Région et Développement
n° 61-2025
www.regionetdeveloppement.org

Modeling MENA economies using a GVAR approach: Domestic, regional and international factors

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Abstract - This article seeks to assess the relative contribution of regional, domestic, and international factors in explaining fluctuations in output and inflation in MENA countries. Adopting a GVAR approach, we estimate a model that combines country/region-specific vector error correction models in which domestic variables are linked to country-specific foreign variables. A global framework is designed to evaluate the importance of different shocks and transmission channels of business cycles at the global level. The model is estimated for 16 countries, including 8 countries grouped into a single economy (the Eurozone), the USA, China, and 6 MENA countries, over the period 2000-2022. Using a forecast error variance decomposition exercise, the sources of disturbances are identified according to their geographic origin. Evidence suggests that regional factors do not appear to contribute in any way to explain the variability of output and inflation in the MENA countries. The dynamics of MENA countries is far from depending on intra-regional interdependencies which do not support the existence of a common regional component in the business dynamics of MENA region. Rather, both domestic and external shocks (originating from industrial countries) account for the main share of output and inflation fluctuations. For countries such as Tunisia and Morocco, it's the Euro Area that appears to play a relatively more important role than the US and China. In contrast, the results are reversed for Middle Eastern countries, where the influence of the US and China is significantly greater compared to that of the Euro Area. We also observe that, for the Gulf countries, China plays a role almost as important as that of the US.

JEL Classification
C32, E17, C35, F15, F42

Key-words
Business Cycles
International Co-movement
MENA Region
GVAR Model
GFEVD Exercise

We sincerely thank the reviewers whose comments helped improve this article.

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INTRODUCTION

Assessing the relative importance of regional, international and domestic factors in the cyclical fluctuations of economies remains a crucial issue for policymakers and modern macroeconomic literature. Recently, there has been an increasing focus on macroeconomic models that help define forecasting strategies and assess the impact of various economic policies. The analysis of the impact of global and domestic shocks requires the use of a model that takes into consideration the national problems of economies from a global perspective.

Economies exhibit a high degree of interdependence due to the existence of many transmission channels, trade/financial openness, emergence of regional economic blocks, international coordination of economic policies and technology transfer. However, considering all these channels is not sufficient as other forms of “residual” interdependencies arising from unobserved interactions and cross-country spillovers may play a role. Accounting for such a variety of factors remains a great challenge for global economic modeling. Hence, macroeconomic modeling is forced to pursue approaches that formally and explicitly incorporate the global context.

Econometrically, the international transmission of business cycles can be explained through various channels: observed common global shocks (such as oil shocks), unobserved global factors (spread of technological advances), or idiosyncratic shocks specific to countries or sectors. In this context, dynamic factor models were developed by Forni and Reichlin (1998) and Forni et al. (2000). They summarized the empirical content of many variables through a small number of common factors using principal components. Unobserved factor models with many macroeconomic variables also gained importance with Stock and Watson (2002). Although such models have had a major impact on forecasting, identifying economic disturbances remains problematic, especially when attempting to assign an economic interpretation to them. Beyond this modeling effort, we note that despite accounting for common factors, other channels of interdependence also need to be explained, and a detailed global vision is essential if we look to assess the relative importance of such a variety of global co-movement sources on economies.

This justifies our choice of the *Global Vector Autoregression* (GVAR) approach which provides a relatively simple tool for modeling the global economy. The approach, originally proposed by Pesaran et al. (2004) and developed by Dees et al. (2007a), represents in fact a new method that combines time series, panel data and factor analysis techniques to explain countries dynamics [(1)]. As we will see, the GVAR consists of two steps. First, “individual” country-specific models are conditionally estimated for the rest of the world. These models use domestic variables and weighted cross-sectional averages of foreign variables. Second, the individual VARX* models are combined and solved as a global VAR model. The solution can be used for analyzing and predicting various impulse response scenarios and error variance decomposition exercises as it was traditionally done with standard low-dimensional VAR models [(2)].

[1] Di Mauro and Pesaran (2013) and Chudik and Pesaran (2016) provide a large review of various applications and developments of the GVAR approach.

[2] From a modeling perspective, the individual units are not necessarily "countries" but can also be regions (groups of countries), a mix of regions/countries ("mixed cross-section GVARs"), or even "sectoral" where the cross-sections would be between economic sectors, industries, banks, etc.

In this article, we extend the existing literature on international business cycle synchronization by exploring several new directions. We present a global macroeconomic model specifically designed for emerging economies in the MENA region, an area which remains under-researched. Using the forecast error variance decomposition, *we aim to identify the sources of disturbance based on their geographical origin while examining the relative contributions of domestic, regional and international factors in explaining output and inflation fluctuations in MENA countries.* The model includes 16 countries structured into nine "individual" countries/regions: the Eurozone (Belgium, France, Germany, Italy, Luxembourg, Netherlands, Portugal, and Spain), the US, China and 6-MENA countries (Tunisia, Morocco, Egypt, Saudi Arabia, Jordan, United Arab Emirates).

This paper is structured as follows. Section 1 presents the analytical foundations of the GVAR model. Section 2 introduces the data, along with the main properties of the model supported by various specification tests. Section 3 analyzes country-specific shocks as well as regional and international shocks using forecast error variance decompositions exercise.

1. THE GVAR APPROACH: TO GLOBAL MACROECONOMIC MODELLING

In this section, we provide an overview of the GVAR approach, describe the country-specific models, and explain how the model is constructed. A GVAR consists of two "blocks and/or construction steps" through which the model captures "cross-country spillovers." In the first block, separate "individual" time series models are estimated, each corresponding to a specific country. These are vector error correction models (VECM) since macroeconomic data often shares a common stochastic trend and where domestic variables are linked to country-specific foreign variables. The latter are constructed from domestic variables in a manner that reflects countries' trade interdependence and would thus serve as proxies for unobserved common factors. In the second block, the country-specific models are "stacked" to provide a global model that captures the dynamic propagation of the different shocks.

1.1. Country-specific models and trade weights

A country-specific model is a VAR* model for each country/region considered individually. The exogenous variables (denoted by "*") are foreign variables multiplied by trade weights. Once the variables to be included are specified, we begin the modeling process, following the assumptions of Dees et al. (2007b), where all country-specific variables are I(1), foreign variables are weakly exogenous, and the parameters of the country-specific models are stable over time. Then, we select the number of lags for the VAR(p_i, q_i) models, where p_i is the number of lags for the endogenous (domestic) variables, and q_i is the number of lags for the exogenous (foreign) variables. The following steps follow the modeling approach explicitly presented by Boschi and Girardi (2011).

Let's begin by introducing a simplified VARX* structure. Consider a group of countries/regions i = 0, 1, 2, ..., N forming the global economy, with country 0 taken as the reference country. For a country i, we consider the following VARX*(1, 1):

$$x_{\mathrm{it}} = \Phi x_{i,t-1} + \Lambda_{i0} x_{it}^{*} + \Lambda_{i1} x_{it-1}^{*} + \varepsilon_{it} \tag{1}$$

x_{it} : a $(k_i \times 1)$ vector of domestic variables for country *i*
x_{it}^{*} : a $(k_i^{*} \times 1)$ vector of foreign variables specific to country *i*.

