ESTIMATING THE TOTAL FACTOR PRODUCTIVITY IN ROMANIAN ECONOMY

Emilian Dobrescu
Macroeconomic Modelling Centre - Romanian Academy
E-mail: emiliand@clicknet.ro

Abstract

The paper discusses several problems of estimating the total factor productivity included in the aggregate production function used in the Romanian macroeconomic model. The author suggests an improvement of the formula adopted in the version 2005 of this macro-model.

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Estimating the Total Factor Productivity in Romanian Economy

1. The last operational version of the Romanian macro-model (Dobrescu 2006) included a specific form of Cobb-Douglas production function. It tried to combine the classical conceptual framework with the recent modelling approaches [Aghion and Howitt; Allen; Apel and Jansson; Baxter and King; Burnside, Eichenbaum, and Rebelo; Cechetti; Claus (2000a, b); Denis, Mc Morrow and Rõger; Elmeskov; European Commission 1995; Forni and Reichlin; Froyen; Gerlach and Smets; Gordon; Hodrick and Prescott; Hulten; Kuttner; Nordhaus; OECD 2000; Scott; Solow; Turner, Richardson, and Rauffet; Pindyck and Rubinfeld; Proietti, Mussoy, and Westermanny]. Indeed, some peculiarities of the Romanian economy were also incorporated.

1.1. The starting point of this attempt was a common formula with capital and labour, expressed in yearly indices:

IGDPc=IE^alpha*ICKc^(1-alpha)*ITFP (1)

where:

IGDPc – index of gross domestic product at constant prices;

IE – index of employment;

alpha – elasticity of output with respect to labour, approximated by the extended share of labour income in gross value added;

ICKc - index of tangible fixed assets at constant prices; and

ITFP – index of the total factor productivity.

• There are reliable statistical data concerning IGDPc and IE.

• For alpha and ICKc such information are not yet available. They were replaced by author's indirect estimations.

• The total factor productivity, as an index, has been deduced from the relationship:

ITFP=IGDPc/(IE^alpha*ICKc^(1-alpha)) (2)

1.2. Two categories of determinants are involved in the econometric determination of the total factor productivity: on one hand, the level of alpha itself and, on the other, some variables which essentially influence the dynamics and utilisation of the productive capacities.

1.2.1. Regarding alpha, it seems realistic to assume that:

- if actual alpha is less than its long-run (equilibrium) level, the labour force is not stimulated to reach the highest potential output;
- if alpha exceeds such an optimal point, the firms are obliged to restrain their activity, which also has negative repercussions on the total factor productivity.

Starting from these considerations, the econometric relationship of the index of total factor productivity (ITFP) was built according to the following restrictions:

- if alpha=0 or =1 (that is when the production would be nonsensical for labour force or, respectively, for capital), ITFP tends to zero;
- ITFP depends non-linearly on alpha, admitting a maximum when alpha reaches its long-run (equilibrium) level.

The simplest functional form has been adopted:

ITFP=(alpha-alpha^a)*RV (3)

(+/-) (+)

where RV captures the effect of other variables. The influence of the expression (alpha-alpha^a) depends on the position of actual alpha comparatively to its long-run (equilibrium) level.

The first mentioned assumption (when alpha=0 or =1, ITFP=0) is automatically observed. The second one is also satisfied for a>1. The long-run (equilibrium) level of alpha was noted alphao. It has been estimated separately, using a specific procedure (alphao=0.653821). On this basis, the parameter a has been determined from

∂ITFP/∂alpha=0 (4)

and respectively:

(1/a)^(1/(a-1))=alphao (5)

1.2.2. Concerning RV, the last version of the Romanian macro-model has retained the following factors:

- investment intensity, approximated by the index of gross fixed capital formation at constant prices, computed as a moving geometrical average of two successive terms (AIGFCFc);
- domestic demand pressure (DDP), as a ratio of the domestic absorption index to gross domestic product index;
- unemployment rate; this is represented by its moving arithmetic average of two successive years (maru).

The first factor influences the dynamics of tangible fixed assets; the second has an important impact on the utilisation degree of productive capacities, and the third variable acts on labour-intensity of employed workers.

The effect of transitional reforms was captured by the time (t); a constant has also been included in order to reflect the trend.

1.3. Finally, the expression (6) has been regressed.

ITFP=(alpha-alpha^a)*(c(1)+c(2)*rAIGFCFc+c(3)*rDDP(-1)+c(4)*maru(-1)+c(5)/t) (6)

where rAIGFCFc=AIGFCFc-1 and rDDP=DDP-1.

The following coefficients have resulted (using the statistical series for 1990-2004 years):

a=4.582357

c(1)=1.975529

c(2)=0.393543

c(3)=0.533134

c(4)=1.240195

c(5)=-0.529765

The sign of c(5) attests the increasing positive influence of institutional changes on the global efficiency of the Romanian economy.

2. In case of data covering the whole 1990-2008 time frame, the specification (6) generates parameters with low statistical significance. Consequently, the present paper proposes several changes in this equation.

