Fiscal Reform in the Republic of Moldova. Stochastic Dynamic General Equilibrium (SDGE) simulation

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Abstract

The article describes a discrete-state dynamic and recursive equilibrium for the Republic of Moldova, in the context of declining oil prices and COVID-19. We try to introduce an intergenerational model with the stochastic component, where we describe each self-employed agent, rather we try to adapt the model in a simulative tax reform, a transition from the progressive system that currently we have to a flat tax. For our hypothesis, it is assumed that there are 4 cohorts of population, selected by level of education (secondary, high school, university and lifelong learning) that pay taxes in a system based on social solidarity. Thus, the first conclusions can be drawn, namely that the tax system with 4 different rates 12, 15, 19 and 23% is the one that best approaches the Pareto type optimum, as opposed to the flat tax, which respects dynamic equilibrium. Public budget revenues are simulated in IS-LM-Laffer framework. And the forecast of budget accumulation is made using 4 distinct prediction models: naïve random walk, ARIMA, univariate model (AR) and vector error correction model (VECM). In addition, the main result is placed on the hypothesis that the empirical testing suggest that, unlike complicated models that have difficulty overcoming naïve random walk imitation, using techniques of associating and including monetary and fiscal indicators in linear regression, as well as adding structural shapes, some parameters of the models are quite significant. Of these, it seems that the closest to the economic reality of the country is the univariate model (AR), being also the most relevant for predicting the out-put gap, but also the stochastic component: the basic interest rate of the NBM's monetary policy

Keywords: monetary policy, fiscal reform, Pareto optimality, dynamic general equilibrium; cross-country convergence; prediction and forecasting methods;

JEL classification: C13; E13; E35

1. Introduction

National reform in monetary sector has been and remains a fundamental issue. Fiscal policy plays a key role in the process of macroeconomic stabilization, but also in the process of anchoring to European Union standards. The proposal of a country to adopt a fiscal reform, be it a flat tax or a budget deficit adjustment, is being looked at very carefully at this time. The second decade of the 21st century has changed a lot, with the Moldovan economy facing a severe recession (2015 and 2020 due to the COVID-19 pandemic), with fiscal policy facing challenges to implement new ways to stabilize the way out of this collapse. Even now, more than 29 years after independence, in which tax reform has played a major role in the management of public finances, the situation of contradictory debates among economists about the benefits of a single tax system persists. Some authors as Blannchard (1985), Heijdra and Ligthart (1998), Benttendorf (1998) see the strengths in the simplicity and correctness that emerges from the tax code with its application, lower costs, given that individual agents live in two different periods and seek analytically the applicability of fiscal policy, but also from here a compliance of the single tax rate (18%) could influence consumer behavior compared to the actual fiscal structure, the elimination of ballast losses characteristic of progressive current income tax, the effect on business and foreign investors, simplification of bureaucracies, etc. Other authors Seo, Inamura and Ando (2001), however, come to criticize, arguing that the adoption of a “flat tax” type of tax system can lead to double taxation. Given that opinions are divided, this fiscal policy measure is considered useful as long as the conditions of a fixed tax regime are fully respected. In this paragraph we aim to analyze the impact of adopting a tax mechanism on the population.

If we look in the literature, there have been enough studies that have evaluated the effect of adopting the single tax rate on the economies in different countries. For example, Altig and Carlstrom (1999) study the interaction between inflation, taxation, and macroeconomic performance in a model where generations overlap as described by Auerbach et al. (1997). They address the macroeconomic effects of fiscal reforms, finding that the transition from the current progressive system in the US to a 25 percent unique income tax will lead to a 3 percent long-term GDP growth. Altig et al. (2001) address the issue of welfare and macroeconomic effects by considering five fundamental alternatives to the US federal income tax, highlighting that significant long-term gains in output and aggregate welfare in all cases. The estimated long-term increases in production are: proportional income tax, by 4.9 percent; proportional consumption taxes, by 9.4 percentage points, single tax rate, 4.5 percent, single tax rate with transitional relief, by 1.9 percent; tax X, 6.4 percent. Moreover, it shows that even in the conditions of increasing welfare in general, some population groups will register decreases in income. González-Torrabadella and Pijoan-Mas (2006) propose a series of tax reforms for Spain. They find an increase in output for reforms with fixed marginal tax rates of up to 28.19 percent and fixed deductions of up to 0.40 percent of the average reference income.

2. The Model

To study the effects of a fiscal reform on the economy of the Republic of Moldova, we will use a model of general dynamic equilibrium (DGE) and stochastic component (S) to assess the quantitative effects in the context of a monetary policy scenario used by the National Bank of Moldova (NBM). In the analysis, we will interpret the main changes of the aggregate variables as well as their social implications in the equilibrium state, as a result of the use of the Laffer Curve in the analysis. We also consider the effects of government revenues to be neutral on flat tax reform. Initially, we assume a two-period model of the life cycle in which households have an altruistic purpose of inheritance and face uncertainty about future earnings, life expectancy and medical expenses.

