I. MODELLING AN EMERGENT ECONOMY AND PARAMETER INSTABILITY PROBLEM

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Abstract

The paper examines a largely debated and important modelling problem – the instability of the econometric parameters, which has unpleasant consequences on both analytical and predictive planes. The modification of the estimators and/or of the standard deviations of a given model parameter when identical specifications and computational algorithms are applied on different statistical samples is considered to be its main manifestation. Several sources generating such a phenomenon may be identified: (i) statistical properties of the initial sample (mean, skewness, kurtosis, variance, outliers); (ii) econometric specification (selected explanatory factors and their functional connection with the dependent variables); (iii) changes in statistical data due to revisions; and (iv) dynamic instability, resulted from inherent changeability of real economic behaviours (consumer preferences, risk aversion of investors, households saving propensity, input-output coefficients and sectoral inter-flows, taxation system, domestic institutional context, foreign trade, international financial markets, and many other similar circumstances).

For all these types, specific indicators and quantifying methodologies are proposed. As an illustration, we analysed the last version (2012) of the Romanian model, the macroeconomic parameters of which (182) were estimated using two computational algorithms (OLS and 2SLS) for seven samples: initial data for 1990-2011, the same series updated, and subsequent from 1990 to 2012, 2013, 2014, 2015, and 2016.

Possible solutions to attenuate the parameter instability implications are also described, exemplifying them on the Romanian macromodel predictive simulations for 2017-2018 years.

Some practical recommendations and further research topics are commented in the final part of the paper.

Keywords: macromodel, parameters instability, simulation

JEL Classification: C32, C51, C52, C53

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I. Introduction: Research Methodology

1. The conceptual and applicative problems generated or related to the model parameter instability were for a long time asserted as an outstanding mainstream of modern economic debates. The estimators' and their standard deviations' changeability was already presented as main quantitative measures in this sense (see for example Borenstein *et al*., 2009; Nelson and Kennedy, 2009). Complex implications of such a phenomenon (from confusing analytical statements to considerable forecasting biases) and a large set of testing its presence in modeling works have also received special attention (Dufour, 1982; Hansen, 1992; Andrews, 1993; Stock and Watson, 1996; Zivot, 2003; Pesaran *et al*., 2004; Rossi, 2004; Zeileis and Hornik, 2007; Bates *et al*., 2012; Farhani, 2012; Hendry and Mizon, 2013; Calvori *et al*., 2014; Pettenuzzo and Timmermann, 2015).

Similar questions can be asked in other fields as well (Brigode *et al*., 2013; Li *et al*., 2015, are presented as illustrations), which substantially enlarges the perimeter of multi-disciplinary scientific interferences.

The main goal of this paper is to examine the parameter instability problem as defined here: *the change from sample to sample in the econometric outcomes under the same specification and computational algorithm*. The research focuses on some technical aspects about testing the presence and the most frequent sources of such a circumstance, about identifying solutions to attenuate its disturbing effects, especially on the predictive properties of the models. The advanced methodological and interpretative assumptions were tested empirically on an emergent economy, by performing simulations on the last version (2012) of the Romanian macromodel.

2. More concretely, the instability of a given parameter k is quantified by the relative modification of its estimator (β) and/or its standard deviation (σ), computed from two or more samples by using an identical computational algorithm (q). Normally, the economic significance of the respective parameter does not change, which automatically implies constancy of the econometric specification.

In the case of updated (denoted by c) or any subsequent recorded samples (denoted by t=1, 2,…,T), the following indicators are determined as against the initial one (denoted by 0) considered as reference point:

$$D\beta_{kcq}=\left|\beta_{ktc}/\beta_{k0q}-1\right| \quad (1)$$

and

$$D\beta_{ktq}=\left|\beta_{ktq}/\beta_{k0q}-1\right| \quad (2)$$

respectively

$$D\sigma_{kcq}=\left|\sigma_{kcq}/\sigma_{k0q}-1\right| \quad (3) \text{ and}$$

$$D\sigma_{ktq}=\left|\sigma_{ktq}/\sigma_{k0q}-1\right| \quad (4)$$

The symbol $\left| \; \right|$ means modulus.

These coefficients are easily interpretable. Besides, being expressed in a relative form, they facilitate inter-parameter analyses.

Similar coefficients are traceable for two or more compared samples. The root mean of Euclidean distances has been preferred as a summarising measure, due to its simplicity:

$$MSDP\beta_{ktq}=(1/(1+T))*((\beta_{ktq}/\beta_{k0q}-1)^2+\sum_t(\beta_{ktq}/\beta_{k0q}-1)^2)^{0.5} \quad (5)$$

and

$$MSDP\sigma_{ktq}=(1/(1+T))*((\sigma_{ctq}/\sigma\beta_{k0tq}-1)^2+\sum_t(\sigma_{ktq}/\sigma\beta_{k0tq}-1)^2)^{0.5} \quad (6)$$

Obviously, such an aggregate index could be also defined as a cross-sectional value (K parameters):

$$MSDS\beta_{ktq}=((1/K))*((\beta_{kcq}/\beta_{k0tq}-1)^2+\sum_k(\beta_{ktq}/\beta_{k0tq}-1)^2)^{0.5} \quad (7)$$

and

$$MSDS\sigma_{ktq}=((1/K))*((\sigma_{kcq}/\sigma\beta_{k0q}-1)^2+\sum_k(\sigma_{ktq}/\sigma\beta_{k0q}-1)^2)^{0.5} \quad (8)$$

In this way, an aggregate measure relating to the whole parameter estimations vector of interest is obtained.

