Estimating contribution of factors to long-term growth in Romania

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Abstract

The paper analyses the dynamics and structure of GDP in Romania during the transition period. Starting from the classical Cobb-Douglas production model, the paper investigates different scenarios for the Romanian economy on the basis of different assumptions regarding the model's parameters. The adapted model also tries to cover the implications of some peculiarities of the Romanian transition economy, such as a large agricultural sector.

Keywords: Cobb-Douglas production function, total factor productivity, long-term economic growth, macroeconomic forecasting

JEL classification: C53, C63, E23, O41

ESTIMATING CONTRIBUTION OF FACTORS TO LONG-TERM GROWTH IN ROMANIA*

LUCIAN-LIVIU ALBU

1. THE BASIC MODEL AND AVAILABLE STATISTIC DATA

The technological constraint facing producers is described by a Cobb-Douglas production function:

$$Y = A\, L^{\alpha}\, K^{1-\alpha} \qquad (1)$$

In accordance with the approach initiated by Solow, the scale parameter "A" measures total factor productivity and incorporates Hicks-neutral technical change. Demands for production factors (labour, L, and capital, K) are derived in the lines of the so-called marginal productivity rules.

In order to estimate parameters, A and α, by the standard OLS method (applied on logs of variables), firstly we obtained their analytic solution. Also we estimated the annual change in the capital stock by using the following equation:

$$K_t - K_{t-1} = I_{t-1} - \delta K_{t-1} \qquad (2)$$

or equivalently as its annual growth rate:

$$(K_t - K_{t-1}) / K_{t-1} = [(I_{t-1} / Y_{t-1}) / (K_{t-1} / Y_{t-1})] - \delta \qquad (3)$$

where I denotes gross investment, K the capital stock, Y the gross domestic product and δ the depreciation rate.

Also, we could express the backward capital-output ratio, cK, as follows:

$$cK_{t-1} = a_{t-1} / (rK_{t/t-1} + \delta) \qquad (4)$$

where a is the rate of investment and $rK_{t/t-1}$ is defined as in relation (3).

Using as starting point the hypothesis of a capital-output ratio of 1.3 in 1992 (see IMF Country Report, January 2003, p. 20) we tried a number of simulations.

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In order to simplify the model to be used for forecasts, we added a supplementary assumption: the capital stock in Romania increased by about 10% over the 1992-2001 period (IMF Country Report, January 2003, p. 15). In this case we issued to obtain an estimator for the annual rate of capital depreciation (δ=1-μ) by solving (numerically) the following equation:

$$K092 \cdot \mu^9 + I92 \cdot \mu^8 + I93 \cdot \mu^7 + I94 \cdot \mu^6 + I95 \cdot \mu^5 + I96 \cdot \mu^4 + I97 \cdot \mu^3 + I98 \cdot \mu^2 + I99 \cdot \mu + I00 = K092 \cdot 1.1$$

μSol = 0.8947328426 ~ 0.895, and δ = 0.105. K092 is the stock of capital at the beginning of 1992 and I92…I00 are investments in each year of the1992-2000 period.

2. CASE A (α UNKNOWN)

Certain reported results of simulation, in case of estimating simultaneously parameters A and α are presented in Figs. 1,2 and 3-6 (3-D representation), and in Table 1 (where rY is the annual GDP growth rate and rYe the estimated trend of annual growth rate; rYL, rYK, and rV are the contributions of factors to rY, respectively labor, L, capital, K, and total factor productivity, V; cK is the capital-output ratio and wL is productivity of labor, Y/L).