2.1 Households

Our economy is populated by j-type agents who begin economic activity at the age of 21, have an exogenous number of children between the ages of 20 and 49, and die at the age of 72 or later. Each type of agent constitutes a fixed weight of the total, ω_j. Households born in period, t, choose a consumption, c, time, l, and intergenerational transfers, b, to maximize the utility function of the form:

$$U_t^j = \sum_{s=21}^{72} \beta^{s-21} \left(C_{s,t+s-21}^j, a(1-l)b_{s,t+s-21}^j\right) + \beta^{51}\Psi b_{72.t+51}^j \frac{C_{s,b+s-21}^{1-\sigma}}{1-\sigma} \quad (1)$$

(1−l) – job offer

Here, β, is the subjective updating factor ($0 < \beta < 1$),ψ determines the importance of bequest b, and l- means the weight of time that households allocate to non-commercial activities.

$$U_{s,b+s-21}^j(c, 1-l) = \frac{C_{s,b+s-21}^{1-\sigma_1}}{1-\sigma_1} + \frac{(1-l)^{1-\sigma_2}}{1-\sigma_2} - 1 \quad (2)$$

$$l_t = (W_{t/a})^{-\rho} C_t \quad (3)$$

2.1.1 Budget Constraint

$$a^{j}_{s+1,t+1} = [1 + (1 - \tau^{K}_{t})r_{t}](a^{j}_{s,t} + g^{j}_{s,t}) + [\omega^{j}_{s,t}(1 - \tau^{P}_{t})] - (1 - \tau^{L}_{t})C^{j}_{s,t} + Z^{j}_{s,t} \quad (4)$$

$Z^{j}_{s,t}$ – government consumption

$$a^{j}_{s+1,t+1} = [1 + (1 - \tau^{K}_{t})\ r_{t}]a^{j}_{s,t} + P^{j}_{s,t} - (1 - \tau^{P}_{t})\ C^{j}_{s,t} \quad (5)$$

Where τ^{K}_{t} is capital income tax, and retirees receive a pension, $P^{j}_{s,t}$ inheritances are available equally, $g^{j}_{s,t}$ – by the whole generation who they gave birth to them, that is, $g^{j}_{s,t} = 0, \text{for } s = 40$. The pension system is financed by a gross salary tax, τ^{P}_{t}.

2.2 Firms

We assume that the technology can be represented by a Cobb-Douglas production function, aggregated by capital (K) and labor (L) equal to the respective amounts of individual assets and labor deliveries as indicated in the equations below.

$$Y_{t} = AK^{\alpha}_{t}L^{1-\alpha}_{t} \quad (6)$$

$$K_{t} = \sum_{s=21}^{72}\sum_{j=1}^{4}\phi^{j}\ a^{j}_{s,t-1} \quad (7)$$

$$L_{t} = \sum_{s=21}^{72}\sum_{j=1}^{4}\phi^{j}\ \varepsilon^{j}_{t}(1 - L_{s,t}) \quad (8)$$

$$I_{t} = K_{t+1} - (1 - \sigma)K_{t} \quad (9)$$

Where, α,is the output capital share, $K_t$is the aggregate capital stock. The depreciation rate for physical capital is denoted by σ.

2.2.1 Budget Constraint

Constraint as a global resource is indicated by:

$$C_{t} + K_{t+1} - (1 - \sigma)K_{t} + G_{t} \leq\ AK^{\alpha}_{t}L^{1-\alpha}_{t} \quad (10)$$

În cazul în care K_t, C_t, L_t –represents the aggregate capital stock, aggregate consumption and total labor in period t, and αexpresses the share capital. The depreciation rate for physical capital is denoted by σ.

2.3 Government

For each period of time, t, the government collects tax revenue, having debts, D_{t+1}, which it uses to finance public procurement of goods and services $G_t$and interest payments debt stock, $D_t$divided by each fraction of agents, j, are assessed according to budgetary constraint:

2.3.1 Budget Constraint

$$D_{t+1} + \sum_{s=21}^{72}\sum_{j=1}^{4}\tau^{W}_{s,t}\phi^{j}W^{j}_{s,t}(1 - l) + \tau^{K}_{t}G_{t} = G_{t} + D_{t}(1 + r_{t})[1 + (1 - \tau^{K}_{t})r_{t}]a_{s,t} = G_{t} + (1 + r_{t})D_{t} \quad (11)$$

3. Fiscal Structure

3.1 Pension System

We consider the following pension system. The pension system is modeled as a pay-as-you-go system, consisting of defined contributions. This system is financed by gross salary pension taxes. To run properly, the pension system has a balanced budget every year. In a certain year all pensioners receive the same pension.

$$P^{j}_{t} = \sum_{s=21}^{72}\sum_{j=1}^{4}h^{j}_{s,t} \quad (12)$$

3.2 Welfare Distribution

In order to assess the reform of the single tax rate, we measured the utility for each type j agent, based on the two different tax systems. There are two formulas for the utility function:

$$U^j_{FLAT,s} = \sum_{s=21}^{72} \beta \, [ln(1-x)C^j_{FLAT,s} + \frac{U^{j\ 1-\frac{1}{\gamma}}_{FLAT,s}}{1-\frac{1}{\gamma}} - (1-K) \quad (13)$$

$$U^j_{PRG,s} = \sum_{s=21}^{72} \beta \, [ln(1-x)C^j_{PRG,s} + \frac{U^{j\ 1-\frac{1}{\gamma}}_{PRG,s}}{1-\frac{1}{\gamma}} - (1-K) \quad (14)$$

To measure the effect of applying such a tax system, I first calculate x_j. In this way it can be more easily estimated to increase the utility of each category of population in the consumption equivalent.

3.3 Variable Selection. Data

In order to analyze the two tax systems for the economy of the Republic of Moldova, I propose certain progressive tax rates, as follows: for an income between 1000-5000 MDL, a share of 12%, for 5000-1000 MDL, 15%, for 10000-17000 MDL, 19% and for an income higher than 17000 MDL, respectively 23%. The increase of the utility of each category of population in the consumption equivalent due to the new reform.

$$x_j = 1 - e^{\frac{U^j_{FLAT,s} - U^j_{PRG,s}}{\sum_{s=21}^{72} \beta^{51}}} \quad (15)$$

3.4 Model Parameters

For this model we used the following parameters (see Table 1) in order to estimate the impact of the single tax rate on the economy.