3. The components and sources of the model parameter instability was certainly one of the most debated issues. Stock and Watson (2009) decomposed instability into three components - factor loading, factor dynamics, and factor model idiosyncratic.

Nelson and Kennedy (2009) identified five problems or procedures that help define a complete meta-analysis: (1) sample selection criteria; (2) basic data summary; (3) primary data heterogeneity; (4) treatment of heteroskedasticity; and (5) dependency of multiple observations from the same primary study (p. 347).

Most authors insisted on structural factors in explaining the model parameter instability: Stock and Watson, 1996, 2002; Cogley and Sargent, 2005; Boivin and Giannoni, 2006; Sims and Zha, 2006; Inoue and Rossi, 2008; Fernandez-Villaverde *et al.*, 2010; Corradi and Swanson, 2011; Stevanovic, 2010, 2015; Hendry and Mizon, 2013.

Factual heterogeneity, and particularly methodological solutions as sample selection, measurement, level of aggregation, specification search and econometric model in general, estimation method, and time horizon of prediction were also invoked (Dutkowsky and Atesoglu, 1986; Bidarkota, 1996; Inoue and Rossi, 2008; McLean and Pontiff, 2012; Nelson, 2013; Neely, 2016). The vulnerabilities of too complicated models in interpreting and forecasting actual economic processes were outlined often enough as causes of coefficient instability (Goyal and Welch, 2004; DeMiguel *et al.*, 2006; Della Corte *et al.*, 2007; Engstrom, 2014).

Returning to our application, the regressions outcomes of the Romanian macroeconomic parameters were processed for all the above types of samples (0, c, and t=2012…2016), maintaining constancy of econometric specification and computational algorithm. This exercise allowed us to achieve a coherent systematisation of model parameter instability forms, which are intimately linked with their sources.

3.1. *Initial sample instability* (Ω_{kqs}). This is intrinsically associated with the properties of the starting sample (mean, skewness and kurtosis of series, its variance, outliers' effect). As a quantifying measure, the ratio of corresponding standard deviation (σ_{k0q}) to estimator β_{k0q} is adopted:

$$\Omega_{ksq}=\sigma_{k0q}/|\beta_{k0q}| \quad (9)$$

Modulus is the simplest way to avoid complications generated by negative estimators.

3.2. The updated sample can change econometric estimators and standard deviations of one or more parameters. How can we explain it? A handy solution would be to interpret them as a simple facet of data revision repercussions. However, could we completely relieve the model specification itself of such "responsibility"? There are not convincing reasons in favour of such an option.

Both primary and updated sample refer to the same time interval, as they are statistical images of a common socio-economic environment, in other words, of an identical modelling object. Also, the econometric specification results from a long chain of trials, developed always in strong connection with database analysis (stationarity tests, information criteria, choosing adequate functional links among variables, etc.). Under such conditions, a double imputation of the mentioned differences seems more consistent.

As a result, the paper interprets revision data effect as revealing both these parameter instability sources. For the moment, the following conventional distribution is adopted:

a) Changes in estimator associated with data revision are admitted as *modelling specification instability* (Ω_{kmq}):

$$\Omega_{kmq}=|(\beta_{kcq}-\beta_{k0q})|/|\beta_{k0q}| \quad (10)$$

The subtraction observes algebraic signs, but its result is used as modulus. This means that cases with contrary algebraic sign for β_{kcq} and β_{k0q} are supplementarily penalised.

b) Instead, the modification of standard deviation is accounted as *data revision instability* (Ω_{krq}):

$$\Omega_{krq}=|(\sigma_{kcq}-\sigma_{k0q})|/|\beta_{k0q}| \quad (11)$$

3.3. For the subsequent samples (t), such a separation is less consistent. New data - observing the same informational collecting procedure - can incorporate possible structural effects of changes in consumer preferences, risk aversion of investors, households saving propensity, input-output coefficients and sectoral inter-flows, taxation system, domestic institutional context, foreign trade, international financial markets, and a lot of other similar circumstances. In a very fluid framework, as the contemporary one is, such implications may be significant even in the short-run.

Obviously, the previous solution would be too artificial. Behavioural and other structural mutations involve both specification and data generating, maybe an entire set of modelling assumptions. Consequently, the changes in parameter size and its standard deviation are considered together as *dynamic instability* (Ω_{kdt}):

$$\Omega_{kdq}=[(\sigma_{kqt}-\sigma_{kcq})+|(\beta_{kqt}-\beta_{kcq})|]/|\beta_{koq}|]/t \quad (12)$$

The horizon interval at which β_{kqt} and σ_{kqt} are determined can differ from one application to another. This is the reason why Ω_{kdq} will be determined as a mean.

3.4. By a simple addition of the above-presented partial coefficients, a global measure of model parameter instability can be calculated:

$$\Omega_{kq}=\Omega_{ksq}+\Omega_{kmq}+\Omega_{krq}+\Omega_{kdq} \tag{13}$$

Their relative shares

$$s\Omega_{ksq}=\Omega_{ksq}/\Omega_{kq} \tag{14}$$

$$s\Omega_{kmq}=\Omega_{kmq}/\Omega_{kq} \tag{15}$$

$$s\Omega_{krq}=\Omega_{krq}/\Omega_{kq} \tag{16}$$

and

$$s\Omega_{kdq}=\Omega_{kdq}/\Omega_{kq} \tag{17}$$

may become of interest in some specific investigations.

