1 MODELLING THE ROMANIAN ECONOMY: SOME DATA PROBLEMS

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Abstract

The version 2005 of the Romanian macromodel (Dobrescu 2005, 2006) was built using data for the period 1990 (sometimes 1989) - 2004. This paper insists on three (probably the most complicated) problems: the evaluation of export, import, foreign capital inflows and exchange rate in euros, since the available information was expressed mainly in USD; the computation of more or less credible series regarding the tangible fixed assets, without which any attempt to elaborate an acceptable production function would inherently fail; the estimation of the alpha coefficient, taking into consideration different sources of labour income of households.

Key words: model, input-output analysis, econometric relationships
Jel Classification: C5, E2-E6, H6

The version 2005 of the Romanian macromodel (Dobrescu 2005, 2006) was built using data for the period 1990 (sometimes 1989) - 2004. As a rule, the data were extracted or deduced from:

- Romanian Statistical Yearbooks and other publications of the National Institute of Statistics;
- Estimates of the National Commission for Prognosis;
- Publications of the National Bank of Romania;
- Outlooks of the International Monetary Fund.

When different sources for the same indicator existed, we preferred the information derived from national accounts. The transformation of former series, expressed in ROL, into the new denominated currency (RON) has been done by simply dividing the first ones by 10,000.

A great difficulty derives from the fact that some important indicators are not yet computed using homogenous methodologies. In such cases, we have to involve indirect – *ad hoc* – procedures.

This paper insists on three (probably the most complicated) problems:

- The evaluation of export, import, foreign capital inflows and exchange rate in euros, since the available information was expressed mainly in USD;

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- The computation of more or less credible series regarding the tangible fixed assets, without which any attempt to elaborate an acceptable production function would inherently fail;
- The estimation of the alpha coefficient, taking into consideration different sources of labour income of households.

A. Re-Estimate of the Foreign Trade and Exchange Rate in Euros

The oncoming accession of Romania to Europeean Union imposes the need to express in euros the series concerning foreign trade and exchange rate. In order to fulfill this request, we have combined available information in foreign currencies with some national account relationships.

1. First, we generated a continuous series of exchange rate in RON per EUR (ERE), using:
   - statistical data in EUR for 1998-2004, and
   - statistical data in ECU for 1991-1997.

In the absence of any information regarding the period 1989-1990, the 1991 level was also adopted for these two years. The resulted data are presented in Table 1, together with the same series for USD (ERD).

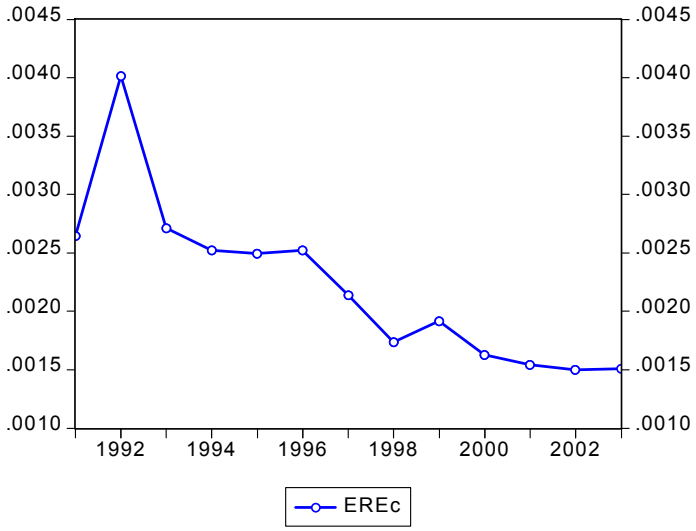
Table 1

Exchange Rate

Year	RON per EUR (ERE)	RON per USD (ERD)	EUDOER (ERE/ERD)
1989	0.001839	0.001600	1.149496
1990	0.002578	0.002243	1.149496
1991	0.008781	0.007639	1.149496
1992	0.040000	0.030795	1.298912
1993	0.088460	0.076005	1.163871
1994	0.196714	0.165509	1.188540
1995	0.262951	0.203360	1.293032
1996	0.386290	0.308260	1.253130
1997	0.809090	0.716794	1.128762
1998	0.998925	0.887555	1.125480
1999	1.629496	1.533381	1.062682
2000	1.995576	2.169270	0.919930
2001	2.602690	2.906087	0.895599
2002	3.125525	3.305546	0.945540
2003	3.755587	3.320000	1.131201
2004	4.053210	3.263657	1.241923

The real exchange rate (EREc) is approximated by the ratio of ERE to the internal inflation, represented by the gross domestic product deflator with 1989 as base year (PGDP89). The Graph EREc describes its dynamics.

Graph EREc

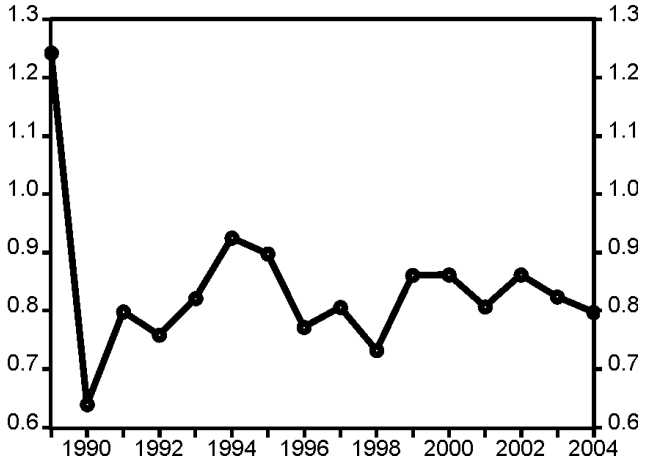


The sharp real depreciation in the RON produced in the first part of the transition was followed by a converse tendency, such a pattern being also revealed in other emergent market economies.