Table 1: Model parameter values

Symbol	Name	Value
	Preferences	
δ	Elasticity of demand	0.5
φ	Importance of labor supply	0.05
μ	Importance of inherited wealth companies	3
	Firms	
α	Share of capital in production	0.36
β	Time factor parameter	0.965
γ	Capital rate depreciation	0.08
	Target values of initial steady state	
I/Y	Investments/ output	0.2
K/Y	Capital/output	2.5
P/Y	Size of pension/ output system	0.69
	The values of fiscal variables in the initial steady state	
τ^C	Consumption tax rate	29.8%
τ^K	Capital income tax rate	35.7%
τ^ρ	Pension contribution rate	11%

Source: National Bureau of Statistics; own estimated data

For starters in economics, it is assumed that there are 4 cohorts of population, selected by level of education (secondary, high school, university and lifelong learning - eng. Longlife-learning) who pay taxes in a system based on social solidarity. This has helped us to more easily estimate the effect of tax reform on consumption. The negative values in the table explain that the adoption of that tax rate will be reflected in a decrease in the utility level of consumption (see Table 2).

Table 2: Reform of tax rate system on each category of population, X_j

Level of education	Rate of 12%	Rate of 15%	Rate of 19%	Rate of 23%
ω_1	-0,246	-0,046	-0,071	-0,098
ω_2	0,1104	0,098	0,066	0,046
ω_3	0,5823	0,036	0,119	-0,011
ω_4	0,104	0,083	0,060	-0,026
Total X_i	0,5500	0,1171	-0,4665	-0,0260

Source: National Bureau of Statistics; own estimated data

4. Scenario Analysis of the Is-Lm Model, Leverage In the Tax Reform Simulation

SCENARIO 1: THE IS-LM-PC MODEL, WITH THE PHILLIPS CURVE (PC)

We derived the following equation for short-term output behavior:

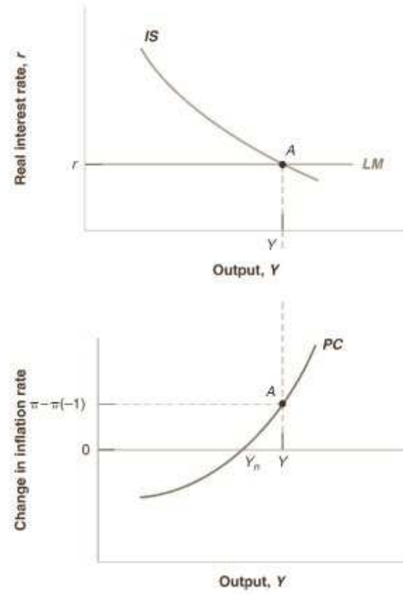
$$Y = C(Y - T) + I(Y, r + x) + G \tag{16}$$

In the short run, production is driven by demand. Demand is the sum of government consumption, investment, and spending. Consumption depends on disposable income, which is equal to the net income from taxes. The investment depends on the production and the real loan rate; the real interest rate relevant for investment decisions is equal to the loan rate, the amount of the real interest rate, r, chosen by the central bank and a risk premium, X. Government expenditures are exogenous. We can draw the default IS curve from equation (16) between output, Y and inflation rate, $r$for given taxes, T risk premium X and government spending G. This is done in the upper half of Figure 1. The curve is inclined in down. The lower the real policy rate, r, given by the plane LM curve, the higher the equilibrium level of the output. The mechanism behind the relationship should be familiar so far with the assumption that a monetary policy with a lower interest rate increases investment. A higher investment leads to a higher demand. Increasing production further increases consumption and investment, leading to further growth in demand and so on. Now is the time to draw attention to the lower half of Figure 1. We derived the following equation (Equation 17) for the relationship between inflation and unemployment, a relationship we called the Phillips curve:

$$-\pi^e = -\alpha(u - u_n) \tag{17}$$

u_n - natural rate of unemployment

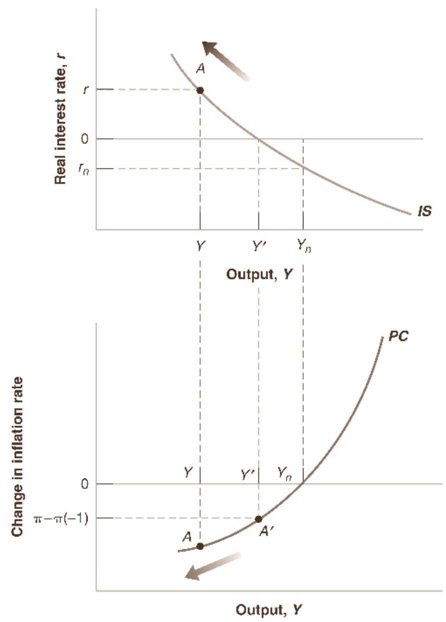
Figure 1: Model IS-LM Phillips curve. Above: Low policy rates lead to high GDP growth rates. Below: High GDP growth rates lead to abrupt changes in inflation dynamics.



