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ESTIMATING THE CORRELATION BETWEEN NATALITY AND ECONOMIC GROWTH

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Accepted July 8, 2022

The birth rate is one of the key demographic indicators and by its major impact on labour force and employment it is in a strong positive correlation with economic growth. Based on available data for various periods, we are analysing the complex dynamics of demographic balance both at the global level and the EU's level. At the global level, empirical data demonstrate the existence of two general strong processes of convergence: for the natality towards a birth rate of 10 crude, per 1000 people and for the mortality towards a death rate of 7 crude, per 1000 people. In case of the EU's level, our study is demonstrating that the demographic balance is equilibrated by the emigration phenomenon. Our study demonstrates the existence of three distinctive trajectories, along with the income per inhabitant growth. Each of them is corresponding to a so-called behavioural regime and the transition between regimes seems to occur "naturally" when the level of development is increasing. Moreover, a model allowing a smooth transition between the empirical trends corresponding to the three groups of states (classified by their income per capita: low, middle, and high) is presented.

Keywords: Demographic Balance, Birth Rate, Death Rate, Behavioural Regime.

INTRODUCTION

The impact of changes in birth rate is manifesting in many areas of human society and of economy. Primarily, the birth rate is one of the main factors influencing the population dynamics, both quantitatively and qualitatively. From here, it is influencing dynamics of labour force and employment, and consequently their productive capacity and finally it is as one of the decisive factors of economic development and progress of society.

After a short presentation of the definitions and sources of data related to main demographic variables, our study is focussing on the analysis of some correlations between them and the economic dynamics, synthetically expressed by the trend in value of per capita income, both at the level of global economy and European Union. Moreover, we are analysing the convergence process at the two levels. Based on such results, we are trying to identify some stages or regimes in the evolution of the global economy and to estimate a theoretical trajectory which could simulate a smooth transition from a behavioural regime (or stage) to another one.

DEFINITIONS AND DATA

The birth rate is the ratio of total live births to total population in a specific community or area over a certain period. The birth-rate is usually expressed as the number of live births per 1,000 of the population per year and it is also called natality. In order to evaluate the impact of natality on the evolution of population and on that of economy, every time it must be considered together with the other demographic variables, such as mortality rate, migration, average age of population and its structure by age (cohorts of population) or the age pyramid etc. For instance, the rate of natural increase refers to the difference between the number of live births and the number of deaths occurring in a year, divided by the mid-year population of that year, multiplied by a factor (usually 1,000). It is equal to the difference between the crude birth rate and the crude death

rate. This measure of the population change excludes the effects of migration.

Moreover, on the side of its economic impact is necessary to be considered the ratio active/inactive population, dependency ratios of population (total dependency ratio, child or youth dependency ratio, and aged or old dependency ratio), structure of labour force and of employment by age (by level of education, by occupation) etc.

For instance, the dependency ratio is an age-population ratio of those typically not in the labour force (the dependent part ages 0 to 14 and 65+) and those typically in the labour force (the productive part ages 15 to 64). It is used to measure the pressure on the productive population. Consideration of the dependency ratio is essential for governments, economists, bankers, business, industry, universities and all other major economic segments which can benefit from understanding the impacts of changes in population structure. Low dependency ratio means that there are sufficient people working who can support the dependent population. Lower ratio could allow for better pensions and better health care for citizens. Higher ratio indicates more financial stress on working people and possible political instability.

While the strategies of increasing fertility and of allowing immigration especially of younger working age people have been formulas for lowering dependency ratios, future job reductions through automation may impact the effectiveness of those strategies. Alternatively, the labour force dependency ratio could be better than the old age dependency ratio it measuring the ratio of the older retired population to the employed population at all ages (or the ratio of the inactive population to the active population at all ages). Also, migrant labour dependency ratio is used to describe the extent to which the domestic population is dependent upon migrant labour.