2.1. In order to aproximate alphao, a VAR for alpha series has been applied:

alpha=0.301332+0.541104*alpha(-1) (7)

from which yields alphao=0.301332/(1-0.541104)=0.656645. A similar level would be obtained using the previous methodology, based on econometric estimates of the first order differences of alpha. In the new determination of alphao, the coefficient a changes slightly: a=4.657958. This will be included in the updated regression.

2.2. Regarding other variables, it seems more suitable to involve not only the gross fixed capital formation, but the whole volume of the tangible fixed assets. On the other hand, the degree of utilization of productive capacities depends greatly on exports, which are absent in the relationship (6). Consequently, the total demand pressure in real terms (TDPc) will be introduced:

TDPc=[(DAD+X)/(PGDP*(DAD(-1)+X(-1))]/ICKc (8)

where

DAD – domestic absorption at current prices;

X – exports in national currency at current prices; and

PGDP – gross domestic product deflator.

We prompt that the index of tangible fixed assets at constant prices (ICKc) is computed as follows:

ICKc=(CK(-1)*(1-dfa)+GFCFc)/CK(-1)=1-dfa+GFCFc/CK(-1) (9)

where:

CK(-1) – tangible fixed assets of previous year in prices of the same year;

dfa – depreciation rate of the tangible fixed assets;

GFCFc – gross fixed capital formation at previous year prices (its value in current prices is deflated by the corresponding price index - PK).

Normally, TDPc substitutes rAIGFCFc and rDDP used in (6).

2.3. As it is known, the weight of the sectors providing natural raw materials remains significant. Their output depends on climatic conditions. Such a circumstance cannot be neglected. A possible way to take it into account is to include, among explicative factors of ITFP, the variation registered by the index of gross value added (at constant prices) produced in agriculture, forestry, fishing, and hunting (AG1-AG1(-1)).

2.4. We can also admit that t - as a separate independent variable (reflecting the influence of transitional changes) - has ceased to be representative. However, it will be attached – as an amortizing factor - to (AG1-AG1(-1)). The economic development attenuates step by step the impact of climatic oscillations on global output.

2.5. Therefore, the ITFP function could be defined as follows:

ITFP=(alpha-alpha^4.657958)*(c(6)+c(7)*TDPc+c(8)*maru+c(9)*(AG1-AG1(-1))/t) (10)

This new specification has been regressed using statistical series for 1990-2008 years (Appendix). The obtained results are presented in Table no. 1

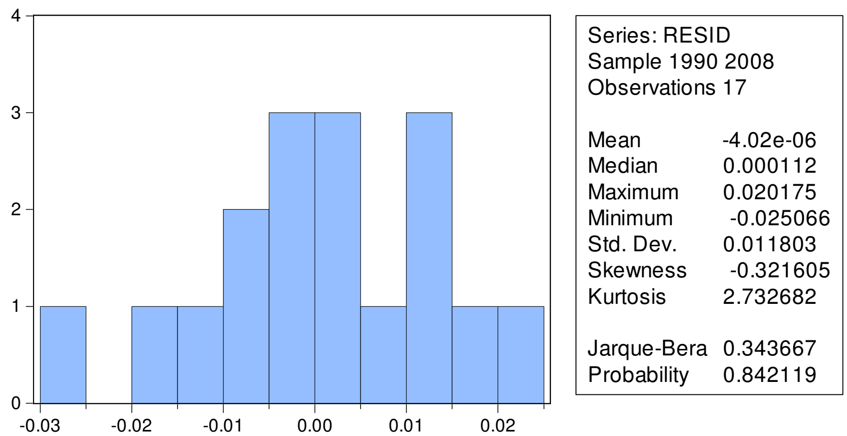
Table no. 1

Dependent Variable: ITFP		
Method: Least Squares		
Sample (adjusted): 1992 2008		

ITFP=(alpha-alpha^4.657958)*(c(6)+c(7)*TDPc+c(8)*maru+c(9)*(AG1-AG1(-1))/t)				
	Coefficient	Std. Error	t-Statistic	Prob.
c(6)	1.030516	0.085412	12.06522	0
c(7)	0.617856	0.081938	7.54052	0
c(8)	5.130551	0.606539	8.458727	0
c(9)	2.373125	0.319154	7.435671	0
R-squared				0.94755
Adjusted R-squared				0.93545

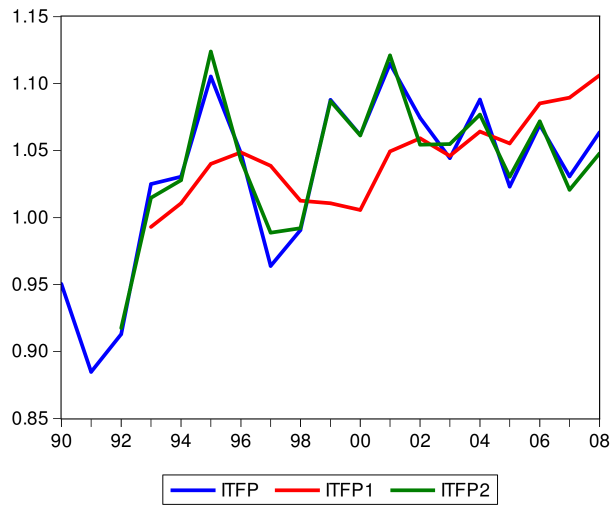
All the retained factors, including the variation of agriculture output, are significant. The Jarque-Bera statistics of residuals shows as follows:

Table no. 2



3. In order to establish if the expression (10) is suitable or not, two simulations will be processed.

3.1. One of them confronts the estimations for ITFP1 (specification and parameters for (6)) with those for ITFP2 (specification and parameters for (10)). The updated series 1990-2008 are used in both cases. The results are compared with the corresponding statistical data (ITFP) in the following Graph:



Graph ITFP

It is clear that ITFP2 reflects better the actual series. The correlation coefficient ITFP2-ITFP is 0.954113, while the correlation coefficient ITFP1-ITFP represents only 0.216619.

3.2. The second simulation compares the behaviour of ITFP in both formulas, depending on variation of alpha. This exercise is based on data for 2007, namely:

rAIGFCFc=0.251787

rDDP(-1)=0.009420

maru(-1)=0.072244

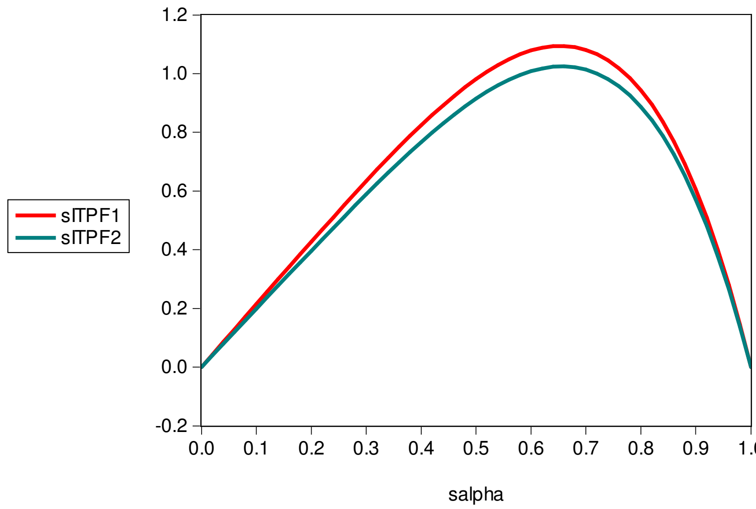
t=19

TDPc=1.016068

maru=0.068837

AG1-AG1(-1)=-0.199

Only alpha is changing (from 0 to 1). The results are noted with prefix s. They are presented in Graph salpha.



Graph salpha

The estimations obtained using formula (10) seem to be more realistic, in the sense that they are comparable with the similar coefficients used in the macro-models of other UE countries (normally, for closed alpha).

Our experiment confirms again the need to re-examine periodically the specification of a model especially under frequently changing statistical series.

Appendix

Statistical Series

Year	ITFP	alpha	AIGFCF	DDP	maru	TDPc	AG1
1990	0.950555	0.721966	-	1.131312	NA	1.075781	1.366347
1991	0.884687	0.68395	0.665499	0.953015	NA	0.874546	0.875098
1992	0.912989	0.574054	0.871786	1.043864	0.033317	1.049447	0.858203
1993	1.024945	0.60137	1.090631	0.967632	0.058166	0.868805	1.137795
1994	1.030434	0.608583	1.1421	0.972695	0.07759	1.021459	1.030115
1995	1.105212	0.646958	1.136446	1.034519	0.081767	1.171229	1.050228
1996	1.04819	0.639608	1.062692	1.026819	0.072574	1.050883	0.961066
1997	0.963765	0.634923	1.036982	0.987439	0.061303	0.918839	0.997348
1998	0.9907	0.668191	0.977913	1.009007	0.059696	0.9955	0.886009

Year	ITFP	alpha	AIGFCF	DDP	maru	TDPc	AG1
1999	1.087856	0.680407	0.945929	0.970421	0.065213	1.16205	1.031173
2000	1.061419	0.704771	1.002052	1.007609	0.070778	1.188215	0.819548
2001	1.114863	0.67385	1.077838	1.020071	0.070969	1.13345	1.273484
2002	1.074492	0.656387	1.091039	0.980694	0.076336	1.099262	0.938407
2003	1.044469	0.684953	1.084034	1.017407	0.07638	0.994834	1.050558
2004	1.088066	0.671309	1.098922	0.985458	0.075745	1.050741	1.201029
2005	1.023196	0.686882	1.118745	1.041238	0.076261	1.03433	0.826344
2006	1.069076	0.667355	1.159518	1.00942	0.072244	1.053753	1.034
2007	1.030701	0.682341	1.251787	1.029859	0.068837	1.016068	0.835
2008	1.063896	0.65303	1.288952	0.983507	0.061227	1.040494	1.214

Source: National Institute of Statistics, National Commission for Prognosis, author's estimations

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