Table 1

Contributions of factors to the annual growth of the GDP (rY), in % (case A)

t	rY_t	rYL_t	rYK_t	rYV_t
1991	- 12.9	- 0.3	1.6	- 14.0
1992	- 8.9	- 1.9	- 0.3	- 6.8
1993	1.5	- 2.4	0.1	3.8
1994	4.0	- 0.3	0.5	3.9
1995	7.2	1.4	1.3	4.4
1996	4.0	- 1.2	1.5	3.7
1997	- 6.1	0.6	1.6	- 8.1
1998	- 4.7	- 1.1	1.4	- 5.0
1999	- 1.2	- 0.4	0.9	- 1.7
2000	2.2	- 0.1	0.6	1.7
2001	5.7	- 0.3	0.8	5.3
2002	4.9	- 8.8	1.1	13.7

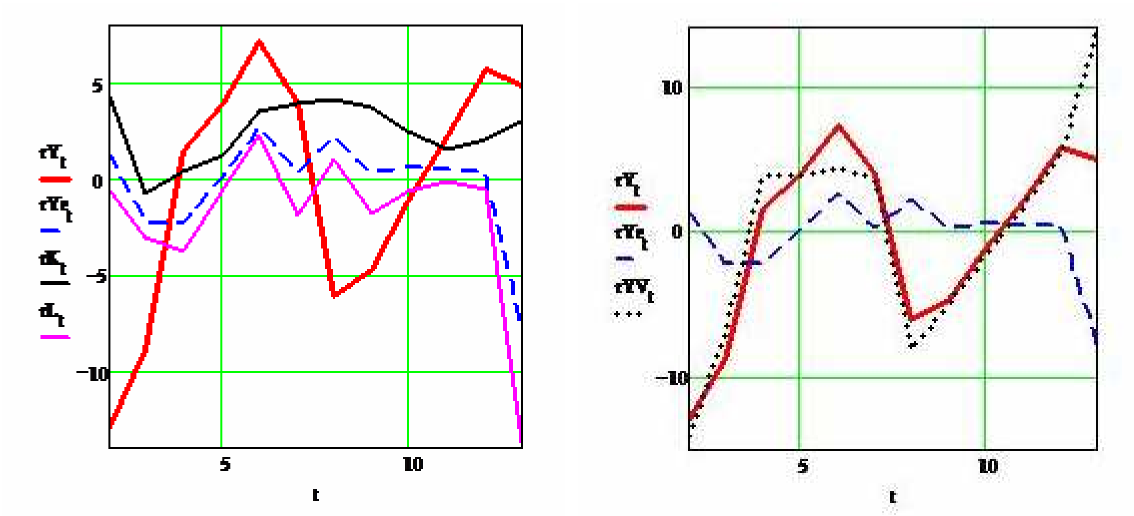


Fig. 1

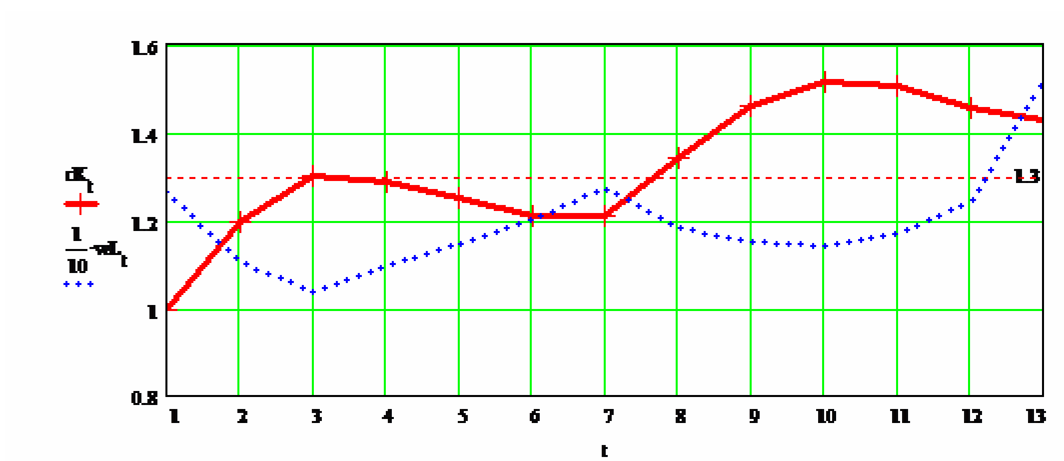


Fig. 2

