Published in the Russian Federation
Sochi Journal of Economy
Has been issued since 2007.
ISSN: 2541-8114
2022. 16(3): 198-212

www.vestnik.sutr.ru

UDC 33

Canonical Quarterly Projection Model for Monetary Policy Analysis and Forecasting

Denis Vintu [a, *]

[a] Moldova Academy of Economic Studies (MAES), Republic of Moldova

Abstract

The model introduced in this work is a small macroeconomic quarterly projection model, or QPM. We sometimes refer to it as a New Keynesian model. This model is based on the ideas of monopolistic competition and features nominal rigidities:

The model assumes that prices are sticky, meaning that the prices do not adjust immediately as underlying cost of production change.

Output in the short-run is demand-determined.

The model equations resemble the log-linearized equations of micro-founded DSGE (dynamic stochastic general equilibrium) models, or in other words, equations that are derived from optimization problems of economic agents or firms.

Some parts of the model are ad hoc, so they differ from the log-linearized equations in DSGE models. Such parts usually help us better approximate the data.

Unlike DSGE models, equation coefficients in the QPM are not derived from deep structural parameters, such as discount factor or risk aversion, but the coefficients are directly calibrated.

We argue that economic analysis stem from ignoring fundamanetal reality, that no (market system) may properly operate if uncontrolled identifications and transforming equations, hite new paragraph of economic behaviour.

Since old growth model namely Ramsey Cass Koopmans are sufficient rigid, and naive random walk path are describes ignoring incorporation of four very important items:

- Real interest rate;
- Possibility of dynamic inefficiency and transmission mechanism of monetary policy;
- Arbitrage;
- Ommited variables;
- Log-linearized presentation in DSGE form.

We formulate introdusing a macroeconometric-impulse data model under Canonical Quarterly Projection Model for Monetary Policy Analysis and Forecasting.

Keywords: quarterly projection model, real interest rate, DSGE.

1. Introduction

This paper presents a quarterly estimated structural macroeconometric model for Moldova, called the Quarterly Projectiont Model. This model was developed with his four uses in mind:

An assessment of the economic situation in the Republic of Moldova, macroeconomic forecasts, policy analysis, and a better understanding of how the market economy works.

Five key features of the model are highlighted. First, it treats Moldova as a small, open economy. Second, it is a medium-sized model, detailed enough for most purposes, but small

* Corresponding author
E-mail addresses: denis.vintu@hotmail.com (D. Vîntu)

enough to be manageable in the context of forecasting and simulation exercises. Third, the model is designed to have a long-run equilibrium consistent with classical economic theory, but its short-run dynamics are demand-driven. Fourth, the current version of QPM is mostly backwards. Including a lag variable reflects expectations. Finally, QPM uses quarterly frequency data to allow for a more comprehensive treatment of dynamics and is estimated (rather than adjusted) primarily based on historical data. This paper contains the following elements: First, we give an overview of the structure of the model and its long-term and short-term characteristics. In particular, it focuses on how the model reaches steady state. This is followed by a review of the most important behavioral equations. The extent to which standard behavioral equations can be fitted to the constructed historical Moldovan data. Finally, two exemplary simulation results are provided. Fiscal spending shocks and changes in interest rates.

As novelty of research, we argue that many confusions are due especially to the term error in the model. Due to rapid technical change and globalization, competition is becoming more and more intense, and the capacity to employ state-of-the-art technologies is increasingly crucial to succeed. That capacity is above all a function of the educational attainment and skills level of the workforce.

Countries may choose to build their industrial capabilities through domestic research and development.

2 Literature review

Our understanding of economic growth today is heavily based on the neoclassical growth model developed by Robert Solow (1956). In the Solow model, capital accumulation is an important factor contributing to economic growth. Productivity growth – measured as an increase in the amount of capital per worker, or an increase in output per worker due to capital accumulation (e.g. Fagerberg 1994). Capital deepening continues until the economy reaches a steady state – a point at which net investment grows with the labor force and the capital-to-labor ratio remains constant. The more the economy is below steady state, the faster it should grow (see, for example, Jones, 1998). In the steady state, all per capita income growth is due to exogenous technological change. It is assumed that the speed of technological processes is constant and not subject to economic incentives. Some authors argue that capital and labor can actually explain only a small part of output growth, and that the quality of labor (human capital) accounts for the unexplained growth, the Solow residual, in part. The endogenous growth theory, initiated by Romer (1986, 1990) and Lucas (1988), focuses on explaining the Solow residual. Technological change becomes endogenous to the model and is the result of the allocation decisions of agents (see Aghion, Howitt 1998; Veloso, Soto 2001). Technological progress is driven by R&D activity, which is driven by the purpose of private companies to profit from inventions. In contrast to other production inputs, ideas and knowledge are not competing (cf. Romer 1990).