Related to the dynamics of natality, there are two basic relations of definition for the birth rate or natality rate, b (expressed as birth rate, crude, per 1,000 people) and respectively for death rate or mortality rate, d (expressed as death rate, crude, per 1,000 people):

$$b = B \times 1000 / P0$$

and

$$d = D \times 1000 / P0$$

where B is the number of births per year and D – the number of deaths per year; P0 being the total population in the base year. An important derived demographic indicator is the so-called natural growth rate of population, ng, calculated by subtracting the death rate from the birth rate, crude (per 1,000 people):

$$ng = NG \times 1000 / P0 = b - d$$

where NG = B – D is the natural growth of population. Moreover, the registered change in population, ΔP, and its rate, δ, crude (per 1,000 people), are as follows:

$$\Delta P = P1 - P0$$

and

$$\delta = \Delta P \times 1000 / P0$$

where P0 and P1 are two successive years (base year and respectively current year).

And finally, from such balance relations we can evaluate the so-called implicit net migration, M, and its rate, m, crude (per 1,000 people):

$$M = P0 + NG - P1 = NG - \Delta P$$

and

$$m = ng - \delta$$

where a positive value means outward migration (emigration) and a negative one inward migration (immigration).

As usually in macroeconomic and demographic studies, the main sources of data are from international organisations as Word Bank, International Monetary Fund, United Nations, Organisation of Economic Cooperation and Development, and Eurostat.

EMPIRICAL EVIDENCES AT THE GLOBAL LEVEL AND AT EU LEVEL

The empirical study of natality dynamics is important to analyse the relations with other demographic variables and its impact on the general development process and correlations with some significant economic variables, especially with the income per inhabitant. Depending on its value, the analyse at the global level demonstrates the existence of some distinct trends. In order to demonstrate, on an empirical basis, the medium and long-term dynamics of such correlations, our research approach was based on the analysis of statistical data for the period 1980–2019 (data for natality and related demographic variables) and for 1980–2020 (GDP and total population at the beginning of each year) in case of a representative

sample of states and territories worldwide (noted as W119) for which there are comparable statistical data (*World Development Indicators*), its composition being presented in Annex 1.

The representativeness of the sample of states and territories selected by us results primarily from the comparison with aggregated data published by the World Bank for the whole world. Thus, in 1980, the states and territories in the W119 sample covered 97.6% of the world's population and 96.3% of world GDP. In 2020, the percentages covered by the W119 sample were 86.5% for the population and 89.5% for the GDP, respectively.

The distribution of the 4760 points, according to the basic matrices in relation to the per capita income, y, in the period 1980–2019 (119 states × 40 years) is shown in Figure 1, for the birth rate (per 1000 people), b, in the top graph of figure, and for the death rate (per 1000 people), d, in the bottom graph of it.

According to these distributions, at the level of the countries set included in the sample W119, there are two relative significant negative correlations between b and y (the value of the correlation coefficient being -0.564) and respectively between d and y (the value of the correlation coefficient being in this case -0.352).

Related to income level (on the horizontal axis), as international dollars PPP (*Purchasing Power Parity*) the graphical representation of the two distributions suggests the existence of two processes of convergence towards: lower values, in the case of the natality, to around an average value of 5–10 birth rate, crude (per 1000 people) and respectively very low values, in case of the mortality, to around an average value of 1–3 death rate, crude (per 1000 people). On the two graphical representations are also shown the values for Romania in 1980 and respectively in 2019 (as bRO, dRO, and yRO).