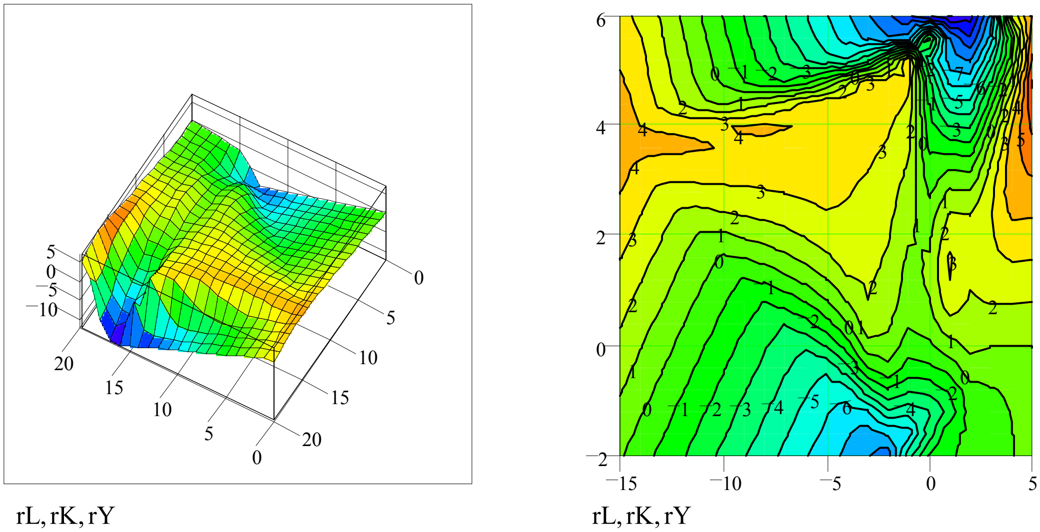


Fig. 3

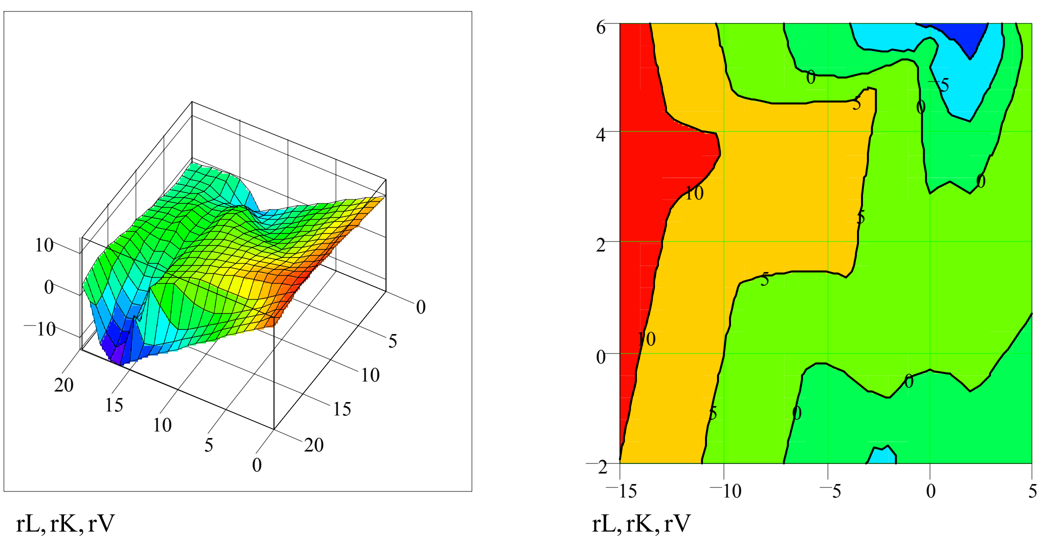


Fig. 4

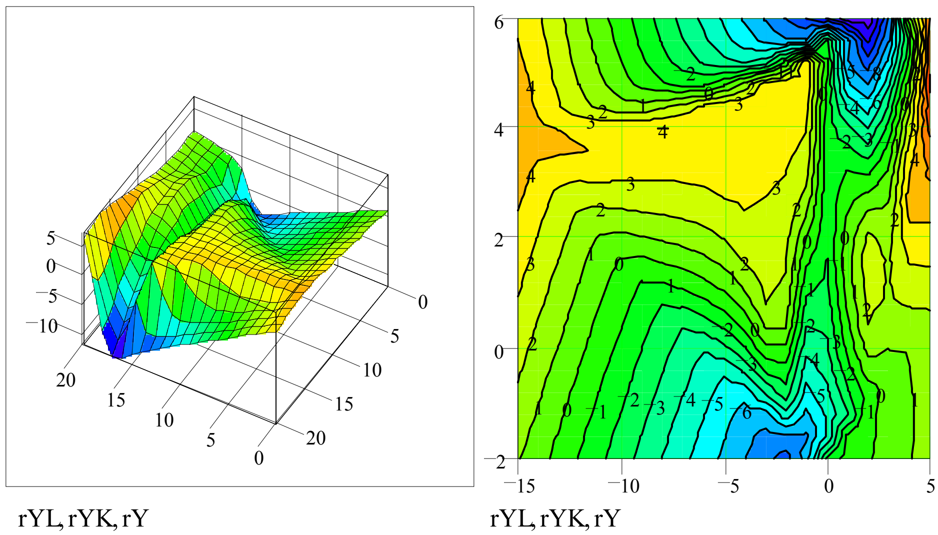


Fig. 5

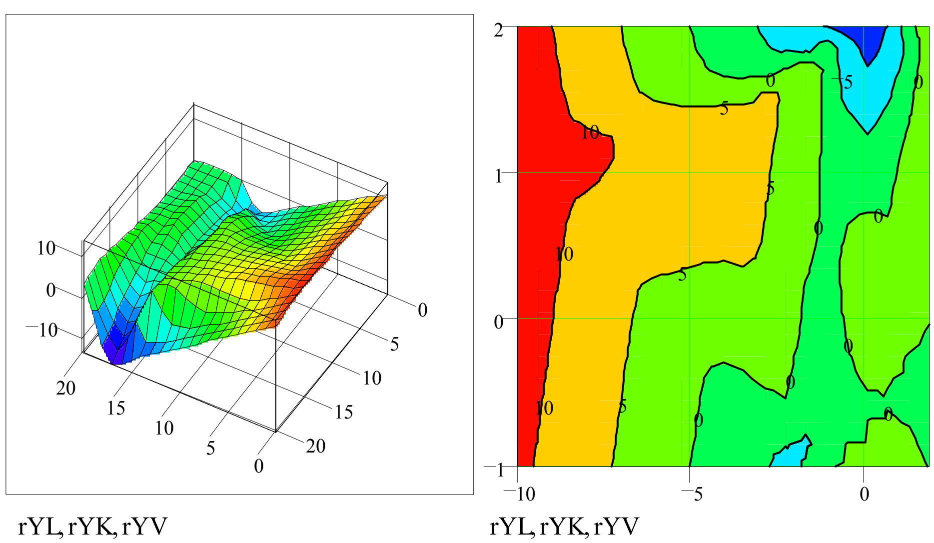


Fig. 6

At the level of the period 1992-2002, the estimated contribution of factors to the growth rate of GDP is as follows:

- rY92_02 = +17.8% (rYm92_02/year = +1.7%)
- rYL92_02 = -12.3% (rYLm92_02 = -1.3%)
- rYK92_02 = +10.2% (rYKm92_02 = +1.0%)
- rV92_02 = +21.9% (rYVm92_02 = +2.0%)

3. CASE B (α GIVEN)

In the case of computing parameter α on the base of "compensation of employees" (as they are reported in National Accounts), the results are different from case A.

Certain reported results of simulation, in case of computing parameter A̩ for each year of the period, are presented in Figs. 7 and 8 (3-D representation), and in Table 2 (where rY is the annual GDP growth rate, and rYL, rYK, and rTFP – the contribution of factors to it, respectively labour, L, capital, K, and total factor productivity, TFP).