Scenario 2: Low Interest Rates and the Deflation Spiral

Our description is subject to adjustment towards a medium-term balance. If output is at a higher level, the central bank tightens monetary policy until output returns to potential. If output is below its potential level, the central bank lowers the policy interest rate until output returns to the appropriate level. The reason for this IS-LM framework is the combination of zero lower limit and deflation. In Figure 1, we considered where output was above potential and inflation was rising. Instead, we consider the case, represented in Figure 2, where the economy is in a recession. At the current policy rate r, the output is equal to Y, which is far below Y_n. The production gap is negative and inflation is declining. This initial equilibrium is represented by point A, in the graphs above and below. What should the central bank do in this case seems simple? Either the monetary policy interest rate should decrease until production rises back to its natural level, or (in terms of Figure 2) the policy rate should decrease from r down to rn. At rn, the output is equal to Y_n, and inflation is at a new equilibrium level. It should be noted that if the economy is sufficiently in recession, the value of the real policy rate, rn., Needed to bring production back to its natural level can be negative. Forcing the lower limit to zero can, however, make it impossible to achieve this goal, and the real policy rate is negative. Suppose, for example, that the initial inflation is zero. Therefore, the lower the rate, the central bank would reduce the nominal interest rate to 0%, which, combined with zero inflation, implies a real policy rate of 0%. In Figure 2, the central bank can reduce the real interest rate to only 0%, with the associated level of output Y',. At Y',, output is still below potential and thus inflation is still declining. This is the beginning of the scenario, which economists call it - the deflation spiral or the deflation trap. Furthermore, suppose that inflation expectations are such that unions, which set the wage in the national economy, expect inflation to be the same as last year, so a negative output gap implies a decrease in inflation. If inflation has been zero to it can become negative. Zero inflation turns into deflation. In turn, this implies that, even if the nominal rate remains zero, the real policy rate on the interest rate ceiling increases, leading to even lower demand and a lower level of output. Deflation and low power feed each other. The output is lower leading to deflation which ultimately follows a higher real interest rate and a lower output (as indicated by the arrows in Figure 2, instead of converging towards the average equilibrium level, the economy moves away from it, generating a steady decline in production).

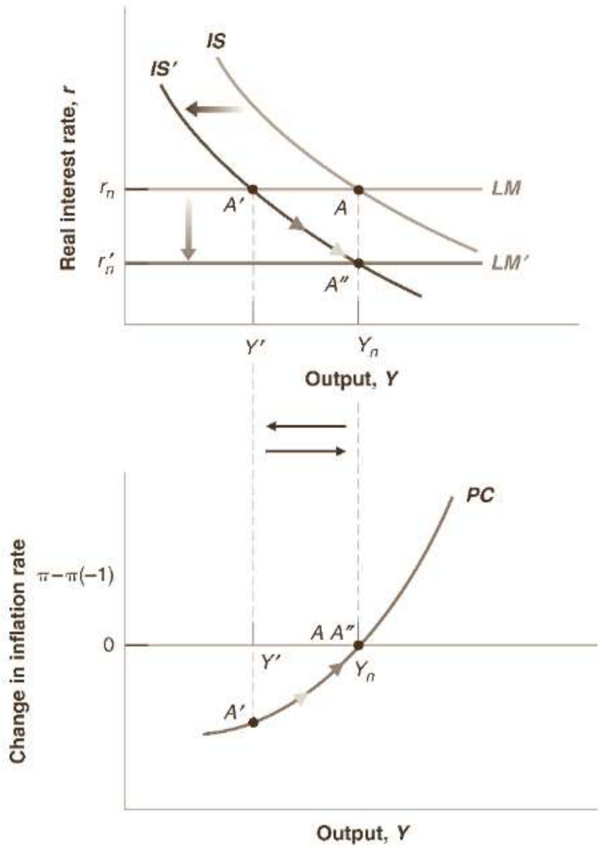
Figure 2: Deflation spiral within the IS-LM model



Simulation: Fiscal Consolidation through the IS-LM Model

We can now analyze the IS-LM model with CP (Phillips curve) in terms of its rhythms. In this section, we return to the question of fiscal consolidation that interests us to use the model in a tax reform. Now we can look not only at the short term, but also at its medium term effects. Suppose that production is at its potential level, so the economy is at point A in both the top and the bottom half (Figure 3.) Output **Y** is equal to Y_n, the monetary policy interest rate is equal to rn, and inflation being stable. Now, suppose the government is dealing with a deficit, it decides to reduce it, it raises taxes. For Figure 3, the increase in the charge level shifts the IS curve to the left, from IS to IS'. The new short-term break-even point is given by the point IS' received at both the top and bottom of the graph in Figure 3. At the monetary policy interest rate rn, output falls from Y_n to Y' premiums and inflation begins to rise. decreases. In other words, if production starts at its potential level, fiscal consolidation, however desirable, leads to a recession. This is the short-term balance. We note that as income decreases and taxes increase, consumption decreases from both points. It should also be noted that as the level of taxes decreases, so do investments. In the short term, for macroeconomic reasons, fiscal consolidation looks quite unattractive: both consumption and investment are declining. However, let us return to the dynamics and the medium term. As output is too low and inflation falls, the central bank is likely to react and lower the monetary policy interest rate until output returns to its potential level. Also in Figure 3, our economy moves down the IS curve at the top of the graph, and production increases. As production increases, the economy moves up the Phillips curve (CP) until output returns to its potential level. Thus, in the medium term the equilibrium is given by the point A''in the upper and lower part of the graph. The output is again at Y_n, and inflation is stable again. The policy interest rate required to keep output at potential is now lower than before, equal to r_n' premiums rather than r_n The composition of the result in this new equilibrium is as follows. Because revenues are the same as before the fiscal consolidation, but taxes are higher, consumption is lower, though not as low as it was in the short term. As the output is the same as before, but the interest rate is lower, the investment is higher than before. In other words, the decrease in consumption is offset by an increase in investment, although demand is unchanged. This is in stark contrast to what has happened in the short term which makes fiscal consolidation seem more attractive. Although consolidation may decrease investment in the short term, it will increase investment in the medium term. This discussion raises some of the same issues. Firstly, it seems that fiscal consolidation could take place without a decrease in output in the short term. All that is needed is fine mutual coordination between the central bank and the government. As fiscal consolidation takes place, the central bank should relax policy to maintain output at its natural level. In other words, the right combination of fiscal and monetary policy mix and medium-term balance can also meet the goal of short-term coordination.