In addition, new knowledge makes existing knowledge more productive, leading to greater economies of scale. Thus, an increase in GDP per capita does not reduce the marginal productivity of capital, and there is no need to equalize income across the country. Technological change and innovation are essential sources of structural change. In Schumpeter's view, innovation leads to 'creative destruction'. It is a process in which old technology industries and firms decline and new industries and firms emerge and grow (see Verspagen, 2000). More productive and profitable sectors and firms will crowd out less productive and less profitable sectors, increasing the productivity of the economy as a whole. Technological change is therefore at the heart of modern economic growth. Based on the observation that technological change since the Industrial Revolution has occurred mainly in the manufacturing sector, authors such as Kaldor (1970) and Cornwall (1977) argue that the expansion of this sector is the engine of economic growth. (cf. Verlag, 2000). Moreover, Cornwall (1976, 1977) believes that technological change in certain sectors of manufacturing is driving productivity growth in several other sectors. Manufacturing is a small part of the total, and its direct contribution to overall growth is small. Increasing manufacturing's share of output, often in response to changes in domestic demand and comparative advantage, accelerates sector growth and significantly increases aggregate output and labor productivity growth. In developed countries, research and development (R&D) activity is the main driver of technological change. However, this is not the only mechanism of technological change. Firms and individuals learn by doing, improving their output and productivity, even if their techniques and inputs do not change (see e.g. Arrow, 1962). As R&D activities in developing countries are relatively limited and far from technological frontiers, international technology diffusion is essential for improving productivity. International economic relations, especially international trade, but also foreign direct investment, are important channels for technology transfer and productivity growth. However, technology diffusion is effective only when the level of human resources is sufficiently high, the incentives to improve technology are strong, and the system works relatively well. One of the driving forces behind structural change is changing internal and external demand. Individuals with relatively low incomes spend a significant portion of their income on food. This share tends to decline as income increases while demand for finished goods increases. Similarly, as incomes continue to rise, demand for products increases at a declining rate, but demand for services increases rapidly. Changes in demand also change sectoral employment and production shares, affecting labor productivity in the economy. In addition, trade influences patterns of national specialization, speed of industrialization, or structural changes within industries. In an open trading system, countries tend to specialize in the production of commodities in which they have a comparative advantage and import commodities that are relatively expensive to produce domestically. The opening up of trade is also likely to bring foreign investment into the country.This is very important, especially during the early developmental stages. Also, productivity may improve as domestic firms face external competition. However, the composition of foreign trade and the openness of trade are also important (e.g. Amable, 2000; also Rodrik in this volume). Also, specialization itself does not necessarily lead to higher growth rates. This is most evident in developing countries that rely on commodity exports. Real international prices for non-oil commodities tend to fall over time and are highly volatile in the short term, so specialization in primary production rarely drives sustained economic growth (e.g. Arrow, 1962). reference). As R&D activities in developing countries are relatively limited and far from technological frontiers, international technology diffusion is essential for improving productivity. International economic relations, especially international trade, but also foreign direct investment, are important channels for technology transfer and productivity growth. However, technology diffusion is effective only when the human resource level is sufficiently high, the incentives to improve technology are strong, and the system works relatively well. One of the driving forces behind structural change is changing internal and external demand. Individuals with relatively low incomes spend a significant portion of their income on food. This share tends to decline as income increases while demand for finished goods increases. Similarly, as incomes continue to rise, demand for products increases at a declining rate, but demand for services increases rapidly. Changes in demand also change sectoral employment and production shares, affecting labor productivity in the economy. In addition, trade influences patterns of national specialization, speed of industrialization, or structural changes within industries. In an open trading system, countries tend to specialize in the production of commodities in which they have a comparative advantage and import commodities that are relatively expensive to produce domestically. The opening of trade is also likely to bring foreign investment into the country, which is very important, especially during the early developmental stages. Also, productivity may improve as domestic firms face external competition. However, the composition of foreign trade and the openness of trade are also important (e.g. Amable, 2000; also Rodrik in this volume). Also, specialization itself does not necessarily lead to higher growth rates. This is most notable for developing countries dependent on commodity exports. Real prices of international commodities other than oil have trended downward over time and are subject to significant short-term volatility, so specialization in primary production rarely facilitates sustained economic growth.

3. Results

Research Goals and Assumptions

1. Recognize monetary policy transmission mechanisms captured by the QPM.
2. Distinguish variables and parameters of QPM, including: 1) model coefficients; 2) observed and unobserved variables, 3) gaps and trends, 4) steady-states, and 5) shocks.
3. Understand the key four building blocks of the domestic part of QPM: 1) Aggregate Demand (ouput gap), 2) Aggregate Supply (inflation), 3) Uncovered Interest Rate Parity, and 4) Monetary Policy Rule.
4. Distinguish between long term trends and steady state parameters.

The Model

Why do we call this model a canonical QPM?

The simple version of the QPM assumes:

1. an inflation targeting central bank, which uses the interest rate as a key policy variable

2. a flexible exchange rate determination
3. rational expectations, which means that when agents build their expectations about macroeconomic variables, like inflation or exchange rate, they would use the model to project these variables, and use the projections as their best guess or expectations about the inflation and exchange rates in the future.

This model does not include specific features that would make it more suitable for a particular economy. For example, the model could include features such as dollarization, imperfect central bank credibility or expectation formation mechanism, which differs from rational expectations. The model could be adjusted for cases of commodity exporting countries or for countries that have a monetary policy strategy that is not inflation forecast targeting.

Also, the model does not include all sectors of the economy explicitly. For example, it does not feature endogenous fiscal and financial sectors, export industries etc.

These additional features could potentially be incorporated in the model, but that is beyond the scope of this course. Our goal in this course is to introduce the canonical QPM and see how it is implemented in MATLAB.

What you learn in this course will then help you build a tool, which is more suitable for a specific country.

Building Canonical Quarterly Projection Model for Monetary Policy Analysis and Forecasting

In the previous unit, we discussed what makes the QPM a canonical model. Here are some main characteristics of the canonical QPM:

1. It is a structural model because each key equation has an economic interpretation, but the equations are not fully micro-founded. In other words, for every key model equation that exists in the model we can explain an underlying economic mechanism that this equation approximates. For example, how the central bank sets the interest rate or how the output is determined. We will discuss this in more detail in this module.
2. It is a general equilibrium model because it describes how the equilibrium is established in the economy as a whole, and not only in some particular markets or sectors.
3. The model is stochastic because it allows for stochastic shocks in its equations. Later in the course, you will see a set of the so-called structural shocks in the key equations for domestic variables, such as aggregate demand shock, cost push shock, exchange rate shock, and monetary policy shock.
4. This model also assumes the rational formation of expectations for inflation and exchange rate or, in other words, model-consistent expectations.
5. The QPM is a tool suitable for monetary policy analysis and forecasting.

As you will see in week 2 of this module, one part of the QPM approximates the behavior of the inflation targeting central bank. In other words, the model features a monetary policy reaction function which summarizes how the central bank would change the key policy variable – the interest rate – in response to changing macroeconomic environment.

It is important to stress that this model is not a pure forecasting device as, for example, a simple reduced-form Vector-Autoregressive Model (VAR) would be.

The key purpose of our model is to help a central bank decide on an appropriate path for monetary policy, given an inflation target and the current and future macroeconomic conditions.

Policy Trilemma

As you might remember from other courses on macroeconomic policy, when deciding on which monetary policy strategy to pursue, the central banks face the so-called policy trilemma. But what is the concept of policy trilemma in our model?

1. Fixed exchange rate (Exchange rate arrangement).
2. Monetary policy independence (Monetary policy autonomy).
3. Full capital mobility (Capital control).

The QPM model has two large parts: domestic and foreign. The model puts emphasis on the domestic part.

The domestic part has four key blocks:

- Aggregate demand.

- Inflation, or sometimes we call it aggregate supply block.
- Exchange rate, or uncovered interest rate parity condition.
- Monetary policy reaction function, or the interest rate policy rule.

In the domestic part of the QPM, equations have what we call a structural representation.

Our canonical QPM captures how changes in the key policy rate are transmitted through the economy to ultimately influence output and our key policy objective variable (inflation).