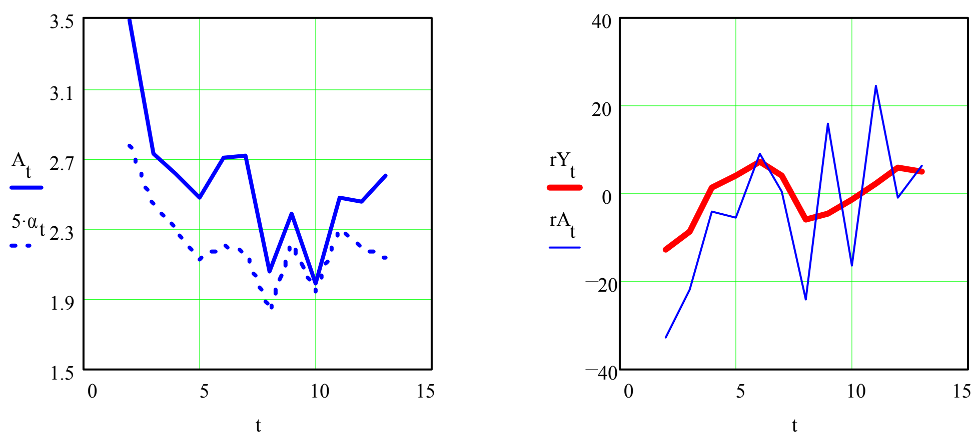
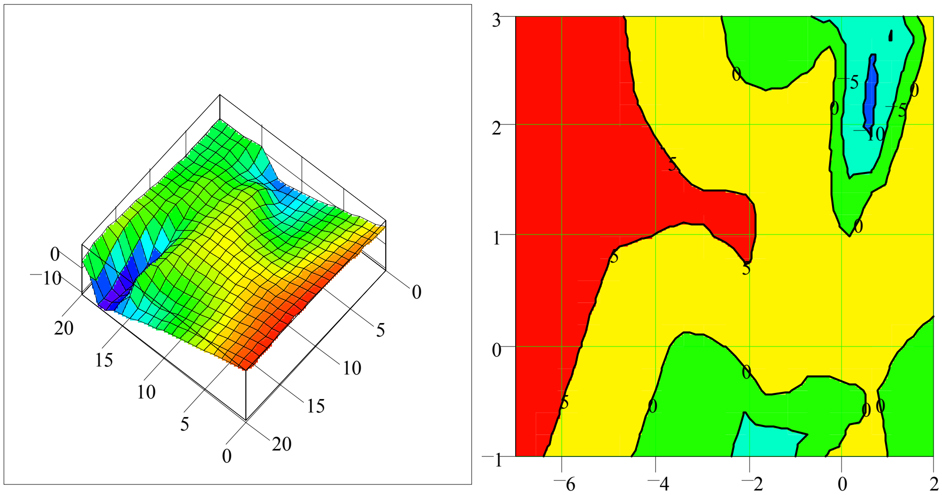


Fig. 7



rYL, rYK, rYTFP   rYL, rYK, rYTFP

Fig. 8

Table 2

Contributions of factors to the annual growth of the GDP (rY), in % (case B)

t	rY_t	rYL_t	rYK_t	$rYTFP_t$
1991	-12.9	-0.3	1.5	-14.1
1992	-8.9	-1.7	-0.3	-6.8
1993	1.5	-1.9	0.2	3.2
1994	4.0	-0.3	0.7	3.6
1995	7.2	0.9	2.0	4.3
1996	4.0	-0.8	2.2	2.6
1997	-6.1	0.4	2.3	-8.9
1998	-4.7	-0.7	2.4	-6.5
1999	-1.2	-0.3	1.4	-2.3
2000	2.2	-0.1	1.0	1.3
2001	5.7	-0.3	1.1	4.9
2002	4.9	-6.3	1.6	9.5

At the level of the period 1992-2002, the estimated contribution of factors to the growth rate of GDP is as follows:

- rY92_02 = +17.8% (rYm92_02/year = +1.7%)
- rYL92_02 = -9.8% (rYLm92_02 = -1.0%)
- rYK92_02 = +14.1% (rYKm92_02 = +1.3%)
- rV92_02 = +13.5% (rYVm92_02 = +1.4%)