Figure 3: Short-term and long-term fiscal consolidation. Note: Fiscal consolidation leads to a short-term decline in GDP. In the medium term, GDP converges at its potential rate, at a low interest rate.



For a better understanding of the function of fiscal policy, we have represented above the Laffer curve (Fig. 4), which explains why after a certain tax rate, fiscal policy fails to accumulate the necessary to the state budget, and therefore the reduction of the national budget is the first component or the first explanation deriving from the sub-optimality of the taxation action.

Figure 4: Laffer curve and state budget revenues

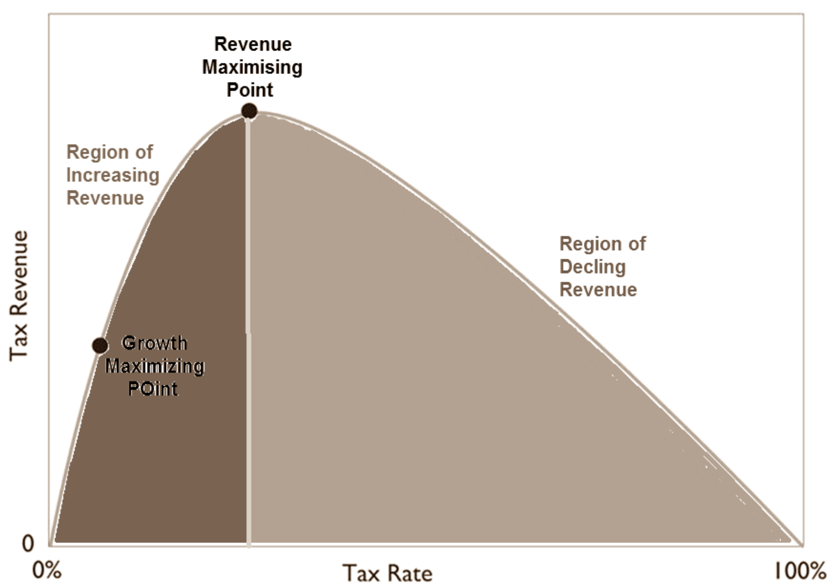
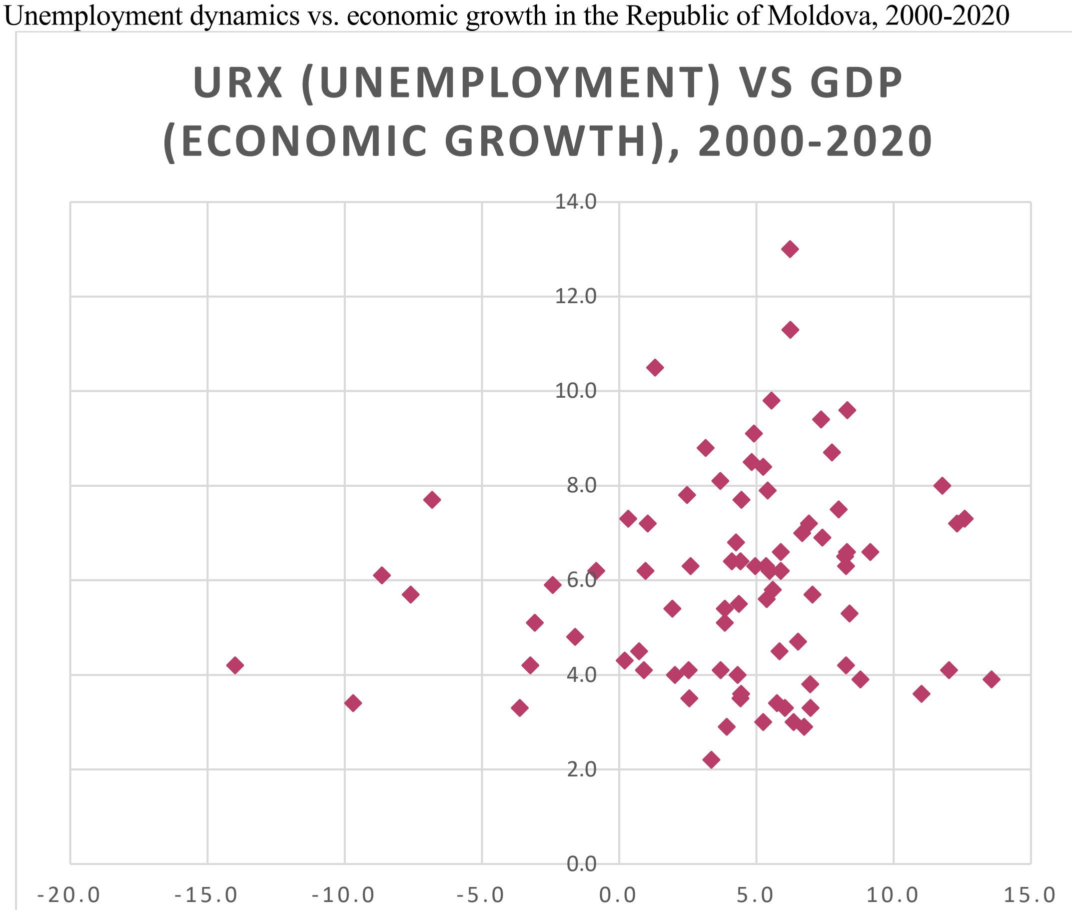