2. The ratio of export to import (XM) was also computed:
   - For 1989-2002, the statistical data in USD were admitted as relevant;
   - For 2003-2004, the estimates of the National Commission of Prognosis regarding the foreign trade in EUR were included.

The obtained series is presented in the Graph XM.

Graph XM



The high level registered by XM in 1989 was a consequence of the forced policy (promoted at that time) to get rid of the external debt. The transition to the market economy began with a sharp deterioration of the trade balance, after which the ratio XM tended to oscillate around 0.8.

3. Further, it was assumed that the net export in RON - calculated using the exchange rate (NXERE) - was to be equal to the corresponding difference resulted from the national accounts. Thus:

$$NXERE=GDP-DAD \quad (A.3.1)$$

These series are presented in Table 2.

Table 2

Net Export in RON

Year	Gross domestic product (GDP), crt. prices, bill.RON	Domestic aggregate absorption (DAD), crt. prices, Bill.RON	Net export, (NXERE) crt. prices, bill.RON
1989	0.08	0.0771	0.0029
1990	0.0858	0.0939	-0.0081
1991	0.2204	0.2291	-0.0087
1992	0.6029	0.6536	-0.0507
1993	2.0036	2.1032	-0.0996
1994	4.9773	5.0801	-0.1027
1995	7.2136	7.4668	-0.2532
1996	10.892	11.81	-0.918
1997	25.293	27.079	-1.7866
1998	37.38	40.38	-3.0004
1999	54.573	57.21	-2.6372
2000	80.377	84.902	-4.5251
2001	116.77	125.82	-9.0499
2002	151.48	160.06	-8.5895
2003	190.34	205.17	-14.835
2004	238.79	261.12	-22.333

4. The series ERE, XM, and NXERE are given. Starting from the accounting identities:

$$(XGSE-MGSE)*ERE=(XM*MGSE-MGSE)*ERE=NXERE \quad (A.4.1)$$

it is simple to deduce:

$$MGSE=NXERE/(ERE*(XM-1)) \quad (A.4.2)$$

and

$$XGSE=XM*MGSE \quad (A.4.3)$$

5. The above presented algorithm has been applied to the entire interval, except for 1995, when it generated implausible results. Consequently, for this year the index of

import in USD (IMGSD) was used:

$$MGSE_{1995}=MGSE_{1994}*IMGSD_{1995}$$

maintaining XGSE=XM*MGSE.

The resulted difference in NXERE for 1995 has been adjusted by a small correction in the level of private consumption of households.

Finally, the following series of export, import, and foreign trade (FTE=XGSE+MGSE) were obtained (Table 3):

Table 3

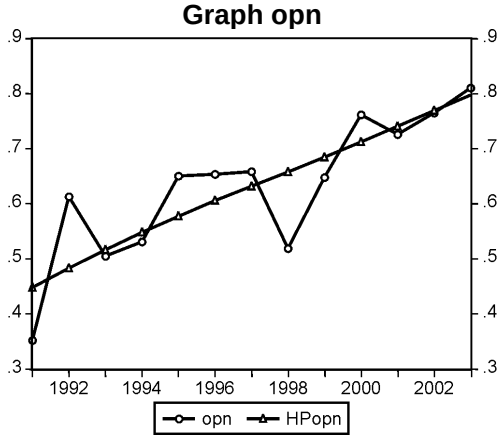
Export, Import and Foreign Trade

Bill. EUR

Year	Export, bill.EUR	Import, bill.EUR	Foreign trade, bill.EUR
1989	8.1091	6.5247	14.634
1990	5.5706	8.7149	14.285
1991	3.9247	4.9127	8.8374
1992	3.9854	5.2524	9.2378
1993	5.1548	6.2807	11.436
1994	6.4573	6.9796	13.437
1995	8.4398	9.4028	17.843
1996	8.0306	10.407	18.438
1997	9.182	11.39	20.572
1998	8.1977	11.201	19.399
1999	10.042	11.66	21.701
2000	14.196	16.464	30.66
2001	14.538	18.015	32.552
2002	17.15	19.899	37.049
2003	18.554	22.504	41.058
2004	21.735	27.245	48.98

The resulted degree of openness of the Romanian economy (opn=FTE*ERE/GDP) is plotted in Graph opn.

Graph opn



The Hodrick-Prescott filter indicates a clear increasing trend of this parameter – one of the most significant features of transition to the market economy.

