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## Editorial Board



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# A REVIEW ON THE DYNAMIC STOCHASTIC GENERAL EQUILIBRIUM MODELS (DSGE)

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*In the recent times, the dynamic stochastic general equilibrium models have been widely adopted in operations of central banks, ministries, international financial organizations and in the academic circles. Despite some deficiencies, the DSGE models represent a good starting point for understanding and explanation of many economic interrelations.*

*This class of models is used to solve various objectives: performing a historical analysis and explaining the dynamics of studied macro variables, forecasting key macroeconomic indicators, simulation experiments, formulating and implementing the monetary policy. In particular, the DSGE models are often used to perform the scenario analysis and determine the optimal monetary policy rules presenting a significant practical interest in the activities of the National Bank of the Republic of Kazakhstan.*

*This Paper addresses theoretical aspects and structure of the canonical DSGE model, presents an overview of models of this class applied at central banks of different countries worldwide. Alongside with that, it shows advantages and disadvantages of dynamic structural models, describes the DSGE models used at central banks of the countries that adhere to the inflation targeting regime and discusses the practicability of designing and implementing the DSGE models for the monetary policy purposes at the National Bank of Kazakhstan.*

Key Words: DSGE, new Keynesian Phillips curve, inflation, monetary policy, Kazakhstan.

JEL-classification: C11, C13, C32, E17, E32, E52.

## 1. Preamble

At present, the DSGE models represent an analytical toolkit proving a fundamental base for the analysis of policy pursued. This class of models is used to identify the sources of destabilization of the economic situation, structural changes, forecasting of key macroeconomic indicators as well as for the assessment of the effect of changes in the implemented policy. The DSGE models also allow establishing a correlation between structural features of the economy and the model parameters, which is not always possible when constructing complex macroeconomic models whose realization is based on classical econometric approaches.

The DSGE models are now commonly used at the government agencies, international organizations, central banks to analyze the cyclical behavior of the economy and assess effects of the monetary policy and forecasting (Table 1). In the recent years, the DSGE models had been supplemented with the analysis of financial mechanisms, imperfections of financial markets and different mechanisms of expectations formation, which expanded the scope of these models for

the purposes of the ministries of finance and economy. The DSGE models are also actively used by the IMF, OECD and other international organizations.

Table 1

**The DSGE models in different organizations and countries**

| Organization (country) | Name | Forecasting |
|---|---|---|
| IMF | GIMF | yes |
| European Commission | QUEST III | no |
| ECB | NAWM | no |
| *Central banks:* | | |
| Canada | ToTEM II | yes |
| Finland | KOOMA | no |
| Norway | DSGE NEMO | yes |
| USA | SIGMA | no |
| Sweden | RAMSES II | yes |
| The UK | COMPASS | yes |
| New Zealand | DSGE NZSIM | yes |
| The Czech Republic | G3 | yes |
| Israel | MOISE | yes |
| Chile | (XMAS) | yes |
| Brazil | SIMBA | yes |
| Australia | DSGE | |
| England | COMPASS | yes |

Source: prepared by the authors

The researchers have made a tremendous effort to reduce deficiencies referring to the model assumptions, the methods of their solution, and complexities with understanding by the public at large and the policy decision-makers. So, poorly realistic assumptions about the market perfection are replaced by the inclusion of various frictions in the markets and by the modelling of agents with different behavior. The problem of the model linearization method, which is the most popular and simple solution method and is prone to a possible distortion of estimation results is resolved by using non-linear methods owing to the development of relevant algorithms, a faster speed and ease of their application. The problem of poor understanding of the model substance by non-professionals is overcome by gradually building up the awareness through the growth in the number of publications on the topic, open communication of the model results and the increasingly stringent requirements to the group of the policy decision-makers.

This paper looks into the historical development and fundamentals of the dynamic stochastic general equilibrium models. The structure of the model itself and the specific features of each sector are presented in more detail with possible additions and extensions. Further, a brief description of the solution methods and evaluation of the DSGE models was made as well as of the difficulties that arise in this case, which can be hurdled in using these or those procedures of numeric methods.

As examples, a separate section presents an overview of the DSGE models applied at central banks of different countries worldwide. The choice of countries was determined by the regime of monetary policy pursued, namely the inflation targeting, policy effectiveness, development of the modelling toolkit, and specifics of the economy which have similarities to Kazakhstan's economy[1]. In addition to the international experience, the background of building

[1] This Paper reviewed only those models that are designated for one country and meet the objectives of the central bank. The References section also provides a broad presentation of cross-country models, which are mainly used by the global and regional organizations for the analysis of foreign trade relations, mutual influence of economies in the group and a detailed forecast for *all* countries. The application of such models in the central bank practice is

the DSGE models in Kazakhstan was also reviewed. The conclusion section formulated the key points for designing the models of this class for the National Bank of Kazakhstan. Potential difficulties and the ways to address them were outlined.

## 2. Theoretical Aspects of the Dynamic Stochastic General Equilibrium Models (DSGE)

### *2.1. Structure of the DSGE Model*

The DSGE model describes the behavior of economic entities, their interaction and mutual influence based on the information available at the moment and on expectations forming among such entities that is formally expressed in constructing the system of equations, its solution and assessment of parameters. The choice of economic agents and the degree of detailization of economic processes, and, consequently, of the equations themselves for a specific country depends on the purpose of building a model, which can be a quantitative analysis of general patterns in the economy, an emphasis on certain sectors, unconditional and conditional forecasting. In the context of countries, these models may differ due to a different structure of the economy, the degree of its influence on other countries, the openness of the economy and the development of the financial market, different monetary policy regimes, etc.

In general, the following economic agents can be pointed out: households, firms, the financial sector, the external sector, and the government in the form of fiscal and monetary policies. At the same time, these categories can be further divided (households with/without propensity to save, producers of intermediate/final products, importers, exporters, borrowers in the local/foreign currency, trading partners, etc.)

The main assumptions underlying the construction of the DSGE models are the optimal behavior of agents at the micro level given the information they have and the presence of rational expectations in this regard. The starting point for the comprehension and further development of these ideas was the failure of large-scale macroeconomic models, which represented a huge number of econometric models and were based on the neoclassical synthesis that appeared after the Great Depression of the 1930s (Keynes's macroeconomics supplemented by the microeconomics ideas of neoclassical economists). Thus, these models could not explain the simultaneous growth of inflation and unemployment (stagflation) in the United States in response to the oil crisis in the 70s of the last century, which contradicted the Keynesian view of the Phillips curve. This was followed by the Lucas criticism (Lucas, 1976), who argued that the parameters linking macroeconomic variables cannot be estimated solely on the basis of past macroeconomic data, since they are not structural, "deep", i.e. tied to the individual behavior of agents and therefore may change depending on the monetary and/or fiscal policy of a country. In this regard, the ideas of neoclassical economists that are based on the optimization of individual behavior of agents and rationality of their expectations led through their aggregation to the creation of a school of new classical macroeconomics, where the model of real business cycles ("the RBC") became as the core (the first study in this area was that of Kidland and Prescott, 1982). In addition to those mentioned above, the RBC models also contain assumptions about price flexibility, perfect competition in markets (both in the markets of goods and labor), and of markets being in equilibrium.

In the simplest RBC model of a closed economy, many households have a utility function that estimates consumption and labor for a household now and in future periods (it is assumed that the household will exist infinitely). At each moment in time, the household faces a choice between consumption and labor now, consumption now and in future periods, taking into account budget constraints expressed in wages, past savings, dividends from firms, and government transfers. Therefore, by maximizing their utility function, taking into account budget constraints at given prices in the markets for goods, capital and labor, households determine the demand for consumer goods and the supply of labor.

complicated by the need to interpret and forecast a significant number of variables (that may be only available with a certain lag), which may increase the forecast-specific uncertainty and distinctly complicate communication of the model results to the monetary policy decision-makers and the public at large in general.

However, many similar firms in the environment of perfect competition (resulting in a zero dividend profit for households) produce goods and services for households and capital for other firms. Each firm has a production limitation in the form of the Cobb-Douglas production function of the following type:

$$Y_{i,t} = A_t K_{i,t}^{\alpha} L_{i,t}^{1-\alpha} \#(1)$$

where $Y_{i,t}$ – production level of firm $i$ in the period $t$,

$K_{i,t}$ – the level of capital used,

$L_{i,t}$ – the number of man-hours used,

$\alpha$ – a share of capital in the production,

$A_t$ – total factor productivity whose logarithm usually follows the AR(1) process with white noise.

Each firm tries to use such combination of labor and capital at the given prices so that to maximize profits thereby determining the demand for capital and labor.

Resulting from the established equilibrium in the markets, the solution to the RBC system of equations is found. The only factor in the system's deviation from equilibrium and the cause of business cycles is a productivity shock, which is an indication of neutrality of the monetary and fiscal policies. However, the empirical experience of the lack of neutrality in the government policy and the presence of imperfect competition in the markets (Keynesian ideas) based on the RBC (ideas of the classics) led to the so-called new neoclassical synthesis. Evolving since the late 80s of the last century, this theory combines the ideas of both schools and reflects the currently prevailing and most recognized view of the economic phenomena, including among central banks.

Models built on the basis of a new neoclassical synthesis are called New Keynesian models. The main differences with the RBC include the presence of monopolistic competition in the markets of goods and labor, the rigidity of prices in the consumer basket and wages, the description of monetary and fiscal policies, the introduction of habits in the household consumption pattern and different types of households, the inclusion of financial frictions and frictions in the external sector.

In the simplest New Keynesian model, there is monopolistic competition among manufacturers of differentiated goods, which is reflected in the presence of a markup in excess of marginal costs, and rigidity in prices of these goods is introduced due to the fact that some firms are not in a position to change their prices too often (menu costs).

The consumption function of an array of such differentiated goods is typically written with the help of the Dixit and Stiglitz aggregator[2] (Dixit and Stiglitz, 1977) in the form of:

$$\mathrm{C}_t = \left( \int_0^1 \mathrm{C}_{i,t}^{\frac{\varepsilon-1}{\varepsilon}} di \right)^{\frac{\varepsilon}{\varepsilon-1}}, \#(2)$$

where $\mathrm{C}_t$ – is aggregate demand at time $t$,

$\mathrm{C}_{i,t}$ – a demand for -ый commodity of price $P_{i,t}$,

$\varepsilon$ – constant elasticity of substitution among goods in the consumer basket.

However, it is implied that there are retail firms in the economy that function in the environment of perfect competition and consume such products and sell them afterwards to consumers in the form of one common basket with an overall volume $\mathrm{C}_t$ at price $P_t$.

Given maximization of profit by retail firms , the demand for good $i$

[2] The Kimball scheme (Kimball, 1995) with the decreasing volatility of demand at a relative price may serve as a generalized method of aggregation of demand, whereas under the Dixit and Stiglitz scheme the elasticity is constant.

$$\mathrm{C}_{i,t} = \mathrm{C}_t \left(\frac{P_t}{P_{i,t}}\right)^{\varepsilon}, \#(3)$$

and the overall price level

$$P_t = \left(\int_0^1 P_{i,t}^{1-\varepsilon}\, di\right)^{\frac{1}{1-\varepsilon}}. \#(4)$$

In most cases, the price rigidity is introduced via the Calvo model (Calvo, 1983)[3], which assumes that at each moment in time companies are setting an optimal price with the probability of $1-\theta$, and they leave the last-period price with the probability of $\theta$ (instead, they may change prices by the amount of target inflation rate or prior inflation). The companies that optimize the price choose such a price, which maximizes expected profits until the next optimization taking account of a constraint in the form of demand for their products.

Further, for a more visual representation of equations in the model, the concept of an equilibrium (potential) level of GDP is introduced, which corresponds to the level of GDP at flexible prices, when producers in the environment of monopolistic competition set prices with the same markup in relation to marginal costs. The percentage deviation of the actual level of GDP from its equilibrium level is called the output gap. By defining the real rate as the nominal rate minus the expected inflation rate, the real neutral rate corresponds to a zero output gap and stable inflation. Then, taking into account the introduction of Taylor's rule, equations of the simplest New Keynesian model can be written as:

$$\pi_t = \beta E_t\{\pi_{t+1}\} + \kappa\tilde{y}_t \#(5)$$
(Philips curve or aggregate supply curve)

$$\tilde{y}_t = E_t\{y_{t+1}\} - \frac{1}{\sigma}(i_t - E_t\{\pi_{t+1}\} - r_t^n) \#(6)$$
(Euler's equation or aggregate demand equation)

$$i_t = \rho + \varphi_\pi \pi_t + \varphi_y \tilde{y}_t + \nu_t \#(7)$$
(Taylor's rule)

$$r_t^n = \rho + \sigma E_t\{\Delta a_{t+1}\} \#(8)$$

$$\nu_t = \rho_\nu \nu_{t-1} + \varepsilon_t^\nu, \rho_\nu \in [0,1), \varepsilon_t^\nu \sim N(0, \sigma_\nu^2) \#(9)$$

$$a_t = \rho_a a_{t-1} + \varepsilon_t^a, \rho_a \in [0,1), \varepsilon_t^a \sim N(0, \sigma_a^2), \#(10)$$

where $\pi_t$ – inflation in the period $t$,
$\tilde{y}_t$ – output gap,
$i_t$ – nominal interest rate,
$r_t^n$ – real neutral interest rate,
$a_t$ – total factor productivity,
$\beta, \kappa, \sigma, \varphi_\pi, \varphi_y, \rho$ – structural numeric parameters of the model,
$\rho_\nu, \rho_a$ – autoregressive order one coefficients,
$\varepsilon_t^\nu, \varepsilon_t^a$ – normal random variables with the zero mean and corresponding variations $\sigma_\nu^2$ and $\sigma_a^2$.

[3] Rotemberg's model represents another common method of introducing the price rigidity (Rotemberg, 1982).

In this simplest DSGE model, two shocks "adjust" to the behavior of two observable variables - inflation and the interest rate. It follows from the Phillips curve that a central bank by targeting zero inflation can automatically achieve a zero output gap, thereby (as shown in Gali, 2008) repeating the effective (from the social welfare point of view) fluctuations around the GDP level, which characterizes equilibrium in the absence of any imperfections in the markets. As a result, the central bank has no trade-off between stabilization of inflation and stabilization of the output gap, which was referred to as "divine coincidence" (Blanchard and Gali, 2007). One may generally say that one market distortion (the price rigidity in this case) may be offset by one instrument (the monetary policy).

*Extension of the DSGE model.* Nonetheless, in reality there are different price rigidities in other markets (first of all, in the labor market), which pre-condition the absence of "divine coincidence" and suggest the presence of a trade-off between inflation and output gap stabilization faced by central banks (Erceg, Henderson and Levin, 2000).

Thus, the impossibility of frequent wage revisions is reflected in the DSGE models through rigidity of nominal wages and prices, which leads to the rigidity of real wages, or directly through the rigidity of real wages, which allows "catching" the additional duration of the impact of shocks on the dynamics of variables. In case of nominal rigidity, households are in a monopolistic competitive position; however, only a part of them set optimum wages in accordance with the Calvo scheme. Also, just as in case with the price rigidity, there are retail firms, which operate in the environment of perfect competition, accumulate labor and supply it to the producing companies. As a result, a wage equation for the Phillips curve appears in the model, where the percentage change in wages (wage inflation) depends on their expected change and the gap between a marginal rate of substituting the labor with consumption and a real wage, where the last gap is equal to zero in case of a perfect labor market.

Another common extension of the simplest New Keynesian model is including the element of habits through previous consumption into the household utility function in the form of a term

$$\frac{\left(C_{j,t-\varphi_c \mathrm{C}_{j,t-1}}\right)^{1-\sigma}}{1-\sigma}, \#(11)$$

where $\mathrm{C}_{j,t}$ and $\mathrm{C}_{j,t-1}$ – consumption levels of the household $i$ in the periods $t$ and $t-1$,

$\varphi_c$ – a numeric parameter, which characterizes stability of consumption habits.

This technique enables to take into account a not so fast reaction of consumption to changes in income (Boldrin, Christiano and Fischer, 2001) and indicates the absence of intertemporal separability in consumption, that is, when the question of the amount of consumption is being addressed not only on the basis of the existing but also of the future utility.

Another approximation of the DSGE models theory to the data observed in reality is the denial of the fact that instant conversion of investment into capital does not require any costs, and all capital is used in the production process (Hayashi, 1982; Abel and Blanchard, 1983). The first reflects that capital is not always immediately available at affordable prices, and a part of production resources is diverted for the capital input.

In the model, this distortion is introduced through the function adjustments costs in investments in the form of

$$S\left(\frac{I_t}{I_{t-1}}\right) = 1 - \frac{\chi}{2}\left(\frac{I_t}{I_{t-1}} - 1\right)^2, \qquad S(1) = 0, \#(12)$$

where $I_t$ and $I_{t-1}$ – levels of investments in periods $t$ and $t-1$,

$\chi$ – a numeric parameter, which characterizes the amount of expenditures for adjustments,

$S(\cdot)$ –cost function.

In doing so, the equation of changes in capital is written as

$$K_{t+1} = (1-\delta)K_t + I_t S\left(\frac{I_t}{I_{t-1}}\right), \#(13)$$

that is, only if the level of previous investments remains unchanged, the changes in capital correspond to the dynamics in the model without these adjustments. The second refers to the observed different intensity of capital use, which depends on shocks in the economy.

So, this fact may be introduced either via the varying and not constant degree of capital depreciation $\delta(U)$ (Calvo, 1975, Merrick, 1984), or via the function of expenditures in the under-utilization of the installed equipment (Christiano, Eichenbaum and Evans, 2005, Smets and Wouters, 2003) as

$$\Psi(U_t) = \Psi_1(U_t - 1) + \Psi_2(U_t - 1)^2, \Psi(1) = 0, 0 \le U_t \le 1, \#(14)$$

where $U_t$ – the percentage of the utilized capacity of installed equipment,

$\Psi_1$ и $\Psi_2$ – numeric parameters of the expenditure function.

In general, the inclusion of the above aspects in investment and capital into the model allows considering a smoother reaction of investment and capital to various shocks.

The next extension of the DSGE model is the inclusion of various financial frictions into the model. First of all, it's a differentiation of households by two categories: the ricardian households (with access to the financial market) and non-ricardian households (with no access to the financial market). This appears when there are liquidity constraints for some individuals due to their financial condition, which does not enable them to fully maximize their intertemporal utility function the ricardian households can afford. In the model, the differentiation is introduced through a separate consideration of consumption, labor supply and determination of wages for two types of households, when wages is the only source of consumption for non-ricardian households. As (Mankiw, 2000) shows, the differentiation of households by two categories helped explaining a positive effect on consumption by a positive shock in the government spending (that would later have been replaced by the increase in taxes and would not exert a significant influence on the consumption of ricardian households since the latter when consuming also consider their future earnings).

The next assumption that characterizes financial friction may be the inclusion of risk premiums or spreads in the model (Bernanke, B, M. Gertler and S. Gilchrist, 1998). Thus, entrepreneurial firms that buy capital from capital producers and supply it to the domestic producers financing the first operation with their own funds and funds borrowed from banks are included into the model. In turn, the latter receive financing from the population through deposits. Firms-entrepreneurs, having received financing from banks, are observing a windfall capital gain; it has the amount above which the entrepreneurial firm pays off the debt in full, and below which the firm becomes bankrupt and leaves all available funds to the bank. This implies the asymmetry of information in the financial market, when banks unlike entrepreneurs themselves do not observe the realization of a windfall capital gain and are forced to bear costs in the event of the borrower's bankruptcy for identifying this amount and the corresponding assets of the bankrupt person. Due to the existence of bankruptcies and the costs for their resolution, banks assign such a risk premium to the central bank rate in order to equalize their expected profit with opportunity costs. Entrepreneurs that have this restriction in respect of banks operating in conditions of perfect competition, then determine the amount of capital and the amount of a windfall gain at which they still continue to operate in order to maximize their expected profit. Based on the fact that there is an explicit relationship in the model between the banks' rate and the required capital rate, the spread between the latter rate and the central bank rate is expressed through the increasing leverage function, which is determined as the ratio of the acquired capital to the amount of own funds. As a result, once the leverage and a corresponding indebtedness of entrepreneurial firms increase, the likelihood of bankruptcy increases and the

spread between rates grows. The factor of a change in the spread intensifies the impact of various shocks, such as shocks in government spending or monetary policy, on the dynamics of the GDP components and inflation.