Table 3: Nominal interest rate, inflation and real interest rate in the Republic of Moldova in the period 2000-2020

Year	Unemployment rate (%)	GDP growth rate (%)	Yearly nominal interest rate (%),i	Yearly Inflation rate (%),π	Yearly real interest rate (%), r
Actual / forecast (*)					
2000	8.5	2.3	N/a	31.7	N/a
2004	8.2	7.5	N/a	12.5	N/a
2008	4.0	7.6	N/a	13.0	N/a
2012	5.6	-0.6	N/a	4.6	N/a
2016	4.2	4.2	13.7	6.5	7.25
2020	3,9	-7.0	6.9	3.7	3.23

Source: National Bureau of Statistics; own estimated data

Figure 5: Unemployment dynamics vs. economic growth in the Republic of Moldova, 2000-2020



Source: National Bureau of Statistics; own estimated data

5. Optimal Monetary Policy Scenarios in the Context of Fiscal Reform

Multivariate model (Phillips curve). Gerlach (2003, 2004) proposed a simple trivariate forecast model (having the basic equation in the form of a two-pillar Phillips curve) designed to capture at the same time the information of both monetary and economic indicators. Such trivariate forecast models specify the average inflation by a quarter h according to their own gaps, output gaps, monetary indicators, as well as gaps of non-monetary indicator variables. A step-by-step procedure is used to determine the delayed inflation values, which could lead to an expansionary monetary policy. As monetary indicators were included (with the mention that these variables are in dynamics from year to year): M2, bank loans; unemployment and GDP.

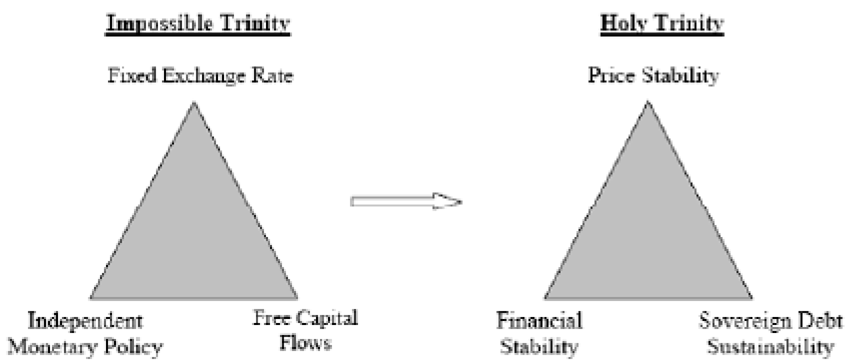
$$\pi_t = \beta_0 + \beta_1(L)\pi_{t-1} + \beta_2(L)x_{t-1} + \beta_3(L)m_{t-1} + u_{t-1} \quad (16)$$

Univariate model (Taylor's rule). Represent the following equation:

$$i_t = \pi_t + r_t^* + a_\pi(\pi_t - \pi_t^*) + a_y(y_t - \overline{y_t}) \quad (17)$$

where, i_t −base rate; π_t – inflation rate; π_t^* − the target inflation rate; r_t^*- the real base equilibrium rate; y_t- the natural logarithm of real GDP; $\overline{y_t}$- the natural logarithm of potential GDP. In this equation, the parameters a_π and $a_y$must be positive.The Timberge model - actually represents the combinations between the 3 frames / scenarios stated above, but also the instruments such as the interest rate, the inflation rate but also the level of taxation.The 3 monetary policy scenarios, which aim at Pareto-type optimization, intertemporally, namely interest rate targeting (Taylor's rule), inflation targeting (Phillips curve) and Laffer curve (targeting of state budget revenues) represent the design of macroeconomic policies, within the tax reform. In the analyzed tables Table 5 and Table 7, it can be deduced that the progressive system pursues the Pareto optimum, while the single taxation provision adjusts the economy in a general-dynamic framework. The intertemporal constraint results from the fact that monetary policy is one that aims to achieve the objectives described below, in Figure 7. The constraint also results from the fact that the NBM has other monetary policy commitments that are to be included in the form of a mix of equations in a framework model (Figure 7).

Figure 7: Impossible Trinity vs Holy Trinity



Source: BIS (Bank of International Settlements) 2012

6. Pareto Optimality and Discrete-State Dynamic-Recursive Equilibrium (DSDRE)

Note: It follows that the progressive tax in the first part is closest to a Pareto equilibrium, while the single tax rate of 18%, Flat tax is the result of a dynamic game, within an IS-LM framework and the Laffer curve. The choice of the tax rate of 18% will be the forecast objective in the 3rd part of the article which represents distinct methods for predicting the revenues to the state budget.

Table 4: Scenarios for choosing the single tax rate based on the 3 monetary policy scenarios

Model/ Objective	Price stability	Sustainability of public finances	Exchange rate stabilization	Financial stability
Timbergen Model	9,0	5,0	-1,6	5,0
Univariate (Phillips Curve)	8,1	12,36	8,6	8,3
Taylor rule	5,9	-6,9	*8,9/**9,0	*7,1/**9,3

Source: National Bureau of Statistics; own estimated data

7. Budget Revenues Forecast

From the practice of econometric modeling, we selected 4 types of forecast models, which would best suit the dynamic analysis of the national economy of the Republic of Moldova, which has specificities and nuances.