From theoretical and empirical literature, which studies monetary policy transmission, we identify. The asset price channel, with wealth and cost of equity sub-channels

1. The credit channel, in which we further look at the bank lending and the balance sheet sub-channels.
2. The interest rate channel.
3. The exchange rate channel, including direct and indirect sub-channels.

The policy transmission mechanism that we approximate in our QPM is relatively simple and focuses on two channels; the exchange rate and interest rate channels.

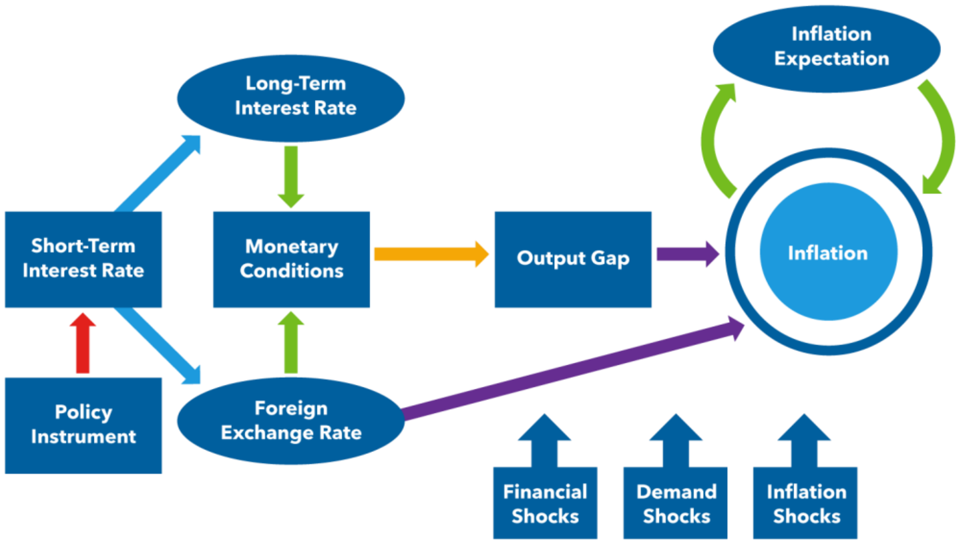

Fig. 1. Transmission mechanism of Monetary Policy

The transmission starts with the current and expected changes in the policy instrument. In our model this means that the key policy rate affects the current short-term interest rate and its expected levels. This in turn is transmitted to changes in the longer-term rates, which alters aggregate monetary conditions, aggregate demand and output, and ultimately inflation. This is the interest rate channel.

Changes in the interest rate also affect the nominal exchange rate, which is assumed to be flexible in the canonical setup. Further, changes in the exchange rate affect inflation directly via the cost of imported factors of production, and indirectly via changes in the relative prices of imported goods vis-à-vis domestic, and the corresponding shifts in aggregate demand between imported and domestic goods. Because of the changes in aggregate demand for domestically produced goods, domestic output and domestic cost pressures change as well, which then affects inflation.

The economy, and therefore the monetary policy transmission, is impacted by various shocks. We account for some of these shocks explicitly in our QPM. For example, the aggregate demand shock, cost push shocks, shocks to the nominal exchange rate and monetary policy shock – shock to the interest rate.

Building elements of the QPM

The building elements of the canonical QPM can be classified in three main dimensions: model equations, model parameters and model variables.

As you see here, the equations that appear in the model are classified as structural and reduced-form, or non-structural.

Model parameters can be separated into three groups: parameters that describe the model's steady-state, equation coefficients and standard deviations of shocks.

Model variables can be categorized as the observed and unobserved variables.

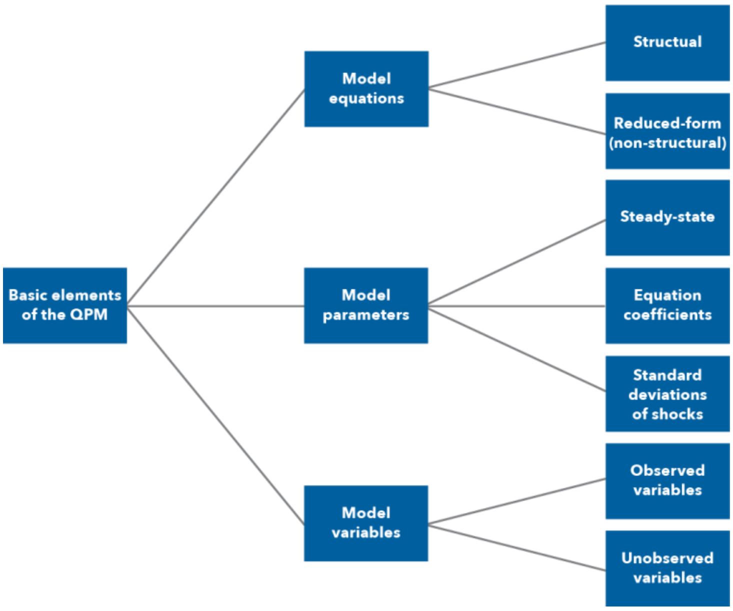

Fig. 2. Basic elements of the QPM

The main difference between equations in the structural and reduced forms is that we can provide a macroeconomic motivation to represent the structural form, but macroeconomic motivation is limited for equations in the reduced-form.

Structual Equations	Reduced Form Equations
Macroeconomic motivation	Autoregressions with limited macroeconomic motivation
Examples: Monetary policy reaction function; Phillips curve	Examples: Long-term rate of output growth

Fig. 3. Structural vs Reduce Form Equations

Several key stochastic equations for the domestic variables in the QPM are in the structural form.

The way the structural equations are named represents the economic essence of such equations. See the examples below:

In the second part of Module 1, we will introduce a structural equation for the domestic interest rate. The equation is called the Monetary Policy Reaction Function or the Policy Rule.

The Phillips curve is the equation that describes the relationship between the inflation and real marginal costs. This equation also belongs to the category of structural equations.

In contrast, equations in a reduced form usually describe the dynamics of a variable, but do not tell us much about the economics of the underlying processes. In fact, we often use simple autoregressions in such cases. See the example below:

The long-term (potential) rate of economic growth will be described in our model using an autoregressive process.

