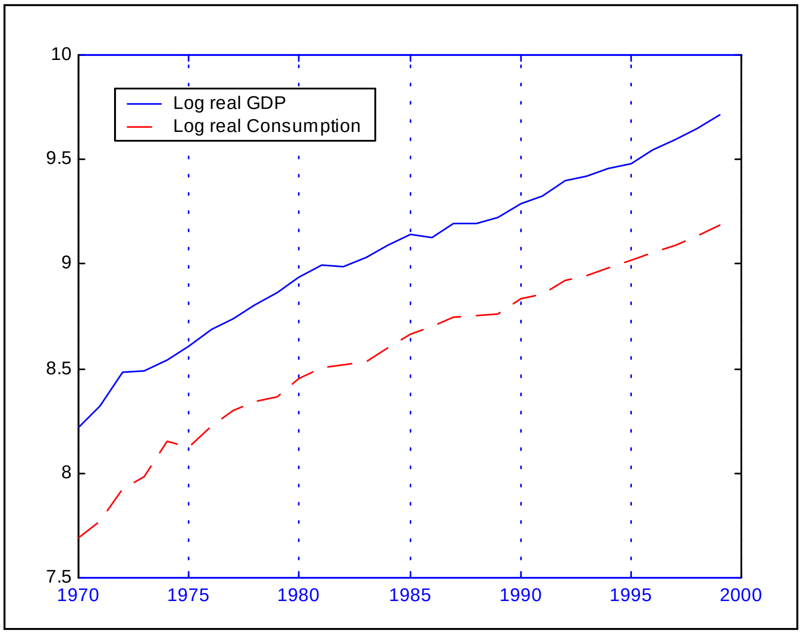
Johansen cointegration test based on MLE estimates

NULL:		Trace Statistic	Crit 90%	Crit 95%	Crit 99%
r <= 0	Real GDP	9.128	13.429	15.494	19.935
r <= 1	Real Consumption	0.073	2.705	3.841	6.635

NULL:		Eigen Statistic	Crit 90%	Crit 95%	Crit 99%
r <= 0	Real GDP	9.056	12.297	14.264	18.520
r <= 1	Real Consumption	0.073	2.705	3.841	6.635

However, it is graphically clear that real GDP and real consumption trend together, but transitory movements in one does not seem to coincide with the transitory movements of the other about their respective secular trends.

Figure B.13: Tunisia: Log Real GDP and Log Real Consumption



c. VAR estimates for Tunisia

Dependent Variable = Dy
R-squared = 0.2815
Rbar-squared = -0.2712
sige = 0.0008
Q-statistic = 1.3672
Nobs, Nvars = 24, 11

****

Variable		Coefficient	t-statistic	t-probability
Dy	lag1	0.193794	0.593380	0.563109
Dy	lag2	0.429917	1.246100	0.234717
Dy	lag3	0.049480	0.171065	0.866807
Dy	lag4	-0.017508	-0.061205	0.952127
Dy	lag5	-0.213661	-0.731634	0.477374
Dc	lag1	-0.730171	-1.732054	0.106907
Dc	lag2	-0.404553	-1.236622	0.238103
Dc	lag3	0.029860	0.111810	0.912682
Dc	lag4	0.233335	1.128681	0.279431
Dc	lag5	0.212263	1.050206	0.312755
constant		0.050309	2.085098	0.057341

****** Granger Causality Tests *******

Variable	F-value	Probability
Dy	0.363651	0.864397
Dc	0.735418	0.609975

Dependent Variable = Dc
R-squared = 0.4940
Rbar-squared = 0.1047
sige = 0.0006
Q-statistic = 2.6472
Nobs, Nvars = 24, 11

****

Variable		Coefficient	t-statistic	t-probability
Dy	lag1	0.409391	1.517216	0.153148
Dy	lag2	0.171011	0.599942	0.558858
Dy	lag3	0.026803	0.112156	0.912413
Dy	lag4	-0.202328	-0.856115	0.407438
Dy	lag5	0.166102	0.688432	0.503282
Dc	lag1	-0.524688	-1.506452	0.155860
Dc	lag2	-0.109943	-0.406767	0.690797
Dc	lag3	0.048978	0.221976	0.827782
Dc	lag4	0.238437	1.395990	0.186101
Dc	lag5	-0.017165	-0.102791	0.919698
constant		0.030300	1.519965	0.152462