Naïve model random walk model andrandom walk with drift:

$$\widehat{\pi_t} = \pi_{t-1} \quad (18)$$

$$\widehat{\pi_t} = \pi_{t-1}+\alpha \quad (19)$$

However, in our practice, we give up the random drift pattern, from our observations it would not be the case of "drifting trends". Thus, the application of the random drift model seems irrelevant. It should be added that the inflation rate at time t is not part of the set of information at time t.

Univariate model (AR):

$$\pi_t = \beta_0 + \beta_1(L)\pi_{t-1} + u_t \quad (20)$$

ARIMA model. If we combine differentiation with self-regression (AR) and a moving average (MA) model, we obtain a seasonless ARIMA model. Since the AR model was introduced in the previous section, here we introduce first the MA model and then the ARIMA model. The basic idea of the Moving-Average model is first to find the average for a specified set of values and then use it to predict the next period and correct any mistakes made in the last forecasts. It takes this form:

$$\pi_t' = w_0 + \varepsilon_t - w_1\varepsilon_{t-1} - \ldots - w_q\varepsilon_{q-1} \quad (21)$$

To specify a moving average (MA) process, the number and value of the parameter must be decided subject to certain value constraints for the process to be stationary. The MA model works well with stationary data, a type of time series without trend or seasonality. In general, to combine the AR and MA model we obtain ARIMA (an acronym for Integrated Moving Motion Regressive Mean (in this context, “integration” is the inverse of differentiation.) The complete model can already be written as:

$$\pi_t' = c + \beta_1\pi_{t-1}' + \ldots + \beta_p\pi_{t-p}' + \theta_1\varepsilon_{t-1} + \ldots + \theta_q\varepsilon_{q-1} + \varepsilon_t \quad (22)$$

where $\pi_t'$is the differentiated series (there may have been a difference several times). The "predictors" on the right include both delayed values of $\pi_t'$and delayed errors. In the notations above:

- p is order of the autoregressive part;
- d is the degree of the first differentiation involved;
- q is order of the moving average part.

Thus, the ARIMA uses combinations of previous values and previous forecasting errors and offers the potential to fit models that could not be properly fitted using an AR model or an MA model alone. In addition, the addition of differentiation eliminates the largest non-stationary in the series.

Vector error correction model (VECM). The reason we also include the vector error correction model (VECM) is to deal with the potential problem of cointegration. The ARMA model is a general framework used to describe

the dynamic interaction between stationary variables. So the first step in time series analysis should be to determine if the data levels are stationary. If not, we will move on to the next step, to consider the first difference in the series. Usually, if certain segments of the time series are not stationary, the first differences may be stationary. If the time series are not stationary, then the ARMA framework must be modified to allow consistent estimation of the relationships between the series. VECM is only a special case of ARMA for the variables that stand in their differences (i.e. I (1)). VECM can consider any type of co-integration of the relationships between variables. The reason we want to apply this technique to forecasting is that the issue of non-stationary can be attributed to the structure of the date series. Furthermore, we use the vector error correction model because: (1) time series are not stationary at their levels, but still appear to be stationary in their differences, and (2) variables are co-integrated. The initial assumptions are obtained from the statistical examination of the data series.
We assume that two variables that are x and y and I (1) are cointegrated. Then ε_t is I (0) in a cointegration equation:

$$y_t = \alpha + \beta x_t + \varepsilon_t \qquad (23)$$

These equations are often interpreted as long-term or equilibrium relationships between x and y. A researcher will also be interested in short-term dynamics - how x and y fluctuate around this long-term relationship, as in a business cycle. This is done by estimating an error correction model, which contains the first differences of x and y, their delays and an error correction term. A VECM is:

$$Dy_t = \mu + \gamma_1 D\gamma_{t-1} + \ldots + \gamma_p D\gamma_{p-1} + \omega_0 Dx_{t-1} + \ldots + \omega_r Dx_{t-r} + \lambda EC_{t-1} + u_t \qquad (24)$$

Where $EC_t = y_t - (a + bx_{t)},$ the error correction term is the delayed OLS residue from the cointegration equation. The delay orders p and r are chosen in the usual ways discussed above. Since the OLS estimate of β is very consistent, the sampling error from its estimation in the cointegration equation is less important than the sampling error of the asymptotic ECM coefficient estimates. This justifies a two-step procedure in which the cointegration equation is estimated first, followed by an ECM with the delayed OLS residue (EC_{t-1}) of the estimated cointegration equation which serves as a term for correcting errors in the ECM.

Step 1: OLS: $y_t = a + bx_t + EC_t$ (cointegration equation)
Step 2: OLS: $Dy_t = \mu^* + \omega_1 Dx_t + \lambda EC_{t-1} + u_t$ (error correlation model)

8. Forecast data and Results.

Several types of observations were included for the forecast. Among these we can list, the gross domestic product, the unemployment rate, the expenditures and incomes of the population, the ceilings of indirect taxes (excises and vat). These were taken over from the national bureau of statistics, the fiscal code of the republic of Moldova (1997), but also the ministry of economy and infrastructure. the forecast results are detailed in the table below.