3.5. The differences resulted from using several computational algorithms are aggregable as Ω_{kq}.

4. The model parameter instability complicates the forecasting problems. It is not at all easy to surpass them even in the case of the first discussed source (Ω_{ksq}), which concerns only the standard deviation of involved estimators. Actually, for an isolated equation within border prediction might be an acceptable solution. Usually, we operate with systems of interdependent relationships. To manage the resulted big tree of interconnected variables within limits becomes an almost impossible task. The variability of the parameters size adds, of course, to the problems.

If a direct solution seems unlikely, some palliatives proved nevertheless worthy of consideration.

As expected, literature continuously paid attention to possible remedies against negative implications of the model parameter instability. A line of suggestions concerned the modeling technique itself. Here are some of the proposed innovations:

- adaptive regression model (Cooley and Prescott, 1973);
- time varying coefficient models (Hall *et al*., 2014; Pettenuzzo and Timmermann, 2015);
- forecast pooling (Hendry and Clements, 2002; Stock and Watson, 2002, 2004; Pesaran *et al*., 2004; Corradi and Swanson, 2011);
- factor models (Stock and Watson, 2016);
- combining a range of individual leading indicators into a single composite indicator (Birchenhall *et al*., 2000);
- composite model (Benavides, 2006; Pettenuzzo and Timmermann, 2015).

An interesting suggestion was proposed by Scott Armstrong (2001), who insisted on the need to integrate the judgmental and the quantitative methods. More generally, Nelson and Kennedy (2009) recognize that meta-analysis involves a difficult balancing between problem definition, data collection, modeling, and application (p. 372).

In comparison with consolidated and developed market economies, in modelling an emergent economy one is confronted with additional difficulties. In the case of Romania, for instance, the shortness of statistical series, the very dynamic institutional and structural framework, and the scarcity of competing model specifications limit severely the applicability of many solutions suggested by previous research (shortly mentioned before). Therefore, only several of them, which seem more applicable to the given conditions, will be discussed.

4.1. The re-examination of conceptual and technical modelling hypotheses is very important. Such a reassessment concerns: the set of selected endogenous and exogenous variables, the formalization of their interdependences, the adopted estimation method and validating tests, etc.

Such an operation may have different proportions, depending on the multitude of envisaged sources of model parameter instability, the necessary labour and maybe financial efforts, and many other circumstances. In some cases, it could be enough to revise one or several equations. But in others, especially when the reality faces profound structural changes, such partial “amendments” might be irrelevant. In other words, the entire model re-specification or/and re-estimation would become unavoidable.

4.2. The information sources are also taken into consideration. Sometimes, and preponderantly for analytical purposes, a model can be modified using the initial database. Most often, however, its substantial renewal is compulsory. As a matter of fact, it would be preferable to cover all modelling segments affected by parameter variability, using recent and credible statistics. Special caution should be paid to “extending” the data series by post-sample model estimations (Scott Amstrong, 2001) or other artificial data multiplication procedures. Usually, these techniques just reproduce structural peculiarities of the old data that generated parameter instability.

4.3. If the disturbances discussed here can be anticipated with a reasonable confidence degree, some corrective interventions are also available:

- the so-called latent anchoring parameters, which can help the system to find compatible points between some contradictory relationships;
- adding different *ex ante* expert evaluations;
- comparing several local solutions in order to retain those estimations which are most plausible;
- completing the algorithm with economically justified restrictions (thresholds, bands of variation).

It would be useless to insist on the decisive role of qualitative analysis in choosing the appropriate tools for reducing the parameter instability effects, beginning with econometric specification and ending with corrective insertions in the solving algorithm.

5. The previously discussed problems will be illustrated using the Romanian macroeconomic model, which was developed during the transition from the centrally planned system to the market mechanisms.

5.1. After several experimental forms, an operational version was published in 1996 (Dobrescu, 1996), followed by other annual ones until 2000. Important extensions were achieved in 2005 and 2012 (Dobrescu, 2005, 2012, 2014b), the last one being still in use. The model has two interconnected modules: one contains macroeconomic relationships (as behavioural equations and accounting identities), and the other one the I-O technical coefficients.

In the first part, the problems of measuring the model parameter instability and its sources are examined. In the second one, short-run predictive simulations (2017-2018 years) are presented.

5.2. The macroeconomic module is segmented into the following blocks (Pauna-Saman; Romanian Journal of Economic Forecasting - XVI (4) 2013 p. 7):

Table 1

Macroeconomic Module of the Romanian Macromodel - 2012 Version

Block	Number of accounting relationships	Number of econometric relationships	Total
Employment, capital, labor income	20	6	26
Production function and output gap	17	10	27
Domestic absorption and foreign trade	26	13	39
Prices, exchange rate, monetary variables	10	7	17
General consolidated budget and public debt	43	17	60
Balance of payments and external debt	7	4	11
Primary energy and CO2 emissions	33	14	47
Total	156	71	227

Source: Romanian Journal of Economic Forecasting - XVI (4) 2013 p. 7.

The macroeconomic module contains 182 econometric parameters. These cover a large area of socio-economic variables: employment, capital accumulation, labor income, macroeconomic production function, output gap, households and public consumption, other components of domestic absorption, foreign trade, consumer price index, GDP deflator, exchange rate, monetary base and monetary multiplier, general consolidated budget and public debt, balance of payments, primary energy consumption and CO2 emissions.

5.3. The parameters were estimated using seven databases:

- the statistical series for 1990-2011 officially available in 2012, when the original 2012 version of the macromodel was structured;
- the series updated in 2017 for the same period;

- the series for 1990-2012;
- the series for 1990-2013;
- the series for 1990-2014;
- the series for 1990-2015; and
- the series for 1990-2016.