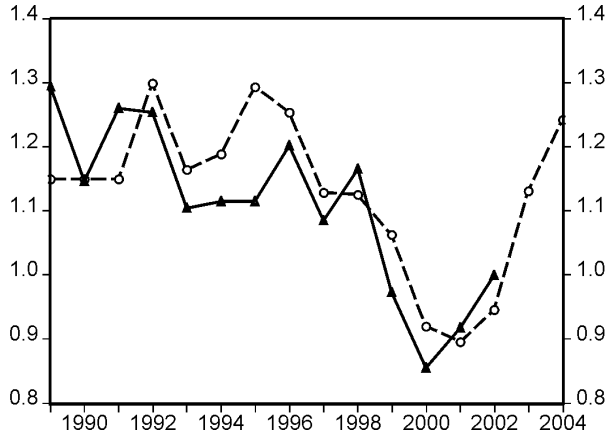
6. Using this procedure, the same ratio EUR/USD (noted EUDOXM) is valid both for export and import. Such a property directly results from the coefficient XM (=XGSE/MGSE) used in the algorithm:

$$XGSE/XGSD=XM*MGSE/XGSD=(XGSD/MGSD)*MGSE/XGSD=MGSE/MGSD \quad (A.6.1)$$

$$EUDOXM=XGSD/XGSE=MGSD/MGSE \quad (A.6.1a)$$

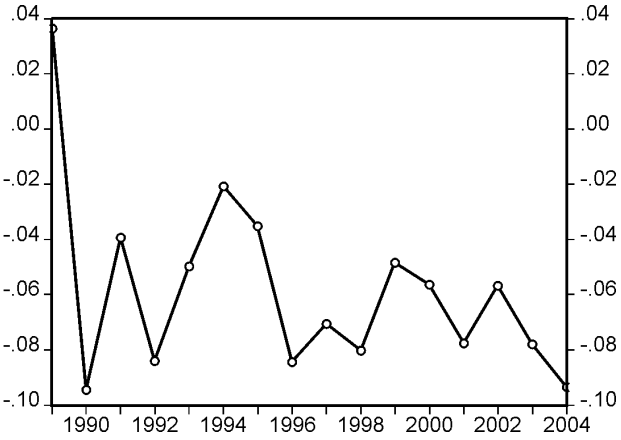
EUDOXM slightly differs from the similar ratio derived from the corresponding exchange rates (ERE/ERD), denoted EUDOER (Graph EUDO).

Graph EUDO



The evolution of the net export rate (rNX=NXERE/GDP) is plotted in Graph rNX.

Graph rNX



We obtain a similar picture for the rNX, if the series expressed in USD (export, import, and exchange rate) are used.

B. Index of Tangible Fixed Assets in Constant Prices

One of the very difficult problems was to compute a reliable series of tangible fixed assets, in constant prices, which is necessary in order to determine the aggregate production function.

1. The information from „Romanian Statistical Yearbook 2002 – Time Series 1990-2001" and „Romanian Statistical Yearbook – 2004" cannot be directly included in the econometric analysis because of the frequent methodological changes that occurred in this period (updated evaluations, more extended interpretation of this indicator, etc).

1.1. The initial statistical data are presented in Table 4 (where K – tangible fixed assets):

Table 4

Statistical Data Concerning the Tangible Fixed Assets

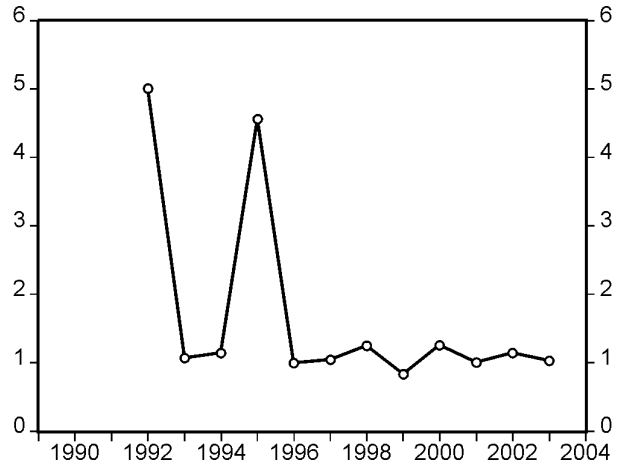
Year	Initial K, crt.pr., bill.RON	Input, crt.pr., bill.RON	Output, crt.pr., bill.RON	Final K, crt.pr., bill.RON
	Kin	Inp	Out	Kfin
1991	0.404	0.084	0.038	0.451
1992	2.259	0.093	0.03	2.322
1993	2.495	0.211	0.047	2.658
1994	3.048	0.44	0.107	3.381
1995	15.42	2.455	0.886	16.99
1996	16.99	3.117	1.21	18.89
1997	19.73	6.86	2.323	24.27
1998	30.29	19.17	6.558	42.9
1999	35.92	52.31	18.04	70.19
2000	88.1	91.42	34.55	145
2001	145.8	107.5	36.23	217.2
2002	248.7	87.15	50.26	285.6
2003	294.6	423.1	45.46	672.2

The methodological breaks can be revealed by comparing the data for the level of tangible fixed assets at the beginning of the current year with those at the end of the previous one. This ratio

$$fsk=Kin/Kfin(-1) \qquad (B.1.1)$$

is presented in Graph fsk.