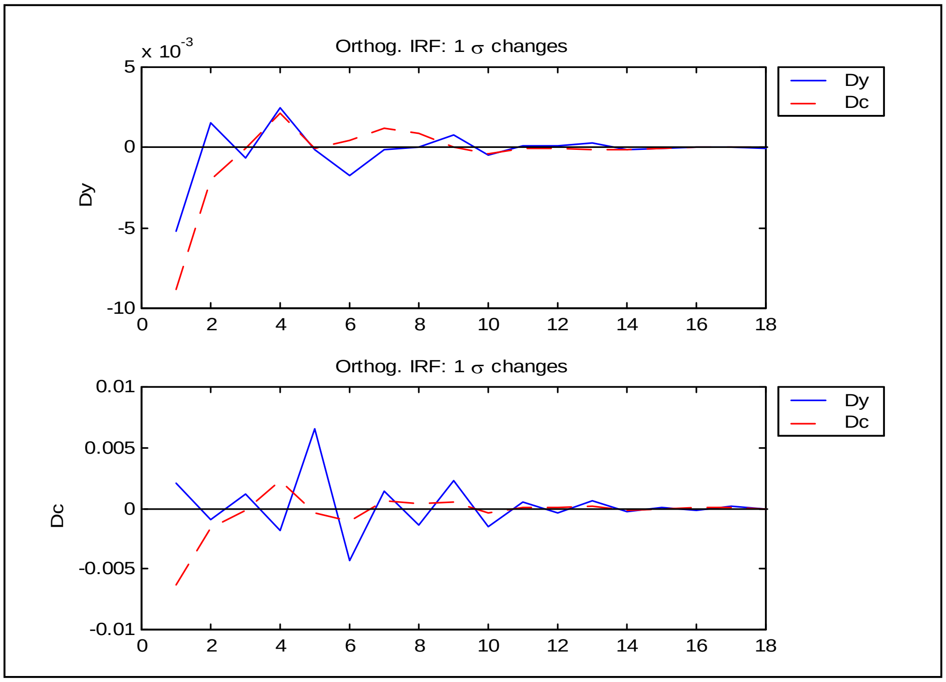
****** Granger Causality Tests *******

Variable	F-value	Probability
Dy	1.115914	0.398959
Dc	1.158516	0.379892

d. Impulse Response functions

We then use the estimated VAR parameters and residuals, and employ a Cholesky decomposition to orthogonalize the residuals and obtain impulse response functions. The results are plotted in the following figure:

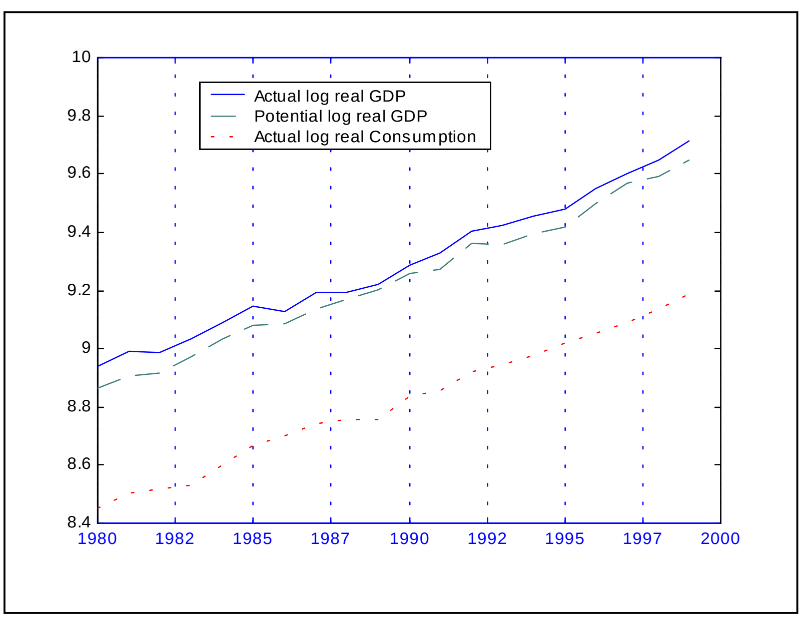
Figure B.14: Tunisia: Impulse Response Functions for Real GDP and Real Consumption Growth Rates



e. Estimated potential GDP

Using the estimated VAR parameters and IRFs, we can estimate potential log real GDP:

Figure B.15: Tunisia: Actual and Potential Log Real GDP, with Log Real Consumption



Appendix C

Country-by-Country Monetary Profile

Consider the three variables: log(nominal GDP), log(M1), and interest rates for the five countries Egypt, Jordan, Kuwait, Saudi Arabia, and Tunisia.