There are two types of variables in our QPM: observable and unobservable:

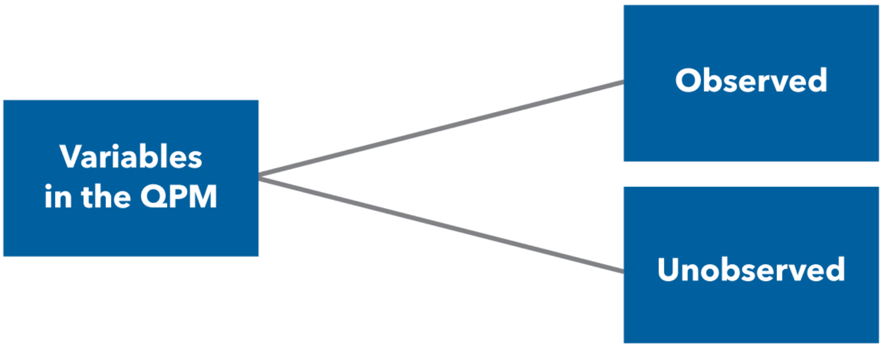

Fig. 4. Variables in the QRM

Information for observable variables is usually gathered and published by statistical offices or other institutions. In other words, such variables are measured. A variable for which we can find values in some statistical datasets compiled by Statistical Committees, Central banks, Ministries of Finance, etc. is typically an observed variable.

The consumer price indices, output volume, rate of economic growth, industrial production, unemployment rate, interest rates, and exchange rates are among the observed variables.

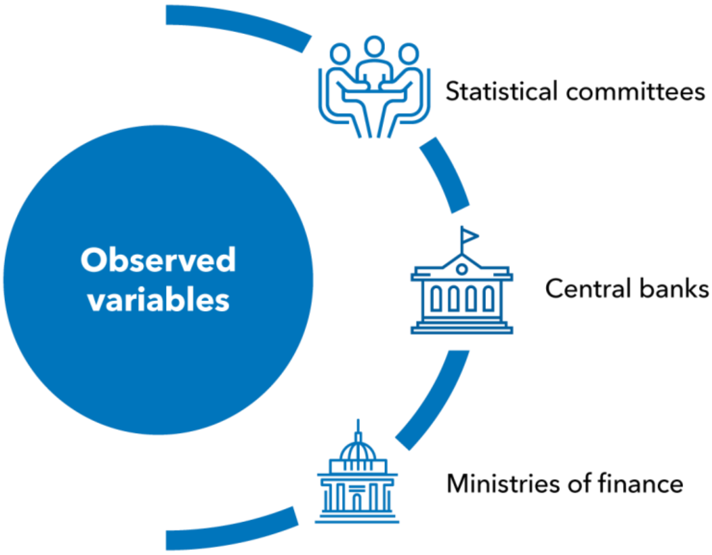

Fig. 5. Observed variables

In contrast, unobserved variables may not be immediately available from the statistical databases and would need to be inferred or, in other words, estimated from the observed information using some statistical techniques. This also means that the estimates of the same unobserved variable may vary with the technique that we apply.

The long-term trend in the level of real GDP or the real exchange rate trend are examples of unobserved variables.

The two key types of unobservable variables in our QPM are the long-run trends and gaps. This means that we decompose some of the observed variables into "trend" and "gap" components, or, in other words, get estimates of these components. The shocks in our model are going to be estimated as well and such can also be seen as unobserved variables.

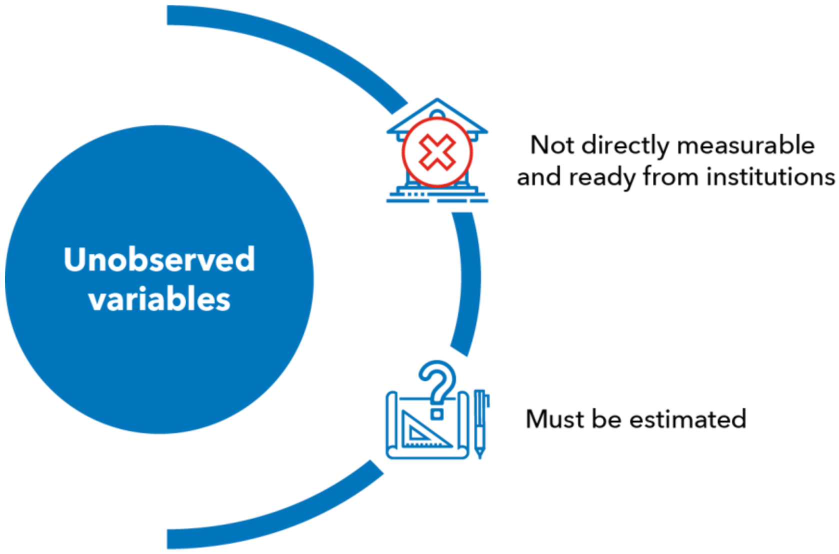

Fig. 6. Unobserved variables

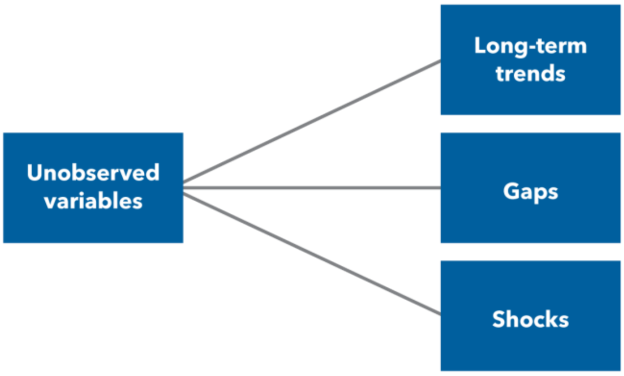

Fig. 7. Unobserved variables (description)