Other sources of financial frictions may include the consideration of openness of the economy when the external sector is introduced into the model (Gali and Monacelli, 2005). Consumption and investments consist of the domestically produced and imported goods and there is also the demand for the domestically produced goods on the part of other countries. The inflation and consumption are determined via the changes in relative prices for the domestically produced and imported goods, the share of such goods and the elasticity of substitution between them. Assuming a perfect pass-through effect of import prices onto the domestic prices (the so-called law of one price) and perfect international financial markets, the absence of arbitrage leads to an equation of uncovered interest rate parity. However, in case of imperfect financial markets, a risk premium depending on the level of external debt is factored into the last equation as:

$$i_t = i_t^* + E_t\{\Delta e_{t+1}\} + \zeta b_t^*, \#(15)$$

where $i_t$ and $i_t^*$ – interest rates of the country and of the external sector, respectively,

$e_{t+1}$ – nominal exchange rate,

$b_t^*$ – external debt level,

$\zeta$ – a numeric parameter, which characterizes the risk premium sensitivity to the level of external debt.

Other sources of financial friction may include the difference between dollarization, tradable and non-tradable goods, costs for portfolio changes, and the impact of world commodity prices, etc. (Copaciu, Nalban, Bulete, 2016). Consideration of these factors allows taking into account the individual characteristics of countries, especially small open developing economies, which may be absent in the case of developed countries.

Finally, the last key sector in the DSGE models, in addition to the central bank, is the public sector represented by the country's fiscal policy. The government spending allocated for different purposes (government consumption, government investment, transfers to the population) can be funded through taxes, public debt issuance or seigniorage (Celso Jose Costa Junior, 2016). Taxes in the system can be entered through a single amount charged from households, or through different rates of taxes (on consumption, on investment, on profit, and others). At the same time, the fiscal policy can be exogenous, when the dynamics of expenditures are entered into the model through an exogenous process, or can be endogenous, when the dynamics of expenditures and/or taxes is tied to the comeback of government debt to its target (desired) level.

The inclusion into the model of the production function where there is the capital accumulated owing to the government investments may be referred to a broader description of the government's influence on the economy, in the following form:

$$Y_{i,t} = A_t(K_{i,t}^p)^{\alpha_1} L_{i,t}^{\alpha_2} \left(K_{i,t}^G\right)^{\alpha_3}, \#(16)$$

where $Y_{i,t}$ – output of -oro commodity,

$A_t$ – total factor productivity,

$K_{i,t}^p$ – private capital,

$K_{i,t}^G$ – government capital,

$\alpha_1, \alpha_2, \alpha_3$ – shares of private capital, labor, and government capital, respectively (Cashin, 1995; Bajo-Rubio, 2000).

Besides, the element of habits may be factored into the government consumption (Ravn, 2006) and the government consumption itself – into the household utility function (Aiyagari, Christiano and Eichenbaum, 1992). Nonetheless, the choice for this or that scheme of the

government sector presentation in the model depends on the specifics of the country's economy, the possibility of conducting a discretionary fiscal policy, sources and areas where the public funds are used and other possible significant factors.

Summing up the general DSGE model structure, let us present its approximate layout (Figure 1).

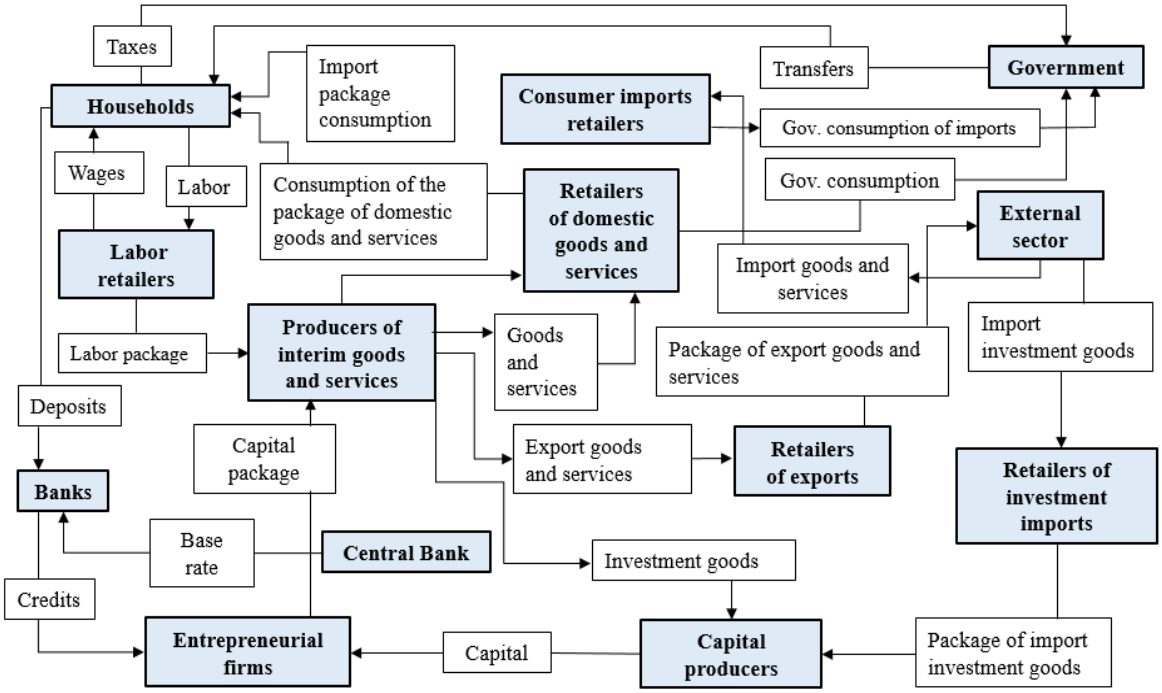
*2.2. Solution and Estimation of the DSGE Parameters, Forecasting via the DSGE*

After all economic agents have been factored into the model, optimization conditions have been described and equilibrium conditions in the markets are taken into account for each of these agents, the equations in the model represent non-linear functional relationship between variables (implicitly) and contain operators of future expectations. For this reason, it's impossible to get an accurate analytical solution for the system variables (except for the fairly strong limitations and simplifications). In order to overcome this difficulty, models of this type are solved approximately with the help of numeric mathematical methods.

First of all, to make the model stationary, a trend is preliminarily taken out from the data. In this case, either the general trend of economic growth is assumed, or individual trends in macroeconomic variables are modeled (Argov et al, 2012).

Figure 1

**Approximate Layout of the DSGE Model Describing the Interaction of Economic Agents**




Source: compiled by the authors

Further, the Taylor series expansion is carried out in the neighborhood of the equilibrium point of the system (when all structural shocks are equal to zero or to one, depending on the form of the equation, and the previous and expected values are equal to the current one). If the Taylor series expansion is up to the first order, then the system of equations will be linear, and the system of DSGE equations itself will be called linearized[4]. This method is the most common and quite reliable for an approximate description of nonlinear relationships; however, in some cases (for example, the search for the optimal monetary policy or the existence of strong fluctuations in variables due to various shocks), it becomes preferable to expand into a Taylor series up to

[4] Usually, the linearization of natural logarithms of variables is used. Simple and quick rules for the transition from a non-linear model to a log-linear model were shown in (Uhlig, H., 1999).

higher orders or to apply other non-linear methods (Gali and Monacelli, 2005; Linde, Trabandt, 2019).

In case of a linearized model, equations are written as follows (StataCorp., 2019)

$$A_0 y_t = A_1 \mathbb{E}_t(y_{t+1}) + A_2 y_t + A_3 x_t \#(17)$$

$$B_0 x_{t+1} = B_1 \mathbb{E}_t(y_{t+1}) + B_2 y_t + B_3 x_t + C\epsilon_t, \#(18)$$

where $y_t$ – a vector of control (endogenous) variables,
$x_t$ – a vector of state variables (non-observable exogenous variables),
$\epsilon_t$ – a vector of structural shocks in the period $t$.

The $A_i$ and $B_j$ matrices are the functions (probably, non-linear functions) of structural parameters. $A_0$ and $B_0$ are diagonal matrices, the $A_2$ matrix has zeroes at the main diagonal and the $C$ matrix is the matrix of choice, which determines what state variables are exposed to shocks. Thus, in the case of variables that have lags of more than one forward and backward, an additional dummy variable is introduced into the system and the equations are reduced to a standard form using augmented matrices $A$ and $B$.

Further, the solution of the model lies in expressing the control variables via the state variables and describing the dynamics of state variables per se in the form of equations of the state of spaces

$$y_t = \Phi x_t \#(19)$$

$$x_{t+1} = \Psi x_t + \Upsilon \epsilon_{t+1}, \#(20)$$

where $\Phi, \Psi, \Upsilon$ – matrices dependent on structural parameters.

The solution method suggested in the study of (Blanchard and Kahn, 1980) is the most known and is broadly highlighted in the literature. It is based on the Jordan decomposition of matrices, classification of variables into stable (eigenvalues corresponding to Jordan decomposition modulo less than 1) and unstable (greater than 1), on a separate solution for transformed variables of equations that do not contain other variables and reversion to the original variables. In addition, this procedure enables to determine whether with certain values of the structural parameters there is a unique stable solution when the system, after some perturbation, returns to its equilibrium in a unique way. This condition is called the Blanchard-Kahn condition and asserts that the system has a stable solution if and only if the number of unstable eigenvalues is equal to the number of control variables. In practice, the case of an unstable solution is not considered, and the values of structural parameters are limited only to the area where only stable solutions exist. The works of (Klein, 2000) and (Sims, 2002) are the generalization of the Blanchard-Kahn method, where some of Blanchard-Kahn's assumptions were weakened (for example, matrix invertibility). Another method for solving linearized systems with forward looking variables is the method of undefined coefficients (McCallum, 1983), when the solution is sought in the assumption that the control variables are a linear combination of state variables and is found by plugging in the original equation. Finally, in the case of solution of a non-linear system of equations, the perturbation method widely known in physics is used, when the equation is supplemented with a parameter, which in case of its zero value enables to find a solution and use the latter to approximate the original solution (Judd, 1998). All of the above methods are implemented in the standard Dynare package[5], which is a popular tool in building and analyzing the DSGE models.

Once the set of equations for the DSGE models had been written in the form of a state space, in case if the model is fully calibrated it can be used for analysis and forecasting purposes

[5] https://www.dynare.org/

(Kydland, 1996). Usually, estimates of structural parameters obtained from other studies or similar to other countries are taken as a calibration. However, due to the fact that the values of parameters can be sensitive to changes in the model and it is not always easy to select the values of parameters so that the model simulates data that are acceptable for reality, the modern models, either partially or completely, use the structural parameters estimation approaches. The latter approaches are divided into classical and Bayesian. In turn, classical methods are subdivided into distance methods and maximum likelihood methods. In the case of the distance method, the estimation of the vector of parameters minimizes the distance between certain statistics (means, covariance matrices, impulse responses) calculated on the real and model-based data. The disadvantage of this method is that one or another kind of statistics cannot accommodate all relationships between variables. By contrast, the standard likelihood function solves this problem, and such vector of parameters that maximizes the likelihood function is sought when using this method (Canova, 2007). In this case, the likelihood function can be estimated by using the Kalman filter or other multivariate filters (Fernández-Villaverde et al, 2016). The main disadvantage of using the maximum likelihood method is that in case of the presence of a set of local maximums, dramatic cliffs, or a very straight surface in the likelihood function, the search for the global maximum can be complicated or impossible, which often occurs with a large number of structural parameters.

The use of Bayesian methods for estimating structural parameters, when additional information is taken into account by specifying the a priori distribution of parameters in the model, became a solution for the latter problem. This fact, along with the development and availability of computing capacities, was the reason for that at present the Bayesian approach for estimating parameters of the DSGE models has become very common. Since it is impossible to obtain the posterior distribution of the parameters explicitly, by using the Metropolis-Hastings algorithm or its modifications (Fernández-Villaverde, 2009) it is possible to obtain an approximate sample of a sufficiently large size from this distribution, whereby the mode, mean, variance and confidence intervals for structural parameters can be calculated. Despite by the fact that the results of Bayesian estimation depend on the choice of a priori distribution, this approach combines the advantages of the calibration method (availability of knowledge without regard to the real data) and the maximum likelihood method (ignoring any information not contained in the data). The latter methods are extreme realizations of the Bayesian method, when a priori variance of the parameters is equal to zero (calibration method) or equal to infinity (likelihood method).

Ultimately, being fully estimated by one method or another, the model can be used for analysis and forecasting. To understand the relationships in the economy, functions of impulse responses of variables for various shocks are built. An important tool for understanding the historical and current dynamics is the decomposition of variables by structural shocks across the entire sample. To track the impact of one or another shock on the economy, one may perform a pseudo-forecast when the reviewed shock turns into zero, and the rest of the shocks are fixed. In the case of forecasting, an unconditional forecast (when all future paths are set according to the current development of shocks, and ultimately the model converges to equilibrium) or a conditional forecast (when the path of one or several variables is assumed to be known) can be performed. The latter allows central banks to do scenario forecasts of the economy and assess their reaction to shocks, as well as take into account the reaction of economic agents to various shocks, both expected and unexpected.

## 3. Specifics of the DSGE Models at Central Banks of Different Countries

### *3.1 The DSGE Model of the Bank of Canada (ToTEM)*

The Bank of Canada was the second central bank in the world (after the Reserve Bank of New Zealand) that implemented the inflation targeting in 1991 as the main monetary policy regime. From the beginning of 1990s, the Bank of Canada manages to keep inflation within the range from 1% to 3%. In order to pursue this policy successfully, the Bank of Canada developed

a quarterly projection model (QPM – Poloz et al., 1994). The Terms-of-Trade Economic Model ("the ToTEM") replaced the QPM in December 2005 as the main projection and policy analysis model of the Bank of Canada for the Canadian economy (Fenton, Paul & Murchison, Stephen, 2006). In essence, the ToTEM uses the advantages of technological progress in the economic modelling and the computing capacity for enhancing the strong fundamental features of the QPM. The model has a more solid theoretical background, it is easier to deal with and it better explains the dynamics of the Canadian economy. Behaviors of nearly all key variables in the ToTEM reflect the basic structure of many countries with the developed economy. The DSGE models in these countries are based on the classical version of the model. The main specific feature of the ToTEM is segregating the production of primary products into a separate sector. A slightly updated version of the model (ToTEM II) had replaced ToTEM in June 2011. Structurally, the ToTEM II consists of several sectors (Dorich J. et al.,2013).

*1. Firms*

*Sector of final products*

*The first stage: manufacturing of interim goods*. The ToTEM II uses the production function of the constant elasticity of substitution (CES) for combining the capital, labor force, goods and imports into the manufacturing of interim goods. The capital and the labor force are supplied by households and imports and goods are produced in the sectors of imports and the manufacturing of goods, respectively.

The production structure of the ToTEM II has two specific features. First, adjustment costs take the form of an irrecoverable loss of relevant production resources. Second, the model implies that the use of capital affects the depreciation and not the cost of resources.

*The second stage: production of final goods and production resources.* It is assumed that there is a continuum of monopolistically competing firms. Each firm produces a product that can be used for both consumption and production. For the production of final goods, firms use intermediate goods and a set of production resources in accordance with the technology. It is also assumed that firms take the price of their resources for granted. In addition, since the produced resources and the consumer goods are the same, the price of the main consumer package is equal to the price of the mixture of the produced resources. The pricing follows the Calvo model.

*Sector of primary products*

The ToTEM II distinguishes between producers of primary products and producers of final goods. Such segregation is important for Canada due to a significant share of production of primary products in the GDP structure (8% in 2019 according to the data from the Statistics Canada) as well as different technologies and competition structures in the sectors of production of final goods and production of primary products. The production of primary products is subject to a number of real rigidity factors, and therefore the supply in the short-term perspective is highly inelastic in terms of price. This sector is closer in its structure to the perfect competition, at least from the point of view of a Canadian producer, than the production of final goods, where product differentiation is a common phenomenon. Therefore, in order to have a proper understanding of the consequences of commodity price shocks, it is important that the model is clearly distinguishing between the primary and commodity sectors and their respective markets.

Primary commodity in the ToTEM model is used either to manufacture the final goods or is purchased by households directly as a separate consumer product, or is exported to the global markets. There is an assumption that the law of one price is applicable to exported goods, while temporary deviations from the law of one price are allowed for goods purchased domestically.

It is assumed that a typical competitive Canadian firm produces primary products or sells them to a distributor or exports them. In any case, the firm sells primary products at a price corresponding to the law of one price and adjusted for the nominal exchange rate. A product is produced by combining the capital, labor and land in the embedded CES production function, which is presented as:

$$G(\cdot,t) = ((\alpha_{com,1})^{\frac{1}{v}}(A_t H_t^{com})^{\frac{v-1}{v}} + (\alpha_{com,2})^{\frac{1}{v}}(u_t^{com} K_t^{com})^{\frac{v-1}{v}} + A_t F)^{\frac{v}{v-1}}, \quad \#(21)$$

where F is a fixed factor of production and it may be regarded as the land holding.

*Commodity sector*

The domestic commodity sector consists of competitive producers that export raw materials and non-energy goods to the rest of the world or sell them to distributors who turn them into processed goods and non-energy goods and then sell them to households and companies.

*Manufacturers.* There are two sectors of competitive firms: primary and non-energy firms. Each firm in each sector produces raw materials by combining capital services, labor and land in a production function with a constant elasticity of substitution. Just as in the final goods sectors, the company faces costs for labor, capital and investment resources in addition to the costs of using capital.

*Trade distributors.* The distribution of non-energy final goods is carried out by two types of firms. First, there is a large number of imperfectly competitive firms that buy non-energy goods from producers at competitive prices. These firms face price rigidity in setting prices in the same way that manufacturers of final goods do. They produce their own differentiated variety of non-energy goods and sell them to a large number of competing firms, which combine all differentiated non-energy goods into a non-energy final product that is then sold to households and firms.

On the contrary, the distribution of final energy resources among households is carried out by the sector of competitive firms, so the price of the final energy product encountered by households is determined by the international price.

*Aggregation of goods.* It is assumed that households and firms that buy final energy and non-energy goods combine them into final goods in accordance with Leontief's technology, and also that non-energy goods are permanent.

*2. Household sector*

The ToTEM II assumes the existence of three types of consumers: (i) unlimited lifetime income consumers, (ii) limited lifetime income consumers, and (iii) current income consumers. Unrestricted households face lifelong budget constraints and are free to borrow or save to reallocate consumption over time, trading in both short-term and long-term bond markets. Restricted households are similar to unrestricted households, except that they can only trade in long-term bond markets and do not have to pay transaction costs. Current income consumers face a budget constraint by periods that equates their current consumption to their disposable income, including government transfers.

Aggregate consumption is obtained by combining the basic consumption and primary products and by using the Leontief technology with a fixed ratio. The latter assumption helps the model to better match the data in two respects. First, the consumer demand for primary products is very inelastic and there is little substitution between the basic consumption and consumption of primary products in response to movements of relative price. This, in turn, means that commodity exports are also less responsive to movements in prices of primary products.

In the ToTEM II, stationarity of net foreign assets is achieved by assuming that households become more tolerant when the ratio of their financial wealth to disposable income is low, and vice versa. Financial wealth, in addition to net foreign assets, depends on the number of housing, government debt and the state of the stock market assessed by the “fundamental” hidden cost of capital[6].

*Prices of assets.* The assumption of exogenous risk distributions is an important constraint on the interest rate structure in the ToTEM II. The distribution of risk is expected to be related to endogenous variables such as leverage ratios. Modeling such relationships will allow macroeconomic shocks and policies to influence the distribution of risks and, therefore, will influence the monetary policy decisions resulting from the model.

[6] The value of assets owned by the company that has not yet been evidenced in the company’s equity price.

The UIP (uncovered interest rate parity) used in the ToTEM differs from the standard one, first, in that the country risk premium is influenced by the UIP through the exogenous shock factor of the exchange rate. Second, the weighting factor is applied not only to the expected exchange rate, but also to the percentage difference with the current exchange rate.