With this information, all the above characterized sources of model parameter instability could be empirically studied. In order to examine possible differences linked to the implied computational techniques, the system was tested using nine computational algorithms (without changing instrumental variables in cases when such a technique is involved):

- ordinary least squares (OLS),
- weighted least squares (WLS),
- two-stage least squares (2SLS),
- weighted two-stage least squares (W2SLS).
- three-stage least squares (3SLS),
- seemingly unrelated regression (SUR),
- full information likelihood (FIML),
- GMM – cross section (White cov.), and
- GMM - time series (HAC).

Unfortunately, the last five algorithms failed (near singular matrix) in some applications. Appendix Ap1 presents the outcomes for the other four. The OLS and WLS, on one hand, and 2SLS and W2SLS, on the other hand, generated similar results. Consequently, the paper discusses quantitative aspects of model parameter instability on estimations generated from OLS and 2SLS.

6. The second chapter contains the analysis of the basic statistical indicators of the model parameter instability manifesting itself in the variation of both the estimator and its standard deviation. The main sources of instability are examined, with special attention being paid to the properties of the used sample, the suitability of the specification, the implications of data revisions and the changes in the real socio-economic environment. The possible solutions to attenuate the distorting effects of the model parameter instability are illustrated in the third chapter of the article. A set of applicative and further researching suggestions are sketched in the final part of the paper.

II. Measuring Parameter Instability

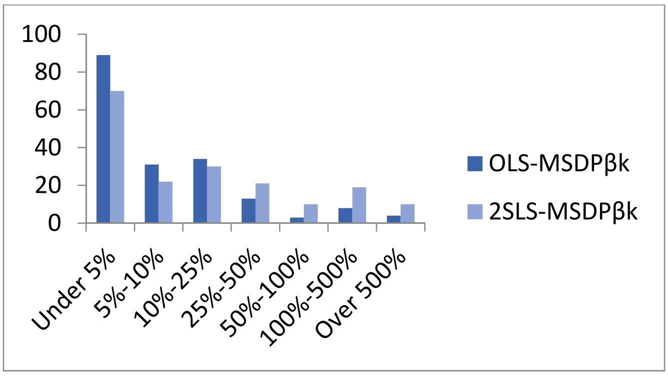
As already mentioned, the main statistical indicators of the model parameter instability are the variation in estimators (β) and their standard deviations (σ) under the same econometric specification for different samples. Appendix Ap2 details the components of macromodel parameters instability for 2016.

In our case study, the problem is examined either for each separate parameter or for the entire set. The differences generated by the computational algorithm used are illustrated by comparing the OLS and the 2SLS outcomes.

1. In order to test the individual parameter behavior, MSDPβ_{ktq} and MSDPσ_{ktq} were determined, according to formulas (5) and (6). All six coefficients for the above defined post-initial samples are calculated. The parameters are grouped according to the following thresholds: under 5%; 5%-10%; 10%-25%; 25%-50%; 50%-100%; 100%-500%; and over 500%.

1.1. The Graph MSDPβk shows the resulted distribution for parameter estimators.

Graph MSDPβk - Root Mean Square of Estimator Instability



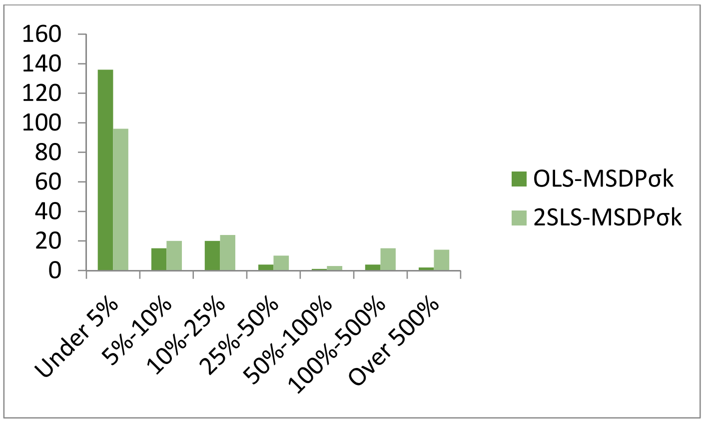
To summarize, approximately two thirds of OLS estimators have the mean square deviation below 10%, which does not look too bad for a very dynamic emergent economy. For the 2SLS estimations, however, this proportion slightly exceeds 50%.

The shares of the coefficients between 10% and 50% is similar (26% and 28%) for both computational algorithms.

1.2. The same distribution is plotted in Graph MSDPβ for parameter standard deviations.

In the case of the parameter standard deviations more coefficients lie in the 'below 10%' interval – almost 83% for OLS and 64% for 2SLS. Remember, however, that such an apparently better stability refers to many estimators which are characterized by more than 10% mean square deviation (previous graph).

Graph MSDPσ - Root Mean Square of Standard Deviations Instability



2. As expected, the parameter instability (in both expressions) changed from sample to sample. MSDSβ and MSDSσ are described in the Graph MSDS for all six examined samples. It is known that the mean and the other similar measures can be substantially biased by the presence of the so-called outliers in the data. In order to minimize such possible situations, each of the samples used have been preliminarily cleaned - the positions which have mean square deviations in excess of 500%, are considered outliers and were removed (Table 2).