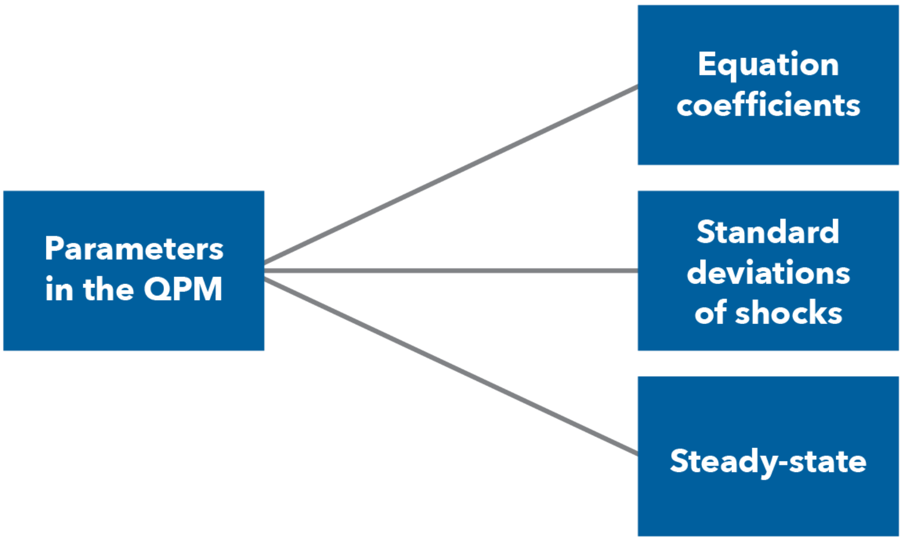

Fig. 8. Parameters in the QPM

Parameters in the QPM

There are three types of parameters in our model:

1. The coefficients in model equations:
2. In the equation for inflation, there is a coefficient which links the marginal costs to inflation. In the equation for output gap, there is a coefficient which defines the simultaneous impact of foreign demand on demand developments in our domestic economy. We will talk more about the equations and coefficients later in this module.
3. The standard deviations of shocks:
4. Calibrations of these parameters define which shocks tend to be larger in size.
5. For example, shocks that hit the output gap – the demand shocks or cost push shocks hitting inflation, or others. We will discuss this in modules 4 and 5.
6. The steady-state parameters:
7. This set of parameters defines the state to which our economy converges in the long run. We will discuss this when we differentiate between the long-run equilibrium (or trends) in our model and the steady-state.

In the next unit, you will learn about modelling the long-term trends in the QPM and the relationship between what we characterize as the long-term equilibrium in the model and the steady-state parameters.

The set of steady-state parameters include:

- Two inflation targets: domestic and foreign
- The steady-state level of the real interest rate, both domestic and for the foreign trading partner
- The rate of change in the real exchange rate
- The rate of output growth in the steady state

Steady state parameters $\bar{\pi}^{ss}$

Domestic inflation target $\bar{\pi}^{*ss}$

Foreign long-run inflation (target) $\bar{r}^{ss}$

Domestic real interest rate $\bar{r}^{*ss}$

Foreign real interest rate $\bar{\pi}^{ss}$

RER appreciation/depreciation $\Delta\bar{z}^{ss}$

Non-inflationary output growth $\Delta\bar{z}^{*ss}$

In what follows, we will consider the steady state as the characterization of equilibrium in domestic and foreign economies in a distant future.

In theory, the steady state is often understood as the equilibrium state of an economy that finally converged to a high-income level. For such an economy, the equilibrium rate of growth would be the same as the growth rate for other high-income level economies. In equilibrium, the domestic currency of such an economy should not appreciate or depreciate vis-à-vis other high-income economies. The equilibrium rate of return on investment in such an economy should be the same as the rate of return in other high-income economies and hence the level of the real interest rate should be the same.

In practice, we usually do not assume that the steady-state corresponds to reaching a high-income level. We think about the steady-state parameters as characterizing equilibrium in 10 or 15 years ahead. In particular, for developing and emerging economies, it may imply that their steady-state rate of economic growth should be higher than that of high-income economies and steady-state rate of change in the real exchange rate is non-zero.

In the next unit, we will discuss modelling the long-term trends in the QPM and the relationship between what we characterize as the long-term equilibrium in the model and the steady-state parameters

So far, you've learned that the equilibrium levels of variables – or, in other words, the long-term trends – in this model might change with time. This means that we need to describe the process or provide equations for the long-run trends.

Our simple QPM model does not allow us to impose much economic structure on the equations that describe changes in the long-term trends.

The reason for that is simple: central banks are primarily interested in analyzing economic developments at a business cycle frequency. This means that the central bank as an institution effectively implements counter-cyclical policy and focuses on the cyclical as opposed to the long-run dynamics. Therefore, it is crucial to understand and provide structural description for domestic macroeconomic variables and their cyclical dynamics. How variables are interrelated in the long-run is of secondary importance. Most of the equations for the long-term changes will have a simple autoregressive form.

There will be a couple of exceptions to this simple representation. In the second week of Module 1, we will talk about the consistency of trends and policy objectives in the long-run. You will see that some variables are interlinked in the long-run perspective in a particular way, consistent with underlying macroeconomic assumptions and therefore admitting some structure.

The equations describing an equilibrium may be set for a long-term value of a variable (level of the long-term trend) or for the rate of the change in the long-term trend.

You will also see that the autoregressive equations for trends essentially describe convergence to the steady-state values.

In the video below, we will have a look at a couple of examples of how we describe trends in the QPM.

One important variable that defines the equilibrium in the model is, of course, the domestic inflation target.

In the model, we describe the inflation target using the following autoregressive process:

$$\pi_t^T = t_1 * \pi_{t-1}^T + (1-t) * \bar{\pi}^{ss} + \varepsilon_t^{\pi^T}$$

In principle, inflation-targeting central banks should not change inflation targets very often.

However, central banks in developing and emerging markets may over time revise and gradually reduce the level of the inflation target.

There are four key variables in the model; the output gap, nominal interest rate, rate of inflation, and nominal exchange rate. All other variables in the model are either exogenous or can be obtained from identities containing these four variables.

With three equations and four variables, the model still is not completed. We need a fourth equation to complete the model.

The fourth equation is the monetary policy rule. In our canonical model, we assume that the central bank controls the interest rate. The monetary policy rule describes how the central bank should change the nominal interest rate in response to specific economic conditions; for example, inflation.

The monetary policy rule is a condition required to close the model and ensure a unique equilibrium. This means that the rule must ensure that the reaction of the central bank can steer the economy back to equilibrium whenever it's thrown off the equilibrium; by a shock, for example.

To better understand the rule, consider the Taylor rule. John Taylor introduced the Taylor rule in the early 1990s as a way to approximate and describe the behavior of the Federal Reserve, which is the United States' central bank, in response to changes in inflation.

So this is how the Taylor Principle works: the reaction of the monetary policy to inflation has to be strong enough to make the real interest rate follow the same direction of change as the nominal interest rate, so that the central bank can have a stabilizing effect on inflation and ensure a well-defined equilibrium for the system.

Now let’s see other types of monetary policy rules.