*Consumption and investments for life-time consumers*. Consumption in the ToTEM II is notable for two specific features. First, the model allows the long-term interest rate to play a more important role in the decision-making about consumption as compared to short-term rates. Such specific feature appeared since: (i) the interchangeability between short-term and long-term bonds is not perfect, and (ii) the long-term rate is the only rate that has significance for consumers with a limited lifetime income. Second, it enables the welfare gap[7] to influence consumption.

*3. Wage-setting*

It is assumed that there is a continuum of trade unions in the economy, each representing one type of differentiated labor. Each union sets a wage rate for its members. Within each union, there are two types of members: unlimited lifetime income consumers and limited lifetime income consumers. Current income consumers receive gross wages. Firms distribute the demand for labor evenly among different workers, regardless of the type of their household.

It is assumed that there are two different types of trade unions: rules of thumb (RT) and forward-looking (FL) unions. For each type of union, there are two different types of wage setting. With probability $\theta$, all trade unions index their wages in accordance with the inflation target. With probability $1 - \theta$, RT trade unions and FL trade unions have different wage-setting rules.

*4. The monetary policy*

It is contemplated that the monetary authority sets the short-term risk-free interest rate and selects the sequence of these rates in accordance with the extended Taylor rule, which depends on the output gap, the deviations of the expected core inflation for two quarters ahead from the inflation target and the interest rate smoothing period.

*5. Fiscal policy*

The government functions in the ToTEM II are as follows: (i) purchasing of goods and services for the government from the local producers, which encounter the imperfect competition and some degree of price rigidity; (ii) distribution of transfers among households; (iii) collection of taxes on labor income and consumption; (iv) sale of nominal government bonds to households within the country and abroad. The government demonstrates non-ricardian behavior.

*3.2. The DSGE Model of the Czech National Bank (g3)*

The Czech National Bank had accomplished the transition to the inflation targeting regime at the beginning of 1998 and implemented the Forecasting and Policy Analysis System as part of such regime. The QPM (Quarterly Projection Model) had been used as the main model for forecasting over a lengthy period of time and was later replaced by the “g3” DSGE model due to the increased demand for a more structural analysis.

The “g3” model of the Czech National Bank reflects a small open economy in its transition that is exposed to many structural changes. Despite the fact that the model was constructed specifically for the Czech economy, it may be used also for other small emerging economies. The model is based on many standard versions of modelling in the sphere of applied dynamic general equilibrium model that use various nominal and real rigidities and frictions.

The two most important aspects in the analysis are the assessment of the current macroeconomic situation, and the analysis of forecasts and scenarios. Assessment of the current state of the economy is based on the identification of structural economic shocks that govern the economy. An important step here is to assess how new information affects and changes the assessment of the economic trend. In addition, the multi-vector character of the model enables to determine the signals about the true state of the economy on a timely basis. After determining

[7] A standard deviation of households’ financial well-being.

and interpreting the current state of the economy, a forecast and scenario analysis is performed. Scenarios can be formed in relation to specific economic variables or in a way of forming expectations about these variables.

The economic dynamics in the model is the result of interaction of households, firms in certain sectors, and central fiscal and monetary authorities. The monetary policy authority in the model uses the inflation targeting regime, and both households and companies are aware of the current monetary policy regime. Therefore, the monetary policy does not raise questions of trust or uncertainty in communication.

The structure of the model is set to capture the main characteristics of the Czech economy:

– a clearly defined path of the balanced economic growth. Since the economy is going through a transition period, realistic forecasting properties require moving away from the generally accepted stationary steady condition to a path of the balanced growth;

– trends in relative prices and constancy of nominal shares of GDP expenditures. The growth in productivity with a large share of exports in the internal sector led to the strengthening of the real exchange rate causing a shift in relative prices; this, in turn, has a downward effect on inflation (Andrle et al., 2009).

The economy in transition is characterized by a high share of investment-related expenditures as compared to the consumer spending, which may be associated with an intensive process of capital accumulation, the formation of consumer habits and control over consumer loans in the international financial markets. The shares of medium-term expenditures of the GDP sectors in the Czech Republic are gradually approaching their levels in more developed countries. In the “g3” structure, an assumption is made about constant specific nominal shares of GDP components. Trends in relative prices across sectors, with the nominal share of expenditures remaining unchanged, imply that physical volumes should compensate for the price dynamics. The dynamics of relative prices and shares of expenditures are closely related to a balanced growth path;

– the intensity of imports in exports and the growing openness of trade. Most of the imports are used as a component for the production of exports of goods. In the Czech Republic, the import intensity of exports and increased participation in trade are associated with a massive inflow of foreign direct investments in the past, many of which have been green-field investments. Foreign firms are closely related to parent companies abroad and are engaged in “vertical specialization”, that is, they specialize in the stages of production. The rapid growth of imports compared to GDP (Rule of four: imports grow four times faster than the added value) casts some doubt on the assumption about constant shares of GDP components; therefore, the technology of trade openness was introduced, which is an exogenous factor responsible for increasing the degree of trade openness.

– nominal price rigidity and a gradual pass-through effect. At the aggregate level, industry prices are tight. Each sector producing final goods has a different level of price rigidity, which helps securing several stages of the exchange rate pass-through. In addition, a gradual pass-through effect is guaranteed by the local currency pricing. Domestic importers deal with external prices and exchange rate fluctuations, but their prices are rigid in the local currency, while exporter prices are rigid in foreign currency. Contracts with nominal wages are also rigid and function on a temporal basis. Rigidity of nominal wages is much stronger than that of consumer prices and producer prices in the interim sector are less rigid than prices of final consumption;

– real (natural) rigidity. To show the dynamics of a business cycle, several mechanisms were included in the model that cause real (natural) rigidity and friction. These include the formation of external habits of households, a temporary limitation for accumulation of the means of production and imperfect elasticity of substitution between new and old capital (investment) goods (Beneš et al., 2005).

The model is tested using the analysis of the impulse response of unexpected and expected shocks, the analysis of structural shocks filtering and the decomposition of historical data shocks, the forecast error variance decomposition, time and frequency analysis of the moments of the model, and the analysis of recursive filtration. The forecasting process consists of the following stages: identification and interpretation of initial conditions, projection of simulation on exogenous variables and judgment, scenario analysis and analysis of decomposition of the forecast dynamics and communication of the forecast (Andrle et al., 2009).

*3.3. DSGE Model of the National Bank of Armenia*

The Central Bank of Armenia moved to the inflation targeting regime in 2006. Given that one of the preconditions for successful implementation of this policy is a well-designed macroeconomic model and thorough understanding of the transmission mechanism, in addition to the existing key quarterly projection model (QPM), the Bank of Armenia was developing the DSGE model.

At present, there is a number of studies (Ara Stepanyan, Anahit Tevosyan, 2008; Ashot Mkrtchyan, Era Dabla-Norris, Ara Stepanyan, 2009; Igityan, 2016) devoted to the construction of a New Keynesian-type small open economy model with microeconomic foundations for Armenia taking into account the specifics of its economy.

Early efforts of building DSGE models for Armenia cover the period of its economic development before the global financial crisis. Thus, Ara Stepanyan, Anahit Tevosyan (2008) estimated the general equilibrium model for Armenia before 2008. The authors extended the model described by Svensson (2000), Gali J., T. Monacelli (2004) and T.Monacelli (2005), supplementing it with foreign financial inflows into the economy (remittances). A high share of foreign transfers is one of the specific features of the Armenian economy. According to the World Bank data, foreign transfers to GDP in 2002-2008 accounted for 17% on average. The general equilibrium model constructed by the authors covers this period. The importance of remittances in the country's economic development of that period the authors associate with several resultant factors:

1) they accounted for about 20% of GDP and had increased by more than 45% since 2002;

2) a part of these foreign transfers was directed to the real estate market causing a construction boom (Figure 2);

3) they had a significant impact on the nominal exchange rate and had sparked a 40% appreciation of the national currency since 2003 (Figure 2).

Remittances were incorporated into the model as a part of the output gap equation:

$$y_{gap_t} = -\frac{k}{\sigma} r_{gap_t} + \frac{c_1}{\sigma} \delta_{gap_t} + (1-k) a^* \psi_t + c_2 tr_{gap_t}, \#(22)$$

where $r_{gap_t}$ – is a real interest rate gap,

$\delta_{gap_t}$ – a percentage deviation of the terms of trade from a steady state,

$\psi_t$ – Law of one price gap-LOP[8],

$a^*$ – elasticity of substitution between the domestically-produced goods and imported goods for foreign economy,

$tr_{gap_t}$ – private foreign transfer gap presented as the ratio of remittances to GDP.

A calibration was performed for the structural parameters of the model (the degree of openness of the economy, the discount factor, the elasticity of labor supply, etc.).

The model results showed that adding a real foreign transfer gap increases the explanatory power of the output gap equation. Standard shocks in the model create responses of

[8] The Law of one price says that if two countries trade with each other in some kind of a good, then the prices for this good in two countries, expressed in the same currency, should be the same. However, for a situation with an incomplete carry-over effect, the LOP is not executed and the Law of one price gap is applied.

macroeconomic parameters similar to the traditional New Keynesian model but none of them explains the specifics of Armenia's economic development at that time. Exceptionally the shock of remittances highlights the country's economic trends during the development period before 2008.

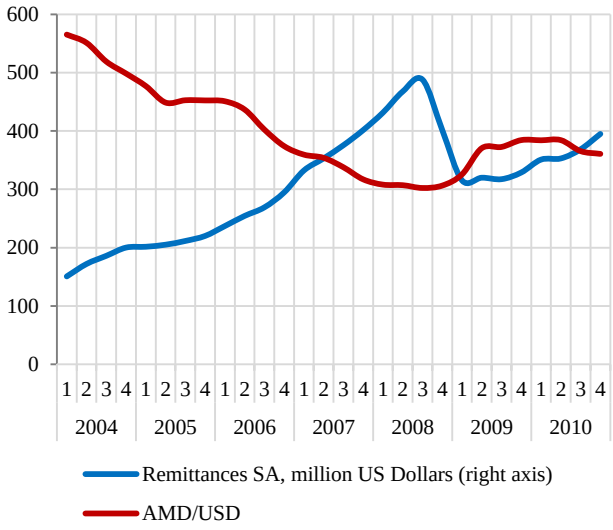
The IMF economists (Ashot Mkrtchyan, Era Dabla-Norris, Ara Stepanyan, 2009) also estimated a New Keynesian-type model with microeconomic foundations for the Armenian economy that covers the development period of 2001-2007. Structural equations just as in the first study were built on the basis of models suggested by Gali J., T. Monacelli (2004) and T.Monacelli (2005).

Within the framework of the model, in addition to a high share of remittances, a deeper insight into another specific feature of the economy is presented - a low sensitivity of prices for imported goods to the change in the exchange rate. The authors note that prices for imported goods in Armenia are less sensitive to changes in the exchange rate as compared to the classical literature. For example, during the period from 2004 to 2007, the nominal exchange rate appreciated by more than 40%, while import prices did not show a significant decline (Figure 2).

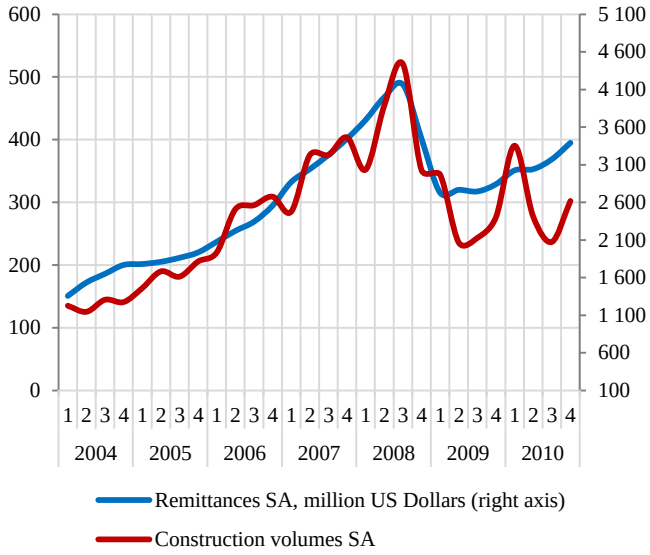
Figure 2

**Dynamics of remittances, construction and the nominal exchange rate in the Republic of Armenia**

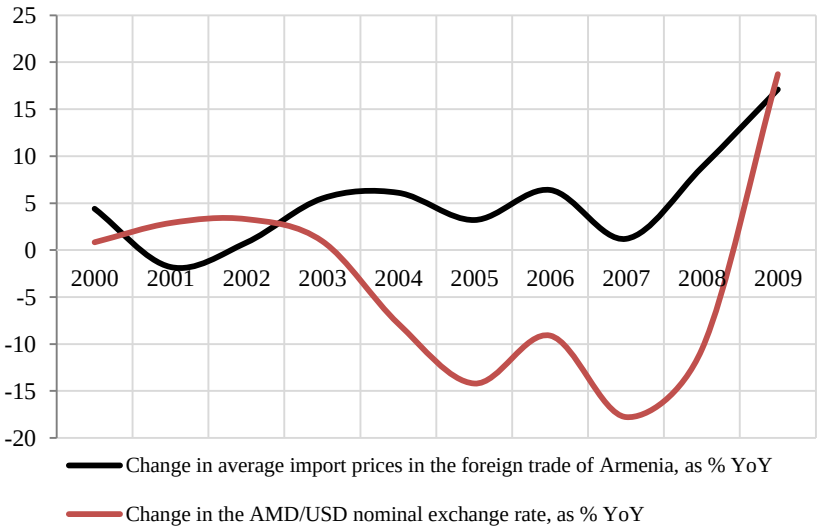
a)




b)




c)



*Source: The Statistics Committee of the Republic of Armenia (construction volumes, import prices in foreign trade), the Central Bank of Armenia (exchange rate, cash inflows)*

The authors, in addition to the incomplete pass-through effect[9] of the exchange rate in the short-term period implying a gradual pass-through of the dynamics of world prices onto the domestic prices, assume that importing firms in their pricing take into account the local unit labor cost. As a result, all indicators, for example, the level of prices, real wages, real marginal costs for the Armenian economy are less sensitive to the change in the exchange rate as compared to the standard model with nominal rigidities.

The headline inflation represents the sum of the domestic and imported inflation:

$$\pi_t = (1-\gamma)\pi_t^h + \gamma\pi_t^m, \#(23)$$

where $\gamma$ – the degree of openness of the economy (a share of imports in the consumption),

$\pi_t^h$ – domestic inflation,

$\pi_t^m$ – import inflation.

$$\pi_t^m = \beta_m\pi_{t-1}^m + (1-\beta_m)\beta E_t\pi_{t+1}^m + \lambda_{\pi^m}\psi_t^m, \#(24)$$

where $\psi_t^m$ – importers' real marginal costs presented by the LOP gap, $\lambda_{\pi^m} = \frac{(1-\omega_m)(1-\omega_m\beta)}{\omega_m}$,

$\omega_m$- the degree of price rigidity for importers,

β – discount factor.

The accounting of internal marginal costs in the cost function of importing firms is a specific feature of the import inflation equation in the model. This specific feature is consistent with the basic premise of the model about the use of domestic labor by importing firms to distribute imported goods among retail chains.

$$C_t^m(j) = M_t(j)S_tP_t^* + W_tN_t(j), \#(25)$$

where $M_t(j)$ – a volume of goods imported by a firm,

$S_tP_t^*$ – the cost of imported goods,

$W_t$ – wages in the economy,

$N_t(j)$ – the number of employees required to sell the imported goods.

Additionally, the model also includes remittances to the Armenian economy. They are presented as foreign consumption shock and incorporated into the model as an exogenous factor, and the utility function of foreign consumers is written as:

$$E_t\sum_{i=o}^{n}\beta^i\left\{\frac{e^{-\xi_t}(C_t^* - hC_{t-1}^*)}{1-\sigma} - x\frac{N_{t+i}^{1+\eta^*}}{1-\eta}\right\}, \#(26)$$

where $\xi_t$ – exogenous consumption of foreign households.

The negative sign implies that the foreign household (Diaspora Armenians) invest in the Armenian economy at the expense of its own consumption.

[9] Many authors such as Monacelli (2005), Adolfson (2001, 2007), Devereux and Engel (2002), Smets and Wouters (2002), Corsetti and Pesenti (2005), Sutherland (2005), as opposed to canonical models with a perfect pass-through effect, considered the effect of incomplete pass-through of the exchange rate dynamics on inflation and concluded that the latter makes the analysis of the monetary policy of an open economy fundamentally different from the analysis of a closed economy. In general, they agreed that the exchange rate volatility and the degree of the pass-through effect are key parameters in formulating the optimal monetary policy.

In the research paper, steady state variables were parameterized using the Armenian data, autoregressive coefficients were estimated using the OLS, and the Bayesian technique was used for behavioral parameters.

According to the results of the impulse response functions, the nominal and real exchange rates are appreciating in response to a positive shock of remittances (remittances shock), which leads to a decrease in competitiveness of domestic producers, and the output gap is narrowing. The presence of rigidity on import prices weakens their sensitivity to appreciation of the exchange rate; on the other hand, domestic prices are declining in response to a low output gap. According to the interest rate rule, in response to low inflation, a central bank lowers the key rate, which ultimately results in depreciation of the nominal exchange rate.

Later works of the DSGE models were presented by the staff of the Central Bank of Armenia. In his work (Igityan, 2016), he estimated the migration costs for a small open economy as Armenia with a full micro-foundation of Russia's external sector, and additionally incorporated a system of the migration legislation into the model. At the same time, there is a given exogenously external sector for Russia. The Armenian economy is linked to the Russian economy through trade, terms of cross-country risk sharing, interest rate parity and migration. The nominal exchange rate of Armenia is considered as the ratio of the dram to the ruble. External shocks to the domestic economy come through the Russian economy.

The utility function of consumers in the model differs from previous models, since it takes into account the costs of migration and the factor of migration policy:

$$C_t^{arm} + \frac{B_t^{arm}}{P_t^{arm}} + \frac{E_t^{arm} B_t^{rus}}{P_t^{arm}} + COST_t POLITICS_t N_t^m = \frac{W_t^{arm}}{P_t^{arm}} N_t^{arm} + (1-\tau)\frac{E_t^{arm} W_t^{rus}}{P_t^{arm}} N_t^m + \frac{R_{t-1}^{arm} B_t^{arm}}{P_t^{arm}} + \frac{E_t^{arm} R_{t-1}^{rus} B_{t-1}^{rus} \varepsilon_{prem,t-1}^{arm}}{P_t^{arm}} + Div_t \quad \#(27)$$

The population buys the domestic ($B_t^{arm}$) and Russian securities ($B_t^{rus}$), with $R_{t-1}^{arm}$ and $R_{t-1}^{rus}$ being interest rates of securities.

$\varepsilon_{prem,t-1}^{arm}$ – the country risk premium of Armenia,

$E_t^{arm}$ – the dram/ruble exchange rate,

$W_t^{arm}$ and $W_t^{rus}$ – real wages in Armenia and Russia,

$(1-\tau)$ – a share of income spent by the migrants in Russia,

$Div_t$ – dividends of firms received by the population.

The level of migration costs is written as:

$$COST_t = \sigma \frac{W_t^{arm}}{E_t^{arm} W_t^{rus}}, \#(28)$$

where σ –coefficient of the migration cost level.

When a relative wage rises, the population prefers to stay and work in Armenia. When a relative wage decreases as a result of a drop in wages in Armenia or an increase in wages in Russia, or depreciation of the nominal exchange rate of the dram against the ruble, migration, by contrast, grows. $POLITICS_t$ – is modeled as a first order autoregressive process.