VAR: We performed a three-variable VAR estimation using annual data 1980-1999 for the five countries. Using the Likelihood Ratio test for the number of lags (using the Sims correction of the variance covariance matrices), we get five lags as the optimal number for all five countries:

1. Egypt LRs

nlag = 6 5, LR statistic = -12.3639, probability = 1
nlag = 5 4, LR statistic = 175.8115, probability = 0
nlag = 4 3, LR statistic = 24.3811, probability = 0.003738
nlag = 3 2, LR statistic = 3.9803, probability = 0.9127

2. Jordan LRs

nlag = 6 5, LR statistic = 1.7846, probability = 0.9944
nlag = 5 4, LR statistic = 178.4973, probability = 0
nlag = 4 3, LR statistic = 29.2392, probability = 0.0005905
nlag = 3 2, LR statistic = 31.8641, probability = 0.0002102

3. Kuwait LRs

nlag = 6 5, LR statistic = -1.7592, probability = 1
nlag = 5 4, LR statistic = 188.3289, probability = 0
nlag = 4 3, LR statistic = 5.8959, probability = 0.7503
nlag = 3 2, LR statistic = 11.6179, probability = 0.2357

4. Saudi Arabia's LRs

nlag = 6 5, LR statistic = -18.8468, probability = 1
nlag = 5 4, LR statistic = 173.8791, probability = 0
nlag = 4 3, LR statistic = 30.9999, probability = 0.000296
nlag = 3 2, LR statistic = 7.9039, probability = 0.5439

5. Tunisia's LRs

nlag = 6 5, LR statistic = -4.7909, probability = 1
nlag = 5 4, LR statistic = 177.4855, probability = 0
nlag = 4 3, LR statistic = 22.6757, probability = 0.006967
nlag = 3 2, LR statistic = 20.1257, probability = 0.01715

The Long-Term Money-Output Relationship

Testing for unit roots using the Augmented Dickey-Fuller test, we fail to reject the unit root null in log(M1) at the 5% level for the models with 3+ lags for Egypt, 2+ lags for Jordan, 5+ lags for Kuwait, 4+ lags for Saudi Arabia, and 1+ lags for Tunisia. The ADF test applied to log(Nominal GDP) fails to reject the unit root null at the 5% level for the model with 1+ lags for Egypt, Jordan, Kuwait, and Tunisia, and for the model with 2+ lags for Saudi Arabia. In what follows, we discuss the long-term relationship (in terms of cointegration) between those pairs of I(1) variables for the five countries.

Using the estimated number of lags (5) for all countries, obtained in the previous section, we performed a Johansen cointegration test for the three variables (log(NGDP), log(M1), and interest rates) for the period 1970-1999. Cointegration is a long-term relationship that is best estimated using a long series. For the long period 1970-1999, we find a cointegrating relationship that includes all three variables (marginally at the 95% level in the case of Egypt), which corresponds to the developed country experience where the long-term relationship between money and output involves interest rates. For all series, we reject $r<=0$ and $r<=1$, but fail to reject that $r<=2$, where r is the number of cointegrating relationships.

However, our period of interest is 1990-1999. For this period, we first re-perform the LR-tests to decide on the optimal number of lags in a VAR —obtaining an optimal number of 2 lags— and then use that number of lags in Johansen cointegration tests. The set of tests reported below for the period 1990-1999 illustrate that the relationship between M1 and NGDP continues, but now interest rates are no longer a factor in the long-term relationship (we reject $r<=0$, but fail to reject $r<=1$).

1970-1999 Cointegration Tests

1. Johansen cointegration test for Egypt:

NULL:		Trace Statistic	Crit 90%	Crit 95%	Crit 99%
r <= 0	M1	42.480	27.067	29.796	35.463
r <= 1	Nominal GDP	15.340	13.429	15.494	19.935
r <= 2	interest rate	1.054	2.705	3.841	6.635

NULL:		Eigen Statistic	Crit 90%	Crit 95%	Crit 99%
r <= 0	M1	27.140	18.893	21.131	25.865
r <= 1	Nominal GDP	14.286	12.297	14.264	18.520
r <= 2	interest rate	1.054	2.705	3.841	6.635

2. Johansen cointegration test for Jordan:

NULL:		Trace Statistic	Crit 90%	Crit 95%	Crit 99%
r <= 0	M1	84.808	27.067	29.796	35.463
r <= 1	Nominal GDP	30.989	13.429	15.494	19.935
r <= 2	interest rate	0.474	2.705	3.841	6.635

NULL:		Eigen Statistic	Crit 90%	Crit 95%	Crit 99%
r <= 0	M1	53.819	18.893	21.131	25.865
r <= 1	Nominal GDP	30.516	12.297	14.264	18.520
r <= 2	interest rate	0.474	2.705	3.841	6.635

3. Johansen cointegrationtest for Kuwait:

NULL:		Trace Statistic	Crit 90%	Crit 95%	Crit 99%
r <= 0	M1	58.992	27.067	29.796	35.463
r <= 1	Nominal GDP	19.210	13.429	15.494	19.935
r <= 2	interest rate	8.748	2.705	3.841	6.635