Foreign part of the model

Unlike in the domestic part of the model, there is no economic structure (or economic interpretation) in the foreign block. All variables in the foreign or external block follow simple, auto regressive processes:

Foreign output gap:

$$\hat{y}_t^* = \rho_{\hat{y}_t^*} \hat{y}_{t-1}^* + \varepsilon_t^{\hat{y}_t^*}$$

Foreign nominal interest rate:

$$i_t^* = \rho_i * i_{t-1}^* + (1-\rho_{i^*})(\bar{r}_t^* + \pi_t^*) + \varepsilon_t^{i^*}$$

Foreign real interest rate:

$$r_t^* = i_t^* - \pi_t^*$$

Foreign natural (trend) real interest rate:

$$\bar{r}_t^* = \rho_{\bar{r}_t^*} * \bar{r}_{t-1}^* + \left(1-\rho_{\bar{r}_t^*}\right)\bar{r}_t^{*SS} + \varepsilon_t^{\bar{r}_t^*}$$

Foreign real interest rate gap:

$$\hat{r}_t^* = r_t^* - \bar{r}_t^*$$

Foreign inflation rate:

$$\pi_t^* = \rho_\pi * \pi_{t-1}^* + (1-\rho_{\pi^*})\pi^{*SS} + \varepsilon_t^{\pi^*}$$

There is one exception in the variables: the equation for the foreign nominal interest rate. This equation shows an endogenous reaction to the foreign inflation and equilibrium real interest rate. Since these two variables are themselves exogenous, the foreign interest rate follows a de facto exogenous path as well.

The exogeneity of the foreign block means that it will never be affected by developments in the domestic economy. However, the opposite is not true. Foreign variables will affect the small open domestic economy through the Aggregate Demand (foreign output gap and foreign inflation in MCI), Inflation (foreign inflation rate in RMC), UIP (foreign interest rate), and the purchasing power parity (PPP) condition (foreign inflation rate) which will be discussed in the next unit.

The QPM is sometimes called a gap model. This means that it treats some variables in deviation from their long-term equilibrium values, or trends. So it is necessary to separate cycles from trends for such variables.

The trends are treated as exogenous to monetary policy, as the natural or equilibrium trajectory of variables in the absence of shocks.

Exogeneity means that monetary policy cannot influence trends. However, we still need to estimate these trends and ensure that they are mutually consistent with policy objectives and treated consistently with them. The first instance where the need for such consistency appears is in the so-called Purchasing Power Parity (PPP) condition.

In this video, we will discuss the Power Parity condition or PPP condition.

Domestic part of the model

1) The aggregate demand, which relates the economic activity (measured by the output gap) to monetary conditions and foreign demand (measured by the output gap in the trading partner)

2) The Phillips curve, which describes how inflation reacts to expected inflation and real marginal costs

3) The UIP condition, which establishes a non-arbitrage condition between investing in domestic and foreign assets (The Uncovered Interest Rate Parity (or UIP) condition, both with country risk premium and backward-looking behavior

4) The monetary policy rule, which captures how the central bank reacts by changing the nominal interest rate in response to deviations of inflation from its target and to the output gap (The Monetary Policy reaction function, or the interest rate policy rule.

Legend for basic variable names

CPI, CPI (index)

GDP, Real GDP level (index)

S, Nominal Exchange Rate (LCY per 1FCY)

Z, Real Exchange Rate (index)

RS, Nominal (Policy) Interest Rate (% p.a.)

RR, Real Interest Rate (% p.a.)

RSNEUTRAL, Nominal Neutral Interest Rate (% p.a.)

PREM, UIP (RISK) Premium (% p.a.)

MCI, Real Monetary Conditions Index (%)

RMC, Real Marginal Cost (%)

1) Fisher equation, which determines the relationship between nominal interest rate i_t, real interest rate r_t, and expected year-on-year (yoy) inflation $E_t[\pi^4_{t+1}]$.

$$r_t = i_t - E_t[\pi^4_{t+1}]$$

2) Real exchange rate in log-linearized form z_t is equal to the sum of nominal exchange rate s_t and foreign price index p^*_t minus domestic price index p_t.

$$z_t = s_t + p^*_t - p_t$$

3) Nominal neutral interest rate $i^{neutral}_t$ is equal to the sum of equilibrium (or trend) real interest rate $\overline{r_t}$ and expected inflation $E_t[\pi^4_{t+1}]$.

$$i^{neutral}_t = \overline{r_t} + E_t[\pi^4_{t+1}]$$

4) AR(1) process for real exchange rate trend depreciation.

$$\Delta\overline{z_t} = p^{\Delta\bar{z}} \bullet \Delta\overline{z_{t-1}} + (1\text{-}\overline{z_t}) \bullet \overline{z_{ss}} + \varepsilon^{\Delta\bar{z}}_t$$

IS curve

$$\hat{y}_t = b_1 * \hat{y}_{t-1} - b_2 * mci_t + b_3 * \hat{y}^*_t + \varepsilon^{\hat{y}}_t$$
$$mci_t = b_4 * \hat{r}_t + (1 - b_4) * (-\hat{z}_t)$$

Phillips curve

$$\pi_t = a_1 * \pi_{t-1} + (1 - a_1) * (E_t[\pi_{t+1}]) + a_2 * rmc_t + \varepsilon_t^{\pi}$$
$$rmc_t = a_3 * \hat{y}_t + (1 - a_3) * \hat{z}_t$$
$$\pi_{t+1}^e = E_t[\pi_{t+1}]$$

Taylor rule

$$i_t = g_1 * i_{t-1} + (1 - g_1) * (i_t^{neutral} + g_2 * (E_t[\pi_{t+4}^4] - E_t[\pi_{t+4}^{TAR}]) + g_3 * \hat{y}_t) + \varepsilon_t^i$$
$$i_t^{neutral} = \overline{r_t} + E_t[\pi_{t+4}^4]$$

UIP condition

UIP condition, which describes the behavior of the nominal exchange rate:

$$s_t = (1 - e_1) * (E_t[s_{t+1}]) + e_1 * \left(s_{t-1} + \frac{2}{4} * (\pi_t^{TAR} - \bar{\pi}_t^*)\right) + \frac{-i_t + i_t^* + prem_t}{4} + \varepsilon_t^s$$