1.2. Trade and aggregation weights

Trade-weighted foreign variables (x_{it}^{*}) are constructed as trade-weighted averages of the corresponding domestic variables from other trade and financial partners, excluding country *i*. The country/region-specific weights (w_{ij}) are given by the shares in foreign trade; the share of country *j* in the total trade of country *i* over the period under study. The form of the foreign variables (x_{it}^{*}) can be written as follows [3]:

$$x_{it}^{*} = \sum_{j=0}^{N} \mathrm{w}_{\mathrm{ij}}\, x_{\mathrm{jt}} \quad \text{with} \quad \mathrm{w}_{\mathrm{ii}} = 0; \;\; i = 0,1 \ldots N\,; \; \sum_{j=0}^{N} \mathrm{w}_{\mathrm{ij}} = 1; \; \forall i, j = 0,1, \ldots N$$

The weights (W_{ij}) belong to matrix W, which represents the intensity of economic links between countries, based on trade flows transactions between countries.

1.3. GVAR Global: Stacking the individual country models

The econometric approach involves aggregating multiple VECM systems to obtain a global autoregressive model that describes the world economy. It combines country-specific models in which domestic variables are linked to foreign variables constructed from domestic variables to reflect trade interdependence between countries and serve as proxies for unobserved common factors. The result is a system that describes multiple variables by their lagged values, which can be used for forecasting purposes without the need for specialized modeling software[4].

In fact, the strong "parameterization" of empirical models is a recurring problem in global macro-econometrics. This occurs when the number of countries is high compared to the available temporal dimension, making it difficult to estimate an unrestricted global VAR. This is the identification constraint of the standard VAR models[5]. As a solution, two categories of restrictions were imposed in the literature (Bussière et al., 2009): (i) data shrinkage (e.g., factor models) and (ii) reduction of parameter space (e.g., spatial models or Bayesian shrinkage). An alternative procedure to solve this dimensionality problem is GVAR modeling.

Like traditional vector models, the GVAR approach is based on combining a long-term economic perspective by identifying stationary linear combinations of cointegrating vectors describing the configuration of a steady state to which the model converges in the long run. The GVAR also enables analysis of the short-term

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[3] In the literature, the choice of weights often varies. Several GVAR studies, including those by Pesaran et al. (2004), Dees et al. (2007a), Galesi and Lombardi (2009), and Feldkircher and Korhonen (2012), have used weights based on trade flows. Galesi and Sgherri (2009) used financial weights based on bank credits data. Hiebert and Vansteenkiste (2007) used weights based on input-output industrial sectoral data. Milani (2021) introduced a different connectivity matrix based on social networks, which may be promising for various fields of application.
[4] See Smith and Galesi (2014).
[5] These are the identifying restrictions of the SVAR models by Sims (1986) and Bernanke (1986), where many restrictions $(n^2\text{-}n)/2$ are imposed, which can be very restrictive and could make it impossible to estimate models when the number of series is high. GVAR models help avoid this technical constraint of identifying restrictions.

dynamics of the system through different simulation scenarios. The advantage is, even if the shocks affecting the global system are not identified according to their economic nature (supply shock, demand shock, etc.), they remain identified according to their geographic origin. This is because each country/region-specific system is conditionally estimated with respect to the foreign variables.

Rather than directly estimating the entire system composed of N country-specific models, we follow Pesaran et al. (2004) and estimate the parameters of each country-specific model separately, then we stack the estimated coefficients into a single GVAR model. All country/region-specific endogenous variables are collected within a $(k \times 1)$ global vector $x_{\mathrm{t}} = (x'_{0t}, x'_{1t}, \dots, x'_{Nt})'$ where $k = \sum_{j=0}^{N} \mathrm{k}_i$. So, we have $z_{it} = W_i x_t$, where W_i is a $((k_i + k_i^*) \times \mathrm{k})$ matrix collecting the weights $\mathrm{w_{ij}}$. Consequently, for each specific country/region, the following VAR form is obtained. Consider a VARX* (2, 2):

$$\mathrm{x_{it}} = \mathrm{a_{i0}} + \mathrm{a_{i1}t} + \Phi_{i1} x_{i,t-1} + \Phi_{i2} \mathrm{x_{it-2}} + \Lambda_{i0} x_{it}^* + \Lambda_{i1} x_{it-1}^* + \Lambda_{i2} x_{it-2}^* + \varepsilon_{it} \quad (2)$$

The VECM specification of the VARX* (2, 2):

$$\Delta \mathrm{x_{it}} = c_{i0} - \alpha_i \beta_i' \left[z_{i,t-1} - \gamma_i (t-1) \right] + \Lambda_{i0} \Delta x_{it}^* + \Gamma_i \Delta z_{i,t-1} + \varepsilon_{it} \quad (3)$$

with $z_{it} = (x'_{it}, x_{it}^{*\prime})'$, a vector of the domestic and foreign variables.

Note that k_i and k_i^* are the numbers of domestic and et foreign variables for every country *i*. The parameter α_i is a $(k_i \times r_i)$ matrix with rank r_i and β_i a $(k_i + k_i^*) \times r_i$ denotes a matrix with rank r_i. The error correction terms as defined above can be written:

$$\beta_i' [z_{it} - \gamma_{it}] = \beta_{ix}' x_{it} + \beta_{ix^*}' x_{it}^* - (\beta_i' \gamma_i) t$$

This allows for the possibility of cointegration both between x_{it} and between x_{it} et x_{it}^*, and therefore between x_{it} *and* x_{jt} for $i \neq j$.

For estimation purposes, x_{it}^* is treated as "long-term forces" or I(1) weakly exogenous variables. The VARX* models are estimated separately for each country/region, considering these possibilities of cointegration. The number of cointegration relationships, r_i, the speed of adjustment coefficients α_i, and the cointegrating vectors β_i for each specific model are obtained. The remaining parameters of the VARX* will be estimated using the OLS method, based on the following equation:

$$\Delta \mathrm{x_{it}} = c_{i0} + \delta_i ECM_{i,t-1} + \Lambda_{i0} \Delta x_{it}^* + \Gamma_i \Delta z_{i,t-1} + \varepsilon_{it} \quad (4)$$

$ECM_{i,t-1}$ describes the error correction terms corresponding to r_i, the rank of the cointegration relationships in the country-specific model for country *i*.

Once the variables to be included in the individual VARX* are defined, the number of lags for domestic and foreign variables, p_i and q_i , are chosen according to the AIC criteria. The corresponding VARX* models are estimated, and the rank of the cointegrating space is determined through the estimation of the error correction form of the country-specific VECM*, as given by Eq. 3. This estimation is achieved in three steps:

i. The estimator β_i is estimated using the maximum likelihood estimator $\hat{\beta}$.
ii. The rank of β_i, r_i, is calculated using the "trace" and "maximum eigenvalue" statistics as proposed by Pesaran et al. (2000).
iii. Similar to Dees et al. (2007), the parameters $(c_{i0}, \alpha_i, \Lambda_{i0}, \Gamma_i)$ can be estimated using the OLS method by regressing Δx_{it} on the intercepts and the estimated error correction terms $(\widehat{\beta_i'} z_{i,t-1}), \Delta x_{it}^*, \Delta z_{i,t-1}$.

1.4. Solution of the GVAR model

Although the estimation is done country by country, the GVAR is estimated simultaneously for all endogenous variables within a single global economy. All variables are endogenous to the system. The global model (see Eq. 8 below) represents a compact empirical representation of the global economy, with the countries linked in several ways: First, the model directly explores the trade weights to reflect the interdependence between countries by calculating foreign variables, and then, by "stacking" the models. These are the main channels through which spillover effects are expressed in the model. Secund, economies are then linked through the dependance of domestic variables on global variables, and finally, through non-zero off-diagonal elements of the variance-covariance matrix Σ_u.