NULL:		Eigen Statistic	Crit 90%	Crit 95%	Crit 99%
r <= 0	M1	39.782	18.893	21.131	25.865
r <= 1	Nominal GDP	10.463	12.297	14.264	18.520
r <= 2	interest rate	8.748	2.705	3.841	6.635

4. Johansen cointegration test for Saudi Arabia:

NULL:		Trace Statistic	Crit 90%	Crit 95%	Crit 99%
r <= 0	M1	107.165	27.067	29.796	35.463
r <= 1	Nominal GDP	33.359	13.429	15.494	19.935
r <= 2	interest rate	0.653	2.705	3.841	6.635

NULL:		Eigen Statistic	Crit 90%	Crit 95%	Crit 99%
r <= 0	M1	73.806	18.893	21.131	25.865
r <= 1	Nominal GDP	32.706	12.297	14.264	18.520
r <= 2	interest rate	0.653	2.705	3.841	6.635

5. Johansen cointegration test for Tunisia:

NULL:		Trace Statistic	Crit 90%	Crit 95%	Crit 99%
r <= 0	M1	79.835	27.067	29.796	35.463
r <= 1	Nominal GDP	37.321	13.429	15.494	19.935
r <= 2	interest rate	8.341	2.705	3.841	6.635

NULL:		Eigen Statistic	Crit 90%	Crit 95%	Crit 99%
r <= 0	M1	42.514	18.893	21.131	25.865
r <= 1	Nominal GDP	28.981	12.297	14.264	18.520
r <= 2	interest rate	8.341	2.705	3.841	6.635

1990-1999 Cointegration tests

1. Johansen cointegration test for Egypt:

NULL:		Trace Statistic	Crit 90%	Crit 95%	Crit 99%
r <= 0	M1	37.867	27.067	29.796	35.463
r <= 1	Nominal GDP	6.304	13.429	15.494	19.935
r <= 2	interest rate	0.318	2.705	3.841	6.635

NULL:		Eigen Statistic	Crit 90%	Crit 95%	Crit 99%
r <= 0	M1	31.562	18.893	21.131	25.865
r <= 1	Nominal GDP	5.986	12.297	14.264	18.520
r <= 2	interest rate	0.318	2.705	3.841	6.635

2. Johansen cointegration test for Jordan:

NULL:		Trace Statistic	Crit 90%	Crit 95%	Crit 99%
r <= 0	M1	30.261	27.067	29.796	35.463
r <= 1	Nominal GDP	8.365	13.429	15.494	19.935
r <= 2	interest rate	0.010	2.705	3.841	6.635

NULL:		Eigen Statistic	Crit 90%	Crit 95%	Crit 99%
r <= 0	M1	21.895	18.893	21.131	25.865
r <= 1	Nominal GDP	8.355	12.297	14.264	18.520
r <= 2	interest rate	0.010	2.705	3.841	6.635

3. Johansen cointegration test for Kuwait:

NULL:		Trace Statistic	Crit 90%	Crit 95%	Crit 99%
r <= 0	M1	42.531	27.067	29.796	35.463
r <= 1	Nominal GDP	14.288	13.429	15.494	19.935
r <= 2	interest rate	1.380	2.705	3.841	6.635

NULL:		Eigen Statistic	Crit 90%	Crit 95%	Crit 99%
r <= 0	M1	28.243	18.893	21.131	25.865
r <= 1	Nominal GDP	12.907	12.297	14.264	18.520
r <= 2	interest rate	1.380	2.705	3.841	6.635

4. Johansen cointegration test for Saudi Arabia:

NULL:		Trace Statistic	Crit 90%	Crit 95%	Crit 99%
r <= 0	M1	22.003	27.067	29.796	35.463
r <= 1	Nominal GDP	9.609	13.429	15.494	19.935
r <= 2	interest rate	0.037	2.705	3.841	6.635

NULL:		Eigen Statistic	Crit 90%	Crit 95%	Crit 99%
r <= 0	M1	12.394	18.893	21.131	25.865
r <= 1	Nominal GDP	9.571	12.297	14.264	18.520
r <= 2	interest rate	0.037	2.705	3.841	6.635

5. Johansen cointegration test for Tunisia:

NULL:		Trace Statistic	Crit 90%	Crit 95%	Crit 99%
r <= 0	M1	33.189	27.067	29.796	35.463
r <= 1	Nominal GDP	7.793	13.429	15.494	19.935
r <= 2	interest rate	1.916	2.705	3.841	6.635

NULL:		Eigen Statistic	Crit 90%	Crit 95%	Crit 99%
r <= 0	M1	25.396	18.893	21.131	25.865
r <= 1	Nominal GDP	5.876	12.297	14.264	18.520
r <= 2	interest rate	1.916	2.705	3.841	6.635