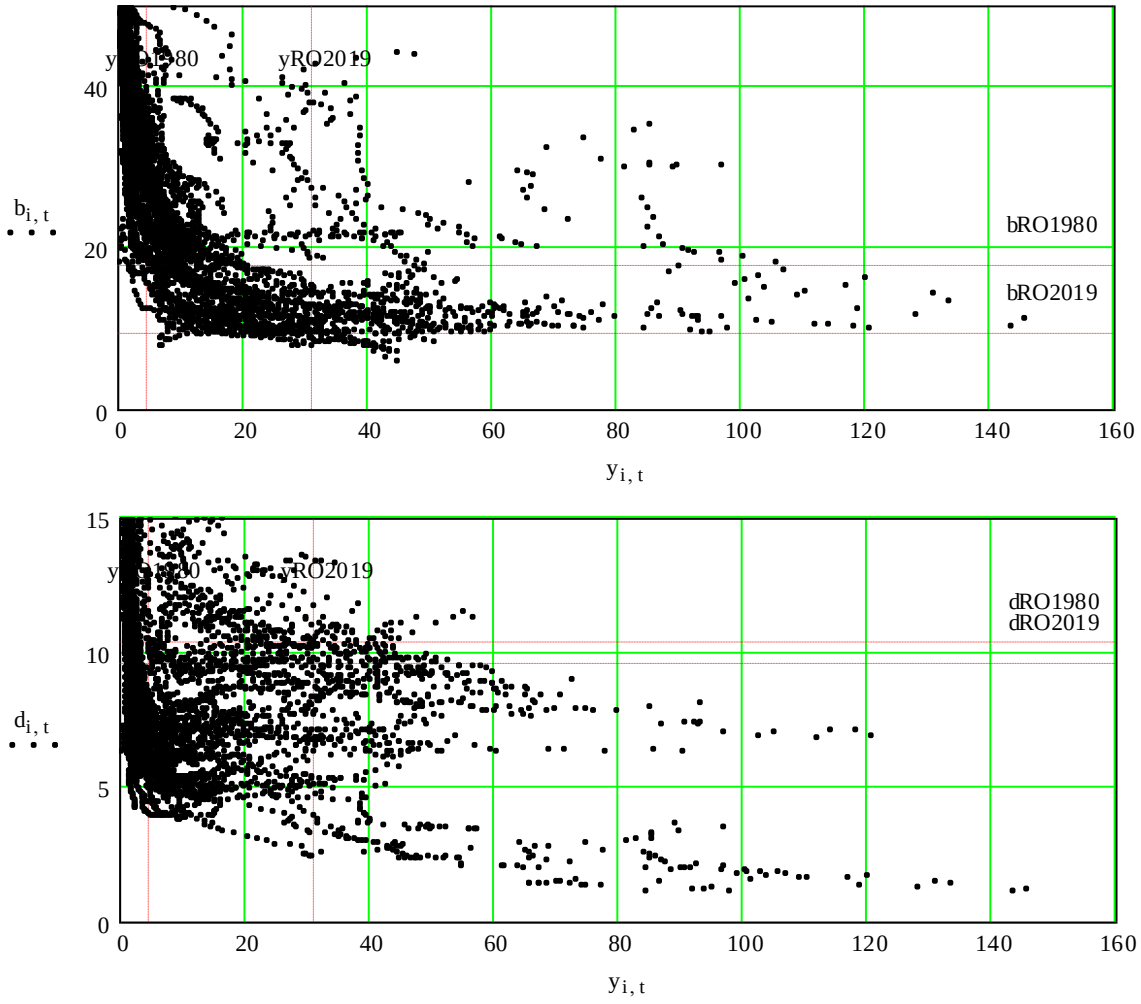

Figure 1

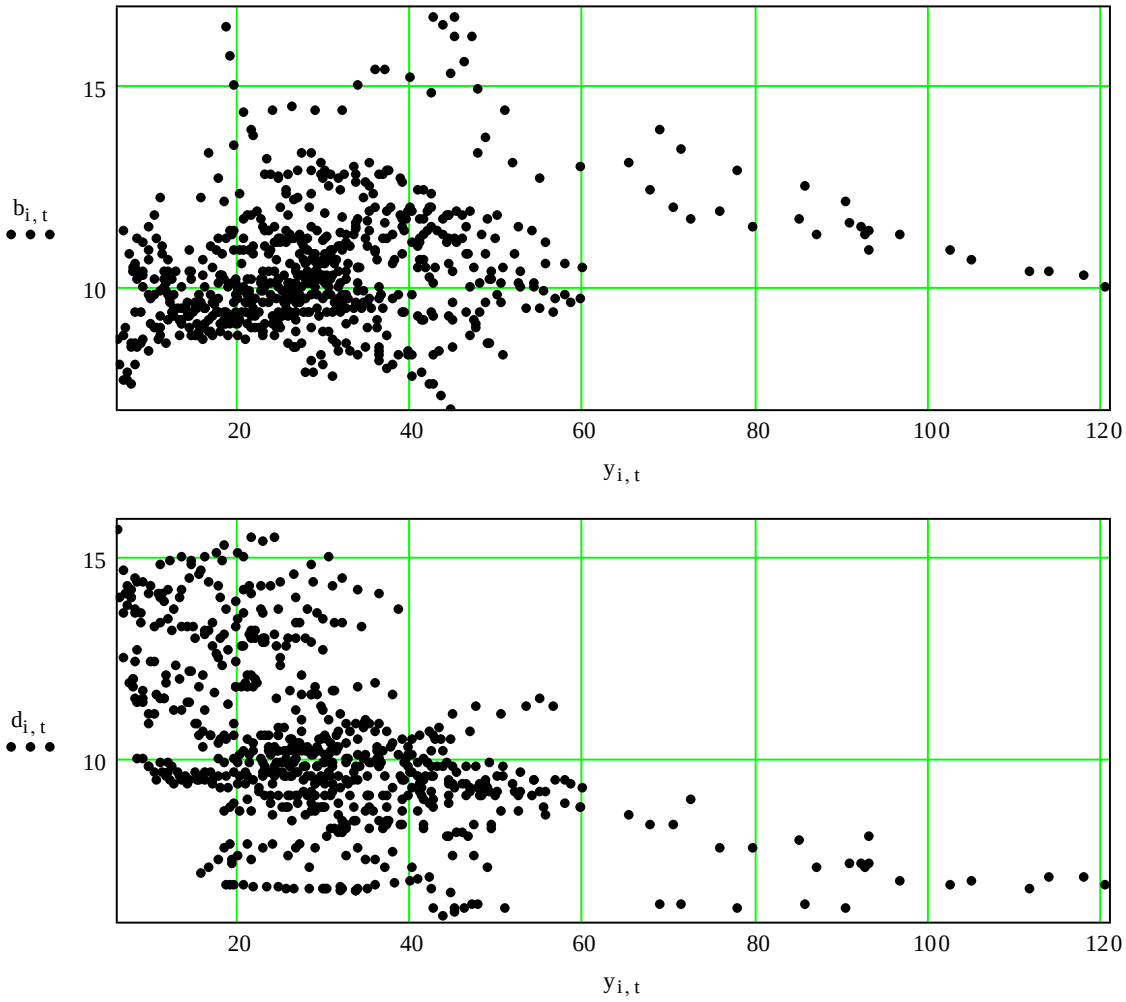

Figure 2

Moreover, in the graphical representations of Figure in Annex 2 there is presented the distribution in case of sample W119 for the other three variables, the natural growth rate of population, ng, the registered change rate of population, δ, and respectively the implicit rate of net migration, m, all of them per 1,000 people. Corresponding to such distributions, there are some relative significant negative correlations between ng and y (the correlation coefficient value being -0.514) and respectively between m and y (the correlation coefficient value being -0.427), but an insignificant correlation between δ and y (only 0.028 as correlation coefficient).

In order to study the distribution of birth rate and those of main related demographic variables in European Union (EU27 after Brexit), we considered the grouping of Member States into three conventional classes, established following detailed analyses on the similarity of economic structures and some macroeconomic behavioural characteristics: the North-western group (NV10), comprising 10 countries (Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Luxembourg, Netherlands and Sweden); the southern group (S6), consisting of 6 states (Cyprus, Greece, Italy, Malta, Portugal and Spain); the Eastern Group (E11), which includes the former communist countries having joined the EU since 2000 (Bulgaria, Croatia, Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia).