Table 2

Eliminated Positions Considered as Outliers

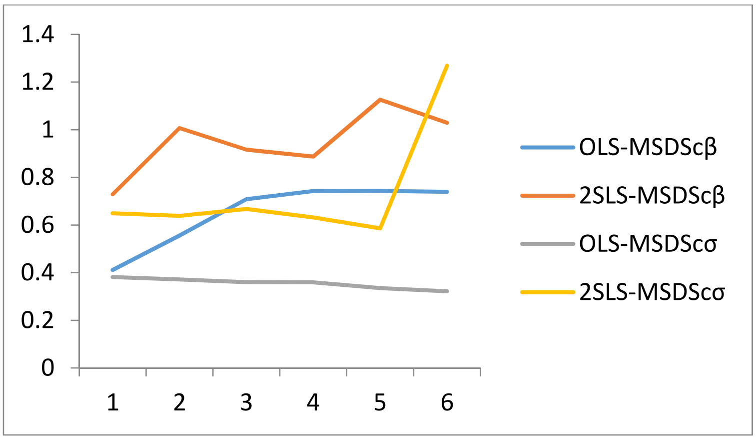
OLS algorithm		2SLS algorithm	
β-estimations	σ-estimations	β-estimations	σ-estimations
C(116) C(24) C(14) C(16)	C(14) C(16)	C(116) C(20) C(21) C(113) C(59) C(24) C(14) C(58) C(57) C(16)	C(174) C(73) C(72) C(34) C(14) C(19) C(74) C(35) C(21) C(20) C(16) C(59) C(58) C(57)

In our opinion, the impact of sample changes on computed estimators and standard deviations becomes more relevant for most of the parameters. The resulted MSDSβ and MSDSσ are presented in Graph MSDS.

In the case of OLS estimation, the data revision visibly expands the estimator values, but only for two years, and then the sample change has practically no effect on parameter stability. The standard deviations are less sensitive to data revision, even in the case of the first year.

In the case of 2SLS algorithm coefficients, the situation is slightly different. Both estimators and standard deviations values are higher, and fluctuate more. At least in our application, the OLS seems to be more robust as regards parameter stability.

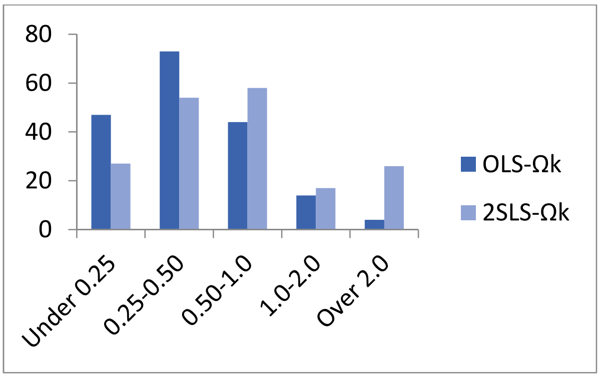
Graph MSDS - Root Mean Square of Standard Deviations Instability for Corrected Sample



3. The above described methodology for parameter instability sources was applied. Two series (one for the OLS estimations and the second for the 2SLS estimations) of Ω_{kqs}, Ω_{kmq}, Ω_{krq}, and Ω_{kdt} for all 182 macromodel parameters were obtained. The last year (2016) which was considered most representative for the dynamic source (Ω_{kdt}) was included,

The four mentioned sources were then aggregated into Ω_k. Their values are plotted in Graph Ωk.

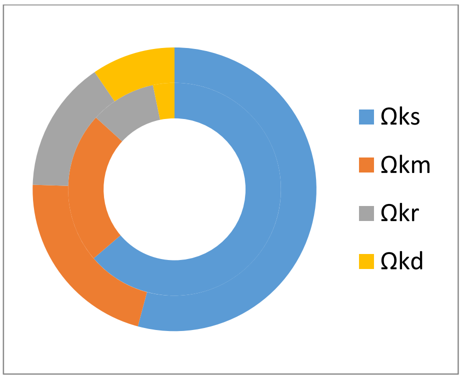
Graph Ωk - Parameter Instability Sources



Most of the macromodel parameters are situated in the lower or medium groups (below 1), but the higher levels of the global instability cannot be neglected. Again the 2SLS results appear to be less stable than the OLS ones. This is in line with the analysis developed under points 1 and 2 of this paper.

4. As it is normal, the contributions of different sources to global parameter instability vary between large limits. See Graph wΩ for the evidence.

Graph wΩ - Contributions of Different Sources to Global Parameter Instability. Outer Circle - 2SLS; Inner Circle – OLS



The quantitative approach proposed in the present paper indicates as a main cause of parameter instability (in the case of 2012 Version of Romanian macromodel) the properties of the initial sample (almost two third in OLS determination and more than 54% in 2SLS one). Together with the second instability source (modelling specification), they cover over 85% and over 75%, respectively. This result outlines again the crucial role (in performant modelling) of identifying maximally efficient estimators.

It should be also noted the not at all negligible effect of data revision on coefficient instability, which reinforces the importance of the reliability of the database, including its periodical update.

We must not care about the relatively low level of dynamic parameter instability (last listed factor). There are reasons not to reject the possibility that it reflects real phenomena. The reference time span (2012-2016) is characterized by relatively similar policies, linked preponderantly to post-crisis consequences and socio-economic recovery.

III. Managing Parameter Instability on Romanian Macromodel Simulations (2017-2018 Years)

The first chapter outlined the methodologies to attenuate the consequences of model parameter instability in practical applications. Some of them will be hereinafter exemplified by the short-run Romanian macromodel simulations for 2017 and 2018. Our exercise maintained the specification and estimators of the original 2012 version, except for several cases which will be punctually mentioned.

These simulations were preceded by some work centered, on one hand, on solving several purely modelling problems and, on the other hand, on correctly identifying the socio-economic objectives and significant constraints to the actual evolution of the Romanian economy.