Table 5: State budget revenues - billion / Prediction (**models**)

Anul	Random Walk	Univariate	ARIMA	VECM
2018	32.556	33.142	31.859	35.433
2019	33.791	35.966	29.687	29.455
2020	33.041	36.329	34.904	33.022
2021	36.507*	32.643*	31.158*	34.541*
2022	32.266*	33.86*	30.49*	32.629*

Source: National Bureau of Statistics; own estimated data

9. Method of comparing model performance

Obviously, all models are abstract of reality, and therefore no model can capture every aspect of reality. The truth is that there is no "true" or "perfect" model in econometric modeling. It can be non-linear and then there is the difficulty of being able to be captured by us. The theory gives us the ease to return to the "driving forces" of the markets for goods and services on the one hand, and the (money) money market on the other, which could be to some extent observable. A comparison of model performance would shed light on those systemic elements (Leung, Kwan, & Dong, 2014). To compare the forecasting performance of different models, we perform the standard RSME and MAE criteria that give us the ability to calculate the forecast error. The RMSE and MAE formula take the form:

$$\mathrm{RMSE(i)} = \sqrt{\frac{1}{N}\left(\sum_{j=1}^{N}(e^i)^2\right)} \quad (25)$$

$$\mathrm{MAE(i)} = \frac{1}{N}\sum_{j=1}^{N}\left|e^i\right| \quad (26)$$

We also use Theil's U criteria, which is a measure of relative accuracy, comparing the predicted results with minimal historical data. It also preserves deviations to give more weight to large errors and to overestimate “weight as value” errors, which would help us eliminate methods with large errors. Theil's U criteria could tell us directly whether or not the model exceeds the performance of the naïve random walk model. The formula for calculating Theil's U statistics takes the form:

$$U = \sqrt{\frac{\sum_{t=1}^{n-1}\left(\frac{f_{t+1}-a_{t+1}}{a_t}\right)^2}{\sum_{t=1}^{n-1}\left(\frac{a_{t+1}-a_t}{a_t}\right)^2}} \quad (27)$$

Where, *f* is the predicted value and *a* is the effective value. If U = 1, there is no difference between a naive forecast and the technique used; if U <1 technique is better than a naive forecast; and if U> 1 the technique is no better than a naive forecast.

Table 6: Interpretation of the MFA coefficient

MAE	Interpretation
<10	High accuracy
10-20	Good accuracy
20-50	Satisfactory accuracy
>50	Unsatisfactory accuracy

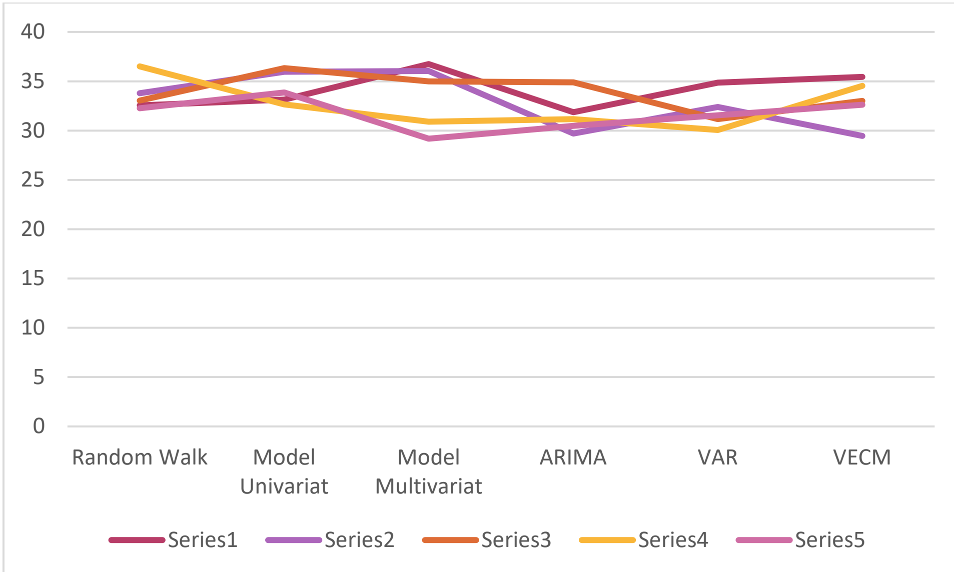
Source: National Bureau of Statistics; own estimated data

Tabel 7: Truthfulness of forecast models / Comparison of models according to different criteria

Model	e.g. Forecast 2021 (%)	RMSE	MAE	Theil-U
Random Walk	36.507*	8.127	8.134	0.615
Univariate Model	32.643*	8.598	8.392	0.821
ARIMA	31.158*	9.217	6.259	0.672
VECM	34.541*	7.921	9.176	0.983

Source: National Bureau of Statistics; own estimated data

Figure 9: Forecast results of different models (period 2018-2022)



Source: National Bureau of Statistics; own estimated data

10. Conclusions

For the economy of the Republic of Moldova, a share of 18% would be more optimal, compared to 16% in Romania. However, the share of 18% is more appropriate than 20% and 14%, respectively. In addition to the progressive share, its impact on welfare is about 30%, for all 4 categories of population taken into analysis. This simulation allows us to say that in the event of the adoption of a progressive quota, its impact on the economy could be different and would hinder the process of economic growth, so necessary especially in the context of the latest pandemic crisis due to COVID-19. Just as fiscal policy alone cannot solve the problems of financial stability, it is necessary for it to be coherent for increased effectiveness and to act as an element of the whole, alongside other economic policies. Namely the firm and consistent implementation of the balanced mix of macroeconomic policies - monetary, fiscal and budgetary, as well as the structural reforms in agriculture and industry agreed in the multilateral external financing arrangement by the international financial institutions is essential to strengthen the disinflation process and of financial stability. Last but not least, the adoption of an optimal policy mix would be necessary to foster rapid convergence with the countries of Central and South-Eastern Europe.

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