Once VECM* estimation is achieved as described above, the corresponding VARX* models are re-established. Let us begin with the country-specific VARX* (p_i, q_i) models:

$$x_{it} = a_{i0} + a_{i1}t + \Phi_{i1}x_{i,t-1} + \cdots + \Phi_{ipi}x_{i,t-p_i} + \Lambda_{i0}x_{it}^* + \Lambda_{i1}x_{i,t-1}^* + \ldots + \Lambda_{iqi}x_{i,t-q_i}^* + \varepsilon_{it} \quad (5)$$

$$z_{it} = \begin{pmatrix} x_{it} \\ x_{it}^* \end{pmatrix}$$

The equation (5) can then be rewritten for each economy as follows:

$$A_{i0}z_{it} = a_{i0} + a_{i1}t + A_{i1}z_{it-1} + \cdots + A_{ipi}z_{it-p_i} + \varepsilon_{it}$$

with $A_{i0} = (I_{k_i} - \Lambda_{i0}), A_{ij} = (\Phi_{ij}, \Lambda_{ij})$ for $j = 1, \ldots, p_i$

We can use the interdependence matrix W_i to obtain the following identity:

$$z_{it} = W_i x_t \quad (6)$$

It is the vector $x_t = (x_{0t}', x_{1t}', \ldots, x_{Nt}')'$ of dimension $(k \times 1)$ that contains all the variables of the system. Using this identity, we can write:

$$A_{i0}W_i x_{it} = a_{i0} + a_{i1}t + A_{i1}W_i x_{it-1} + \cdots + A_{ip_i}W_i x_{t-p_i} + \varepsilon_{it} \qquad i = 0,1, \ldots, N$$

These "individual" models will be stacked to obtain the following global model:

$$G_0 x_t = a_0 + a_1 t + G_1 x_{t-1} + \cdots + G_p x_{t-p} + \varepsilon_t \quad (7)$$

G_0 is a known, non-singular matrix that depends on trade weights and the estimated parameters. Pre-multiplying Eq. (6) by G_0^{-1}, the GVAR(p) model is obtained:

$$x_t = b_0 + b_1 t + F_1 x_{t-1} + \cdots + F_p x_{t-p} + \varepsilon_t \tag{8}$$

2. DATA SET USED AND PRELIMINARY ANALYSES

2.1. Data description

In this paper, VECM models are estimated for 16 countries, structured into the following 9 "individual" countries/regions: the Eurozone (Belgium, France, Germany, Italy, Luxembourg, Netherlands, Portugal, and Spain), the US, China and 6-MENA countries (Tunisia, Morocco, Egypt, Saudi Arabia, Jordan, United Arab Emirates). Quarterly time series have been used for the period (2000:1 - 2022:4). Each model contains five domestic endogenous variables, four foreign variables, and the international oil price (as a global exogenous variable). Both, the real and financial endogenous (domestic) variables, included in the country/region-specific models, as well as most of the GVAR applications in the literature, will be denoted as $(y_{it}, \pi_{it}, r_{it}, e_{it}, q_{it})$, and specified as follows:

- *Real GDP* $(y_{it}) = ln(GDP_{it}/CPI_{it})$, with GDP: nominal gross domestic product (local currency), CPI: Consummer Price Index [(6)].
- *Inflation rate* $(\pi_{it}) = ln\,(CPI_{it}) - ln\,(CPI_{i,t-1})$
- *Short-term interest rate* $(r_{it}) = 0.25 * ln\left(1 + \frac{R_{it}^S}{100}\right)$ with R_{it}^S : the nominal short-term interest rate, in percent.
- *Real equity prices* $q_{it} = ln\left(\frac{EQ_{it}}{CPI_{it}}\right)$; with EQ_{it}: nominal equity price index.
- *Real exchange rate* $(e_{it}) = ln\left(\frac{E_{it}}{CPI_{it}}\right)$; with E_{it} nominal exchange rate of country *i* currency at time *t* in USD.

In the VARX* models, exogeneous variables are $(y_{it}^*, r_{it}^*, e_{it}^*, q_t^*)$, using commercial aggregate weights (W_{ij}): $y_{it}^* = \sum_{j=0}^{N} w_{ij}\, y_{jt}$; $e_{it}^* = \sum_{j=0}^{N} w_{ij}\, e_{jt}$; $r_{it}^* = \sum_{j=0}^{N} w_{ij}\, r_{jt}$; $q_{it}^* = \sum_{j=0}^{N} w_{ij}\, q_{jt}$.

The trade weights (W_{ij}) for *i,j* =0,1…,N represent the trade weights between countries *i* and *j*, calculated using simple averages of the total trade of a country/region during the period 2000-2022 (see table 2 in the appendix).

Once the variables to be included in the country/region-specific models are defined, we proceed by assuming, as in Dees et al. (2007b), that, these variables are

[6] Noting that it is possible to use quarterly Industrial Production Index (IPI) series instead of GDP (as in Garfa (2013) and Koukouritakis et al. (2015)) particularly when facing data unavailability issues. However, we adopt the GDP for the following reasons. First, quarterly GDP is globally available for most of the studied panel, except for certain MENA countries (see table 1 in appendix for more details). Second, the empirical GVAR studies on which we based our analysis have used quarterly GDP, which facilitates comparisons with our results. Third, although the IPI may be considered better suited to reflect business cycle dynamics, as it is assumed to respond more strongly to economic shocks, its use remains controversial, especially for emerging countries where agricultural sector contributes significantly to aggregate supply.

I(1), the country-specific exogenous (foreign) variables are weakly exogenous, and the parameters of the country-specific models remain stable over time (assumptions to be tested later). We determine the number of lags for the country-specific VARX*(p_i, q_i) models. As mentioned, p_i and q_i are the number of lags for the endogenous and exogenous variables, respectively [(7)].

But, before proceeding with the empirical estimations, we present elements of descriptive statistics regarding the structure of the MENA foreign trade, which will help better understand their regional trade integration. The analysis of Graph 1 in appendix, illustrating the structure of foreign trade in MENA countries, reveals key trends in the trade dynamics of the MENA region over the last two decades. First, the weak growth in Intra-MENA Trade. Trade within this region remains too modest and relatively stagnant. The lack of economic integration and regional geopolitical tensions with limited progress in regional economic cooperation continue to hinder growth in this region. The future of MENA trade will depend on economic policies and global geo-political developments. Secund, Europe and USA remain the main trade partner, but also, China has emerged as the biggest winner in MENA trade since 2000 and China's growing influence is becoming more evident.

2.2. Stationarity test

The assumption that the included variables are I(1) plays an important role. It allows for the distinction between short and long-run relationships and facilitates the interpretation of long-run cointegration. So, the first preliminary test to be carried out is the stationarity test. The result is given in Table 3 in appendix which summarizes the Augmented Dickey-Fuller (ADF) statistics. We find that with a few exceptions, the non-stationarity hypothesis I(1) cannot be rejected for most exogenous and endogenous variables. Differentiating these series seems to lead to their stationarity.

As already emphasized, a crucial assumption for the estimation strategy is the weak exogeneity of the foreign variables x_{it}^* in the VECM models. This assumption is tested by calculating the significance of the error correction terms estimated in Eq. (4) for the country-specific foreign variables (Dees et al., 2007b). More specifically, for each *l-th* element of x_{it}^* , we perform the following regression:

$$\Delta x_{it,l}^* = \omega_{il} + \sum_{j=1}^{r_i} \lambda_{i,j,t} ECM_{i,t-1}^t + \sum_{k=1}^{p_i} \varpi_{ik,l} \Delta x_{i,t-k} + \upsilon_{il,t} \Delta \tilde{x}_{it-1}^* + \varsigma_{it,l} \tag{9}$$

The term $ECM_{i,t-1}^t$ is the estimated error correction terms corresponding to the cointegration relationships r_i found for country *i*. The test for weak exogeneity is a Fisher F-test statistic for the hypothesis $\lambda_{i,j,t} = 0$. The results are shown in Table 4 in appendix. Most of the F-statistics are not significant at the 5% level. For all the panel, this hypothesis is rejected only for output and the short-term interest rate in Jordan, and the real equity prices for Egypt. Given the theoretical and econometric justification of the weak exogeneity assumption, foreign variables and oil prices were treated as weakly exogenous (Boschi and Girardi, 2011; Han and Hee Ng, 2011). Note that weakly exogenous variables are part of the cointegration space. In

[7] The number of lags for the foreign variables q_i is set to 1 for all countries/regions. The maximum value of p_i will not exceed 2. Based on this AIC criterion, and depending on the specific cases, a VAR*(2,1) and/or a VAR(1,1) will be estimated for the 9 countries/regions.

the literature, it is assumed that foreign variables "force" the endogenous variables in the long term.