In this paper, the equation for the Phillips curve is similar to the prior papers and the internal inflation equals:

$$\pi_{H,t}^{arm} = \beta \pi_{H,t+1}^{arm} + \lambda_H mc_t^{arm} \#(29)$$

$$\lambda_H = \frac{(1-\beta\theta_H^{arm})(1-\theta_H^{arm})}{\theta_H^{arm}} \#(30)$$

At the same time, the distinguishing feature of the imported inflation is that inflation is imported exclusively from Russia, however, the real marginal costs of importers are identical with prior studies, and they are equal to the LOP gap

$$\frac{E_t^{arm} P_t^{rus}}{P_{F,t}^{arm}} = \psi_t^{arm} \#(31)$$

Consequently, the Phillips curve for the inflation imported from Russia is written as:

$$\pi_{F,t}^{arm} = \beta \pi_{F,t+1}^{arm} + \lambda_F \psi_t^{arm} \#(32)$$

The Phillips curve for the model of the Russian Federation itself has a similar view but the import inflation is not limited by imports from one country.

In studying the transmission, it was found out that the main channel through which shocks affect migration and real transmittances in Armenia is the real exchange rate of the Armenian dram against the Russian ruble. For example, the monetary policy shock in Armenia will lead to reduction in the domestic demand and appreciation of the nominal exchange rate through the uncovered interest rate parity. In response to low business activity, firms cut their labor force, and nominal wages are decreasing. This effect prevails over the deflation effect, and real wages fall, subsequently marginal costs decrease, and producers reduce prices for their products. A stronger exchange rate reduces the marginal costs of importers, which also allows lowering prices; as a result, the terms of trade are improving and the real exchange rate is appreciating. In response to such appreciation, the migration costs are growing. The effect of low employment exceeds the effect of high migration costs and the population increases the migration to Russia; in doing so, real remittances will decrease as a result of a stronger real exchange rate.

Based on the studies drawing on historical simulations, the author came to the conclusion that the model may be used for forecasting key performance indicators of the labor market in Armenia and Russia.

One more paper related to the DSGE was published by the Central Bank of Armenia in January 2020. The paper describes the assessment of structural parameters and a potential economic growth in Armenia with the help of various specifications of the DSGE and RBC (real business cycles) models, with the premise about the well-balanced growth[10].

The first DSGE specification includes permanent and transient performance shocks and monetary policy shocks, the following specifications separately include demand and mark-up shocks, and the latter combines all of the above. The model, which does not include parameters of demand shocks and price increases, misestimated a potential economic growth. The potential growth of the latest model specification was similar to the previous estimates of the Central Bank of Armenia. The parameters obtained through the RBC model correlate significantly with the estimates of the DSGE model. Also, the forecasts of economic growth obtained by the DSGE model are able to compete with VAR-models on the out-of-sample forecast dynamics. Therefore, the authors conclude that it is possible to use the latest specification of the constructed model for forecasting purposes.

*3.4. The DSGE Model of the Central Bank of Russia*

Russia is a developing country with the economic structure similar to that of Kazakhstan and alongside with that it is a key trading partner. Russia has the same monetary policy regime as Kazakhstan that was implemented at the end of 2014 given the imposition of sanctions and the falling oil prices. Within the framework of inflation targeting, the Central Bank of Russia set a medium-term goal for the annual inflation at 4%. Thus, close trade relationships, orientation at

[10] Macroeconomic variables (GDP, consumption, investments, real wages, and capital) are growing at a constant speed.

exports of energy resources, similarity of impact by different factors on the economic processes in our countries, common monetary policy regimes call for the study of experience with the construction of DSGE models in Russia.

Specialists from the Central Bank of Russia Kreptsev D., Seleznyov S.. (2016) constructed two DSGE models for Russia with a small number of equations: with a fixed and floating exchange rate of the ruble. Both models are used for a small open economy with the assumption about a stochastic trend in the price of oil.

The main reason for constructing a model with the fixed exchange rate for Russia is a lengthy use of this exchange rate regime in the historical retrospective. The model with the fixed exchange rate was estimated on the period from the second quarter of 2003 through the first quarter of 2013, and the specification with the floating exchange rate – on the period from the second quarter of 2013 through the third quarter of 2015.

The equation for the real exchange rate targeting looks as follows:

$$rer_t = e^{e_t^{\varepsilon}} * rer_{ss,t}, \#(33)$$

where $rer_t$– the dynamics of the real exchange rate,

$\varepsilon$ – the dynamics of the nominal exchange rate.

$rer_{ss,t}$– an equilibrium level of real exchange rate at time t. The equation for the floating exchange rate is written as follows:

$$dRes_t = \left(e^{e_t^{\varepsilon}} - 1\right) * \frac{1}{A_t * P_t^{cpi}}, \#(34)$$

where $dRes_t$– a variable characterizing the change in reserve assets

The authors observe that the real exchange rate targeting does not suggest keeping it at a fixed number permanently. The targeting only implies the drive of the real exchange rate in the long-term perspective to a certain level in the absence of various shocks. Given the model's properties, maintaining a fixed exchange rate would mean its deviation from a long-term fundamental level, which, in turn, would result in the economy's deviation from its equilibrium.

It is worth mentioning that irrespective of the exchange rate regimes used in specifications, the monetary policy is defined as:

$$\frac{R_t}{R_*} = \left(\frac{R_{t-1}}{R_*}\right)^{\phi_R} \left(\frac{\mathrm{E}_t(\pi_t * \pi_{t+1} * \pi_{t+2} * \pi_{t+3})^{0.25}}{\pi_*}\right)^{(1-\phi_R)\phi_\pi} * exp^{e_t^R}, \#(35)$$

where $R_t$ – internal interest rate,

$\pi$ – inflation,

$\phi_R$, $\phi_\pi$ – numeric parameters.

Since the oil price is the most important external indicator determining the path of key macro indicators in Russia, the impact of the 10% positive shock of oil prices on the key variables was analyzed in the study. Thus, the accumulated impact on the economic activity after ten quarters equals 0.65% for the specification with fixed exchange rate and equals 2% for the specification with floating exchange rate. The effect on the change in the level price is estimated at 1% and 3.7%, and for the exchange rate – 6% and 19%. In addition, it was found out based on the results of analysis that the impact of the oil price shock on the key macro indicators in the model with a fixed exchange rate turns out to be much weaker compared to the model with a floating exchange rate; however, the impact of this shock on real variables does not depend on the exchange rate regime in the long run and the observed difference in impulse responses reflects only the difference in the estimates of the parameters.

Further, the authors highlight one of the distinctive properties of a specification with a fixed exchange rate - the lack of reaction of the observed variables to the risk premium shock. The main reason for that is the support by the central bank of the real exchange rate on the long-term equilibrium, thus the risk premium shocks are fully compensated by the change in reserves. In particular, in the interest rate parity equation, the risk premium shock is offset by the change in the volume of debt, and in the balance of payments equation, an additional change in debt is, in turn, offset by the change in reserves. The equations for the path of the remaining variables do not change, and the exchange rate remains fixed.

As part of further research, along with the responses to the oil price shock, the historical contribution of the total factor productivity, monetary policy and oil price shocks to the decomposition of the key variables is presented. Thus, the shock of total factor productivity over the entire period had been making the largest contribution to the dynamics of change in GDP, while exerting a downward effect on the inflation and interest rate (except for the period from the second half of 2008 through the first half of 2009). In turn, given the decomposition of inflationary processes, the monetary policy shock made the major contribution to the growth of inflation, indicating that interest rates were not high enough to keep inflationary processes in the proximity of 4%.

As for the influence of oil prices on the dynamics of the key macro indicators, their historical path on average contributed to the appreciation of the exchange rate of the ruble, which subsequently had a downward effect on inflationary processes and interest rates.

Moving on to comparing models with different exchange rate regimes, it is worth mentioning that for most of the criteria (impulse responses, structural relationships between variables, and historical decomposition), the model using a fixed exchange rate is more preferable than the one with a floating exchange rate. However, the GDP and interest rate forecasts are more accurate for the floating exchange rate version of the model.

When comparing the DSGE models with other classes of models, the authors note that, despite significant dependence on the given a priori values and incorrect specification, the estimated models demonstrate more acceptable results in comparison with Bayesian vector autoregressive models.

The DSGE models give a more accurate forecast of the exchange rate, inflation and interest rate and a slightly worse projection of GDP. Despite the acceptable predictive properties of the estimated model, the authors emphasize that the structural decomposition of key macro indicators and impulse responses give rise to doubts about acceptability of the selected specification, and small-sized models with a different specification may show more accurate results.

As part of a further expansion and improvement of the dynamic stochastic general equilibrium model, Kreptsov D. and Seleznyov S. had constructed two DSGE models already in their next study, “The DSGE Model of the Russian Economy with the Banking Sector” (2017), - the basic model and the model supplemented with the banking sector, which is used for making simulation experiments. These experiments are used to assess the impact of a particular event on macro variables and optimal behavior in a model economy.

The base model is a standard model for a small open economy with a simple public sector. It includes households, manufacturers, domestic retailers, importing retailers, exporting retailers, consumer and investment goods retail firms, investment firms, oil exporters, the central bank, the public sector, and the external economy.

In order to add the banking sector, agents taking loans are included into the base model. For the sake of simplicity, loans were added only to firms, thereby excluding the possibility of the spread of shocks to the banking sector onto the indicators through household lending. Entrepreneurs who acquire capital from investment firms are included into the model, similarly to Bernanke et al (1999) and Christiano et al (2014). However, contrary to the base model, this capital is “raw” and cannot be used directly for the production of goods. Entrepreneurs create capital suitable for the production of goods and rental from the “raw” capital. After a full

production cycle is completed, the capital is sold back to the investment firms. It should be noted that entrepreneurs use both their own and borrowed funds to acquire "raw" capital. Similarly to Christiano et al. (2010), it is assumed that there is a business unit in the bank, which is engaged in providing loans to entrepreneurs and is operating with a zero profit. In fact, this business unit adds a risk premium to the risk-free rates set by another business unit of the bank.

The work demonstrates the impact of oil price shock, risk premium shock and monetary policy shock initially within the framework of the basic model.

With a positive shock of oil prices, the exchange rate appreciates and, respectively, imported goods become cheaper, which leads to a decline in prices for consumer and investment goods. In turn, a decline in prices of consumer goods leads to a decrease in interest rates, which, along with other factors, contributes to an increase in the investment-purpose production, in consumer products and GDP. Alongside with that, there is a drop in export volumes due to the exchange rate appreciation.

As a result of the risk premium shock, the interest rate at which Russian agents borrow abroad increases, while the external rate itself does not change. This shock leads to the exchange rate depreciation and an increase in interest rates on foreign loans and has a similar effect on indicators just like the shock of oil prices, but with the opposite sign.

A positive shock to the monetary policy (a rise in interest rate) leads to a drop in consumer and investment demand. The reaction of the exchange rate to an increase in the interest rate is its appreciation, which, in turn, results in cheaper imported products and subsequently in the decrease in the general price level. Similarly to the oil shock, due to appreciation of the exchange rate, the exports fall.

In the version of the specification with the banking sector added, the model properties changed only quantitatively, while the qualitative characteristics did not show significant changes. The key advantage of the model with the banking sector is the ability to analyze the impact of the banking sector indicators on the economy. So, the impact of the mark-up shock for deposit rates initially has an upward effect on the deposit rates, which subsequently leads to a reduction in the consumer demand, GDP and inflation.

Along with the Bank of Russia, some DSGE models were built by third party organizations and/or specialists. So, Drobyshevsky S. and Polbin A. in their paper, "Decomposition of the Dynamics of Macroeconomic Indicators of the Russian Federation Based on the DSGE Models", made an assessment of the contribution of external and internal fundamental factors to the dynamics of the key macroeconomic indicators of Russia from the first quarter of 2008 through the first quarter of 2014. In this study, instead of conducting an econometric estimation of the model parameters, the approach of their calibration was used. In determining the model parameters, the authors assume that the share of non-ricardian households in total households is 0.5, and the reaction coefficient of lump-sum taxes to the change in the public debt is 0.3. In addition, the estimate for the long-term economic growth is calibrated at 1.87% QoQ, which is consistent with the average estimates of the GDP growth rates in the pre-crisis period. Taking into account the specifics of the Russian economy, the degree of rigidity of nominal variables was slightly changed. Thus, the parameters of price rigidity for imported goods and tradable domestic goods, with the exception of energy resources, are calibrated in accordance with the average duration of the price contract according to Calvo pricing - 1.5 quarters, price rigidity for non-tradable goods - 3 quarters, and wage rigidity - 4 quarters.

The main feature in the structure of the constructed DSGE model is that there are four types of goods in the economy: domestic tradable and non-tradable goods, import products and oil. At the same time, oil means not only oil itself, but also oil products and gas. The first three types of goods are intended for final consumption by households, by the government and for the formation of investments. Non-tradable goods are consumed exclusively within the country, and tradable goods can be used for export. Oil can be used both for export and as a factor of production for domestic goods.

The key task of the study is to construct a decomposition of GDP and its components by assessing the contribution of the main shocks to the dynamics of macroeconomic indicators. It is noted that the drop in real GDP in 2009-2011 versus the first quarter of 2008 is explained by shocks from the worsening external conditions. Thus, the accumulated negative impact of the oil price shock led to a 5% decline in GDP in the second quarter of 2009. The fall in oil prices does not have a direct impact on GDP but exerts influence via the channel of the decrease in total income and demand in the economy, which, in turn, contributes to a decline in the production of goods and services, and gross fixed formation. The negative contribution of the oil shock to the gross fixed formation in 2009 averaged 19%, to household consumption - 8%, and to imports - 13%. Another important component of the "oil" shock is the drop in production and exports of energy resources. The drop in oil production and exports has a direct negative effect on GDP, since this factor is a component of GDP. There is also an indirect impact through a reduction in income and demand for other domestic goods. The negative contribution of this shock to the real GDP in 2009 is estimated at 2.8%, and to the household consumption – at 2.3%.

Another significant factor in the fall of Russia's GDP is a decrease in external demand for domestic tradable goods, with the exception of energy resources. The decomposition of the dynamics of macro indicators suggests what the GDP dynamics would be if the Central Bank of Russia used a fixed exchange rate regime for the ruble (due to the absence of an officially announced monetary policy regime in Russia in the period from the first quarter of 2008 through the first quarter of 2014, the authors assume the regime of strict targeting of the nominal exchange rate) and prevented a drop in the exchange rate of the ruble in the second half of 2008 and at the beginning of 2009. If such regime were used, the average negative contribution of external demand to output in 2009 would be about 10%, which is associated with a 40% decline in exports, excluding energy resources. However, the observed depreciation of the Russian ruble considered as a positive shock to the monetary policy, substantially neutralized this negative effect, leading to a more moderate decrease in exports of tradable goods, with the exception of energy resources.

The fiscal policy shock also served as the key internal factor that had a stabilizing effect on the dynamics of economic activity. The growth in budget spending had some positive effect on the dynamics of economic activity during the global financial crisis through a slight increase in government consumption, however, to a greater extent, this had a positive effect on household consumption. Thus, the growth of budget expenditures assumes, first of all, an increase in payouts to the population that leads to an increase in disposable income of non-ricardian households and, subsequently, to an increase in total consumption of all households (a positive contribution in the first quarter of 2009 is estimated at the level of 11%). In general, a positive shock to the fiscal policy has an upward effect due to the GDP dynamics in the short term (positive contribution in the first quarter of 2009 accounted for 2.7%), while contributing to the crowding out of investments (negative contribution in the first quarter of 2009 was 6%).

Along with the above shocks, the paper also assesses the impact of a technology shock. Incorporating the technology shock into the DSGE model specification is a standard practice, however, this has its drawbacks. So, when a negative technological shock is realized, a technological regression is assumed, which is difficult to interpret. In this regard, the authors introduce a technology shock as the shock of trend dynamics or a performance shock. The authors, on the one hand, note that the trend growth of the economy is the main factor in the GDP recovery dynamics after the crisis, with some slowdown since the fourth quarter of 2013. However, on the other hand, in the post-crisis period, productivity in the Russian economy grew at a slower pace than before the crisis of 2008-2009. This has a negative impact on the gross formation. Thus, before the crisis, investment decisions of economic agents were made based on the expected higher GDP growth rates, and investments accounted for a high share of GDP. By the end of 2013, the negative contribution by the trend growth dynamics of the economy to the gross fixed formation is estimated at 11%.

*3.5. The DSGE Models in the Republic of Kazakhstan*

The National Bank of the Republic of Kazakhstan had officially moved to the inflation targeting regime in August 2015. The transition to the new monetary policy regime was preceded by the effort to improve the model toolkit that included the construction and implementation of a macroeconomic model of Kazakhstan's economy for the medium-term forecasting of the key macroeconomic indicators.

The Quarterly Projection Model of the National Bank designed for this purpose represents a structural model of Kazakhstan's economy based on the New Keynesian theory of business cycles, where the parameters are calibrated and not micro-founded as is the case with the DSGE models. At the same time, the QPM model refers to the class of small ad hoc DSGE models. The structure of the model of this class, estimation of parameters including those of the QPM model of the National Bank of Kazakhstan is provided in a greater detail in the papers of Berg et al, 2006, Hlédik et al, 2018, Chernyavskiy, 2017(I), Chernyavskiy, 2017(II), Chernyavskiy, Mukanov, 2017.

However, despite of high popularity of the DSGE models in developed and developing countries, the survey of literature showed that this area is feebly developed in Kazakhstan. As opposed to the reviewed central banks, full-pledged DSGE models are not officially used at the National Bank of Kazakhstan for assessment of the influence of monetary policy measures on the economy or for forecasting the economic development scenarios.

At the same time, the development of dynamic stochastic general equilibrium models became very popular in the academic literature in Kazakhstan, in particular after the global financial crisis of 2008 given the growing interest in a more structured analysis of the economy. The second wave in the construction of DSGE models in Kazakhstan came after 2015 in view of the transition to the inflation targeting and free floating exchange rate regime by the National Bank of Kazakhstan.

Professor Mukhamediev (2014) constructed a DSGE model for Kazakhstan's economy with the structure based on the study of Gali & Monacelli (2005). In addition to that, the designed model also includes the oil production sector, thus reflecting the specifics of Kazakhstan's economy where crude oil accounts for a significant share in exports and a large portion of revenues to the state budget is secured by the oil sector.

The model represents a small open economy with several sectors. The household sector is classified into ricardian and non-ricardian households, the enterprise sector is represented by manufacturing firms and firms involved in the production and export of oil, and the public sector is represented by the central bank. The first two categories of economic agents function within the framework of solving optimization problems: households maximize welfare (utility), and firms maximize profit (value). The central bank follows the Taylor rule.

Just as in many canonical DSGE models, the main prerequisites for Mukhamediev's model are the mobility of labor resources between sectors, the production of diversified goods by firms in the environment of monopolistic competition. Pricing in the market of goods and services follows the Calvo model. Additionally, it is assumed that all firms use crude oil in the production process, the cost of which is determined by world prices of oil.

A specific feature of the model is the segregation of the oil sector. It is assumed that a part of the oil sector production is consumed by domestic firms in order to manufacture final products, and the remaining part is exported. For oil-producing companies, the oil price and wages are set exogenously, while the volume of oil produced is determined based on the amount of labor in the oil sector $N_t^o$.

Firms in the oil sector maximize their profit

$$\max[P_t^o O_t^o - W_t N_t^o] \quad \#(36)$$

proceeding from a restriction

$$O_t^s = Z_t \, N_t^{o^v} \#(37)$$

where $P_t^o$ – oil price,

$O_t^o$ – a volume of oil production,

$W_t$ – wage,

$v$ – a parameter that reflects the diminishing return on labor in the oil production technology, with $0 < v < 1$,

$Z_t$ – determines effectiveness and follows the autoregressive order one process

$$lnZ_t = \rho_Z lnZ_{t-1} + \varepsilon_{Z,t}, \rho_Z \in [0,1). \#(38)$$

The order one condition for oil-producing companies takes the form of:

$$vZ_t P_t^o {N_t^o}^{v-1} = W_t. \#(39)$$

For firms that do not use oil in the production of goods, marginal costs are written as follows:

$$MC_t = \frac{W_t}{A_t P_t}, \#(40)$$

where $A_t$ – total factor productivity, whose dynamics are described by the autoregressive order one process

$$lnA_t = \rho_A lnA_{t-1} + \varepsilon_{A,t}, \rho_A \in [0,1) \#(41)$$

For other firms that are using crude oil in the production of final products, marginal costs are determined by the following formula:

$$MC_t = \frac{W_t + \zeta P_t^o}{A_t P_t}. \#(42)$$

Therefore, a new Keynesian Phillips curve is written as:

$$\pi_{H,t} = \beta \mathrm{E}_t[\pi_{H,t+1}] + \lambda(\varphi + \sigma) y_t + \lambda(1-\omega) s_t + \lambda\zeta(p_t^o + p_t). \#(43)$$

Revenues from oil exports are presented as $P_t^o O_t^*$, in real terms they are written as

$$\frac{P_t^o O_t^*}{P_t}. \#(44)$$

It is worth mentioning that a part of oil revenues is accumulated at the National Fund, and only a part of them is allocated to the current consumption ($\kappa$), which corresponds to the facts. Including oil revenues allocated to consumption , the government consumption function in real terms takes the form of:

$$Y_t = \kappa \frac{P_t^o O_t^*}{P_t}. \#(45)$$

The monetary policy of a central bank follows the Taylor rule and has the form of:

$$r_t = \delta_\pi \pi_t + \delta_y y_t + \varepsilon_{M,t}. \#(46)$$

The model's parameters were estimated by using three techniques: Bayesian estimation using the Metropolis-Hastings algorithm, estimation based on the statistical data and international experience.