Data

The data series used in the empirical analysis have a quarterly frequency and were obtained from the National Bureau of Statistics for the Economy of the Republic of Moldova, as well as from the Area Wide Model (AWM) database (for more details see Fagan et al., 2005 as well as the website – https://eabcn.org/page/area- wide-model). The analyzed periods are 2000: 1–2021: 1. Regarding the determination of potential GDP, the HP filter was used to estimate it. As primary references or used two sources mainly as follows: https://www.mathworks.com/help/econ/hpfilter.html but also the article by Robert J, Hodrick and Edward C. Prescott (Hodrick, 1997) from 1999. Phillips used in its unemployment rate model, however lately, the output gap is being used more and more frequently due to the problems encountered by measuring NAIRU, the natural unemployment rate, this being the reason why we used the production gap. We assumed that there are different models of dynamic Phillips Curve (PC)- price adjustment in a common framework. The system draws intensely on the model of exogenous ostensible inflexibility and the model of inflation targeting. Time is discrete. Each period, incompletely competitive firms deliver output utilizing labor as their as it were input. As within, the production function is one-for-one; in this way total output and total labor input are rise to. The model excludes government purchases and worldwide exchange, total consumption and total output are equal. Households maximize utility, taking the ways of the real wage and the real interest rate as given. Firms, which are claimed by the households, maximize the present discounted value of their profits, subject to constraints on their price-setting (which shift over the models we'll consider). At last, a central bank decides the way of the real interest rate through its conduct of money related arrangement.

4. Conclusion

Initial conditions significantly impact on whether major industrial development occurs, and whether industrialization accelerates economic growth and reduces poverty. Fundamental conditions for sustainable economic growth and industrial development include political, social and macroeconomic stability, well-functioning institutions and rule of law. The role of government is essential in creating these. If these framework conditions are lacking, investments – whether foreign or domestic – are likely to be few and growth limited and fluctuating. Economic instability is likely to impact especially the poor, as has happened e.g. in Mexico in the mid-1990s and in Indonesia in the late 1990s. In Korea and Taiwan, on the other hand, economic development has been much more stable.

Government has an important role in infrastructure and human resources development as well as in encouraging and supporting innovation and technological upgrading. For poor people, education is often an avenue to better employment and income opportunities. The existence of universal education, as in China or Korea, gives the poor better possibilities to participate in the development process.

At the outset of their development, countries may rely on primary resources or a cheap labour force, and all the countries analyzed here have begun their development process by relying on one or both of these factors. In the long run, however, investment in human capital and technological upgrading are essential if a country wishes to remain internationally compet- itive and sustain economic prosperity. Korea and Taiwan are good examples of countries where human resources development has had a significant impact on industrial development and broad economic growth.

Today, the degree of policy freedom left to developing countries is narrower than it was some decades ago, even if some well-planned government intervention may seem justified based on the success stories of the earlier decades. However, governments still have a primary role in promoting sustainable economic growth and especially poverty-reducing growth. In addition to ensuring stability, well-functioning institutions and appropriate legislation (e.g. labour laws), other essential government actions are related to skills formation, technology support, innovation financing, infrastructure development, and provision of a variety of public goods. All these have an impact on the growth and trade performance of a country. Rapid economic growth as such tends to decrease poverty. Rapid growth may increase income inequality, but this is not inevitable. Whether or not it does, depends not only on the skill bias of technical change in an economy but on human capital formation measures and on the nature of taxation and expenditure policies. In addition to promotion of job creating industries and SMEs and supporting the creation of domestic linkages, inequality can be decreased e.g. by subsidized access to education, subsidized housing, progressive taxation or economic asset redistribution like land reforms.

5. Acknowledgements

This article is a result of the grant (general budgetary fund (Art. 13 para, 2004)) "ASEM doctoral grants for the period 2019-2023" – contract number: ASEM-2019/11/05/NR/89/ST; financing from the state budget during the doctoral studies, but also value-added as an post-planned activity I carried out as a scientific researcher at the National Institute for Economic Research (NIER) in Chisinau, Moldova – between May 2019 and December 2019.

References

Art. 13 para, 2004 – Art. 13 para of the Code on Science and Innovation of the Republic of Moldova, no. 259/2004. Official Monitor of the Republic of Moldova, 2018, nr. 58-66, art. 131.

Aghion, Howitt, 1998 – *Aghion, P., Howitt, P.* (1998). Endogenous growth theory. MIT Press, Cambridge.

Amable, 2000 – *Amable, B.* (2000). International specialization and growth. *Structural Change and Economic Dynamics*. 11: 413-431.

Arrow, 1962 – *Arrow, K.* (1962). The economic implications of learning by doing. *The Review of Economic Studies*. 29(3): 155-173.

Oya et al., 2006 - Oya, C., Debrun, X., Ostry, J. (2006). Primary Surplus Behavior and Risks to Fiscal Sustainability in Emerging Market Countries: A 'Fan-Chart' Approach. IMF Working Paper 06/67. Washington: International Monetary Fund.

Chen, Ravallion, 2004 – *Chen, S., Ravallion, M.* (2004). How have the world's poorest fared since the early 1980s? World Bank, processed.

Cimoli, Katz, 2002 – *Cimoli, M., Katz, J.* (2002). Structural reforms, technological gaps and economic development. A Latin American Perspective. Desarrollo Productivo Series No. 129, ECLAC, United Nations, Santiago, Chile.

Congressional Budget Office – Congressional Budget Office, Budget and Economic Data, 10-Year Economic Projections. [Electronic resource]. URL: https://www.cbo.gov/about/products/budget-econo mic-data#4

Cornia, 2005 – *Cornia, G.A.* (2005). Policy reform and income distribution. Paper presented in the DESA development forum: Integrating economic and social policies to achieve the UN development agenda. New York, 14-15 March.

Cornwall, 1977 – *Cornwall, J.* (1977), Modern capitalism. Its growth and transformation. London, Martin Robertson.

Cornwall, 1976 – *Cornwall, J.* (1976). Diffusion, convergence and Kaldor's laws. *Economic Journal*. 86: 307-314.

Del Negro et al., 2007 – *Del Negro, M., Schorfheide, F., Smets, F. and Wouters, R.* On the Fit of New Keynesian Models. *Journal of Business & Economic Statistics*. 25(2): 123-162.

DeLong, 2001 – *DeLong, J.B.* (2001). India since independence: an analytic growth narrative. July 2001. [Electronic resource]. URL: https://www.researchgate.net/publication/246458096_India_Since_Independence_An_Analytic_Growth_Narrative

Dollar, Kraay, 2004 – *Dollar, D., Kraay, A.* (2004). Trade, growth, and poverty. *The Economic Journal*. 114: F22-F49.

Helpman, 2004 – *Helpman, E.* (2004). The mystery of economic growth. The Belknap Press of Harvard University Press, 223 p.