2.3. Foreign variables - Domestic variables: Degree of impact

In this paragraph we focus on the degree of impact of foreign variables on domestic variables (Table 5 in appendix). These statistics can be interpreted as elasticities of impact between these two types of variables. To illustrate, for Tunisia, a 1% change in foreign output results in 1.1% increase in real GDP. It should be highlighted that all these elasticities are statistically significant and have a positive sign, with one exception for the foreign interest rate in Jordan. For all MENA countries, increases in foreign output and foreign inflation results in significant and positive current impact on their domestic counterparts which implies that MENA countries are as open as the other countries/regions under consideration. Another interesting finding is that for the foreign international interest rates and the real equity prices, in all 6-MENA countries, there is a significant and positive effect on their domestic counterparts. This suggests a relatively strong financial link between these countries and international financial markets.

2.4. Cointegration test

Regarding the cointegration test, table 6 in appendix provides the estimates of the "maximum eigenvalue" and "trace" statistics for all country-specific models. The interpretation of these results suggests the presence of a cointegration rank of 1 for China, Tunisia, Morocco, Egypt, and 2 for the USA and the Eurozone. For Saudi Arabia, Jordan, and the UAE, the results do not provide a clear conclusion. However, since the maximum eigenvalue statistic can lead to an inconsistent testing strategy, we chose the trace statistic instead and set the cointegration rank to 1 for these three countries. Table 7 in appendix summarizes the number of cointegration relationships and the number of lags for all country-specific VARX* models.

2.5. Misspecification tests and robustness of the country-specific models

As mentioned previously, we are forced to set a lag order for the exogenous variables equal to 1 for all country-specific models. And, due to data limitations and the relatively large number of variables, it is necessary to assess the adequacy of the estimated models in capturing the interrelation dynamics of the model. Table 8 in appendix shows the F-statistics from the Breusch-Godfrey LM tests for serial correlation of order 4 in the residuals of the error correction regressions for the 46 endogenous variables in the adopted GVAR. These correlation coefficients are obtained as averages of the correlation coefficients between the residuals of each equation relative to those of other equations corresponding to other countries/regions. The goal is to test the hypothesis that these coefficients are significantly different from zero. Among these results, it is reassuring to note that 34 out of 46 regressions pass the residual serial correlation test at the 95% level. The null hypothesis of no serial correlation is rejected only in 12 out of 46 cases. For MENA countries, only 8 out of 30 regressions fail the test at the 95 percent level. So, it seems then that this model could lead to a consistent estimate that captures the current impact of common foreign factors on domestic variables.

2.6. Trade weights matrix and coefficient stability test

As described above, the trade weights matrix is calculated based on an average over the entire period 2000-2022. However, over this period, the structure of global trade may have undergone significant changes. So, we try to demonstrate that our empirical results are not qualitatively affected by changes in the weighting structure. We perform a robustness analysis by using different weighting structures for different periods. First, we divided the period into 2 sub-periods, reflecting significant changes in the global trade structure, and for each one, we calculated a neighborhood matrix.

- 2000-2011: A period that witnessed the 2008 financial crisis and occurred before the Arab Spring which destabilized the MENA region.
- 2012-2022: A relatively recent period characterized by trade changes (post-financial crisis, post-Arab Revolution, and COVID-19).

Secondly, we estimated the GVAR for each weighting structure. Finally, we test the stability and robustness of the main findings (notably, the contribution of regional factors to economic volatility), i.e. we examine whether our empirical results remain qualitatively similar despite changes in the weighting structures.

To this end, we conducted a "coefficient stability test" to verify whether the estimated *coefficients of regional factors* remain relatively constant over time, and if their impact on the dynamics of MENA countries remains valid across the sub-periods. Statistically, we test the null hypothesis H_0 (regional factors coefficients are stable between the two sub-periods) against the alternative hypothesis H_1 (regional factors coefficients change between the two sub-periods). This involves a coefficient difference test (Wald test) to determine whether the differences between the estimated coefficients are statistically significant (see table 9 in appendix).

The p-value is greater than 0.05, and the Wald statistic for regional factors is 1.17, inferior to χ^2 critical value (3.84). So, we do not reject (H_0) of regional factors coefficient stability; the difference between the regional coefficients for the 2 sub-periods is not statistically significant, and there is no significant difference in the impact of regional factors between the 2 sub-periods. We are therefore reassured that the effect of trade exchanges structure on economic volatility has not changed over these two periods.

3. ESTIMATIONS RESULTS: DOMESTIC VS INTERNATIONAL DETERMINANTS OF MENA BUSINESS CYCLES

We are now able to assess the dynamic propagation of foreign shocks on the MENA region according to their geographical origin. The exercise we consider is the forecast error variance decomposition (GFEVD), adapted for VAR models by Pesaran and Shin (1998), Pesaran et al. (2004), and Dees et al. (2007b). This allows for a better understanding of the underlying dynamics and helps analyze the role of foreign factors relative to domestic factors in explaining the variance of errors. This analysis, based on the orthogonalized variance-covariance matrix, is conditioned by the set of non-orthogonalized shocks and allows for contemporaneous correlation between shocks and those from other equations. The proportion of forecast error variance at *n* steps for the *l-th* element of x_t explained by the innovations of the *j-th* element can be expressed by Eq .10 as follows:

$$GFEVD\left(x_{(i)t}; u_{(j)t}; n\right) = \frac{\sigma_{jj}^{-1} \sum_{l=0}^{n} \left(s_l' F^n G^{-1} \sum s_j\right)^2}{\sum_{l=0}^{n} s_l' F^n G^{-1} \sum G'^{-1} F'^n s_l} \tag{10}$$

with σ_{jj}^{-1} notes the *jj-th* element of the variance-covariance matrix $\sum$ et *n* the forecast horizon.

We aim to analyze the contribution of different shocks to the forecast error variance of output and inflation in MENA countries, depending on their origin, whether is domestic, regional (if originating from other MENA countries), or international (if originating from the industrial economies, US, China and Euro Area). The results are presented in Tables 9-10. The first two columns indicate the countries of interest and the quarter preceding the shock. The following columns report the percentage contribution of the different shocks originating in different geographical regions: Panel [A] refers to the contribution of domestic shocks (i.e. y, π, r, e and q). Panel [B] summarizes the contribution of regional shocks, i.e. from other MENA countries. Panel [C] summarizes the impact of international shocks originating from the three industrial economic blocs (US, China, Euro Area). Finally, Panel [D] provides an overall comparison of the domestic contribution *vs* the foreign contribution (regional and international).

3.1. Domestic shocks impact

Concerning the variability of production, the main results show that real disturbances (output it-self) are prevalent and persistent over the entire forecast horizon, particularly for countries such as Tunisia, Morocco, Egypt and Saudi Arabia. Although the importance of these supply shocks is gradually decreasing, it remains significant and permanent. For Jordan and UAE, real shocks appear to be comparatively less pronounced and begin to fade more quickly from the 12th quarter.