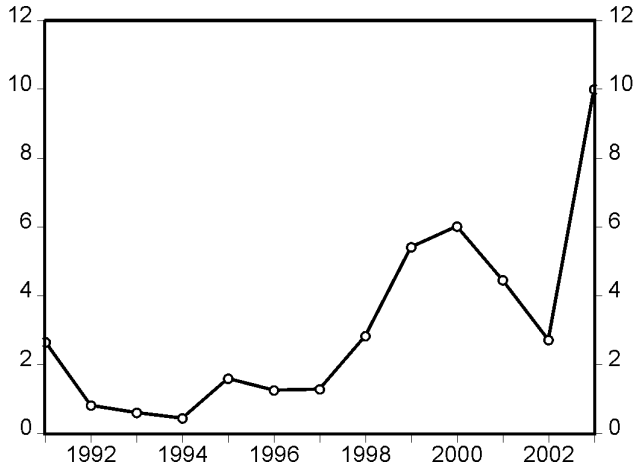
Graph fsk



We interpret the fact that in most years fsk>1 as a progressive extension of the content of this indicator (inclusion of new elements or re-evaluation of former components). Such a tendency is understandable, taking into consideration the transition of the Romanian statistics from the former material production system to the national accounts. However, the presence of differences (sometimes really huge, in 1992 and 1995) shows, in our opinion, that this series is not yet homogenised.

1.2. The absence, from the officially published data, of a consistent relationship between the series of the tangible fixed assets (for instance Inp) and that of the gross fixed capital formation (GFCF), represents another major obstacle. Graph Incfk presents the ratio Incfk=Inp/GFCF.

Graph Incfk



The need to establish such a connection between the gross fixed capital formation and the dynamics of tangible fixed assets is obvious.

2. The algorithm proposed here is an attempt to clarify both these questions.

- Concerning the first one, it seems logical to use, as a pillar of estimations, the officially published level of tangible fixed assets in the last years, which incorporate all or, at least, the most of the computational changes operated during the preceding period. On the other hand, the rest of the data, despite their heterogeneous nature, can offer some useful information. Consequently, starting with the relationships among the main variables (Kin, Inp, Out, and Kfin), an *ad hoc* parameter – conventionally named structural informational coefficient – will be calculated (see below).
- The second mentioned aspect assumes that the gross fixed capital formation series must be explicitly used in the estimation of tangible fixed assets.

\3. The structural informational coefficient (sinc) is a relative measure of one or more essential relationships, which are identified among the given data (concerning the tangible fixed assets in our particular application).

3.1. This parameter is constructed according to the rules below.

- In order to avoid eventual semantic redundancies, it seems natural to employ in its determination only basic (primary) data, and not derived (secondary) ones. It is not easy at all to establish a non-ambiguous distinction between these two kinds of information. In the case of time series, the following working hypotheses will be adopted:

a) Within a given set of data, the basic (primary) ones are those that– due to the nature of the respective process – are not inferred from others;

b) In contrast, the derived (secondary) ones can be deduced from other, prior, information. In our example, data on Kfin – computed as (Kin+Inp-Out) – are derived (secondary), while those regarding Kin, Inp, and Out are basic (primary). Formally, the relationship Kin=Kfin-Inp+Out is correct, but the status of Kfin as a derived (secondary) information does not change by such an algebraical manipulation; Kfin inexorably results from Kin, Inp, and Out.

Certainly, the same indicator can be basic (primary) in a set of data, and derived (secondary) in other informational context. For instance, Kin can be interpreted as Kfin(-1); therefore, Kin appears as a derived (secondary) variable, obtained as (Kin(-1)+Inp(-1)-Out(-1)). But this is another set of data, if compared with the preceding one. We must be extremely careful under these circumstances.

Normally, the structural informational coefficient must avoid a possible repeated presence (directly or implicitly) of one or more basic (primary) variables, which would mean another form of redundancy.

- It would be preferable that such a parameter aggregates all basic (primary) variables belonging to the investigated series. This way, the characteristics of the given set of data are more completely reflected.
- The structural informational coefficients ought to have an economic meaning. For instance, it seems unreasonable to use an expression as Kin*Out, despite its mathematical admissibility; the resulted value has no comprehensible

meaning. The multiplication Inp*Out would be also absurd from the economic point of view. The utilisation of such absurd operations would transform all deductions based on them into a gratuitous game.

- A last observation: As we already mentioned, the estimation of tangible fixed assets series will involve the gross fixed capital formation data (GFCF), determined in national accounts, and the level of K statistically registered in different years. The series GFCF (current prices, billion RON) is presented together with the annual price index of tangible fixed assets (previous year=1):

Table 5

Gross Fixed Capital Formation

Year	GFCF	PK
1990	0.016980	1.102000
1991	0.031700	2.492341
1992	0.115680	2.860543
1993	0.358370	2.928346
1994	1.009570	2.244537
1995	1.542490	1.466105
1996	2.499850	1.562639
1997	5.354010	2.223236
1998	6.791990	1.247369
1999	9.663040	1.432737
2000	15.19472	1.438019
2001	24.11536	1.324212
2002	32.23929	1.236714
2003	42.25351	1.199623

The present section must be considered exclusively as a working framework for our concrete application. We apologise in advance for the possible epistemological deficiencies of such an approach.

3.2. In our example, three ratios are interesting. They involve all basic (primary) data and are significant from the economic point of view.