1. The updating of the statistical series was compulsory, because the macromodel has many lags in its behavioral relationships, both on the macroeconomic level for the main indicators and in the sectoral one for I-O technical coefficients (ten-sector structure).

In the absence of the INS (National Institute for Statistics) 2016 annual indicators, the preliminary data provided by the National Commission for Prognosis were used.

In addition, some supplementary estimations by the author were also utilized. Two of them – tangible fixed assets at constant prices and the alpha coefficient (labor income share in gross value added) – will be further discussed.

1.1. The first concerns the real dynamics of physical capital at the national level, on which – unfortunately - there are not reliable official data during the entire post-socialist period. This explains why the 2012 Version of the macromodel (as well as the previous ones) resorted to indirect and complicated evaluations.

The obtained series of tangible assets at constant 2005 prices (Kc05) for 1990-2011 has been maintained. Its extension to the 2012-2016 period was substituted by a simple recurrent formula which uses only information on the assets depreciation rate (dfa) and gross fixed capital formation (GFCF) deflated by investment prices index (PK05):

$$Kc05=Kc05\ (-1)*(1-\ dfa)+GFCF/PK05 \quad (18)$$

1.2. The lack of data for 2016 for the alpha coefficient was handled by imputing it from an extrapolating autoregressive relationship deduced by the LSVAR procedure (Dobrescu, 2014a):

Table 3

Vector Autoregression Estimates. Sample (adjusted): 1999 2015. Endogenous: Alpha

alpha(-1)	-0.01253	alpha(-6)	0.167226
	-0.3975		-0.5041
	[-0.03151]		[0.33173]
alpha(-2)	-0.16276	alpha(-7)	-0.46251
	-0.46046		-0.4986
	[-0.35347]		[-0.92761]
alpha(-3)	0.487375	alpha(-8)	0.21937
	-0.53627		-0.47089
	[0.90882]		[0.46586]
alpha(-4)	0.189347	alpha(-9)	-0.05722
	-0.51001		-0.33989
	[0.37126]		[-0.16836]
alpha(-5)	0.085179	C	0.305482
	-0.51249		-0.45
	[0.16621]		[0.67885]
R-squared	0.490049	Akaike AIC	-2.47642
Sum sq. resids	0.025796	Schwarz SC	-1.98629
S.E. equation	0.060705	Mean dependent	0.585128
F-statistic	0.747423	S.D. dependent	0.056228
Log likelihood	31.04954		

Note: Standard errors in ( ) & t-statistics in [ ]

This was the longest possible VAR with all the roots of the characteristic polynomials below unit in modulus.

2. Unlike the original macromodel version, the present simulations do not use some latent anchoring coefficients in favor of econometric relationships regarding the output-gap impact on domestic inflation and net export.

2.1. A distinct equation for the GDP deflator (PGDP) was introduced:

$$PGDP=c(1)+c(2)*PGDP(-1)+c(3)*GAP \quad (19)$$

where: GAP represents the output-gap (the ratio of the real GDP to the potential one). The regression outcomes obtained are:

Table 4

Sample (adjusted): 1991-2016

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-2.30484	1.041267	-2.2135	0.0371
PGDP(-1)	0.749833	0.131088	5.720063	0
GAP	2.724422	1.012109	2.691827	0.013
R-squared	0.6145	Mean dependent var		1.498633
Adjusted R-squared	0.580978	S.D. dependent var		0.68121
S.E. of regression	0.44096	Akaike info criterion		1.308443
Sum squared resid	4.472256	Schwarz criterion		1.453608
Log likelihood	-14.0098	Hannan-Quinn criterion		1.350245
F-statistic	18.33137	Durbin-Watson stat		1.534108
Prob(F-statistic)	0.000017			

2.2. The ratio of net exports to GDP, estimated in RON (rnx) has been linked to the current and next year expected output-gap:

$$rnx=c(1)*rnx(-1)+c(2)*GAP+c(3)*GAP(1)+c(4)*D92+c(5)*D94 \quad (20)$$

where: D is a dummy variable. Regression outcomes are the following:

Table 5

Sample (adjusted): 1991 2015

Variable	Coefficient	Std. Error	t-Statistic	Prob.
rnx(-1)	0.770288	0.159424	4.83169	0.0001
GAP	0.172162	0.082373	2.090038	0.0496
GAP(1)	-0.18703	0.081444	-2.2964	0.0326
D92	-0.05201	0.02534	-2.05255	0.0534
D94	0.044877	0.025162	1.783497	0.0897
R-squared	0.640026	Mean dependent var		-0.06419
Adjusted R-squared	0.568031	S.D. dependent var		0.035906
S.E. of regression	0.023599	Akaike info criterion		-4.47839
Sum squared resid	0.011138	Schwarz criterion		-4.23462
Log likelihood	60.97988	Hannan-Quinn criter.		-4.41078
Durbin-Watson stat	1.74865			

2.3. Expert corrective coefficients were also introduced, especially with respect to computational formulas about fiscal and other parameters of the general consolidated budget. This operation is necessary since the new fiscal framework leads to major changes in the firms' and households' behaviours, which changes were not reflected in the 2012 version of model specification.

Obviously, this solution is a temporary palliative. Only a substantial revision of the econometric relationships with a re-estimation of their parameters would be able to solve the problem on a new short-medium horizon.

3. Many behavioral and accounting macromodel relationships contain some exogenously established parameters defining possible socio-economic policies in the envisaged domestic and international context. In approximating these parameters, like the above-mentioned corrective coefficients, our simulations started from two groups of hypotheses. One concerns the real economy, while the other focuses on the public budget revenues and expenditures.