Nominal/financial factors, over the whole forecast horizon, appear to play a modest role in comparison with real shocks. Their effect is more likely to be present in the short term. Globally, for the MENA countries, real interest rates and real equity prices, for example, don't seem to be the main source of output variability, and it is difficult then to consider the financial factors as an important channel of transmission of foreign shocks. In comparison with Tunisia and Morrocco, these factors tend to play relatively a more important role in Saoudi Arabia, UAE, Jordan and Egypt. We remind that in this section, the goal is to identify the sources of shocks based on their geographical origin. So here, we just tried to distinguish between the contribution of "real" and "nominal/financial" variables, and the result requires careful interpretation. In fact, as mentioned above, the GVAR identification strategy and the GFEVD tool do not enable economic identification of shocks but rather a meaningful characterization of disturbances *based on their geographical origin*.

Table 11 shows that the GFEVD estimates for inflation are broadly supportive of the estimates obtained for the GDP variability analysis. The domestic real shocks contribute significantly to explaining the price level. Their explanatory power persists in the medium and long term. The nominal impulse appears to explain a significant part of the inflation variabilities along different horizons.

3.2. Regional and international shocks *vs* domestic shocks

The first remarkable point concerns the regional factors and their very modest contribution to MENA domestic variability. They appear to be sensibly more pronounced for the "Middle East" countries – Egypt, Saudi Arabia, Jordan, and the UAE (varying between 9% and 12%) – than for North Africa countries, Tunisia and Morocco (varying between 2% and 4%). A possible explanation is that the Gulf countries tend to experience more common events, whether related to geopolitical issues or to their reliance on the same export product, oil and gaz.

Overall, this finding does not support the existence of a significant regional component for MENA business cycles. This regional divergence could be explained by the insignificant intra-regional exchanges(8), disparities in the productive (specialization) structures, and the absence of any regional policy coordination. This is consistent with Garfa (2013), despite the use of a different approach based on dynamic factor models designed for assessing the importance of global factor and spillover effects in explaining intra-regional symmetry of MENA countries. The author demonstrated that episodes of symmetry in this region are fundamentally driven by extra-regional factors rather than strong intra-regional interdependencies, and that the MENA is significantly affected by the dynamics of major industrialized countries.

However, our result contrasts with other studies witch highlighted the significant role of regional factor. Boschi et al. (2015) for example showed that regional factors explain more than half of the product fluctuations in the case of European countries. Fidrmuc and Korhonen (2006) mentioned the importance of the regional factor between the Eurozone and Central and Eastern European countries. Boschi and Girardi (2011), using the GVAR approach, showed the existence of a significant role of regional factors in the case of Latin American countries.

Panel [C] of table 10 in appendix quantifies the contribution of external shocks emanating from the 3 major industrial blocks, the US, Euro Area and China. The results show a high degree of similarity in the impact of these shocks on real GDP variability of MENA countries. Most short- and long-run fluctuations in output are due to these industrial shocks rather than regional ones. The impact of these industrial factors appears to be increasing significantly in the long term. The MENA region is strongly and significantly impacted by the dynamics of the industrial economies. They account for a large percentage of product dynamics, varying for example between 43% and 76% for Tunisia, and between 41% and 74% for Saudi Arabia.

More specifically, for Tunisia and Morocco, the Eurozone appears to contribute more to the domestic variability than the US and China. This is expected as these two North African countries have signed free trade agreements with the European Union since the 1990s, and around 75% of their commercial trade occurs with Europe. In contrast, the results are reversed for Middle Eastern countries, where the influence of the US and China is significantly greater compared to that of the Euro Area. We observe also that, for the Gulf countries, China plays a role almost as important as that of the US, a result that confirms the significance of China's recent rise as a key locomotive of the global economy. Our results are consistent with Cashin et al. (2012). They estimated a GVAR to analyze the impact of shocks from systemic economies (China, Euro Area, and US) on the MENA region, as well as the effects on the rest of the world of shocks emanating from the Gulf Cooperation Council (GCC) region and MENA oil-exporting countries. Their impulse response function exercise showed that the spillover effects from China, Euro Area to the MENA region are strongly significant. However, they highlighted that the MENA region is largely more sensitive to the dynamics of the Chinese economy compared to the impact of the Euro area and the US. We just notice that the critical difference between their paper and our study is that, besides the fact that we identify shocks according to their

[8] This interpretaion is corroborated by Graph 1, analyzed earlier.

geographical origine, our goal was to examine the role exerted by neighbor countries on each MENA country's business cycle to assess the contribution of *regional factors*.

In the last column (Panel [D]), we show that the share of domestic production variability in MENA countries is explained by both domestic and international shocks. The importance of domestic shocks seems to be confirmed mainly in the short and medium term, while the importance of external shocks (total foreign factors) tends to increase in the long term and can even reach up to 70% and 86% of GDP variability.

The cyclical behavior of inflation (table 11 in appendix) appears to be explained by most disturbances, both domestic and international (US, Eurozone, China). The impact of international shocks on prices appears to increase over time. Intuitively, this implicitly refers to the functioning of markets and the institutions that govern them, suggesting the possible existence of real and/or nominal rigidities that could characterize the dynamics of business cycles in MENA countries. The regional factors are also insignificant in explaining the price dynamics, in both the short and long term and across the entire panel, varying between 1% and 3%.

CONCLUSION

Using a global vector autoregressive (GVAR) model, covering 16 countries grouped into nine country/regions, this paper evaluates the contribution of domestic, regional and international shocks in explaining output and inflation fluctuations in MENA region. Quarterly data over the period 2000:1–2022:4 were used and a GVAR model was constructed and estimated to include six MENA countries (Tunisia, Morocco, Egypt, Saudi Arabia, Jordan, and the United Arab Emirates) as well as three major industrial economies (US, China and Euro Area).

Our main findings can be summarized as follows. Regional factors do not appear to contribute in any way to explain the variability, neither of the output nor of the inflation in the MENA region over different horizons. This result does not support the existence of a significant regional component in the common business cycle dynamics of MENA countries where their cyclical dynamics are far from being dependent on intra-regional interdependencies. Eventually, this regional divergence could be explained by the modest intra-regional trade among MENA countries, as well as by disparities in their productive structures, and the absence of any regional policy coordination. Hence, discussing for example of an eventual common monetary zone for MENA countries, or even the adoption of a common exchange rate policy, does not seem to be a wise decision. Their disparity in terms of international specialization and economic heterogeneity makes it difficult to address such issues.

The MENA region is found to be significantly affected by domestic shocks and by the dynamics of the major industrialized countries. While the regional factor is not significant, domestic and international factors (originating from industrial countries) account for the main share of output and inflation fluctuations in MENA countries. More specifically, over the entire forecasting horizon, real domestic disturbances are predominant and persistent in explaining output variability. Nominal/financial domestic factors appear to play a much less significant role, and their impact is primarily observed in the short term.

The contribution of external disturbance sources originating in the three major industrial blocs, the Euro Area, the US and China, accounts for a significant percentage of the variance in MENA domestic variability. For countries such as Tunisia and Morocco, it's the Euro Area that appears to play a relatively more important role than the US and China. In contrast, the findings are reversed for the Middle East countries, where the impact of the US and China is significantly more pronounced compared to the Euro Area. We observe also that for the Gulf countries, China plays a role almost as important as that of the US, a result that confirms the significance of China's recent rise as a key locomotive of the global economy.

Finally, the variability of output and inflation in MENA countries is explained by both domestic and international shocks. The importance of domestic shocks appears to be confirmed mainly in the short and medium run, while the impact of international shocks, although relatively weaker in the short run, tends to increase in the medium and long run.