- The first could be named the depreciation rate of the maximal potential tangible fixed assets:

$$sinc1=Out/(Kin+Inp) \quad (B.3.1)$$

in which (Kin+Inp) represents maximum potential K. Including the depreciation rate of the initial tangible fixed assets (dfa) and the gross fixed capital formation (GFCF) in the same prices as K, we obtain:

$$sinc1=K(-1)*dfa/(K(-1)+GFCF) \quad (B.3.2)$$

$$dfa=sinc1*(K(-1)+GFCF)/K(-1) \quad (B.3.3)$$

$$K=K(-1)*(1-dfa)+GFCF=K(-1)*(1-sinc1*(K(-1)+GFCF)/K(-1))+GFCF=$$
$$=K(-1)-sinc1*(K(-1)+GFCF)+GFCF=(K(-1)+GFCF)-sinc1*(K(-1)+GFCF)=$$
$$=(1-sinc1)*(K(-1)+GFCF) \quad (B.3.4)$$

- The second possible ratio represents the relative change in initial tangible fixed assets:

$$sinc2=(Inp-Out)/Kin \quad (B.3.5)$$

where (Inp-Out) approximates the modification of the tangible fixed assets during the given period. Continuing as above:

$$sinc2=(GFCF-K(-1)*dfa)/K(-1) \quad (B.3.6)$$

$$dfa=(GFCF-sinc2*K(-1))/K(-1) \quad (B.3.7)$$

$$K=K(-1)*(1-dfa)+GFCF=K(-1)*(1-(GFCF-sinc2*K(-1))/K(-1))+GFCF=$$

$$=K(-1)-(GFCF-sinc2*K(-1))+GFCF=K(-1)*(1+sinc2) \quad (B.3.8)$$

The above expression is of no interest to us because of the absence of GFCF, which is essential for the estimation of the new series of tangible fixed assets.

- The third structural informational coefficient could be considered as a relative change in the minimal potential tangible fixed assets,

$$sinc3=Inp/(Kin-Out) \quad (B.3.9)$$

where (Kin-Out) is minimal potential tangible fixed assets.

$$sinc3=GFCF/(K(-1)-dfa*K(-1)) \quad (B.3.10)$$

$$dfa=1-GFCF/(sinc3*K(-1)) \quad (B.3.11)$$

$$K=K(-1)*(1-dfa)+GFCF=K(-1)*(1-(1-GFCF/(sinc3*K(-1)))+GFCF=$$

$$=K(-1)*(1-1+GFCF/(sinc3*K(-1)))+GFCF=GFCF*(1+1/sinc3) \quad (B.3.12)$$

Again, this expression cannot be used. It violates another computational assumption, namely the dependence of resulted series on statistical values of K.

4. The coefficient sinc1 (Table 6) will be, therefore, involved in the next estimations.

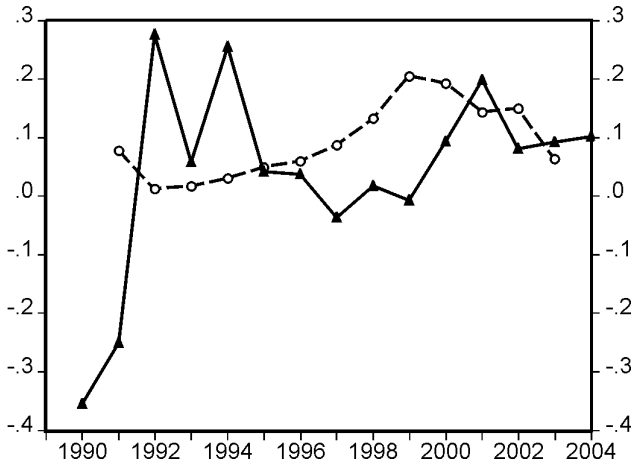
Table 6

Coefficient sinc1

Year	sinc1	Year	sinc1	Year	sinc1
1991	0.0776	1995	0.0496	1999	0.2045
1992	0.0128	1996	0.0602	2000	0.1924
1993	0.0174	1997	0.0874	2001	0.143
1994	0.0307	1998	0.1326	2002	0.1497
				2003	0.0633

The coefficient sinc1 is plotted in the Graph sinc1, together with the real change of the gross fixed capital formation (rIGFCFc=GFCF/(GFCF(-1)*PK)-1).

Graph sinc1



The evolution of sinc1, after the 1989 institutional break, could be interpreted as an effect of the "resistance" (implicit and sometimes explicit) to market accommodation of the Romanian economy, combined with very limited resources for the new investments. Such financial shortage has continued, but enforcing corrective restructuring explains the increase in this indicator in the subsequent period (1997-2000).