3.1. Regarding the first one, a more profound promotion of institutional reforms is expected, targeting stability and predictability of legislation, simplification of economic regulations and radical reduction in bureaucracy, ample improvement of public – central and local – administration, more efficiency in combating corruption, more facilities regarding the creation of new enterprises and labor force mobility, maintaining the monetary policy interest rate at low levels and encouraging banking credit for the economic sector, more active support of the Romanian firms on external markets.

An essential upgrading of the state enterprises management in order to improve significantly their market performances is also necessary.

A consistent absorption of EU structural funds for infrastructure, human capital and other determinants of the modern development is another important pillar of simulations.

Synthetically speaking, the main objective is to create a solid foundation for further long-run sustainable economic growth as one way of real convergence with European Union standards.

3.2. According to the political options of the present Government Coalition, an important extension of public budget expenditures is expected, especially for: the implementation of a new wage system in the budgetary sector, the increase in pensions and in different social protection allocations, the support of the health-care and the education systems, national defense and public order, transport and other infrastructure nets. At the same time, a stronger financial discipline, improvement of tax collection and a more efficient control on all budgetary expenditures are assumed.

4. Based on these assumptions, the macromodel simulations have generated a basic scenario for 2017 and 2018, which would be consistent as much as possible with the Government Program (Table 6).

Table 6

Macromodel Simulations for the Romanian Economy during 2017-2018 Years

Indicator	Symbol		2012	2013	2014	2015	2016	2017	2018
Gross domestic product, current prices, bill. RON	GDP	NCP						815.2	878
		Model	595.367	637.46	668.1	712.8	758.52	804.26	868.97
Index of gross domestic product, constant prices (previous year=1)	IGDPc	NCP						1.052	1.055
		Model	1.0064	1.0353	1.0304	1.0367	1.0479	1.0498	1.0511
Index of households consumption, constant prices (previous year=1)	ICHc	NCP							
		Model	1.0237	0.9943	1.0487	1.0694	1.1013	1.0978	1.0682
Index of gross fixed capital formation, constant prices (previous year=1)	IGFCFc	NCP						1.072	1.079
		Model	1.0009	0.9456	1.0313	1.0814	1.0626	1.0893	1.0972
Index of domestic aggregate demand, constant prices (previous year=1)	IDADc	Model	1.0007	0.9939	1.0269	1.0375	1.0543	1.0658	1.0567
Export of goods and services, bill. EURO	XGSE	Model	49.776	57.308	61.917	65.742	68.52	71.44	75.36
Import of goods and services, bill. EURO	MGSE	Model	56.567	58.422	62.584	66.744	70.6	76.43	81.79
Ratio of net exports to GDP, estimated in RON	rnx	Model	-0.0497	-0.0078	-0.0044	-0.0053	-0.0113	-0.0267	-0.0320
Consumer price index (previous year=1)	CPI	NCP						1.014	1.025
		Model	1.0333	1.0398	1.0107	0.9941	0.984	1.0071	1.0292
Gross domestic product deflator (previous year=1)	PGDP	NCP						1.022	1.021
		Model	1.0469	1.0342	1.0172	1.0292	1.0154	1.010	1.0279
Exchange rate RON/EURO	ERE	NCP						4.46	4.44
		Model	4.456	4.419	4.4446	4.445	4.49	4.5646	4.5183
Employment, mill. persons	E	NCP						8.58	8.67
		Model	8.6051	8.5491	8.6137	8.5354	8.48	8.5285	8.5199
Unemployment rate	ru	NCP						0.059	0.058
		Model	0.068	0.071	0.068	0.068	0.065	0.066	0.0648
Ratio of general consolidated balance to GDP	cbb	NCP							
		Model	-0.0248	-0.0248	-0.017	-0.0145	-0.027	-0.0296	-0.0372

NCP - National Commission for Prognosis.

Our macromodel simulations are in line with other prognoses which reveal the ascending trend of the Romanian economy, preponderantly based on the compression of the negative output-gap caused by the last global crisis, which was followed by a relatively weak recovery.

From a long-run perspective, this is just the main problem. Since it is not based on potential output expansion, the actual economic growth remains uncertain and highly vulnerable to any unbalancing shock.

5. The approach of the public budget deficit during 2017 to the critical ceiling of 3% of GDP and the potential of further increases in the next year poses also a short-run threat.

5.1. Regarding 2017, it is futile to hope that it would be possible to improve the performance of the real economy “on the run”, taking into account the well-known sluggishness of its determinants. The presented scenario already incorporated rather optimistic parameters in this field.

Our simulations show that supplementary enforcing of the demand-side stimulus would translate first of all into a deterioration of the RON exchange rate.

5.2. An increase in the public budget revenues over the above presented estimations is unlikely. The social environment is highly adverse to any worsening of the fiscal burden. Such an option is firmly rejected not only by employers’ associations and trade unions, but also by many civic organizations and media, even by political parties. The acute need to encourage foreign investments also excludes for this moment a strengthening of taxation.

Therefore, considering a very probable stability of the recent adopted Fiscal Code, the general consolidated budget revenues could grow mainly through a significant improvement in the domestic resources collection. We must stress, however, that public income coefficient (ratio of all budget revenues to GDP) was a very volatile series in Romania. Thus, the coefficient of variation (standard deviation to mean) was 7.69% in the 1990-2016 period. This shows very contradictory socio-economic factors which influence taxation level and taxpayer behaviour. Or, the macromodel simulations assumed already an increase in cbr against the 2016 value with 1.5-1.6 percentage points in 2017 and 2018.