4. CASE C (PARAMETERS α, b, c, d UNKNOWN AND α=b+c)

The standard view in neoclassical growth models regards technical progress as completely exogenous, i.e. it does not depend on the past investment activities of firms, households or governments. However, there are many studies trying to include endogenous growth hypotheses in order to explain total factor productivity from investment activities. Usually they try to distinguish among certain alternatives such as vintage models, R&D models, and human capital models. Consequently, trend growth of total factor productivity would be determined either by the age of the capital stock (with average labor productivity being raised by new investment since the latter incorporates labor-embodied technical progress), the stock of R&D capital or the stock of human capital. While such sophisticated approaches are not considered in this study, however we try at least to partially make endogenous the TFP growth. In this sense, given the fact that the Romanian economy in transition period has a relatively large agricultural sector, the present analysis tries to capture the growth effects related to sectoral adjustments.

As a first step, we reformulated the production function by supposing that the total quantity of labor is divided in two sectors: agricultural sector (LA) and non-agricultural or industrial sector (LI). The level of technical knowledge is expressed by TFP:

$$Y = K^{d}\ LI^{b}\ LA^{c}\ TFP \qquad (5)$$

where LI = SI L, LA = SA L.

The production function can be rewritten in terms of aggregate labor as follows:

$$Y = K^{d}\ L^{b+c}\ TFP0 \qquad (6)$$

with $TFP0 = SI^{b}\ SA^{c}\ TFP$ (TFP0 denotes “observed TFP”).

From equation (5), a relationship can be established between the percentage change of TFP at the aggregate level and changes in the sectoral employment share. The production technology, in this case, captures two effects from the sectoral reallocation of employment. Firstly, the productivity increases from lowering the share of low productivity production and secondly, an increase in the marginal product of employment in the low productivity sector. The elasticity of aggregate TFP with respect to a change in the agricultural employment share is given by the following equation:

$$(\Delta TFP0 / TFP0) / (\Delta SA) = (c / SA) - [b / (1 - SA)] \qquad (7)$$

In order to evaluate the impact of sectoral change on observed TFP, it is necessary to estimate b, c and d. A solution is to assume that agricultural and industrial (or non-agricultural) employment gets paid according to their marginal product. In this case the values for b, c and d could be chosen from sectoral wage shares. Other solution is to estimate econometrically their value based on available statistical data. Taking into account that we computed already the stock of fixed capital in each year of the transition period (in case of the above adopted hypothesis of δ = 10.5% per year), it is possible to estimate the value for parameters b, c, and d on a pure time series basis.

In order to obtain analytical expression for parameters, we used the standard OLS method (applied on logs of variables). Because formulas are too large, we present only the computed values estimated on base of the 1990-2002 data: tfp = 1.331, with tfp = log(TFP), b = 0.300, c = -0.287, and d = 0.319. Also some results of simulation, in case of this model for the transition period, are presented in Figs. 9-11 (where Ye is the estimated trend of annual GDP).