5. Using sinc1, five series of tangible fixed assets at constant prices of year j have been determined solving, separately for each year j (j=1999,...,2003), the following system with 14 relationships (II.B.5.1-II.B.5.14) and the same number of variables (CKc90j-CKc03j):

$$CKc91j=(1-sinc191)*(CKc90j+GFCF91/PK91j) \quad (B.5.1)$$
$$CKc92j=(1-sinc192)*(CKc91j+GFCF92/PK92j) \quad (B.5.2)$$
$$CKc93j=(1-sinc193)*(CKc92j+GFCF93/PK93j) \quad (B.5.3)$$
$$CKc94j=(1-sinc194)*(CKc93j+GFCF94/PK94j) \quad (B.5.4)$$
$$CKc95j=(1-sinc195)*(CKc94j+GFCF95/PK95j) \quad (B.5.5)$$
$$CKc96j=(1-sinc196)*(CKc95j+GFCF96/PK96j) \quad (B.5.6)$$
$$CKc97j=(1-sinc197)*(CKc96j+GFCF97/PK97j) \quad (B.5.7)$$
$$CKc98j=(1-sinc198)*(CKc97j+GFCF98/PK98j) \quad (B.5.8)$$
$$CKc99j=(1-sinc199)*(CKc98j+GFCF99/PK99j) \quad (B.5.9)$$
$$CKc00j=(1-sinc100)*(CKc99j+GFCF00/PK00j) \quad (B.5.10)$$
$$CKc01j=(1-sinc101)*(CKc00j+GFCF01/PK01j) \quad (B.5.11)$$
$$CKc02j=(1-sinc102)*(CKc01j+GFCF02/PK02j) \quad (B.5.12)$$
$$CKc03j=(1-sinc103)*(CKc02j+GFCF03/PK03j) \quad (B.5.13)$$
$$CKcjj=\text{Statistical level for year j in current prices} \quad (B.5.14)$$

where: CKcij – tangible fixed assets in the year i (i=1990, 1991,...,2003) estimated in prices of the year j; these will be named conventional tangible fixed assets (CK), due to the indirect procedure used to obtain them;

sinc1i – coefficient sinc1 in year i;

GFCFi – gross fixed capital formation in year i in current prices;

PKij - basic price indices of tangible fixed assets, in which the level of the year j is 1; these were computed in Table 7 for annual series (PK) - and are denoted as PK99 (for 1999=1),..., PK03 (for 2003=1).

Table 7

Basic Price Indices of Tangible Fixed Assets

Year	PK99	PK00	PK01	PK02	PK03
1990	0.002344	0.001630	0.001231	0.000995	0.000830
1991	0.005843	0.004063	0.003068	0.002481	0.002068
1992	0.016714	0.011623	0.008777	0.007097	0.005916
1993	0.048944	0.034036	0.025703	0.020783	0.017325
1994	0.109857	0.076395	0.057691	0.046649	0.038886
1995	0.161062	0.112003	0.084581	0.068392	0.057011
1996	0.251682	0.175020	0.132169	0.106871	0.089088
1997	0.559550	0.389111	0.293844	0.237600	0.198063
1998	0.697965	0.485365	0.366532	0.296375	0.247057
1999	1.000000	0.695401	0.525143	0.424628	0.353968
2000	1.438019	1.000000	0.755166	0.610623	0.509012
2001	1.904242	1.324212	1.000000	0.808594	0.674040
2002	2.355003	1.637672	1.236714	1.000000	0.833595
2003	2.825115	1.964588	1.483591	1.199623	1.000000

6. Thus, the estimated levels of the conventional tangible fixed assets will be transformed into annual chain indices (previous year=1), denoted as ICKc99...ICKc03.

Table 8

Annual Chain Indices of the Conventional Tangible Fixed Assets

Year	ICKc99	ICKc00	ICKc01	ICKc02	ICKc03
1991	1.027357	0.958653	0.949055	0.943990	0.930192
1992	1.126734	1.038878	1.025592	1.018471	0.998681
1993	1.112903	1.034885	1.021924	1.014837	0.994613
1994	1.114285	1.031877	1.016968	1.008655	0.984280
1995	1.083416	1.012428	0.998356	0.990330	0.966012
1996	1.065675	1.002596	0.989026	0.981113	0.956337
1997	1.023155	0.971249	0.959217	0.952048	0.928832
1998	0.971806	0.925728	0.914335	0.907410	0.884250
1999	0.893363	0.852902	0.842269	0.835676	0.812874
2000	0.929137	0.882244	0.869174	0.860901	0.831260
2001	1.023411	0.964653	0.947146	0.935790	0.893247
2002	1.024742	0.970033	0.952420	0.940643	0.893859
2003	1.141483	1.085162	1.065652	1.052200	0.995260

7. The final series (ICKc) is obtained as a geometrical average of these five indices:

ICKc=(ICKc99*ICK00*ICK01*ICK02*ICK03)^(1/5) (B.7.1)

The value for 2004 was approximated with the usual formula, admitting dfa=0.04. The following table presents the annual indices (ICKc, in which the level of previous year=1), and those compared to 1990 (level of this year=1); the second series is denoted ICKc90.