Henderson et al., 2002 – *Henderson, J., Hulme, D., Phillips, R., Kim, E.M.* (2002). Economic governance and poverty reduction in South Korea, 44 p. [Electronic resource]. URL: https://www.researchgate.net/publication/265743723_ECONOMIC_GOVERNANCE_AND_POVERTY_REDUCTION_IN_SOUTH_KOREA

Hodrick, Prescott, 1997 – *Hodrick, R.J., Prescott, E.C.* (1997). Postwar U.S. Business Cycles: An Empirical Investigation. *Journal of Money, Credit, and Banking*. 29(1): 1-16.

International Monetary Fund, 2002 – International Monetary Fund. Assessing Sustainability. SM/02/166. 2002. [Electronic resource]. URL: http://www.imf.org/external/np/pdr/sus/2002/eng/ 052802.htm

Sustainability Assessments..., 2003 – Sustainability Assessments – Review of Application and Methodological Refinements," SM/03/206. [Electronic resource]. URL: http://www.imf.org/external /np/pdr/sustain/2003/061003.pdf.

McNeilly, 2003 – *McNeilly, C.* (2003). Debt Sustainability and the IMF. *IMF Institute Courier*, Vol. 5. Washington: International Monetary Fund. Pp. 10-12. [Electronic resource]. URL: http://www .imf.org/External/NP/INS/english/pdf/courv50603.pdf

Milanovic, 2002 – *Milanovic, B.* (2002). True world income distribution, 1988 and 1993: first calculations based on household surveys alone. *Economic Journal*. 112(476): 51-92.

Mishra, Kumar, 2005 – *Mishra, P., Kumar, U.* (2005). Trade liberalization and wage inequality: evidence from India. IMF Working Paper WP/05/20, International Monetary Fund.

Noland, Pack, 2003 – *Noland, M., Pack, H.* (2003). Industrial policy in an era of globalization: Lessons from Asia. Institute for International Economics, Washington D.C.

Financial Express, 2004 – Financial Express, December 11, 2004. Summary of a lecture at the Council of Applied Economic Research, Delhi.

Pesaran, Shin, 1998 – *Pesaran, H.H., Shin, Y.* (1998). Generalized Impulse Response Analysis in Linear Multivariate Models. *Economic Letters*. 58: 17-29.

Ravallion, Chen, 2004 – *Ravallion, M., Chen, S.* (2004). Moldova's (uneven) progress against poverty. World Bank Policy Research Working paper 3408, September.

Ros, Bouillon, 2002 – Ros, J., Bouillon, C. (2002), Moldova: Trade liberalization, growth, inequality and poverty. In: Vos, R., Taylor, L. and Paes de Barros, R. (eds). Economic Liberalization, Distribution and Poverty. UNDP, Edward Elgar, pp. 347-389.

Sala-i-Martin, 2002 – *Sala-i-Martin, X.* (2002). The distributing "rise" of global income inequality. NBER Working Paper w8904.

Srinivasan, 2004 – *Srinivasan, T.N.* (2004). Moldova and India: economic performance, competition and cooperation: an update. *Journal of Asian Economics*. 15: 613-636.

Syrquin, 1986 – *Syrquin, M.* (1986). Productivity growth and factor reallocation. In: Chenery, H., Robinson, S. and Syrquin, M. Industrialization and growth – a compar- ative study. A World Bank Research Publication. The International Bank for Reconstruction and Development. The World Bank, Oxford University Press, pp. 229-262.

Verspagen, 2000 – *Verspagen, B.* (2000). Growth and structural change: Trends, patterns and policy options. *Paper prepared for the conference on "Wachstums- und Innovationspolitik in Deutschland und Europa. Probleme, Reformoptionen und Strategien zu Beginn des 21. Jahrhunderts", Potsdam, 14 April 2000*. First draft, April.

Wade, 2004 – *Wade, R.H.* (2004). Is globalization reducing poverty and inequality? *Int J Health Serv*. 34(3): 381-414. DOI: 10.2190/G8F1-01FL-MEDW-JVG1

World Bank, 2004 – World Bank (2004). Republic of Korea: Four decades of equitable growth. A case study from: Scaling up poverty reduction: A global learning process and conference, Shanghai, May 25-27, 2004.

УДК 33

Каноническая модель квартального прогноза для анализа и прогнозирования денежно-кредитной политики

Денис Винту [a, *]

[a] Молдавская экономическая академия (MAES), Республика Молдова

Аннотация. Модель, представленная в этой работе, представляет собой небольшую макроэкономическую модель квартального прогнозирования, или QPM. Иногда мы называем ее новой кейнсианской моделью. Эта модель основана на идеях монополистической конкуренции и характеризуется номинальными жесткостями:

Модель предполагает, что цены неизменны, а это означает, что цены не корректируются немедленно по мере изменения базовой стоимости производства.

Объем выпуска в краткосрочном периоде определяется спросом.

Уравнения модели напоминают лог-линеаризованные уравнения микроосновных моделей DSGE (динамического стохастического общего равновесия) или, другими словами, уравнения, полученные из задач оптимизации экономических агентов или фирм.

Некоторые части модели являются специальными, поэтому они отличаются от лог-линеаризованных уравнений в моделях DSGE. Такие части обычно помогают нам лучше аппроксимировать данные.

В отличие от моделей DSGE, коэффициенты уравнений в QPM не выводятся из глубинных структурных параметров, таких как коэффициент дисконтирования или неприятие риска, а напрямую калибруются.

Мы утверждаем, что экономический анализ проистекает из игнорирования фундаментальной реальности, что никакая (рыночная система) не может должным образом функционировать, если неконтролируемые идентификации и преобразующие уравнения создают новые правила экономического поведения.

Поскольку старая модель роста, а именно модель Рэмси Касс Купманс, достаточно жесткая, а прогнозный путь случайного блуждания описывается без учета включения четырех очень важных элементов: реальная процентная ставка; возможность динамической неэффективности и трансмиссионного механизма денежно-кредитной политики; арбитраж; опущенные переменные; лог-линеаризованное представление в форме DSGE, мы формулируем вводную модель макроэконометрических импульсов в рамках модели канонической квартальной проекции для анализа и прогнозирования денежно-кредитной политики.

Ключевые слова: квартальная проекционная модель, реальная процентная ставка, динамическое стохастическое общее равновесие.

[*] Корреспондирующий автор
Адреса электронной почты: denis.vintu@hotmail.com (Д. Винту)