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APPENDIX

Table 1. Statistics description and data sources

Variables	Description
Real GDP	Average of 2000=100. Seasonally adjusted, in logarithms. Sources: Nominal Output: Volume of GDP in billions of national currency taken from the IFS. The code is 99B./CZF.... The World Bank (World Development Indicators). The countries that we add to the GVAR dataset of Smith and Galesi (2010) are: first, Tunisia, Morocco, Egypt and Jordan, and, for these countries, quarterly data are available, from the IFS 99BVPZF series. We just seasonally adjust these quarterly series using the U.S. Census Bureau's X-12 program in Eviews software. Secund, only for Saudi Arabia and UAE, that the annual GDP series were seasonally adjusted and interpolated to obtain the quarterly values.
Consumer Price Index (CPI)	Seasonally adjusted, in logarithms. Sources: CEIC and the IMF's International Financial Statistics (code 64...ZF... (2000=100)).
Nominal exchange rate	Sources: The IFS' series of National Currency per US Dollar, with code .RF.ZF... and also from series in CEIC collected from European Central Bank.
Nominal short-term interest rates	The series: Money Market Rate. Sources: IMF's IFS data (code 60B..ZF...).
Nominal equity price index	Sources: The IFS, OECD and Eurostat.
Oil price	Seasonally adjusted, in logarithm. Source: The price of Brent from IFS, with code 11276AAZZF.... and the quarterly Thomson Reuters/Jefferies CRB Index series from Bloomberg.
Trade flows	Bilateral data on exports and imports of goods and services, annual data. Source: IMF' Directions of Trade Statistics.

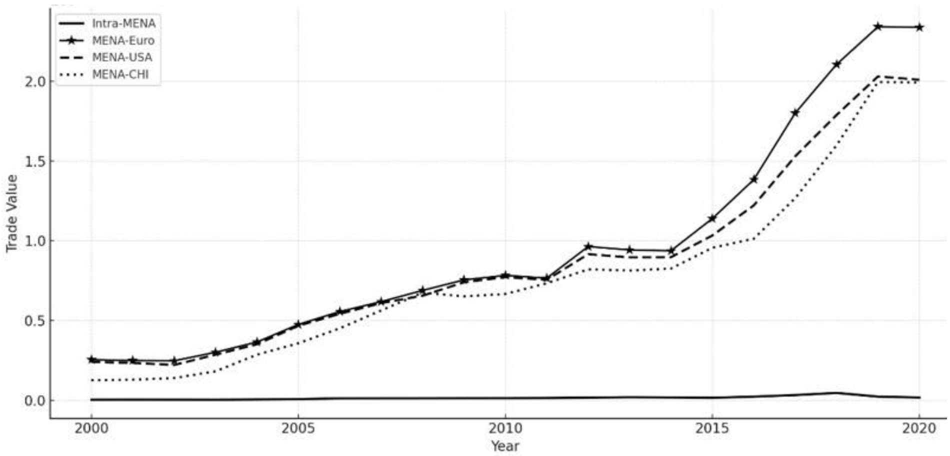
Note: The main data source is the CEIC database, which includes the IMF's international Financial Statistics database and the statistics from other sources as OECD (Economic Outlook), the World Bank (World Development Indicators). The data have been harmonized in several dimensions, including deseasonalization and the use of 2000 as the base year to express the series in real terms.

Table 2. Trade weights based on direction of trade statistics

	USA	Euro	China	TN	MAR	EGY	SAO	JOR	EAU
USA	0	0.208	0.188	0.097	0.08	0.087	0.177	0.079	0.084
Euro	0.353	0	0.192	0.075	0.081	0.066	0.123	0.042	0.068
China	0.178	0.225	0	0.066	0.076	0.101	0.188	0.079	0.087
TN	0.209	0.307	0.126	0	0.091	0.072	0.077	0.056	0.062
MAR	0.26	0.299	0.142	0.046	0	0.081	0.086	0.063	0.023
EGY	0.237	0.201	0.166	0.064	0.065	0	0.099	0.081	0.087
SAO	0.209	0.202	0.205	0.016	0.052	0.124	0	0.091	0.101
JOR	0.225	0.196	0.213	0.043	0.025	0.078	0.143	0	0.077
EAU	0.242	0.156	0.213	0.032	0.041	0.095	0.123	0.098	0

Data source: IMF's Direction of Trade Statistics. These ponderation coefficients were calculated as the shares of exports and imports between countries. Each row of the table provides the corresponding coefficients, with their sum equal to 1.

Graph 1. Evolution of MENA region trade (2000-2022)



Data in millions of USD.

Personal calculation. Bilateral exchanges (bilateral exports and imports). Source: IMF, Directions of Trade Statistics CD-ROM.

Table 3. ADF unit root test statistics

Variables	USA	EUR	CHIN	TN	MAR	EGY	SAO	JOR	UAE
y	-0.512	-2.415	-1.785	-2.748	-1.874	-1.984	-1.775	-1.846	-1.648
Δy	-2.311	-4.888	-5.126	-4.125	-3.989	-5.015	-6.458	-5.525	-4.449
π	-1.887	-1.789	**-3.421***	-2.013	**-3.205***	-1.888	-2.089	-1.754	-3.004
$\Delta \pi$	-6.885	-7.321	-5.641	-4.606	-5.558	-8.221	-4.771	-9.666	-10.17
e	-0.430	-1.333	-1.859	-2.850	-1.698	-1.555	-1.028	-1.421	-1.206
Δe	-4.870	-5.214	-4.448	-5.639	-6.248	-5.231	-3.999	-5.569	-6.318
r	-1.999	-2.164	**-3.188***	-2.113	-2.800	-1.458	-2.333	-2.129	-2.213
Δr	-6.406	-6.669	-5.635	-4.445	-6.512	-3.995	-5.210	-4.402	-6.669
q	-0.423	-0.845	-1.358	-2.135	-2.134	**-3.152***	-0.812	-2.361	-1.234
Δq	-4.182	-5.183	-6.208	-4.155	-7.183	-5.312	-6.123	-4.178	-5.179
y^*	-2.335	-2.132	-1.521	-2.843	-2.463	-1.333	-2.117	-2.088	-2.462
Δy^*	-4.381	-5.482	-4.662	-4.465	-3.778	-4.469	-5.463	-5.463	-5.462
r^*	-1.224	-2.443	-2.111	-1.452	-2.846	-2.446	-1.998	-2.664	-1.871
Δr^*	-4.546	-2.808	-3.998	-1.335	-4.139	-2.966	-2.664	-2.999	-3.436
e^*	-1.133	**-4.887***	-1.462	-2.503	-2.088	**-4.433***	-1.551	-2.337	-2.413
Δe^*	-5.775	-7.108	-5.869	-5.178	-4.446	-3.884	-6.897	-5.499	-4.676
q^*	-2.333	-2.518	**-3.089***	-1.859	-1.338	-2.615	-2.428	-1.918	-1.148
Δq^*	-4.168	-5.918	-6.718	-4.289	-4.448	-3.918	-7.891	-6.152	-5.128
P^*	-1.775	-	-	-	-	-	-	-	-
ΔP^*	-8.514	-	-	-	-	-	-	-	-

Note: Regressions include a constant and a linear trend, except for interest rates and inflation. The statistics are based on the AIC criteria. The 5% critical value of the ADF statistic including the trend and intercept is -3.47, while the value without the trend is -2.91.