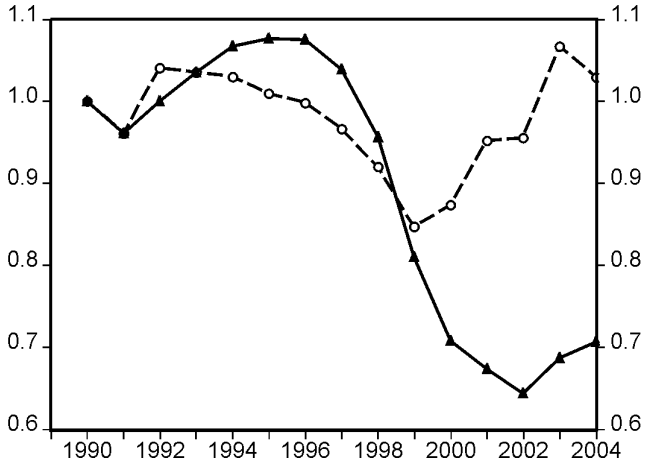
Table 9

Indices of the Conventional Tangible Fixed Assets at Constant Prices

Year	ICKc	ICKc90
1991	0.9613	0.9613
1992	1.0408	1.0004
1993	1.0351	1.0355
1994	1.0303	1.0669
1995	1.0093	1.0768
1996	0.9983	1.075
1997	0.9664	1.0389
1998	0.9203	0.956044
1999	0.847	0.809777
2000	0.874	0.707715
2001	0.9519	0.673684
2002	0.9554	0.643637
2003	1.0669	0.686695
2004	1.0292	0.706755

These series are plotted in Graph ICKc.

Graph ICKc



As we expected, the comments relative to sinc1 parameter are re-confirmed. Only during the last years we see a certain recovery of the investment support of the economic development.

The above index seems to reflect correctly the real processes. Nevertheless, we must keep in mind that they are obtained through an approximation based on indirect methods.

C. The Coefficient Alpha

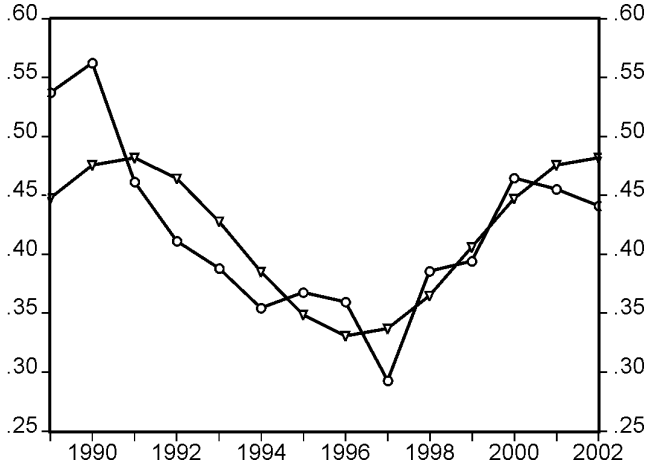
The aggregate output is estimated by a usual production function with capital and labour. The alpha coefficient represents the elasticity of output with respect to labour; as in other similar approaches, the share of labour income in gross value added approximates it. Reliable data for such a coefficient are not yet available.

1. Under these conditions, two informational sources have been investigated.

1.1. The first is the share of labour income in gross value added computed from input-output tables (alpha1b). One could not help noticing the cyclical configuration of such a series. Consequently, a simple trigonometric function has been regressed.

The Graph alpha1b shows the results; alpha1b represents the statistical data and falpha1b the fitted series.

Graph alpha1b

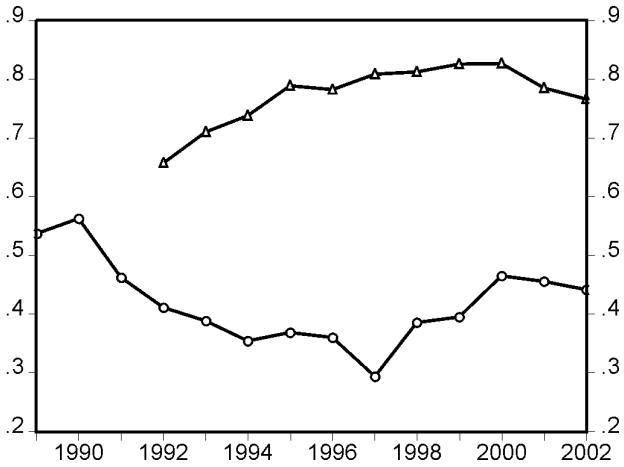


The regressed trigonometric function has been used for the estimation of alpha1b in 2003-2004. We do not know if such a relationship reflects the actual causal determinants or it is a consequence of incidental circumstances. It has been adopted exclusively as an extrapolating tool. Merging together the statistical data for 1989-2002 with the fitted values for 2003-2004, a more representative series has been obtained, denoted by alpha1.

1.2. There are, however, some reasons to think that alpha1 underestimates the real contribution of labour factor to output. One of them comes from the difficulties to

evaluate this contribution in the so-called "unobservable" economy, including the production of households for self-consumption (relatively important in the Romanian economy). That is why a second source of data was used: the gross disposable income of households (the corresponding share in gross value added is denoted by alfa2b). Statistical information covers, in this case, only the years 1992-2002 (Graph alphab).

Graph alphab



Contrary to alpha1, alpha2b – which contains several non-labour revenues - clearly overestimates the searched coefficient.

2. Consequently, our final choice was a combined solution, consisting in the extension of alpha1 with a part of alphax (defined as the difference between alpha2b and alpha1b). Formally:

$$alpha=alpha1+d*alphax \quad (C.2.1)$$

where alphax=alpha2b-alpha1b.

The proposed procedure is built on the assumption that alpha cannot significantly change in two successive intervals. Such a hypothesis seems reasonable from a socio-economic point of view.