5.3. Consequently, an easy way to maintain the public deficit under control is the very careful management of budget expenditures. The following groups are of special interest in this regard, accounting for approximately 91% of all positions included in our simulations.

- The labour cost represents almost one quarter of the total public expenditures.
- Pensions, social allocations (including for unemployment) and other transfers cover together over 36% of the total budget expenditures.
- The share of the general consolidated budget for purchasing goods and services and other temporary expenditures is around 16%.
- Capital expenditures, including co-financing EU projects, slightly exceeds 14%.

We have not discussed extensively this subject, since the public debates and professional studies have already revealed many interesting suggestions for a better utilization of the general consolidated budget resources.

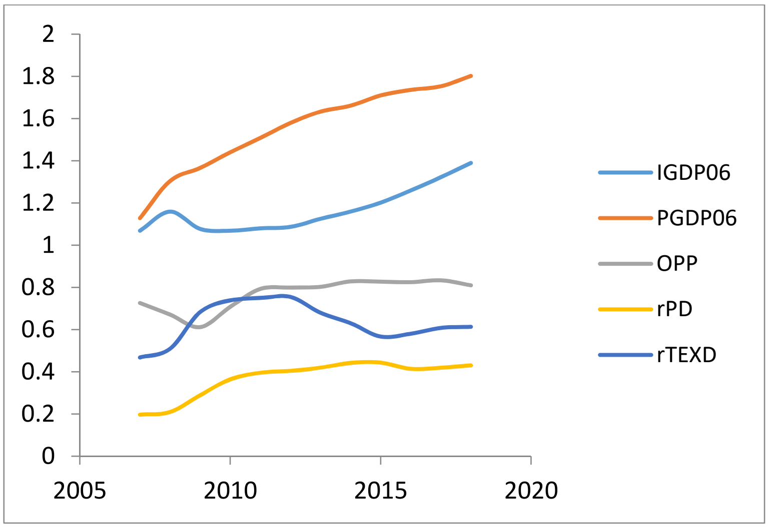
6. The transitional period can be segmented in the Romanian case into three phases (Dobrescu and Gaftea, 2017):

a) the 1990-1999 decade, marked by the destruction – along with the centrally planned mechanism - of the main industries, the transportation networks, the large agricultural exploitations, the educational system;

b) the EU pre-accession period, 2000-2006, characterized by the ending of the chaotic institutional changes and the implementation of complex reforms negotiated with the European Commission;

c) the period after 2007, when Romania became a full EU member. This decade can be divided into two sub-intervals – first one dominated by the ante and post-crisis context and the other associated with recovery and incipient economic recovery after 2012. Graph EUInt sketches synthetically this third development stage of the Romanian economy.

Graph EUInt - Evolution of the Romanian Economy as a Full EU Member



Overall, the highest pre-crisis level of the real output (2008) was already reached in 2014, after which the economic growth continued. The entire period was characterised by a yearly average growth rate of 2.78%, one of the best in the European Union. The inflation was maintained within reasonable limits.

The relatively severe compression of the openness degree of the economy was recovered with noticeable overtaking. More important, this trend was associated with an improvement in the net export balance, which restrained the increasing trend in external debt. The public debt is still within acceptable limits.

However, the position of Romania remains modest from a general development point of view, the economic convergence in real terms with the EU standard remaining an essential objective to be reached.

IV. Some Applicative Cautions and Further Research

1. The methodology of parameter instability analysis has to be expanded in several directions.

- The solution regarding the model specification as a source of parameter instability should be considered only as an exploratory attempt. It would be preferable to define this factor independently of the revision data effect. Therefore, the coefficient of determination might be taken into account, since the unexplained part in the model errors could be linked with possible subsequent modifications in the initially determined estimators.
- Our examination - for a very dynamic socio-economic environment and a medium-size country - is certainly useful. It is, however, far from being relevant enough. More investigations, either as number of case studies or period length, would be, of course, necessary.
- From a technical point of view, it is necessary to compare results obtained by different computational algorithms (we limited the analysis to OLS and 2SLS), and extend the analysis by using several sets of instruments.

2. A consistent systematization of possible “palliatives” for model parameter instability is another interesting theme. We have already presented some recommendations for re-specification or/and re-estimation procedures, the involvement of latent anchoring variables or of exogenous corrective coefficients remains an open question. Definitely, these solutions make the modelling work more flexible and maybe realistic. On the other hand, they “facilitate” discretionary subjective interventions, implicitly manipulation temptations.

The answer to the question how to navigate correctly between these Scylla and Charybdis is not yet very clear, but the problem is of greater and greater interest because of the increasing complexity of modeled economic phenomena.

3. Our 2017-2018 simulations show that the last version of the Romanian macromodel needs a significant updating. Such a new variant has to be based on simplified specification, avoiding too high volatile indicators in level or differences as much as possible.

The experience acquired in managing the 2012 version shows also the necessity of some improvements in the input-output block. The most important would be the extension of the sectoral structure in order to better cover the actual configuration of the economy, more and more marked by “tertiarization”. Normally, the I-O coefficients have to be recalculated in order to solve the present puzzle of nodal inter-flow connections.

4. Stabilization of the taxation system – a problem of special importance on medium horizon - would need intensive research concerning rational financing of the public services, tax-payer behaviors, budget multipliers, efficient management of the public debt. In-depth approach to these issues would facilitate the building of the general consolidated block, which has the leading function in the Romanian macromodel.

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