Table 4. Weak exogeneity test for country-specific foreign variables and oil prices

Country/Region	F-stat	Foreign variables				Oil price
		y^*	r^*	e^*	q^*	P^*
USA	F(2,53)	0.72	0.29	1.12	0.88	-
CHINA	F(4,54)	0.66	0.45	1.25	0.71	0.71
Euro	F(4,54)	1.28	0.66	1.31	0.53	0.66
TN	F(3,55)	1.46	1.09	0.23	1.12	0.47
MAR	F(3,55)	0.69	0.31	1.19	1.06	0.42
EGY	F(2,56)	0.14	0.58	1.13	4.12*	0.64
SAO	F(4,54)	1.22	2.13	0.46	1.32	0.83
JOR	F(2,56)	3.77*	3.72*	0.19	0.81	1.11
UAE	F(3,55)	1.49	0.95	1.33	0.93	2.63

Note: (*) denotes a significance level of 5%.

Table 5. Contemporaneous effects of foreign variables on their domestic counterparts

Country/Region	Domestic variables				
	y	π	r	e	q
USA	0.532*** (0.193)	0.227*** (0.081)			
CHINA	0.152** (0.096)	1.630*** (0.028)	1.325*** (0.247)	2.719*** (0.883)	0.132* (0.143)
EURO	0.219 (0.172)	0.295*** (0.435)	0.461*** (0.169)	0.461*** (0.175)	1.365** (0.121)
TN	1.109*** (0.314)	0.888 (0.253)	0.347* (0.203)	0.699 (0.182)	0.102*** (0.424)
MAR	1.112*** (0.434)	0.931 (0.812)	0.147** (0.071)	0.936*** (0.124)	0.104** (0.037)
EGY	0.135* (0.162)	1.165 (0.792)	5.181** (2.476)	1.322** (0.158)	0.121 (0.358)
SAO	1.345*** (0.268)	0.822 (0.652)	2.731*** (0.903)	1.555 (0.521)	0.152* (0.178)
JOR	0.088 (0.236)	0.157 (0.351)	-0.152 (0.311)	0.142 (0.333)	1.135*** (0.054)
UAE	1.131** (0.569)	0.142** (0.086)	3.740*** (0.539)	0.077 (0.198)	0.141 (0.336)

Note: Values in parentheses are the standard deviations. (*) denotes a significance level of 5%; (**) denotes a significance level of 10%; (***) denotes a significance level of 1%.

Table 6. Co-integration rank statistics

H0	H1		Maximum Eigenvalue Statistics				Critical values 90%	95%
		USA	**EURO**	**CHIN**	**TN**	**MAR**		
r=0	r=1	82.33	72.78	79.36	72.45	67.28	49.59	52.63
r=1	r=2	52.39	55.09	**42.56**	**38.44**	**28.91**	43.66	46.66
r=2	r=3	**35.84**	**37.45**	34.15	28.71	23.51	37.28	40.12
r=3	r=4	20.46	27.45	16.91	24.55	21.36	30.54	33.26
		EGY	**SAO**	**JOR**	**UAE**			
r=0	r=1	101.05	77.63	88.35	98.19		49.59	52.63
r=1	r=2	**39.22**	64.31	51.46	77.75		43.66	46.66
r=2	r=3	30.12	51.29	**29.33**	49.78		37.28	40.12
r=3	r=4	19.66	**24.55**	22.22	**19.34**		30.54	33.26
			Trace Statistics					
		USA	**EURO**	**CHIN**	**TN**	**MAR**		
r=0	r=1	145.31	168.22	144.12	179.42	202.16	135.8	141.2
r=1	r=2	124.66	133.11	**92.19**	**88.74**	**82.15**	102.5	107.6
r=2	r=3	**58.37**	**65.55**	62.18	65.13	46.55	72.33	76.82
r=3	r=4	38.88	32.21	45.99	41.36	36.96	46.10	49.52
		EGY	**SAO**	**JOR**	**UAE**			
r=0	r=1	199.11	177.53	172.49	193.63		135.8	141.2
r=1	r=2	**92.64**	**92.49**	**89.12**	**97.13**		102.5	107.6
r=2	r=3	63.11	56.87	62.38	59.79		72.33	76.82
r=3	r=4	39.64	40.33	42.16	32.19		46.10	49.52

Note: The critical values are taken from Pesaran et al. (2000).

Table 7. VARX* order and number of co-integration relationships in the country-specific models

Country/Region	Co-integration relationships	VARX*(p_i, q_i)	
		p_i	q_i
USA	2	2	1
CHINA	2	2	1
EURO	1	1	1
TN	1	1	1
MAR	1	1	1
EGY	1	1	1
SAO	1	2	1
JOR	1	2	1
UAE	1	1	1

Table 8. Misspecification tests statistics

Country/ Region		y	π	r	e	q	P
USA	F(4,55)	3.972* [0.015]	1.412 [0.037]	0.855 [0.154]	0.486 [1.134]	0.771* [0.01]	2.539 [0.233]
EURO	F(4,59)	1.344** [0.000]	1.175 [0.074]	2.133 [0.789]	1.123 [0.225]	1.458 [0.277]	
CHINA	F(4,59)	1.149 [0.307]	1.373 [0.943]	1.552 [0.372]	1.733** [0.000]	1.844 [0.151]	
TN	F(4,58)	1.821 [0.213]	2.119* [0.112]	0.147* [0.001]	0.782 [0.104]	1.555** [0.001]	
MAR	F(4,58)	0.811* [0.01]	0.832 [0.253]	0.922 [0.145]	0.803 [0.213]	1.146 [0.403]	
EGY	F(4,59)	1.322 [0.142]	3.445 [0.242]	1.157 [0.315]	0.202 [0.307]	1.789** [0.000]	
SAO	F(4,53)	1.788 [0.053]	0.784* [0.02]	1.721** [0.000]	2.614 [0.143]	1.632 [0.256]	
JOR	F(4,52)	1.323** [0.001]	1.253 [0.823]	3.217 [0.321]	2.272 [0.233]	1.394 [0.292]	
UAE	F(4,59)	0.857 [0.162]	0.987 [0.151]	0.768 [0.111]	1.403 [0.217]	0.721 [0.142]	

Note: These are the residual correlation tests. The numbers in brackets represent the probability values associated with the test statistics. The symbols "" and "**" indicate statistical significance at the 5% and 1% levels, respectively.*

Table 9. Coefficient stability test

Factors	Model. 1 (2000-2011)	Model. 2 (2012-2022)	
Regional factors coefficients	0.41	0.38	
Wald Stat. P-value	- -	- -	1.7 0.18**

After estimating the GVAR for 2 sub-periods, we evaluate the stability of the regional factors' coefficients. Statistically, we test the null hypothesis H_0 (the coefficients of regional factors are stable between the two sub-periods) against the alternative hypothesis H_1 (the coefficients of regional factors change between the two sub-periods). The Wald statistic is compared to the χ^2 critical value (3.84). (**) indicate statistical significance at the 5% level.