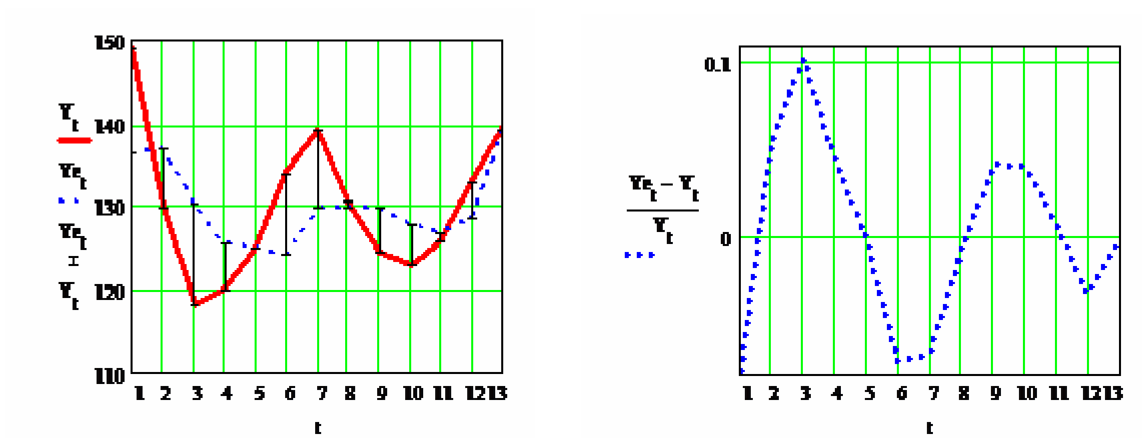


Fig. 9

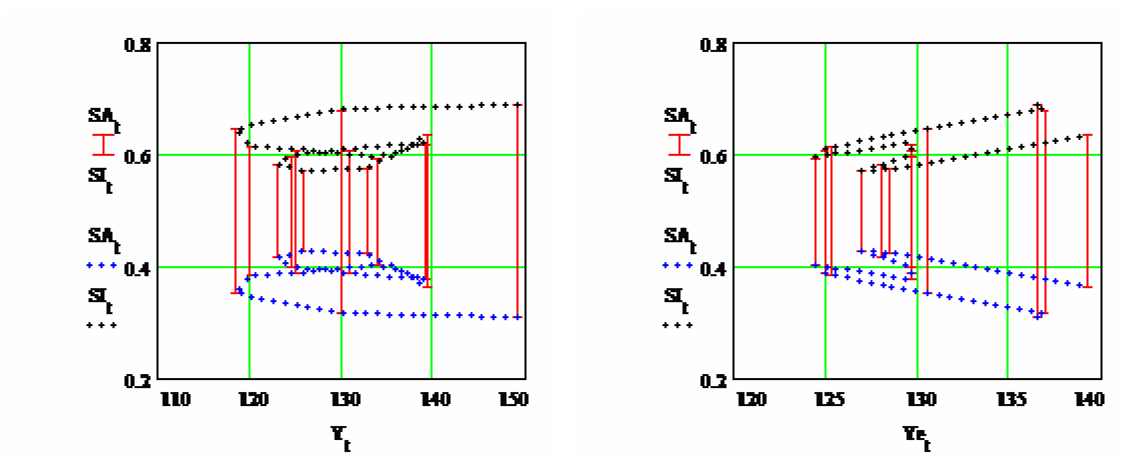


Fig. 10

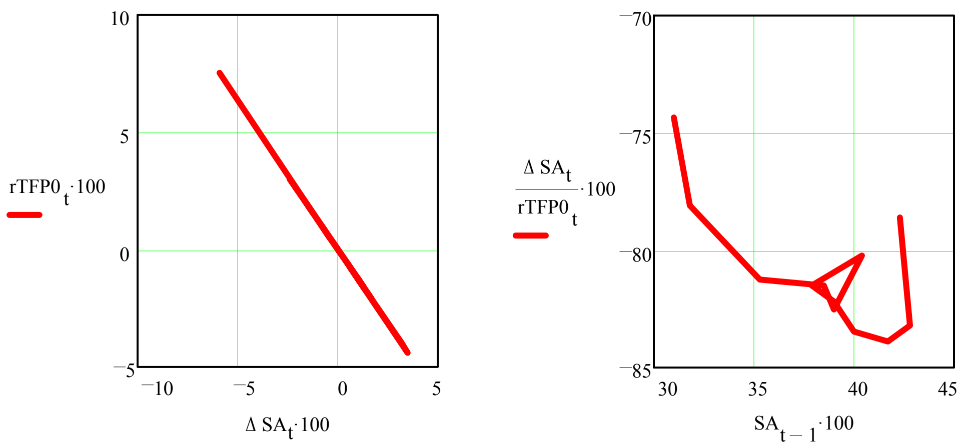


Fig. 11

On the basis of these values, the model would predict that given a large share of agricultural employment in total employment, as currently observed for Romania, a 1 per cent point reduction in the agricultural labor share would increase the level of observed TFP by 0.792 per cent, conforming to the average level registered in the 1990-2002 period. The TFP effect becomes smaller as the agricultural share declines. In Table 3 the detailed data for each year of mentioned period are presented.