The author assesses the quality and transmission mechanism of the model through the analysis of impulse response functions to shocks. Both shocks standard for the DSGE model such as the productivity shock, monetary policy shock, and those typical for Kazakhstan's economy, in particular, the shock to the world oil price, shock to demand for oil, and the productivity shock in the oil sector were considered as shocks. With the rise in world prices of oil or a sharp increase in the external demand for Kazakhstani oil, the indicators of domestic production and net exports improve.

The study of Mukhamediev and Kakizhanova (2014) examines the impact of oil revenues on the dynamics of key macroeconomic indicators in Kazakhstan. By means of the DSGE model, the authors assess "how an increase in the share of oil revenues allocated to the current consumption can have an intensifying or weakening effect on the consequences of shocks for the country's economic performance".

Including the government sector into the DSGE model allows assessing the impact of measures taken in the area of monetary and/or fiscal on the economy. Thus, studies of Ishuova (2013) and Algozhina (2015) are devoted to the assessment of impact made by the monetary policy on Kazakhstan's economy.

Ishuova's DSGE model for a small open economy is constructed in accordance with the Gali methodology (2008). Parameters in the model are estimated based on the data from Kazakhstan'e economy for 1997-2012. The model is solved with the use of Blanchard-Kahn method.

Ishuova's DSGE model traditionally includes the household sector, with households maximizing the utility function based on the budget constraint as well as maximizing the utility of the combination of consumption, labor and money with the given optimum set of consumer goods and services (intertemporal consumer's choice, Euler's equation).

Firms operate under monopolistic competition. The model contains nominal rigidities of prices and wages, and the pricing is derived according to the Calvo model. At the same time, there are no investments in the short-term period. The external sector is represented by the Russian economy.

The monetary policy is formulated based on the interest rate rule (the Taylor's rule). The monetary policy is incorporated into the model as an endogenous process with a short-term interest rate, which serves as the policy instrument enabling to consider different monetary policy regimes.

Thus, to analyze the impact of monetary policy on Kazakhstan's economy, the author uses three rules for a small open economy.

Under the first option, the National Bank reacts to the deviation of inflation from the target level and the output gap in equal measure, under the second option it reacts to inflation only and under the third option the reaction to the output gap would be stronger.

Based on the analysis, the author comes to the conclusion "that the National Bank should react to deviations of the reviewed variables from the target values as strong as possible. The considered option with a strict targeting of inflation is the most effective since under this option specifically the changes of variables after shocks are generally the lowest and the indicators come back to their pre-shock values faster".

Due to different estimates of the output gap, which is an unobservable variable, Ishuova argues that "in setting a parameter with a strong reaction to the output gap, taking into account measurement errors for this unobservable indicator, may lead not to a decrease but to an increase in welfare losses".

In addition, within the framework of the DSGE model developed, the author analyzes the impact of various shocks on Kazakhstan's macroeconomic indicators. Thus, preference shocks, technology shocks, shocks of cost-pushed inflation and interest rate shocks are considered.

According to the model's estimates, the dynamics of inflation in Kazakhstan in the reviewed period is mainly explained by interest rate shocks and technological shocks. The results of econometric analysis point to the fact that preference shocks determine a small fraction of the variation, and shocks of cost-pushed inflation explain the dynamics of Kazakhstani macroeconomic variables by 30% on average.

It is worth mentioning that the DSGE model suggested by Ishuova does not fully reflect the specifics of Kazakhstan's economy.

Algozhina (2015), in addition to highlighting the oil sector, analyzes the optimality of the monetary policy taking into account the correlation with the fiscal policy in a small open resource economy. The correlation of monetary and fiscal policies has become especially relevant after the 2008 global financial crisis.

The DSGE model for Kazakhstan designed by Algozhina has the following structural specifics:

– government investments are considered separately from the government consumption since investments represent a fiscal policy instrument used to stimulate the economic growth (infrastructure investments, investments in human capital);

– in practice, the monetary policy regime as a rule may concurrently include the regime of inflation targeting and the regulated exchange rate regime, which determines the use of two different monetary policy instruments: interest rates and foreign currency interventions;

– in countries with a feebly developed financial market as in Kazakhstan, private sector investments are financed with foreign borrowings; this enables to tie physical capital and external debt via collateral constraint;

– households are subdivided into ricardian households and non-ricardian ones, that is having savings and the access to the financial market of those who "pour down the throat" and are limited by liquidity;

– the production sector is subdivided into the resource sector and non-resource sector, oil producing firms are modelled separately and represent a capital-intensive production that is directly dependent on foreign direct investments, which, in turn, depend on the world oil prices.

One of the important features of Algozhina's DSGE model is an explicit segregation of a fiscal sector including the National Fund where tax revenues from the oil sector are accumulated. Alongside with that, the author included transfers from the National Fund to the national budget into the model, which generally approximates the model to reality to the greatest possible extent. Cyclicity of the fiscal policy depends on the change in the volumes of oil production and is expressed via the change in the general government consumption and government investments.

The model contains nominal rigidities, in particular, an imperfect asset market, investment management costs, collateral constraints, pricing according to the Calvo model, and an assumption of limited capital mobility is made.

The monetary rule is represented by the Taylor's rule:

$$\widehat{R_t} = \rho\, \widehat{R_{t-1}} + (1-\rho)\left[\varphi_\pi \pi_t + \varphi_y \widehat{Y_t}\right], \#(47)$$

where $\rho$ – a smoothing parameter,

$\varphi_\pi$ – a parameter at inflation,

$\varphi_y$ – a parameter at the output gap.

In addition to the consumer price index, Algozhina suggests to consider an alternative index (Product Price Index) proposed in the study of Frankel and Catao as a nominal monetary policy anchor; it reflects the change in producer prices that include the cost of a major export item, raw commodity as a rule. Inflation PPI is calculated as the weighted average of inflation of oil prices in real terms

$$\pi_t^o = \Delta\, \widehat{P_t^{o*}} + \Delta \widehat{RER_t} \#(48)$$

and the internal inflation

$$\pi_t^h = \pi_t - \frac{1-\gamma}{\gamma}\Delta\widehat{RER_t}. \#(49)$$

The shares of the oil ($s_0$) and non-oil (1 – $s_0$) sectors of the economy are used as weights. The use of this index allows reducing the impact of terms of trade shocks in case of a dramatic change of world prices in the commodity markets of countries-exporters of primary products.

The Taylor's rule with the PPI index looks as follows:

$$\widehat{R_t} = \rho\,\widehat{R_{t-1}} + (1-\rho)[\varphi_\pi(\pi_t + \varphi_y\hat{Y}_t\,] \#(50)$$

The model also includes foreign currency interventions for considering a managed exchange rate regime along with the free-floating regime. A rule for currency interventions looks as follows:

$$\widehat{fxr_t^*} = \rho_{fxr}\,\widehat{fxr_{t-1}^*} + \left(1-\rho_{fxr}\right)\left(\alpha_1\widehat{RER_t} + \alpha_2\Delta\widehat{RER_t}\right), \alpha_1 < 0, \alpha_2 < 0. \#(51)$$

In accordance with the rule, when the exchange rate depreciates, the central bank sells foreign exchange, and when the exchange rate appreciates, the central bank buys foreign exchange and replenishes the reserves. Under the free-floating exchange rate regime, parameters $\alpha_1$ and $\alpha_2$ equal zero.

To analyze the model transmission mechanism, the author considers the world oil price shock and external demand shock.

Despite the fact that the DSGE model reflects the structure of Kazakhstan's economy as much as possible, it is quite complex for interpretation of results, which limits its applied potential. The model parameters are calibrated or are taken from the empirical literature.

Abilov (2020) used the Bayesian approach in the DSGE model for Kazakhstan's economy to estimate the model parameters. The author also segregates the resource sector; however, the model structure is more simple compared to that of Algozhina. The specific feature of the model is the consideration of risk premium shocks in the foreign exchange market. By analyzing the impulse responses of internal variables to various shocks, the author comes to the conclusion that the contractory monetary policy negatively affects the output gap, while exerting virtually no influence on inflation. About 60% of movements of the exchange rate over the reviewed period are explained by the risk premium shock.

One of the key points in the construction of DSGE models is the estimation of the model parameters. Along with Bayesian estimates, authors often draw on calibration of parameters based on the analysis of a wider data set or take parameters from the literature. An addition to the empirical literature on the DSGE models for Kazakhstan's economy is the work of Adilkhanova (2019). The author estimates the parameters for the DSGE models by analyzing restricted microdata on households, firms and customs statistics for the period from 2009 to 2018 using various econometric techniques. Thus, the author estimated the following parameters: elasticity of substitution between exports and imports, constant relative risk aversion, intertemporal elasticity of substitution in consumption, elasticity of labor supply according to Frisch, depreciation rate of physical capital, shares of capital and labor, and elasticity of substitution between tradable and non-tradable goods.

The parameters can be used when calibrating the DSGE model as fixed parameters or a priori values for Bayesian estimation.

## 4. Conclusion

Despite the presence of DSGE models in the economic literature that reflect the specifics of Kazakhstan's economy, they were all developed for scientific or research purposes and were not used in implementation of the government policy.

In turn, the successful experience of using the models of this class by central banks of different countries worldwide feeds on the potential for building and using a full-fledged DSGE model at the National Bank of Kazakhstan.

In addition to the possibility of a deeper insight into the impact of the undertaken monetary policy measures on various sectors of the economy and the behavior of economic agents, "the DSGE models represent a tool that provides a consistent basis for discussion and analysis of the measures taken, since through the well-being criterion, alternative politcy decisions can be easily evaluated and matched to the model assumptions" (Flotho, 2009). Thus, the DSGE models provide a fully integrated framework for policy analysis.

Concurrently, DSGE models are often used as a forecasting and quantitative policy analysis tool in macroeconomics. The development of information technologies and the expansion of computing capabilities made it possible to significantly speed up and simplify the estimation of the model parameters of DSGE models for a researcher.

The review of DSGE models of central banks presented in this paper allows using the experience in constructing the DSGE model for Kazakhstan's economy.

In particular, the Bank of Canada's model (ToTEM) reflects the structure of a developed open economy with a separate sector of raw commodities, which enables to better model the shocks associated with the terms of trade, for example, those caused by changes in world prices of raw commodities.

The experience of the Czech National Bank should be given a prominence as the central bank of the country that successfully implemented the transition to the market economy and is pursuing an efficient monetary policy, which is based on the well-designed model toolkit where the DSGE model is the centerpiece. The Czech experience will be useful for Kazakhstan as the country looking towards the economic diversification due to the fact that the model of the Czech National Bank reflects high intensity of imports in the domestic production, developed monetary policy mechanisms, advanced financial market and a high share of investment activity.

At the same time, Armenia, like Kazakhstan, is a developing country with a small open economy that is vulnerable to external shocks. In most cases, the Armenian economy is highly influenced by Russia. A similar dependence on Russia is also typical for Kazakhstan, where the share of all imports from Russia accounts for 34% (in January-September 2020). This is the dependence that is broadly discussed in the works of the staff of the Central Bank of Armenia, which can be useful in constructing the DSGE model for Kazakhstan's economy.

The experience of the Bank of Russia in building the DSGE model is useful in that it considers various options for including the commodity sector into the model and the dependence on world oil prices. Alongside with this, Russia, like Kazakhstan, belongs to the category of countries with an emerging market, which is reflected in the structure of the country-specific DSGE model.

At the same time, both the construction and application of models of this class are associated with certain difficulties. So, despite the technical capabilities of the DSGE model, the interpretation of results and development of appropriate recommendations should be considered through the "prism of common sense", taking into account the fact that any model is a simplification of reality and cannot cover all its important aspects. In addition, the application of a fully linear model for Kazakhstan's economy may not be acceptable due to the presence of significant structural shocks, which may require the use of non-linear estimation methods. Meanwhile, the construction of a reliable model requires high quality statistical data and free access to them, including the availability of microeconomic statistics.

In turn, the international experience of implementing the DSGE models shows that this process is long-term. It undergoes several stages, including the period of collecting and preparing the necessary statistical data, evaluating the model parameters, testing the model and verifying its results, training specialists and improving their qualifications. The latter condition is a particularly important stage, since the DSGE models belong to the class of complex structural models, the work with which implies the presence of high professional qualifications and deep

knowledge in the field of macro and microeconomics. At the same time, the successful experience of using the DSGE models, including by central banks, over more than twenty years, is a proof of reliability of this model toolkit used to substantiate economic policy decisions.

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# FINTECH AND ITS REGULATION

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*Мақала финтехтің әлемдік қаржы жүйесінің трансформациялаудағы рөлін зерттеп, оның қандай мүмкіндіктер мен тәуекелдерді туындыратынын корсетеді. Сонымен қатар, осы мақала финтех дамуын реттеуінің әр түрлі тәсілдерін ұсынып, Covid-19-дың финтехке және оның реттеуіндегі әсерін анықтайды, сондай-ақ Қазақстан Ұлттық Банкінің қаржы bурығындағы финтехті қолдау және дамыту жөніндегі бастамаларын сипаттайды.*

Кілттік сөздер: финтех, қаржылық қызметтер, реттеу, қаржы bурығы, реттеушілер, Қазақстан Ұлттық Банкі.
JEL-жіктемесі: G18, G23, G28, O30, O38.

*Статья исследует роль финтеха в трансформации мировой финансовой системы, раскрывает возможности и риски этих изменений, оказывающие влияние на финансовую систему. Более того, статья демонстрирует различные подходы к регулированию финтех-развития, показывает влияние Covid-19 на финтех и его регулирование, а также описывает инициативы Национального Банка Казахстана по поддержке и развитию финтеха на финансовом рынке.*

Ключевые слова: финтех, финансовые услуги, регулирование, финансовый рынок, регуляторы, Национальный банк Казахстана.
JEL-классификация: G18, G23, G28, O30, O38.

*The article explores the role of Fintech in transforming the global financial system and shows how this transformation brings opportunities together with challenges to the financial system. Moreover, it presents different approaches to regulate Fintech development and reveals the impact of Covid-19 on Fintech and its regulation. In addition, the article describes the initiatives of the National Bank of Kazakhstan to support and develop Fintech in the financial market.*

Key words: Fintech, financial services, regulation, financial market, regulators, the National Bank of Kazakhstan.
JEL-classification: G18, G23, G28, O30, O38.

## Introduction

In contemporary dynamic world the role of financial technology (Fintech) has increased since its presence on financial market. Actually, the current Covid-19 pandemic has even amplified the role of Fintech and its impact on functionality of financial services during the period of financial instability and uncertainty.

Fintech can be described as the technology that improves provision of traditional financial services, simplifies access to finance and fosters innovation. Obviously, both technology and innovation make it possible to expand Fintech ecosystem beyond banking services. Along with benefits that Fintech brings to financial market it can potentially pose some risks, too. Following this reasoning, it is critical for financial regulators to maximize Fintech opportunities while minimizing potential risks and to respond to innovation in a timely manner.

This article presents the role of Fintech in the development of financial system and its different regulatory approaches in the following way: part 1 introduces with the definition of

Fintech; part 2 describes opportunities and risks of Fintech; part 3 reveals Fintech regulatory approaches; following with part 4 that points the pandemic impact on Fintech activity and its regulation. Part 5 shows the key initiatives undertaken by the National bank of Kazakhstan (NBK) to regulate and develop Fintech and innovation in the financial market of Kazakhstan. And finally, a conclusion gives key insights and draws out the article's principal messages.

**1. What is Fintech?**

Although there is no unified interpretation of "Fintech" definition, the Financial Stability Board (2017, p.7) has defined it as "a technologically enabled innovation in financial services that could result in new business models, applications, processes or products with an associated material effect on financial markets and institutions and the provision of financial services". To put it simply, Fintech refers to the application of technology to finance.

Credit cards, debit cards, automated teller machines (ATMs), telephone and internet banking are examples of early presence of Fintech (FSB, 2017). Since then Fintech activities have expanded much and now is taking new forms: ApplePay or AndroidPay (allow to pay remotely, using mobile devices), Insurtech (provides insurance products), crowdfunding (connects lenders with borrowers), robo-advisory services (enhance wealth management), DLT-based applications (provide secure and recorded transactions), digital identity (supports remote financial operations), cloud computing (provides storage of big data), Regtech (optimizes regulatory reporting), Artificial Intelligence (AI) and Machine learning (allow to predict outcomes) and many others.

Fintech can be disruptive and complementary in its nature. Some researchers describe Fintech as technology that disrupts traditional financial services and offers new business-models to financial market. For instance, it is evident that neo-banks such as Germany's N26 and UK-based Revolut, Monzo are disrupting traditional banks and thus, are likely to replace them in the near future. Others states that Fintech can be complementary to the traditional financial services and cannot exist without them. For example, Fintech that works in cooperation with banking system, i.e. it gives new technology in exchange of access to the customer base.

**2. Fintech: opportunities and risks to financial system**

It is hard to imagine our life today without Fintech. In fact, Fintech widens the range of financial services and enhances their efficiency and delivery, increases competition and promotes financial inclusion, lower transaction costs and improves user experience and so on. On the other hand, having such opportunities Fintech may bring some risks and threats to financial market, in general. In its turn, this condition may impact on financial stability of the system over which financial authorities seek to control. For example, after unexpected increase in number of customers of digital bank A during 'black swan' such as the global pandemic, the cybersecurity and data protection of this organization can be at higher risk, eventually turning to the point of economic destabilization.

In table 1, you can see the list of major opportunities and risks that brings Fintech development to different segments of financial market. Depending on which side (supply or demand) stakeholder is located, potential opportunities and risks may vary, correspondingly.

Table 1

**Opportunities and risks of Fintech development to different segments**

| Stakeholder | Opportunities: | Risks: |
|---|---|---|
| For customers | - Financial inclusion<br>- Lower costs<br>- Enhanced user experience<br>- Convenience (flexibility in time and location) | - Cyber-risk<br>- Data protection<br>- Consumer protection<br>- AML-CFT[11] |
| For traditional provider of financial services | 1. In complementary model of interaction with Fintech: | |
| | - Financial inclusion<br>- Lower costs<br>- Enhanced user experience<br>- Higher profits | - Cyber-risk<br>- Data protection<br>- Consumer protection<br>- AML-CFT<br>- Operational risk |
| | 2. In disruptive model of interaction with Fintech: | |
| | - there are no opportunities | - Customer outflow<br>- Low profits<br>- Solvency risk |
| For financial regulator, financial market[12] | - Financial inclusion<br>- More competition<br>- Greater efficiency<br>- Increased transparency<br>- Diversification, or decentralizaition<br>- Lower costs | - Cyber-risk<br>- Data protection<br>- Consumer protection<br>- AML-CFT<br>- Regulatory arbitrage[13]<br>- Operational risk<br>- Market integrity |

Source: the author's analysis compiled from variety of sources

For example, from the customer's perspective innovations in financial services like mobile payments have increased customer access to financial services, decreasing the level of unbanked population and as a result, improving financial inclusion. On the other hand, customers could face with customer protection issues when the platform or application suddenly fails and engages in fraudulent activities. From the viewpoint of traditional providers of financial services there are two models of interaction mentioned before and certainly, complementary model benefits more than disruptive model to them, bringing opportunities and risks similar to customer's position. And finally, from the financial regulator's stance, Fintech improves financial market providing more competition, enhancing efficiency and transparency, decentralizing market structure (dampening the effects from financial shocks). Still, having positive side also involves some negative aspects: Fintech may pose regulators to concern regarding cybersecurity, data and consumer protection, operational threats, regulatory arbitrage and market integrity, overall.