Table 10. Generalized variance decomposition of the output

Country	Horizon	Domestic factors [A]		Regional factors [B]	Industrial countries factors [C]			[D]	
		Real	Nominal & Financial factors		USA	EUR	CHINA	Total domestic factors	Total foreign factors
TUN	0	48.36	6.15	2.71	12.43	21.67	8.68	54.51	45.49
	4	40.33	7.11	3.33	17.12	22.09	10.02	47.44	52.56
	8	36.56	4.08	4.15	16.42	28.38	10.41	40.64	59.36
	12	27.36	2.91	3.44	20.74	33.03	12.52	30.27	69.73
	20	25.34	1.17	4.42	27.96	27.22	13.89	26.51	73.49
	40	17.92	2.25	3.79	26.45	37.11	12.48	20.17	79.83
MAR	0	45.19	8.33	4.48	14.11	16.64	11.25	53.52	46.48
	4	43.78	9.23	3.75	14.12	17.77	11.35	53.01	46.99
	8	44.14	7.14	4.17	12.03	20.26	12.26	51.28	48.72
	12	30.17	6.17	4.36	22.13	26.12	11.05	36.34	63.66
	20	28.14	5.38	4.18	23.13	27.52	11.65	33.52	66.48
	40	20.11	5.82	4.39	25.16	32.53	11.99	25.93	74.07
EGY	0	41.38	11.15	8.51	16.56	9.15	13.25	51.53	47.47
	4	35.34	12.78	9.96	18.31	11.25	12.36	48.12	51.88
	8	32.01	10.11	10.35	22.08	11.6	13.85	42.12	57.88
	12	32.64	9.08	11.22	20.22	12.59	14.25	41.72	58.28
	20	27.11	3.31	10.35	30.12	13.03	16.08	30.42	69.58
	40	26.31	4.27	10.44	31.52	12.21	15.25	30.58	69.42
SAO	0	35.33	13.18	10.12	18.14	8.28	14.95	48.51	51.49
	4	33.39	14.28	9.45	17.39	10.36	15.13	43.67	52.33
	8	23.44	13.15	10.01	21.28	12.06	20.06	36.59	63.41
	12	22.33	6.36	9.71	28.35	10.35	22.9	28.69	71.31
	20	19.2	4.33	10.15	29.31	14.56	22.45	23.53	76.47
	40	12.36	1.52	11.46	30.58	14.02	30.06	13.88	86.12
JOR	0	33.13	12.18	12.35	17.12	9.70	13.52	45.31	40.17
	4	33.51	12.01	10.25	17.14	12.81	14.28	41.52	38.20
	8	30.81	9.16	10.23	20.25	12.02	17.53	39.97	42.50
	12	24.13	5.34	11.47	25.78	13.66	19.62	29.47	50.91
	20	18.35	5.33	10.36	30.33	15.27	20.36	23.68	55.96
	40	14.09	4.85	11.12	30.12	16.31	23.51	18.94	57.55
UAE	0	33.62	14.17	10.74	18.25	9.15	14.07	43.79	52.21
	4	28.35	13.13	11.11	21.16	11.39	14.86	41.48	58.52
	8	23.44	9.52	12.13	23.02	14.66	17.23	32.96	67.04
	12	22.11	3.45	9.63	26.74	15.22	22.85	25.56	74.44
	20	15.08	4.11	9.68	29.42	18.39	23.32	19.19	80.81
	40	14.12	4.63	9.48	27.23	20.17	24.37	18.75	81.25

Table 11. Generalized variance decomposition of inflation

Country	Horizon	Domestic factors [A]		Regional factors [B]	Industrial countries factors [C]			[D]	
		Real	Nominal & Financial factors		USA	EUR	CHINA	Total domestic factors	Total foreign factors
TUN	0	34.15	31.21	1.65	11.54	12.33	9.12	65.36	34.64
	4	31.12	26.53	1.22	14.52	17.38	9.23	57.65	42.35
	8	27.56	23.52	1.62	14.11	21.63	11.56	51.08	48.92
	12	25.81	16.33	1.18	17.54	25.51	13.63	42.14	57.86
	20	20.71	15.1	1.67	21.33	26.08	15.11	35.81	64.19
	40	20.55	11.25	1.33	23.11	28.24	15.52	31.80	68.20
MAR	0	30.31	23.36	1.25	16.66	18.16	10.26	53.67	46.33
	4	28.55	22.63	1.33	16.77	18.36	12.36	51.18	48.82
	8	24.53	19.15	1.16	18.16	21.95	15.05	43.68	56.32
	12	20.19	15.65	1.53	22.07	24.01	16.55	35.84	64.16
	20	16.43	11.52	1.63	25.01	27.89	17.52	27.95	72.05
	40	14.52	8.46	1.11	26.48	30.25	19.18	22.98	77.02
EGY	0	33.25	28.13	2.23	15.01	10.14	11.24	61.38	38.62
	4	30.92	26.15	2.85	16.14	10.69	13.25	57.07	42.93
	8	28.43	24.16	1.83	18.57	12.25	14.76	52.59	47.41
	12	26.31	22.31	1.05	22.11	13.05	15.17	48.62	51.38
	20	26.34	23.43	1.31	19.77	14.13	15.02	49.77	50.23
	40	25.46	23.12	1.89	19.13	14.22	16.18	48.58	51.42
SAO	0	30.12	26.34	3.53	16.11	8.66	15.24	56.46	43.54
	4	28.53	22.66	2.11	19.26	10.17	17.27	51.19	48.81
	8	27.43	21.15	2.05	21.33	10.39	17.65	48.58	51.42
	12	26.55	17.43	1.81	22.43	11.43	20.35	43.98	56.02
	20	24.13	16.25	1.75	21.13	15.43	21.31	40.38	59.62
	40	24.42	16.23	1.04	22.36	13.49	22.46	40.65	59.35
JOR	0	26.45	27.36	2.67	17.53	9.66	16.33	53.81	46.19
	4	24.13	27.43	2.02	18.35	10.53	17.54	51.56	48.44
	8	23.57	25.63	1.82	20.52	11.21	17.25	49.20	50.80
	12	22.43	23.64	1.66	21.63	11.31	19.33	46.07	53.93
	20	22.42	21.32	1.53	22.16	11.42	21.15	43.74	56.26
	40	18.46	19.53	1.23	23.06	12.36	25.36	37.99	62.01
UAE	0	27.53	25.33	2.66	19.86	8.88	15.74	52.86	47.14
	4	24.33	24.25	2.12	20.49	10.29	18.52	48.58	51.42
	8	23.46	21.63	1.99	22.24	11.46	19.22	45.09	54.91
	12	21.18	20.36	1.75	23.35	12.83	20.53	41.54	58.46
	20	22.77	19.36	1.66	23.12	11.64	21.45	42.13	57.87
	40	22.43	21.46	1.89	23.38	11.43	19.41	43.89	56.11

Déterminants des cycles économiques dans la région MENA à l'aide d'une approche GVAR : le rôle des facteurs nationaux, régionaux et internationaux

Résumé – Cet article cherche à évaluer la contribution relative des facteurs régionaux, domestiques et internationaux dans l'explication des fluctuations de la production et de l'inflation des pays MENA. Adoptant une approche GVAR, nous estimons un modèle combinant des modèles vectoriels à correction d'erreurs des pays/régions dans lesquels les variables domestiques sont liées aux variables étrangères spécifiques aux pays. Un cadre global est conçu afin d'évaluer l'importance des différents chocs et canaux de transmission des cycles d'affaires à un niveau mondial. Le modèle est estimé pour 16 pays, parmi lesquels 8 pays sont regroupés en une seule économie, la zone euro, les USA, la Chine et 6 pays MENA, au cours de la période 2000-2022. L'identification des sources de perturbation selon leur origine géographique est faite en se basant sur l'exercice de décomposition de la variance des erreurs de prévision. Les estimations montrent que les facteurs régionaux ne contribuent en aucune manière à expliquer la variabilité de la production et de l'inflation des pays MENA. La dynamique des MENA ne semble pas dépendre des interdépendances intra-régionales, réfutant l'existence d'une composante régionale commune dans la dynamique cyclique de cette région. En revanche, les chocs internes et externes (en provenance des économies industrialisées) exercent un impact significatif sur la dynamique économique des MENA. Pour des pays comme la Tunisie et le Maroc, c'est la zone euro qui semble jouer un rôle relativement plus important que les Etats-Unis et la Chine. En revanche, les résultats sont inversés pour les pays du Moyen-Orient, où l'influence des États-Unis et de la Chine est nettement plus marquée que celle de la zone euro. Pour les pays du Golfe, il est également à noter que la Chine joue un rôle presque aussi important que celui des Etats-Unis.

Mots-clés
Cycles économiques
Co-mouvements internationaux
Pays MENA
Modèle GVAR
Estimation GFEVD