Table 3

Contribution of ΔSA to the increase of the observed TFP (case C)

t	$TFP0_{t-1}$	SA_{t-1}	$rTFP0_t$	ΔSA_t	$\frac{\Delta SA_t}{rTFP0_t}$
1991	26.8	0.31	-0.01	0.008	-0.743
1992	26.6	0.318	-0.044	0.035	-0.781
1993	25.4	0.353	-0.039	0.032	-0.813
1994	24.4	0.385	-0.007	0.006	-0.815
1995	24.2	0.39	-0.016	0.013	-0.825
1996	23.8	0.404	0.03	-0.024	-0.803
1997	24.5	0.379	-0.013	0.011	-0.815
1998	24.2	0.39	-0.012	0.01	-0.822
1999	23.9	0.4	-0.021	0.017	-0.835
2000	23.4	0.417	-0.013	0.011	-0.839
2001	23.1	0.428	0.006	-0.005	-0.833
2002	23.3	0.423	0.075	-0.059	-0.786

There remains an exogenous TFP component. In principle, this component can be influenced by integration, trade, FDI, etc. In this case, assumptions must be made concerning the TFP effects and this paper draws on the literature to obtain estimates. For example, a recent paper by Frankel and Romer (1999) estimates the effect of increasing the trade share in GDP on income levels to be of the order of 0.5 per cent. This translates into very small growth effects (Conforming to our estimates, in Romania, the coefficient of exports, in USD at market prices, within the regression equation of GDP, in USD at PPP constant prices 2000, was around 0.29 for the 1990-2002 period). For example, Breuss (1999) estimates the effect of abolishing trade costs to be 0.08 per cent per year for the CEEC-10. Any effects of increased competition due to membership (bankruptcy of less productive firms) would also show up in TFP.

SELECTED BIBLIOGRAPHY

Albu, L.-L. and Roudoi, A. (2003), *Scenarios of economic development in Romania - medium to ong-term forecasting models*. International Workshop on "Mechanisms of long-term growth in the economies in transition (Cases of Russia and Romania)", Think Tank Partnership Project, Bucharest, October 27-28.

Balasubramanyam, V. N., Salisu, M. and Sapsford, D. (1996), *Foreign Direct Investment and Growth in EP and IS Countries*. The Economic Journal. Vol. 106, No. 434, January, 92-105.

Barro, R. J. (1991): *Economic Growth in a Cross Section of Countries*. Journal of Economics. Vol. CVI, May, Issue 2, 407-443.

Dobrescu, E. (2000), *Macro-models of the Romanian Transition Economy*, third edition, Expert Publishing House.

Fischer, S. (1993): *The Role of Macroeconomic Factors in Growth*. Journal of Monetary Economics, Vol. 32, 485-512.

Maniu, M., Kallai, E., and Popa, D. (2001), *Explaining Growth - Country Report: Romania (1990-2000)*, Global Research Project, Second Draft, December 13-14, Rio de Janeiro.

Mates, N., Westphal, A., Gueorguiev, N., Carnot, N., Harjes, T. and Lall, S. (2002), *Romania – Selected Issues and Statistical Appendix*, IMF Country Report No. 03/12.

Rangelova, R. (2002), *Economic assessment and catching-up the EU standards: the case of CEECs*, The 7th EACES Conference "Globalisation and Economic Governance", 6-8 June, Forli (Bologna, Italy).

Solow, R. M. (2000), *Toward a Macroeconomics of the Medium Run*. Journal of Economic Perspectives. Vol. 14, No. 1, Winter, 151-158.

Tarhoaca, C. and Croitoru, L. (2003), *The Romanian growth potential – a CGE analysis*. Paper prepared for the *Regional Partnership Project Conference*, St. Petersburg, Russia, June 7-9.

*** *The economic impact of enlargement*, Directorate General for Economic and Financial Affairs, European Communities, 2001.