In this context, it is critical for financial regulators to design a proper Fintech regulatory framework based on the assessment of potential opportunities and risks that brings Fintech activity and firms to the market. To explain how financial regulators can base their Fintech regulations, first we should be able to differentiate Fintech activities by its purpose. In this regard, Ehrentraud and *et al* (2020) survey 31 jurisdictions on their policy responses to Fintech

[11] AML-CFT stands to Anti-money laundering and combating the financing of terrorism

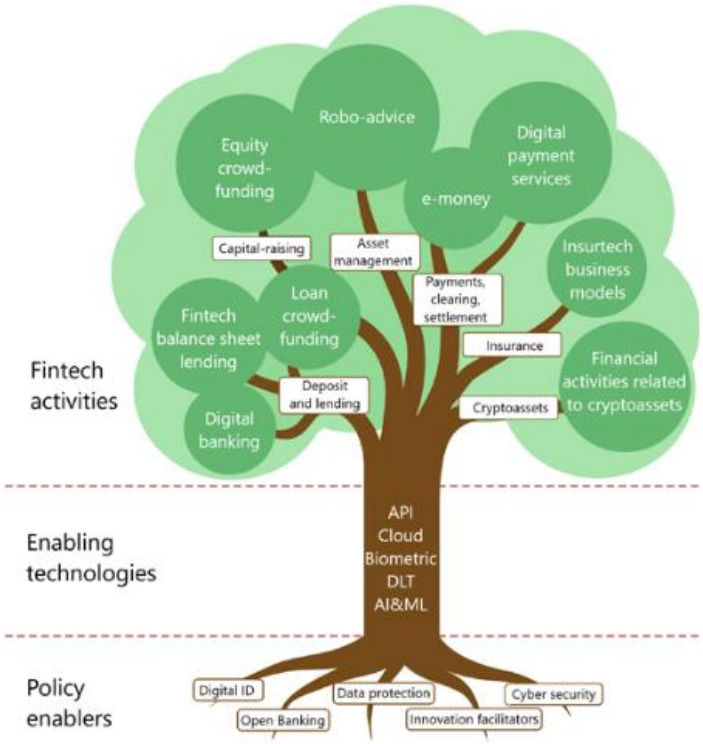
[12] Financial market involves all participants, i.e. individuals, commercial banks and other lenders, insurance companies, payment organizations, government-sponsored enterprises, corporations, brokers and dealers, financial regulator and etc.

[13] See (REG WG, 2019). Regulatory arbitrage occurs when there are regulatory differences in different jurisdictions.

developments and, as a result, propose a classification to categorize the Fintech environment referred as "the Fintech tree" (figure 1) in which the roots represent policy enablers (e.g. Digital ID, open banking), the trunk – enabling technologies (e.g. AI&ML, DLT[14]) and the treetop – Fintech activities (e.g. robo-advice, digital banking).

Figure 1

**Fintech tree: a taxonomy of the Fintech ecosystem**




Source: Financial Stability Institute staff (from "Policy responses to Fintech: a cross-country overview", by Ehrentraud, J., Ocampo, D. G., Garzoni, L., & Piccolo, M., 2020, FSI Insights on policy implementation №23, p.2.).

What is more, the implication of the Fintech tree enables to classify Fintech regulations and policy responses into three groups:

(i) those that directly target Fintech activities (corresponds to Fintech activities);

(ii) those concentrated on the use of new technologies (corresponds to enabling technologies);

(iii) those that promote digital financial services more broadly or encourage financial innovation (corresponds to policy enablers).

### 3. Fintech regulation approaches

Depending on multiple factors such as government policy measures, domestic regulatory settings, level of banking system, proportion of the unbanked, human resource development, mobile phone and internet penetration, share of investment and etc., Fintech development framework varies across countries and regions. In other words, there is no universal rule or golden standard to design such framework.

Above all, a major issue for regulators is to access to timely, standardized and complete information regarding Fintech activity and firms in the market. Based on this information with the socio-political context of the country in mind, they decide on adoption of a certain Fintech

[14] Distributed ledger technologies (DLT) refer to an approach of how transaction records are stored in a ledger (encoded data and distributed database).

regulation. What is more, in making an adequate decision it is necessary to distinguish regulation approaches that will guide the decision-making process.

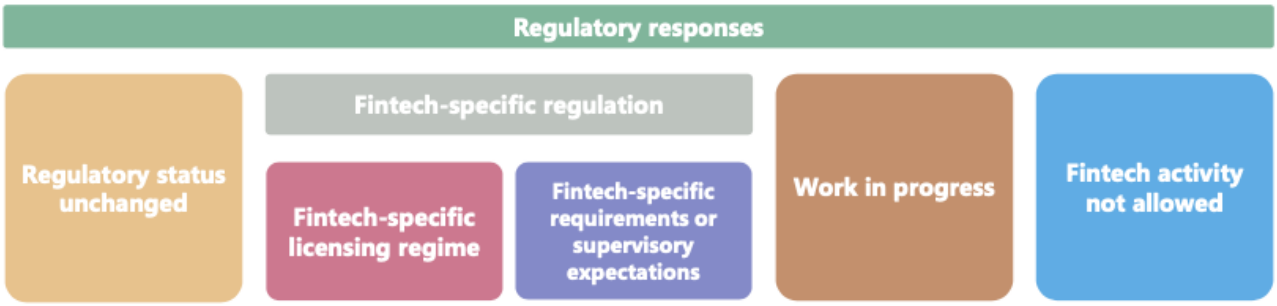
Based on the Fintech tree mentioned above, Ehrentraud and *et al* (2020) generates the classification of regulatory responses to Fintech-related activities (figure 2). As it can be seen, it has four main typologies in making decision whether to include fintech activities, that is:

(i) Regulatory status unchanged (no change in the existing regulatory framework);
(ii) Fintech-specific regulation (change in the existing regulatory framework);
(iii) Work in progress (in order to make amendments);
(iv) Fintech activity not allowed (new prohibition law or regulation).

For instance, the majority of jurisdictions responded in the survey implemented the first typology of the regulatory approach regarding to digital banks, simply because digital and traditional banks are likely to have the same licensing process and regulatory standards (Ehrentraud and *et al*, 2020). Regarding robo-advice services some regulators implemented Fintech-specific licensing while most of them used the existing regulatory treatment as for traditional advisers.

Figure 2

**Classification of Fintech regulatory responses**




Source: Financial Stability Institute staff (from "Policy responses to Fintech: a cross-country overview", by Ehrentraud, J., Ocampo, D. G., Garzoni, L., & Piccolo, M., 2020, FSI Insights on policy implementation №23, p.11.).

Another classification of regulatory response to Fintech activities is presented in the study of Fintech Regulatory Aspects Working Group (2019). Fintech regulation principles can be classified as presented in table 2:

Table 2

**Classification of Fintech regulatory principles**

| # | Principle name | Principle goal | Principle approach |
|---|---|---|---|
| 1 | Functional approach | - to provide flexibility<br>- to control the risk directly | Addressing similar risks with similar regulation |
| 2 | Proportionality | - to make proper and suitable requirements for new entrants | Easing the regulation in exchange of granting limited license |
| 3 | Technological neutrality and flexibility | - to accommodate new developments in timely manner | Formulation of general and technologically neutral regulation |
| 4 | Level playing field and competition | - to provide equal opportunities to all types of entities | Identification of obstacles that hinders competition |
| 5 | Cybersecurity and data protection | - to protect data<br>- to control cyber risk | Identification, mitigation and prevention of cyber-threats and data protection |

| | | | |
|---|---|---|---|
| | | | through regulatory framework |
| 6 | Coordination among regulators | - to synchronize Fintech regulation within one jurisdiction<br>- to have an agreement in specific Fintech issues | Cooperation across multiple financial authorities |
| 7 | International cooperation | - to share experiences and concerns<br>- to prevent regulatory arbitrage<br>- to standardize information reporting<br>- to have an agreement in specific Fintech issues | Harmonization of regulatory frameworks at the cross-border level |
| 8 | Enabling innovation mechanisms | - to explore the viability of Fintech developments | Creation of spaces for collaboration, i.e. sandboxes, innovation hubs, Fintech accelerators and etc. |

Source: Fintech Regulatory Aspects Working Group (from "Key Aspects around Financial Technologies and Regulation Policy report", by REG WG, 2019, p.7-9)

As an example, functional approach, i.e. services driven approach, focuses on risks that Fintech activity may pose: it applies regulations that cope with similar risks. It also concentrates on Fintech activity itself rather than on Fintech institution. For example, the EU's licensing regime implements this approach and depending on the activity of Fintech applies different requirements (REG WG, 2019).

Overall, these two classifications of Fintech regulatory response help the regulators to design their own regulatory framework and supervise Fintech activities.

**4. Covid-19 impact on Fintech and its regulation**

Covid-19 is a black swan event that, apart from affecting all aspects of human life, changed the behavior of both customers and business. In this context, the global pandemic impacted on the provision of Fintech activity and its regulation across countries, too.

The global research conducted by Cambridge Centre for Alternative Finance (CCAF), World Bank & World Economic Forum (2020) studies Fintech market rapid response to Covid-19 by surveying 169 jurisdictions and 1385 Fintech firms. It shows that Fintech activity continues to grow globally in spite of the pandemic impact. Moreover, the majority of Fintech firms (60%) launched new products and services during the pandemic. Nonetheless, they had an extreme necessity in additional regulatory responses related to licensing, permissions and reporting of Fintech activities.

According to another global research (2020) conducted by the joint work of the World Bank and the Cambridge Centre for Alternative Finance (CCAF), the role of digital financial services[15] and Fintech increased in light of Covid-19. The research is based on the survey of more than 110 financial regulators on their response to the challenges of the global pandemic concerning regulation and supervision of Fintech. The research results reveal the following insights.

1. Most of the regulators sped up the existing innovation initiatives or introduced new initiatives mainly on digital infrastructure, RegTech/SupTech, innovation offices, and there was no cancellation of initiatives related to Fintech and innovation due to Covid-19.

[15] DFS is a broader term of Fintech, "since it incorporates both a broader set of financial activities, and a wider set of providers (incorporating traditional financial services providers" (World Bank & CCAF, 2020).

2. The use or offerings of Fintech product and services increased, and priority of Fintech remained high or even increased during the pandemic.

3. There was an increase in the usage of digital payments and digital banks in particular for developing countries, while Insurtech and Wealthtech[16] usage increased in developed countries (figure 3).

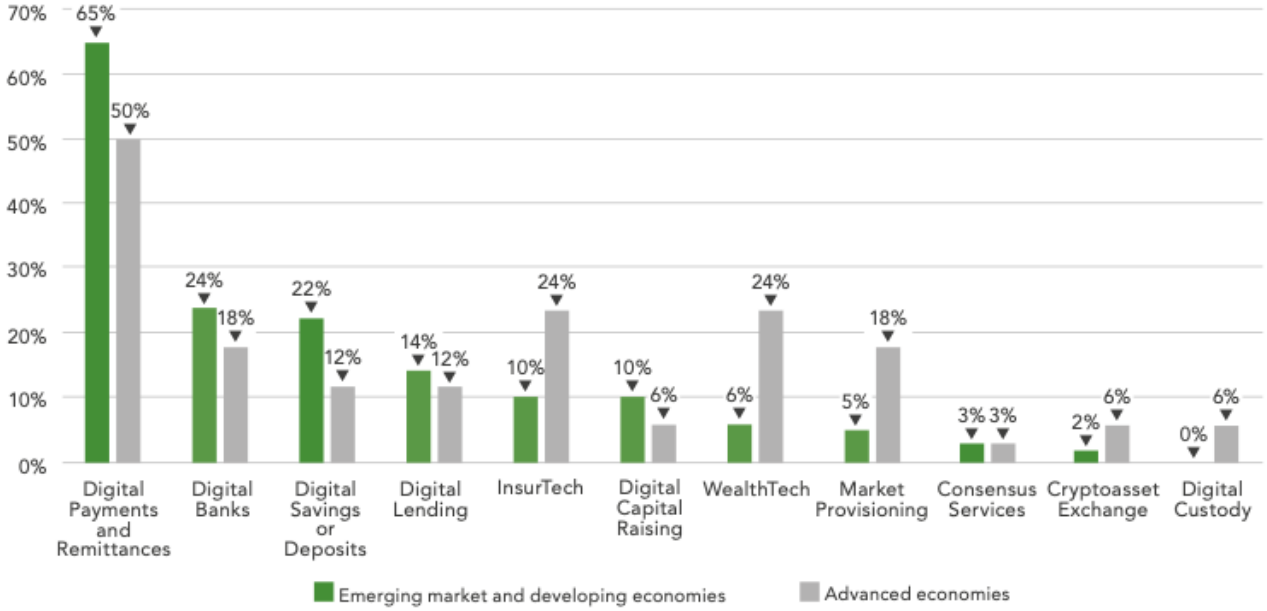
4. The regulators observe the support from Fintechs in achieving regulatory objectives (figure 4) and providing Covid-19 relief efforts.

5. The respondents observe rising risk of cybersecurity, operational risks, consumer protection, and fraud issues as the top risks with the increase of Fintech priority.

6. In comparison to other financial regulators, central banks experienced more difficulties with the speed of delivering Fintech-related regulatory initiatives.

Figure 3

**An increase in FinTech usage/offering due to Covid-19 (in %)**



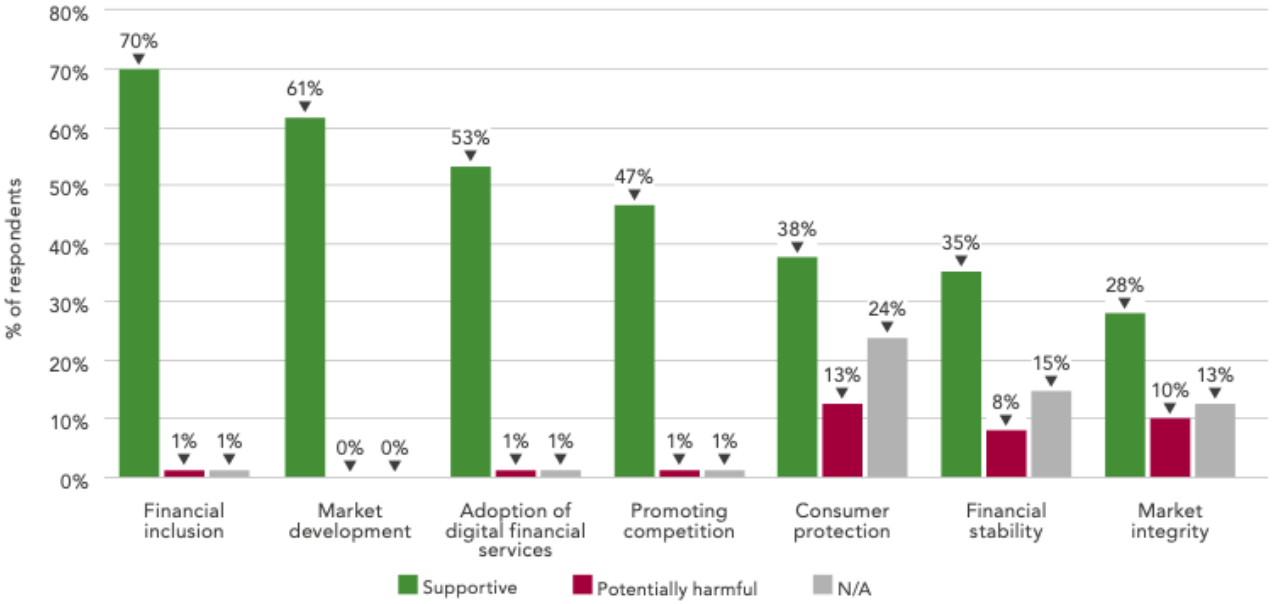

Source: World Bank and CCAF (from"The Global Covid-19 Fintech Regulatory Rapid Assessment Report", by World Bank Group and the University of Cambridge, 2020, p.25.).

Figure 4 highlights the impact of Fintech on achieving regulatory objectives of financial regulators, that is financial inclusion, market development, DFS adoption, promoting competition and other objectives.

[16] Wealthtech refers to digital solutions that improves wealth management and investing (i.e. robo-advisors, robo-retirement, digital brokerage and others).

Figure 4

**Fintech impact on regulatory objectives due to Covid-19 (N=88)**

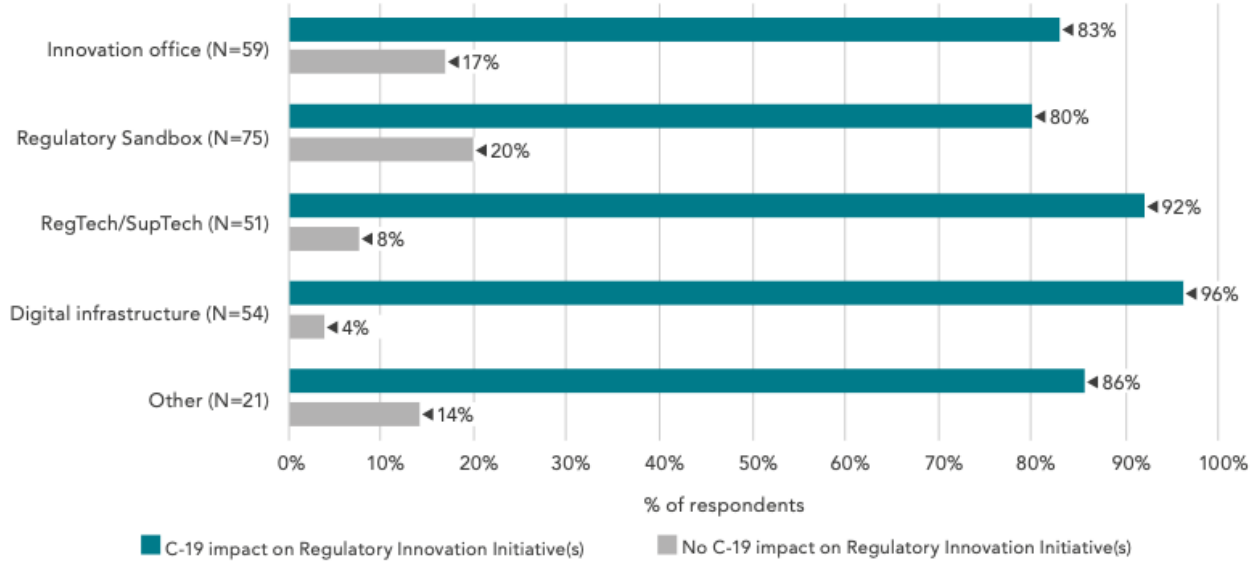



Source: World Bank and CCAF (from "The Global Covid-19 Fintech Regulatory Rapid Assessment Report", by World Bank Group and the University of Cambridge, 2020, p.27).

The respondent regulators observed the impact of Covid-19 on Fintech and innovation regulatory initiatives (figure 5). As it can be seen, more than 80% of the respondents highlights a shift to initiatives regarding digital infrastructure, Regtech/Suptech, innovation office, regulatory sandbox in light of Covid-19.

Figure 5

**The impact of Covid-19 on regulatory innovation initiatives**




Source: World Bank and CCAF (from "The Global Covid-19 Fintech Regulatory Rapid Assessment Report", by World Bank Group and the University of Cambridge, 2020, p.51.).