The considered period was shorter than in case of W119, namely 1995–2019, because some actually EU members resulted from some geopolitical changes in the first part of the last decade of the twentieth century (splitting of former Czechoslovakia in Czechia and Slovakia, emergence of three Baltic countries from former Soviet Union, emergence of a number of independent countries by splitting of former Yugoslavia, among which two became new EU members, Slovenia and Croatia).

The distribution of the 675 points, according to the basic matrices in relation to the per capita income, y, in the period 1995–2019 (27 states × 25 years) is shown in Figure 2, for the birth rate (per 1000 people), b, in the top graph of figure, and for the death rate (per 1000 people), d, in the bottom graph of it. According to these distributions, at the level of the countries set included in EU27, there is a weak positive correlation between b and y (the value of the correlation coefficient being +0.244) and a relative significant negative correlation between d and y (the value of the correlation coefficient being -0.515).

Moreover, in the three graphs of Annex 3 there is presented the distribution in case of sample UE27 for the other three demographical variables: natural growth rate of population, ng, the registered change rate of population, δ, and respectively the implicit rate of net migration, m, all of them per 1,000 people. Corresponding to such distributions, there are two relative significant positive correlations between ng and y (the correlation coefficient value being +0.465) and respectively between δ and y (the correlation coefficient being +0.560), but a relative significant negative correlation between m and y (-0.494 as correlation coefficient).

CONVERGENCE, BEHAVIOURAL REGIMES AND THEORETICAL TRENDS

At the level of the entire world and its composition by groups of income per capita, there are data published by World Bank on natality and related variables only for the period after 1990. Based on such data we analysed the process of convergence in matter of natality by considering the world population in three large groups: Low income (L), Middle income (M), and respectively High income (H).