It means that the difference between alpha and alpha(-1) must be minimised. The following operations do not need special explanations.

$$\Sigma(alpha-alpha(-1))^2=min \quad (C.2.2)$$

$$\Sigma[(alpha1+d*alphax)-(alpha1(-1)+d*alphax(-1))]^2=min \quad (C.2.3)$$

$$\Sigma(alpha1+d*alphax-alpha1(-1)-d*alphax(-1))^2=min \quad (C.2.4)$$

$$\Sigma(\Delta alpha1+d*\Delta alphax)^2=min \quad (C.2.5)$$

$$2*\Sigma(\Delta alpha1+d*\Delta alphax)*\Delta alphax=0 \quad (C.2.6)$$

$$\Sigma\Delta alpha1*\Delta alphax+d*\Sigma\Delta alphax^2=0 \quad (C.2.7)$$

$$d=-\Sigma\Delta alpha1*\Delta alphax/\Sigma\Delta alphax^2 \quad (C.2.8)$$

In our case, we have:

Table 10

Estimation of d

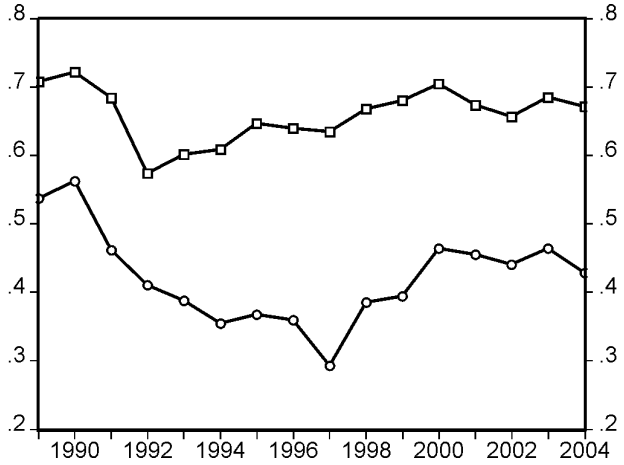
Year	alpha1	alphax	∆alpha1	∆alphax	(∆alpha1*∆alphax)	∆alphax^2
1992	0.4111	0.24592				
1993	0.3879	0.32207	-0.0232	0.0762	-0.0018	0.0058
1994	0.3543	0.3837	-0.0336	0.0616	-0.0021	0.0038
1995	0.3679	0.42113	0.0136	0.0374	0.0005	0.0014
1996	0.3598	0.42217	-0.008	0.001	-8E-06	1E-06
1997	0.2929	0.51611	-0.0669	0.0939	-0.0063	0.0088
1998	0.3856	0.42637	0.0927	-0.0897	-0.0083	0.0081
1999	0.3943	0.43166	0.0087	0.0053	5E-05	3E-05
2000	0.4646	0.36239	0.0703	-0.0693	-0.0049	0.0048
2001	0.4555	0.32954	-0.0092	-0.0329	0.0003	0.0011
2002	0.441	0.324985	-0.0144	-0.0046	7E-05	2E-05
Sum					-0.0224	0.0338

The resulted d=0.66271289 has been used to estimate alpha for 1992-2002, which were regressed as a function of alpha1.

Using the obtained equation, the values of alpha have been approximated for 1989-1991, and 2003-2004, respectively.

The computed series alpha1 and alpha are presented in the Graph alpha.

Graph alpha



The computed alpha has plausible values.

3. The total factor productivity has been determined as an index:

$$ITFP=IGDPc/(IE^{alpha}*ICKc^{(1-alpha)}) \quad (C.3.1)$$

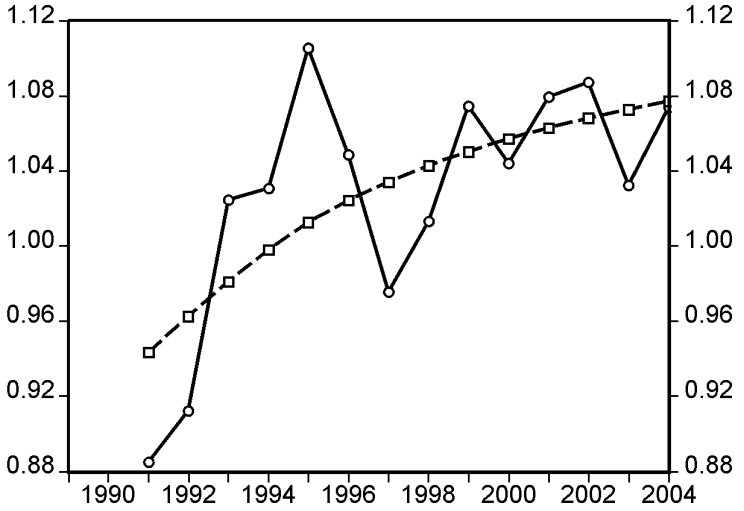
where: IGDPc – index of the gross domestic product at constant prices,

IE – index of the employment,

ICKc – index of the conventional tangible fixed assets at constant prices.

The Graph ITFP describes this series, compared to the Hodrick-Prescott filter (HPITFP) that has been also computed.

Graph ITFP



The increasing trend of ITFP reflects, very likely, the growing positive effects of the transforming processes of transition on the performance of the Romanian economy.

The above proposed computational procedures must be considered as provisional solutions, until the Romanian statistics will be able to offer reliable official data.

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