## 5. The NBK initiatives to support and regulate Fintech

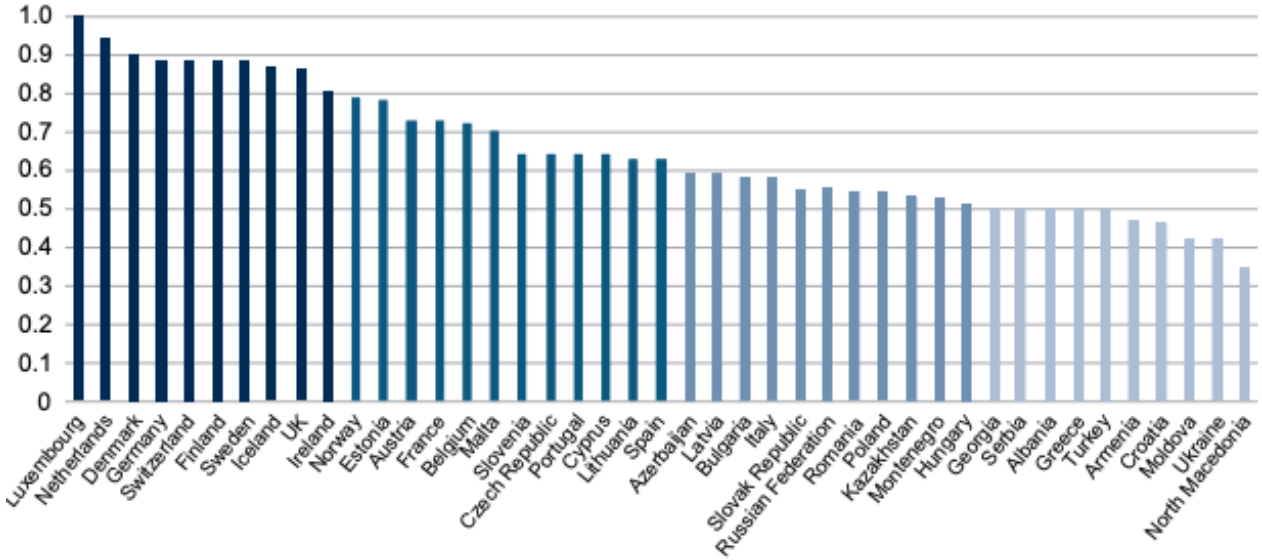
Fintech in Kazakhstan can be considered as a nascent and evolving sector in the financial market which has a huge potential to grow. Increasing demand for Fintech services and innovative products due to low quality of products, dissatisfaction to customer service delivered

by traditional financial players, high concentration of the banking system with emerging Fintech firms, lack of foreign investments but high level of government support in Fintech services and products are highlighting features of Fintech development in the country (AIFC, 2020; World Bank Group, 2020).

Figure 6 shows the level of digitization in Europe and Central Asia (ECA) region by country as of 2017 (World Bank Group 2020). The leader of digitization index is Luxembourg, whereas North Macedonia has the lowest level of this index. What is more, digitization in Kazakhstan is slightly higher than 50%, leaving behind Montenegro, Hungary and Georgia. This fact can restate an immense potential for Fintech and innovation of the country to grow further.

Figure 6

**Digitization in ECA region**




Source: Digitization Index (DiGiX), BBVA Research (2017)

The NBK, along with other financial regulators, understands the importance of Fintech as a transformative power of financial market of the country. In doing so, the regulator supports and encourages Fintech activities through different regulatory initiatives. In this regard, there are several policy regulations of the NBK described below in chronological order.

The adoption in July 2018 of ‘a special regulatory regime’ by the virtue of amendments to the Law of the Republic of Kazakhstan “On the National Bank of Kazakhstan” was one of the NBK’s first steps to introduce regulation in Fintech-related activities. In other words, the financial regulator launched a regulatory sandbox. With the formation and separation of the Agency of the Republic of Kazakhstan for regulation and development of the financial market (Financial Agency) from the NBK in January 2020, the competencies of both authorities regarding regulatory sandbox have been distributed in the following way: the NBK has stayed with regulating the part associated with payment organizations and/or other legal entities not being financial organizations for the purpose of providing payment services, whereas the Financial Agency has left with regulating the part associated with the financial organization and/or other legal entities.

Moreover, creation of Open API standards and regulations for second-tier banks is another project of the NBK to stimulate Fintech market. To be precise, the financial regulator, within the framework of the “Digital Kazakhstan” state program, launched the project called “Implementation of regulation regarding the creation of open platforms (Open API) in the financial industry”. The main goal of this project is to stimulate competition in the financial market and expand financial services through the technological capabilities of Fintech firms. Thus, the NBK finished the first stage by creating specifications of requirements for the Open

API software with a description of B2B, B2C business models and the provision of public data to all persons.

Apart from this, the NBK in an accelerated mode implemented remote biometric identification for receiving financial services, meeting new challenges of the complex epidemiological situation in the world. Remote biometric identification based on “face recognition” technology allows financial market participants to remotely identify customers and provide them with services such as opening bank accounts and deposits, issuing payment cards, and lending. The pilot project was launched in April 2020, following with the industrial launch from October 2020. At the moment, more than 3.5 million banking services have already provided through the system.

On August 2020 the NBK and the Financial Agency (2020) adopted Concept on Fintech and innovation development. In fact, strategic initiatives of the Concept are grouped and prioritized in three key directions:

1) digital regulator – building high-tech interaction between financial market participants and improving the efficiency of regulator’s work (e.g. Regtech, Suptech, customer protection services and etc.);

2) digital infrastructure – increasing the penetration of digital financial services, reducing the overall costs of the industry and creation of a "trust environment" for market participants to interact (Digital ID, Open API, payment services, cybersecurity and etc.);

3) living environment – creation of an environment for the development of innovations. promotion of collaboration between participants of the financial market and construction of a friendly environment for Fintech startups (regulatory sandboxes, Fintech accelerators and etc.).

In addition, the Concept consolidates all initiates of the regulators of the country on the development of digital financial services for the horizon of 2020-2025. It will be implemented in three main stages:

- 2020-2021 – implementation of the anti-crisis measures and establishing the digital infrastructure foundation;
- 2022-2023 – building the regulatory framework and setting key components of the digital infrastructure;
- 2024-2025 – further development of digital infrastructure on the financial market.

In fact, the implementation of the Concept initiatives through its roadmap engages interaction with representatives of the financial market, consequently it will activate cooperation between financial regulators and request an active involvement of different participants of the financial market.

**Conclusion**

Over the last decade, Fintech has shown the revolutionary power to transform financial systems through its innovative approach and technology. Financial inclusion, increased competition, greater efficiency and lower costs are one of the examples of favorable opportunities that gives Fintech to financial players. However, together with opportunities Fintech also burdens potential risks such as cyber risk, customer and data protection that can negatively impact on stability and integrity of financial system.

A challenge for regulators then is, firstly, to maximize opportunities while to minimize its risks and, secondly, to build an adequate regulatory framework, in which Fintech activities and innovation will not be restrained but realized in a timely manner. Nevertheless, there is no universal framework, or approach, to regulate Fintech activities and firms. In this regard, regulators create their own regulatory approach based on the global experience, socio-economic context and Fintech development specifics of corresponding jurisdiction.

In addition, the impact of Covid-19 was indeed positive for Fintech market, even if it posed some challenges to Fintech firms and regulators. The role and priority of Fintech increased along with the increase in number of the usage or offering of Fintech product and services.

However, with the increase in priority there was observed a rising risk of cybersecurity, operational risks, consumer protection, and fraud issues.

Fintech in Kazakhstan is evolving and has a significant potential to grow further. The development Fintech and DFS creates opportunities for the introduction of new products and services in the country. In doing so, the NBK has taken several initiatives which includes the adoption of the regulatory sandbox, preparation of Open API standards and regulations, implementation of the remote biometric identification for receiving financial services and the recent adoption of the Concept on Fintech and Innovation development. All of them will eventually serve to promote non-discriminatory access to financial services for new financial market players of Kazakhstan in order to create and develop a competitive and efficient market. And without doubt, the NBK will continue to contribute on improving the regulatory framework regarding Fintech activities.

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# EXPANSION OF AUTHORITIES OF THE INSURANCE OMBUDSMAN

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*The Paper is devoted to the activities of the institution of insurance ombudsman in the Republic of Kazakhstan and describes potential lines of its development*

Key Words: insurance ombudsman, activities of the insurance ombudsman in the Republic of Kazakhstan, authorities of the insurance ombudsman, expansion of authorities of the insurance ombudsman.

JEL-classification: Y90.

**Insurance Ombudsman. International Experience and Kazakhstan.**

Effective protection of the financial service consumers is a key to a successful development of the financial market. The consumer protection regulation around the world is regarded as the most important condition for expanding the availability and inclusiveness of financial services and improving the financial market. This is also proved by the study conducted by the CGAP staff[17], where outcomes point to the existence of relationship between the protection of rights of the financial service consumers and stable, effective financial markets [2].

An important place in the system of protection of the financial service consumers that affect human rights is the institution of financial ombudsman. The financial ombudsman is a body of extra-(pre-) judicial review of disputes arising between financial organizations and their clients.

In the international practice, the types and amounts of claim are determined, whereby the financial ombudsman makes a decision. As a rule, the financial ombudsman considers small (in terms of the amount) claims and its decisions are binding for financial organizations, but not mandatory for the financial service consumers.

For example, the Financial Ombudsman Service in the UK[18] reviews complaints of individuals and small companies (whose annual turnover does not exceed 2 million Euro) in the area of banking, investments, pension system and insurance. The maximum claim amount is 150 thousand pounds. In the insurance sphere, the ombudsman deals with the disputes related to motor liability insurance, real estate and tourists.

In France, the legislation obligates financial organizations to appoint an authorized person for resolution of disputes regarding deposits and other financial services; the decisions of such authorized person are binding if the claim amount does not exceed 50 thousand Euro.

At the same time, the comparative analysis of the institutions of financial ombudsmen in a number of foreign countries allows making a conclusion that the main model of the institution of ombudsmen in many countries is the German model [5], which implies the structural division of authorities and jurisdictions of ombudsmen by sectors of the financial market.

In particular, the German insurance ombudsman reviews complaints of individuals against insurance companies, where the claim amount cannot exceed 100 thousand Euro. Decisions on complaints below 10 thousand Euro are binding for insurance organizations and if an individual is not satisfied with the ombudsman's decision, he/she may apply to court. Decisions regarding

[17] Consultative Group to Assist the Poor is a global partnership housed at the World Bank and consisting of 34 leading organizations that seek to advance financial inclusion

[18] The Financial Ombudsman Service in the UK is an only centralized and largest financial ombudsman service in the world, with an annual budget of 331.5 million pounds (relevant as at 2020) – Financial Ombudsman's Annual Report and Accounts for the Year Ended 31 March, 2020 (https://www.financial-ombudsman.org.uk/files/287580/Annual-Report-and-Accounts-for-the-year-ended-31-March-2020.pdf)

complaints in the amount above 10 thousand Euro are advisory in nature for insurance organizations.

Taking into account the long-standing international practice of dispute resolutions by the ombudsman arising from various social spheres, the ombudsman has fully realized itself as a public institution that effectively protects the interests of the end consumer, including in the field of finance, insurance.

In turn, in accordance with the effective provisions of the Law of the Republic of Kazakhstan "On Insurance Activities", a natural person independent in his/her activities is an insurance ombudsman who carries out dispute resolutions:

1) disputes between insurance organizations arising with regard to compulsory and voluntary insurance;

2) between insurants (the insured, beneficiaries) and insurance organizations originating from insurance contracts.

In Kazakhstan, the insurance ombudsman may be appealed to by individuals and small business entities within the 10-thousand monthly calculation index (as at 2021 – 29 170 000 tenge); other corporate entities may apply to the insurance ombudsman only as part of the compulsory motor liability insurance contracts.

The insurance ombudsman's decision regarding the disputes between insurance organizations is binding for insurance organizations. The decision of the insurance ombudsman on disputes between an insurant (the insured, beneficiary) and an insurance organization is binding for the insurance organization in case of its acceptance by the insurant (the insured, beneficiary). At the same time, execution of the insurance ombudsman's decision is not binding for the insurant (the insured, beneficiary).

The decision is made by the insurance ombudsman at his/her sole discretion and is communicated to the disputing parties in writing. In doing so, the insurance ombudsman has a right to request the data from insurance organizations and from the Unified Insurance Database that are required to consider the applicant's appeal; the insurance ombudsman is also obliged to observe confidentiality of information received in the course of dispute resolutions and not to disclose it to any third parties, must uphold rights and respect interests of the parties as protected by the law.

In case of disagreement with the insurance ombudsman's decision, an insurant (the insured, beneficiary), an insurance organization may apply to court in order to protect their right in compliance with the legislation of the Republic of Kazakhstan.

At the same time, in case of disputes arising from insurance contracts, an insurant (the insured, beneficiary) may also directly file the appeal to the court, without going to the insurance ombudsman. Along with that, advantages of resolving the arising disputes within the frames of insurance contracts with the help of the insurance ombudsman are obvious:

– an appeal to the insurance ombudsman is free of charge (does not include costs associated with administration of the case);

– independence and professionalism of the insurance ombudsman (insurance ombudsman specializes in the dispute resolutions only in respect of the insurance matters. There are legally prescribed requirements to the insurance ombudsman with regard to education, professional experience and reputation as well as a prohibition of affiliation with insurance organizations. The insurance ombudsman is elected by the board of representatives of the insurance ombudsman, which is composed of representatives of each insurance organization and the competent authority.);

– the insurance ombudsman's decision is binding for insurance organizations.

An appeal to the insurance ombudsman can be filed directly, including via the Internet resource (web site) or via an insurance organization, a branch or a representative office of the insurance organization. At the same time, when an insurance organization receives an appeal from the insurant (the affected person, beneficiary) that is addressed to the insurance

ombudsman, the insurance organization must forward such appeal along with the attached documents to the insurance ombudsman within three business days from its receipt.

**The Role and Lines of Development of the Institution of Insurance Ombudsman in the Republic of Kazakhstan.**

In Kazakhstan, about 4000 claims were filed for the insurance ombudsman's review over more than 12 years of practice whereby 3 810 relevant decisions had been passed. Out of all decisions passed by the ombudsman only 67 (2% of the reviewed cases) were appealed through courts, with 61 decisions being upheld and 6 – cancelled[19]. In other words, only 0.16% of all cases reviewed by the insurance ombudsman were cancelled by the judicial decision.

Taking into account the constant growth of the number of disputes in the insurance industry, we believe that the effectiveness of insurance ombudsman in Kazakhstan can be expressed in the reduction of litigations on insurance issues in most cases related to the assessment of damage to a vehicle and the refusal to make an insurance indemnity payment.

In July 2019, with facilitation and assistance of the insurance ombudsman, in order to reduce the number of disputes in court related to the application of insurance legislation, a pilot project "Prevention of insurance disputes" was launched in the Kostanai City Court. According to the information posted on the Internet resource[20] of the Supreme Court of the Republic of Kazakhstan, during the first month and a half of running the pilot project, 28 out of 30 claims to the court regarding the insurance matters were submitted for consideration of the insurance ombudsman; based on his/her decision, insurance organizations paid out more than one and a half million tenge of insurance indemnities.

The results of the pilot project implementation enable to make a conclusion about the effectiveness of the institution of insurance ombudsman in Kazakhstan and in the long run say that the burden on local judicial authorities decreased due to the establishment of the institution of insurance ombudsman as an essential pre-judicial body for dispute resolutions in the field of insurance in Kazakhstan.

At the same time, in order to fully realize the potential of the institution of insurance ombudsman in Kazakhstan, it is necessary to further expand its authorities, with a commensurate increase in the number of branches, representative offices and the total headcount of the office also including the front office staff to provide advisory and other services in the regions in person, via the hotline as well as through instant messengers and an Internet resource, which in aggregate will allow reviewing the people's appeals in an effective, timely and efficient manner.

Given the extensive experience of the insurance ombudsman, it is possible to involve him/her in delivering workshops, lectures and other events on a regular basis in order to improve financial literacy of the population on insurance issues. It is also necessary to have constant coverage of the insurance ombudsman's activities in the media and other sources of information dissemination with a view to increase general awareness of the population of his/her work and the services he/she provides.

Based on the positive experience of the institution of insurance ombudsman in Kazakhstan and the prospects for its development, a conclusion can be made that the role of the insurance ombudsman as a person for the extra- (pre) judicial resolution of disputes arising under insurance contracts will increase, thus improving the mechanism of protection of rights and legitimate interests of the insurance service consumers.

In order to file an application to the insurance ombudsman in Kazakhstan you may visit the official Internet resource (web-site) at: www.insurance-ombudsman.kz

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# THE IMPACT OF CONSUMER LENDING ON THE DYNAMICS OF IMPORT OF GOODS TO KAZAKHSTAN

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*The Paper is a part of the cycle of studies devoted to achieving the sustainability of Kazakhstan's balance of payments to external shocks by addressing structural problems – a low diversification of exports and a high dependence on imports. The paper describes the impact made by the consumer lending on the current account dynamics via the channel of import of goods. The relevance of the topic is determined by the need of further identification of the risks on the part of imports for inflation, exchange rate and GDP.*

*The conclusion of the study is that the expansion in consumer demand does not always lead to the buildup of risks for the economy. However, in the environment when the domestic production is lagging behind, the growth of the consumer lending in Kazakhstan represents a source of pro-inflationary pressure manifested through the exchange rate due to the demand for foreign currency needed to pay for consumer goods.*

Key words: import of goods, consumer lending, balance of payments, import substitution, diversification of the economy, inflation, exchange rate, economic growth.

JEL-classification: E21, E23, E31, E44, E51.

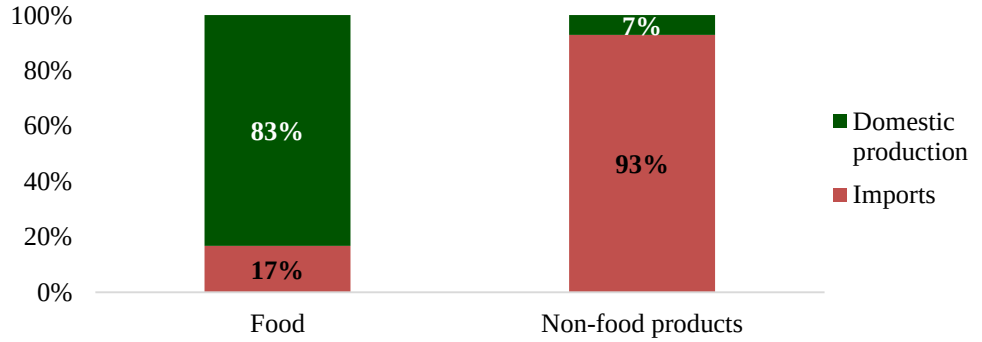
## 1. Dependence of the Population'sConsumption on Imports

The demand of Kazakhstan's population for non-food products is covered by imports nearly to the full extent, whereas the consumption of foodstuffs is mainly satisfied with the domestic production.

During 9 months of 2020, the coverage of the domestic demand with the local production accounted for 83% on food and only 7% – on non-food products (Figure 1).

Figure 1

**Consumption structure of population of Kazakhstan during 9 months of 2020**



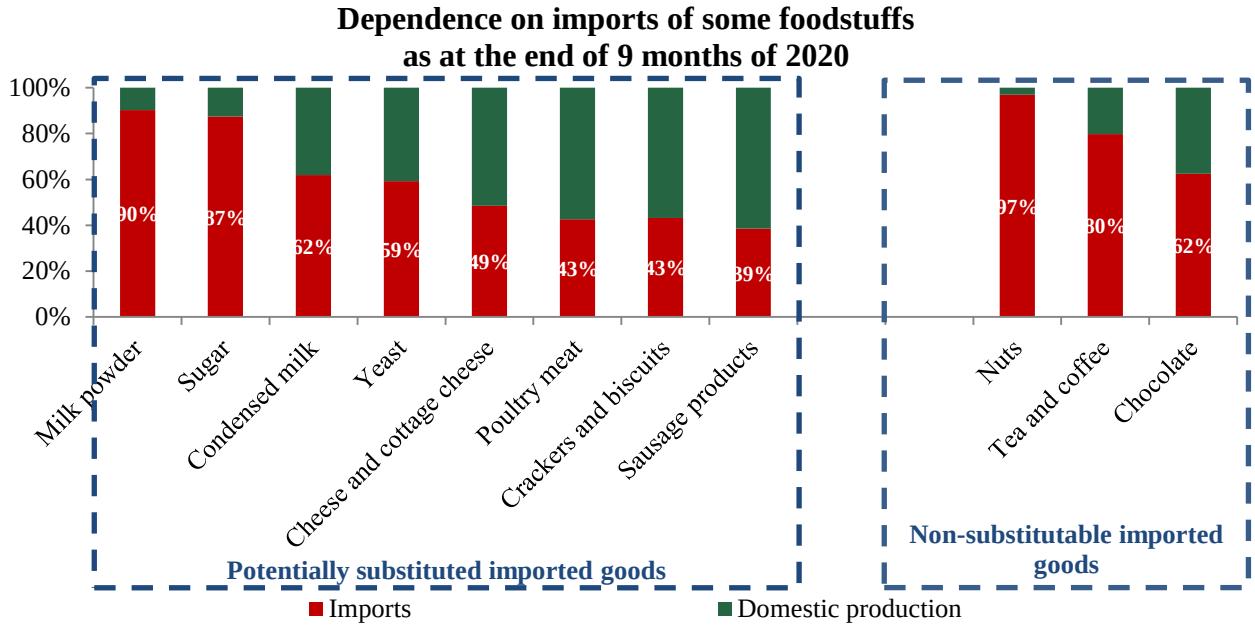

Source: the author's calculations based on the data from the BNS ASPR of the RK and SRC of the MoF of the RK. The indicator was calculated as a percentage of food (non-food) imports in the population's spending on consumption of food (non-food products).

High dependence on imports is observed only in relation to certain foodstuffs (Figure 2). For some of them (for example, nuts, coffee, tea, chocolate and some fruits), the dependence on imports is necessitated by climate and weather conditions required for their cultivation; therefore, import substitution of such goods is impossible. However, there is a potential for import substitution for some foodstuffs (for example, consumption of milk powder is covered with imports by 90%, consumption of sugar – by 87% (during 9 months of 2019 – 55%),

condensed milk – by 62%, yeast – by 59%, cheese and cottage cheese – by 49%, poultry meat – by 43%, crackers and biscuits– by 43%, sausage products – by 39%).

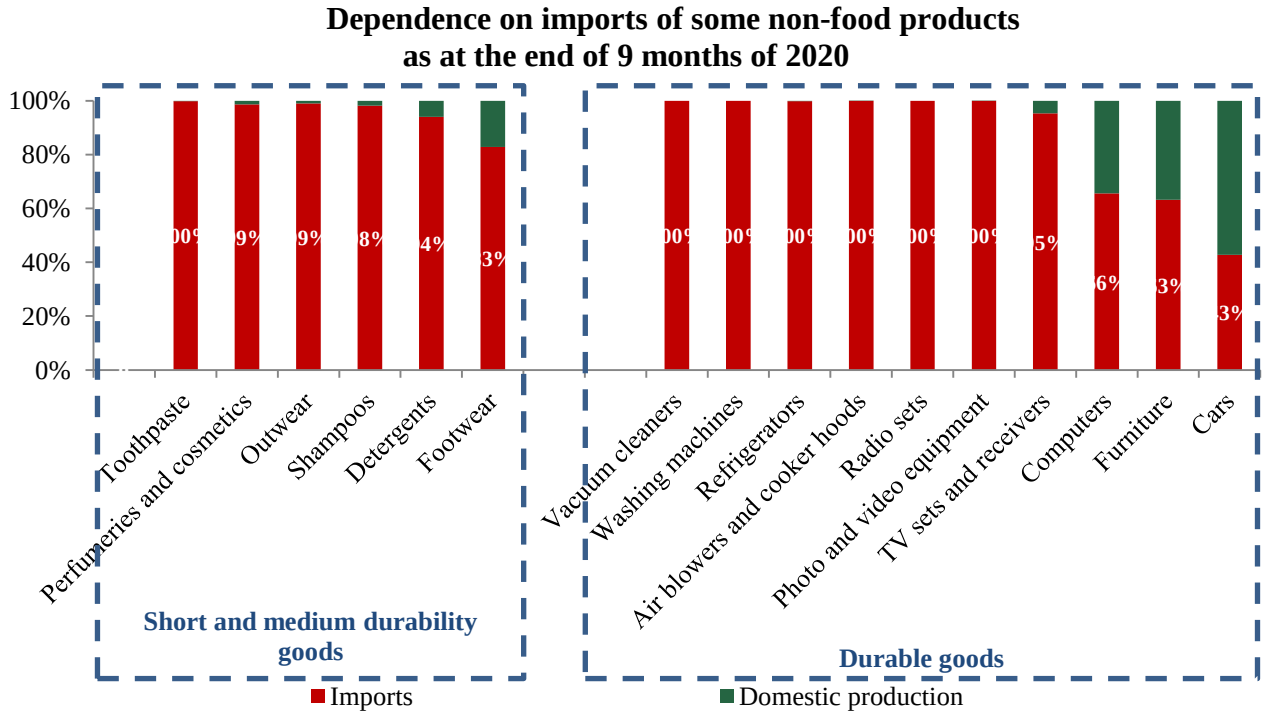
There is almost total dependence on imports among non-food products (Figure 3). It is explained by the absence of domestic production of such goods. So, nearly a 100% dependence on imports is observed among goods with short and medium durability – clothes, footwear, household cleaning products, personal care products, perfumeries, cosmetics; and among durable goods – vacuum cleaners, washing machines, refrigerators, air blowers and cooker hoods, radio sets, photo and video equipment, TV sets and computers.

Figure 2




Source: the author's calculations based on the data from the BNS ASPR of the RK.

Figure 3

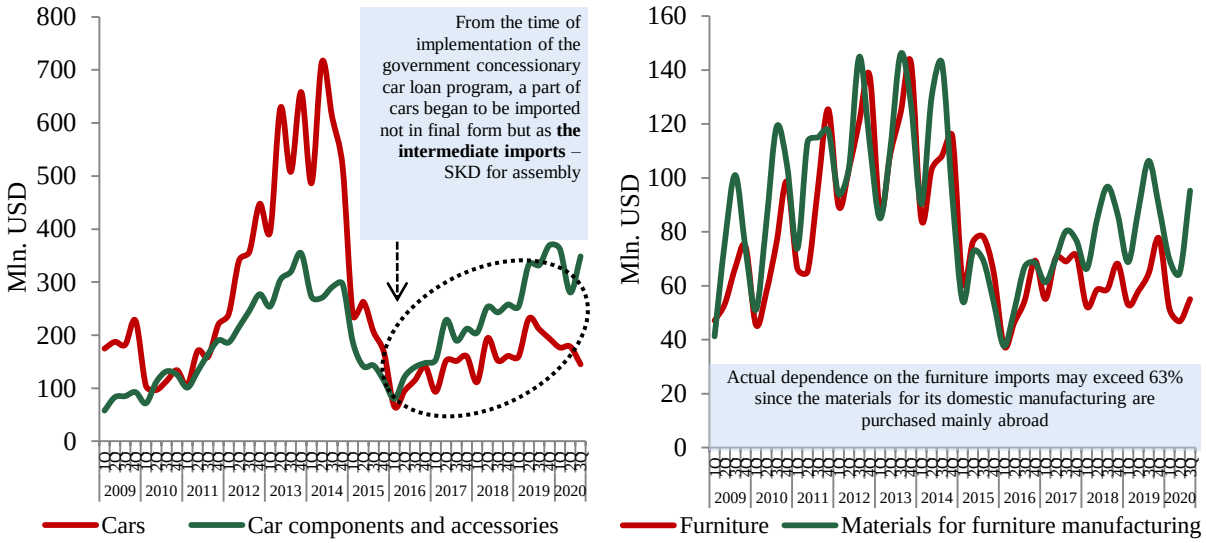



Source: the author's calculations based on the data from the BNS ASPR of the RK.

There is a "conditional" import substitution for some goods. For example, according to the official statistics, Kazakhstani production covers the demand for cars by 57%, and for furniture – by 37%. However, the spare parts for the local car and furniture manufacturing are purchased abroad. Accordingly, they are statistically reported not as consumer imports but as intermediate imports (Figure 4). Based on the above, in reality the domestic production may cover less than 20% of the demand for cars and furniture.

Figure 4

**Import of cars and furniture**




Note: import volumes of spare parts and materials for car and furniture manufacturing are estimative (non-exhaustive) and include goods that can be potentially used in their manufacturing.

Source: the author's calculations based on the data from the BNS ASPR of the RK.

## 2. The Role of Lending in Financing the Population's Demand for the Consumer Imports

The effective demand for consumer goods is secured by own funds of the population and consumer loans in equal measure.

In 2016-2019, the income of the population was growing at a moderate pace[21]: on average, nominal money income was increasing by 11.6% every year, and real money income was increasing only by 3.1% (during the period from 2016 to September 2020 – 11.1% and 3.0%, respectively).

The rise in income as an indicator of creditworthiness of the population was conductive to the growth in new consumer loans. However, the consumer lending was growing faster than the income: on average, during 2016-2019, new consumer loans per capita increased by 24.6% every year (during the period from 2016 to September 2020 – by 13.8% every year). As a result, the percentage of new consumer loans in nominal money income per capita went up from 12% in 2016 to 17% in 2018 and 19% in 2019 (during 9 months of 2020 – 14%). This is an indication of the increasing role of consumer loans in promoting the effective demand for consumer goods.

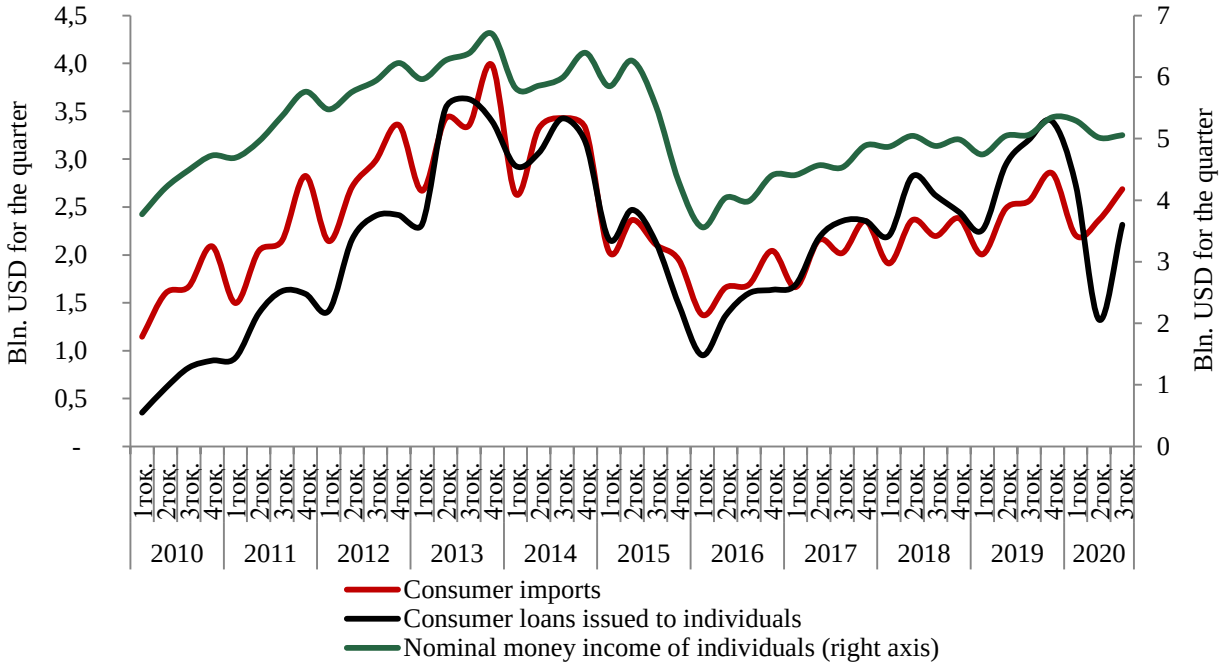
In general, own funds of the population and consumer loans are the sources of effective demand for foreign consumer goods in equal measure. Thus, during 2009-2019, the correlation between consumer imports and nominal money income of the population was 88% and the correlation between consumer imports and new consumer loans was 86% (during the period

[21] The assessment of the role of lending in financing the demand of population for consumer imports was made on the basis of data not including those for 2020. In the statistical calculations, the year 2020 was considered as an outlier due to the fact that the decrease in consumer loans was caused not only by (temporary) loss or reduction in the disposable income of the poppulation but also by the absence of physical possibilities for obtaining loans off-line (the imposition of strict quarantine restrictions, which included restrictions of the domestic and cross-border migrations).

from 2009 to September 2020 – 87% and 84%, respectively). Most recently, the consumer imports have been correlating with new consumer loans to a larger extent (during 2015-2019, the correlation between consumer imports and nominal money income of the population accounted for 68%, whereas the correlation with new consumer loans was 93% (during the period from 2015 to September 2020 – 66% and 78%, respectively), Figure 5).

Figure 5

**Sources of effective demand for consumer goods**




Note: imports broken down by the UN classification by broad economic categories.
Source: NBRK, BNS ASPR of the RK, SRC of the MOF of the RK.

Given a sluggish domestic production of consumer goods, the consumer lending encourages consumer imports, in particular its non-food component. For example, in 2020, three Kazakhstani banks[22] provided loans for the following purposes: buying electronics (mainly, telephones, TV sets, refrigerators, computers, washing machines) – 28% (in 2019 – 27%) of the total disbursement of consumer loans at these banks; repair and improvement of living conditions – 28% (in 2019 – 25%); purchase of cars and accessories – 19% (in 2019 – 17%); buying clothes, footwear and accessories – 6% (in 2019 – 5%); purchase of home products – 4% (in 2019 – 3%); payment for goods and services in the "beauty and health" category – 3% (in 2019 – 3%); arranging weddings, jubilee parties and funeral arrangements – 2% (in 2019 – 7%); payment for education – 2% (in 2019 – 2%); buying food – 2% (in 2019 – 1%); buying goods for kids – 1% (in 2019 – 1%); other purposes – 7% (in 2019 – 7%).

The growth in consumer imports is influenced not only by the decisions of banks and other financial organizations regarding the expansion of consumer loan portfolio, but also by the government loan programs and initiatives. For example, given the ageing of the domestic fleet of vehicles[23], the government concessionary car loan program encourages the import of semi knock down units to assemble relatively cheap cars in Kazakhstan, whereas the precedent with

[22] In 2020, the share of three banks in the consumer loans provided by the banking system to the population accounted for 64%.

[23] At the end of 2020, the percentage of cars older than 20 years within the quantity of transactions on the re-registration accounted for 41.1%, whereas the percentage of 11-20 years old cars accounted for 25.9%. Source: the Union of Motor Industry Enterprises of Kazakhstan "KazAutoProm".

the consumer loan charge-offs for certain categories of people in 2019 might foster certain welfare mentality among the population and motivate to build up the debt burden further[24].

### 3. Factors of the Consumer Lending Penetration

The consumer loans are sought after both by the people with low income and the high-income population. The consumer lending penetration among the people is caused by time value of money, by a rampant development of new banking technologies and products and by their affordability and convenient use.

The earnings of a larger part of the population do not allow them to buy consumer goods in one installment with their own money (in the third quarter of 2020, 73% of the population had a monthly income per capita used for the consumption of food and non-food products as well as of paid services of less than 70 thousand tenge; in 2019 – 77%). Therefore, the low-income people satisfy the need for such goods via consumer loans.

However, the growth in the consumer lending is nurtured not only by the low-income population but also by the population with a high level of income. This is stemming from the fact that buying consumer goods by installments is rather cost-efficient given the temporal and real cost of money.

The example below assesses the cost-efficiency of certain types of consumer loans – loans by installments and concessionary car loans (Table 1).

Table 1

**Assessing the benefits of buying consumer goods on the installment plan (using 201 as an example)**

| | Consumer loan (by installments) | Concessionary car loan | Time deposit in the tenge | Time deposit in foreign currency |
|---|---|---|---|---|
| Interest rate | 0% | 7.5% | 10% | 1.5% |
| Interest rate based on inflation and change in the exchange rate | 0%-5.3%=(-)5.3% | 7.5%-5.3%=2.2% | 10%-5.3%=4.7% | $[(1+1.5\%)*$ $*\left(\frac{383.86\ \text{USD/KZT}}{378.13\ \text{USD/KZT}}\right)-1]$ $-5.3\%=(-)2.3\%$ |

Note. The author used the following assumptions in the course of calculation:

1) period of entering into the agreement – January 2019;

2) period of dissolution of the agreement – December 2019;

3) actual loan/deposit rates as at January 2019 were taken as an interest rate on loans/deposits;

4) inflation in 2019 accounted for 5.3% (YoY);

5) exchange rate of the tenge in January 2019 was 378.13 tenge per dollar, in December 2019 – 383.86 tenge per dollar.

The calculations show the benefits of the following decisions (examples):

1) if an individual has no savings – buying a good by installments (substantiation – negative real interest rate on a loan of (-)5.3%) and/or obtaining a concessionary car loan (substantiation – a low real interest rate on a car loan of 2.2%);

2) if an individual has savings – placing his/her savings as a tenge deposit, and using the payment by installments for buying the good (substantiation – a total real income from the decision will account for 10% = 4.7% on tenge deposit + 5.3% on consumer loan by installments) or obtaining a concessionary car loan (substantiation – a total real income from the decision will account for 2.5% = 4.7% on tenge deposit – 2.2% on a concessionary car loan).

[24] In order to prevent a further buildup of debt burden on the population, the NBK undertook the following measures: imposing a prohibition for lending to those individuals whose income is below the subsistence line, regulating the borrower's debt burden ratio, imposing additional capital requirements for banks.

The appearance of new banking products and campaigns with attractive terms and conditions (for example, payment by installments) increases the demand for "interest-free" consumer loans and, as consequence, serves as a driver for imports growth. In addition, banking technologies enabling to expand the market coverage for sellers of goods (for example, marketplace) also encourage the consumer lending.

**4. The Impact of Consumer Lending on Individual Import Components**

The consumer lending influences all import components: consumer imports – directly, and intermediate and investment imports – indirectly.

The consumer lending makes a direct impact on non-food imports. This stems from the fact that durable goods have a relatively high cost – paying their price by a lump-sum amount puts a burden on monthly income of the population.

The impact of the consumer lending on food imports is expressed both directly and indirectly. The indirect influence is expressed in the following: when purchasing non-food products with consumer loans, a part of the current income of the population is released (i.e. a consumer's disposable income is growing), which is a potential source for financing additional demand for food products.

The direct impact of consumer lending on food imports is driven by both the specifics of consumption by the population of Kazakhstan and the expansion of the product line of consumer loans. The specifics of consumption mean the purchase of food for weddings and anniversaries, which play an important role in the life of a part of the population. Given that the amount of consumer loans provided includes consumer loans used by the population for festive events, consumer loans partially finance the purchase of foodstuffs, including the imported ones.

Credit cards serve as an example of expansion in the product line of consumer loans, enabling to buy foodstuffs by installments. The growth in this indicator is largely driven by the convenience of such cards (a bonus scheme, no need to spend your own funds "here and now", and the possibility of using them if you do not have a "close at hand" debit card).

Given that raw materials, components and equipment for the domestic production of many consumer goods (for example, cars, furniture, toys, clothing) as well as construction materials for renovations are purchased abroad, the consumer lending also stimulates interim and investment imports (for example, SKD units for assembling cars; materials and accessories for the production of furniture; plastic and wood for the production of toys; fabrics and accessories for manufacturing of clothes and footwear).

**Conclusion**

The following conclusions were made based on the analysis performed:

– The effective demand for consumer goods is secured by the people's own funds and consumer loans in equal measure. Along with that, the role of consumer loans in ensuring effective demand for consumer goods continues to grow.

– The increasing role of consumer loans is due to the rapid development of new banking technologies and products, their availability and ease of use, as well as the time and real value of money. As a result, not only the low-income people but also the high-income population began to apply for consumer loans.

– The growth in consumer lending does not always lead to the buildup of risks for the economy. However, given the slippage in the production of consumer goods in Kazakhstan, the advancement in consumer lending is a source of pro-inflationary pressure. The pressure on prices is realized via the exchange rate channel in view of the demand for foreign exchange required for payment, primarily for non-food products.

– The consumer lending affects all import components: it influences consumer imports directly, and interim and investment imports – indirectly.

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