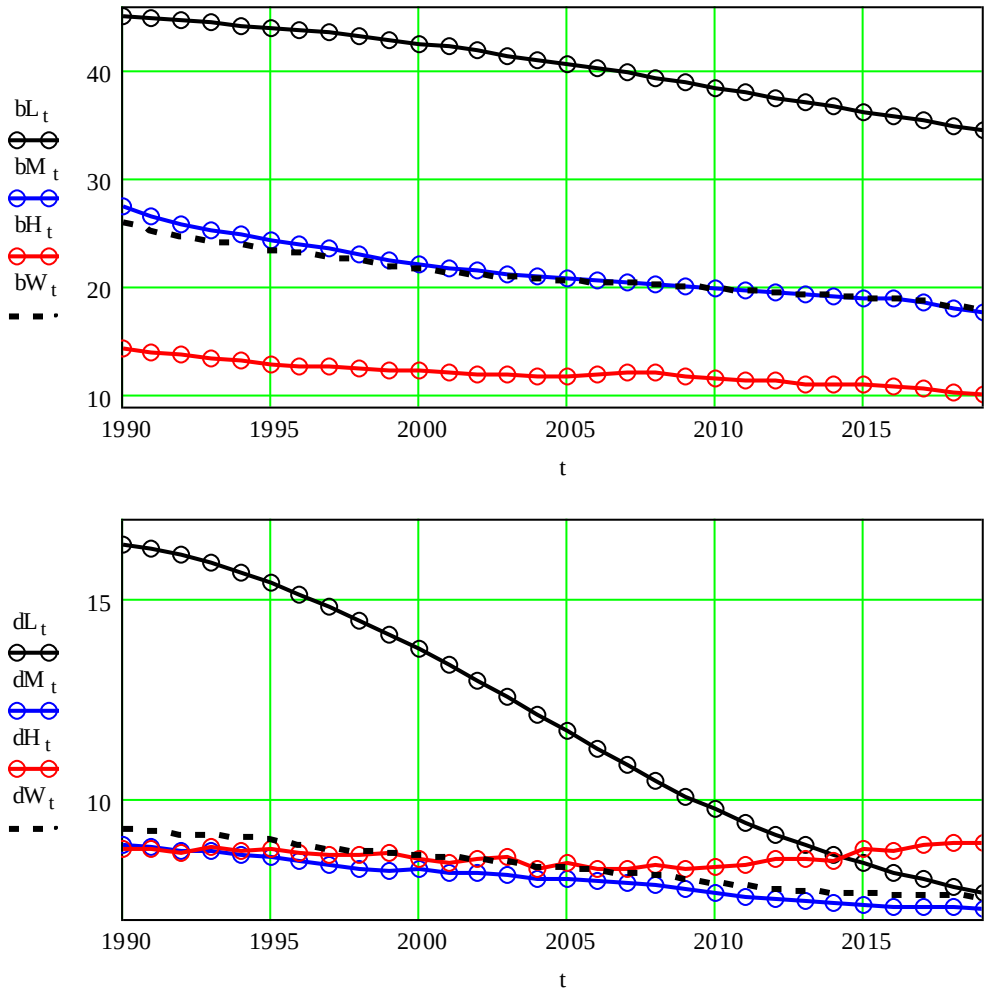

Figure 3

Table 1

Correlation	World	Low income	Middle income	High income	Romania
corr (b, y)	-0.935	-0.992	-0.900	-0.944	-0.356
corr (d, y)	-0.981	-0.972	-0.965	-0.073	+0.833
corr (ng, y)	-0.908	-0.739	-0.877	-0.926	-0.645
corr (δ, y)	-0.903	-0.813	-0.845	-0.674	-0.084
corr (m, y)	-0.171	+0.628	-0.769	-0.181	-0.175

In Figure 3 there are shown the real trajectories in the period 1990–2019 for the aggregated data of birth rate (top graphic) and respectively for those of death rate (bottom graphic), where the trajectories are black for the group L, blue for the group M, and red for the group H. On the two graphical representations are also depicted the real trajectories for the aggregated data at the level of the world (W), as black dashed line.

Moreover, in Figures from Annex 4 there are presented the real trajectories for the other three variables, respectively the natural growth rate of population, ng, the registered change rate of population, δ, and the implicit rate of net migration, m, all of them per 1,000 people.

Again (like in case of the sample W119) dynamics of real registered data demonstrate the existence of two general processes of convergence, one just a little strong for the natality (towards a birth rate of 10 crude, per 1000 people, in case of the group of countries with high level of income) and the other much stronger this time for the mortality (towards a death rate of 7 crude, per 1000 people, in case of the same group).

Corresponding, for the period 1990–2019, at the global level, the values of correlation coefficient in case of considering the average values are presented in Table 1, where the computed data are also presented for Romania.

In Figure 4 it is shown the dynamics of the demographic change balance in Romania for the same period. In this Figure, on the same graphical representation, the trajectories are presented as follows: a trajectory, the natality rate trajectory (b), is presented as a blue solid line with small cercles on it; three trajectories are presented as black lines – one solid line with small cercles on it representing the death rate (d), one dashed line with small cercles on it representing the registered change in the number of total population (δ), and one simple dashed line representing the rate of net migration (m); one solid red line with small cercles on it.

We can see in case of Romania a deterioration of the demographical variables. Thus, a general decreasing trend of the birth rate (from 18.0/1000, in 1980, to 13.6/1000, in 1990, to 10.4/1000, in 2000, to 10.2/1000, in 2015, and to only 9.6/1000 in 2019), simultaneously with a general increasing trend of the death rate (from 10.4/1000, in 1980, to 10.6/1000, in 1990, to 11.4/1000, in 2000, to 13.2/1000, in 2015, and to 13.4/1000 in 2019. Consequently, the natural growth rate of population depreciated drastically from +7.6/1000, in 1980, to +3.0/1000, in 1990, to -1.0/1000, in 2000, to -3.0/1000, in 2015, and to a dangerous -3.8/1000 in 2019.

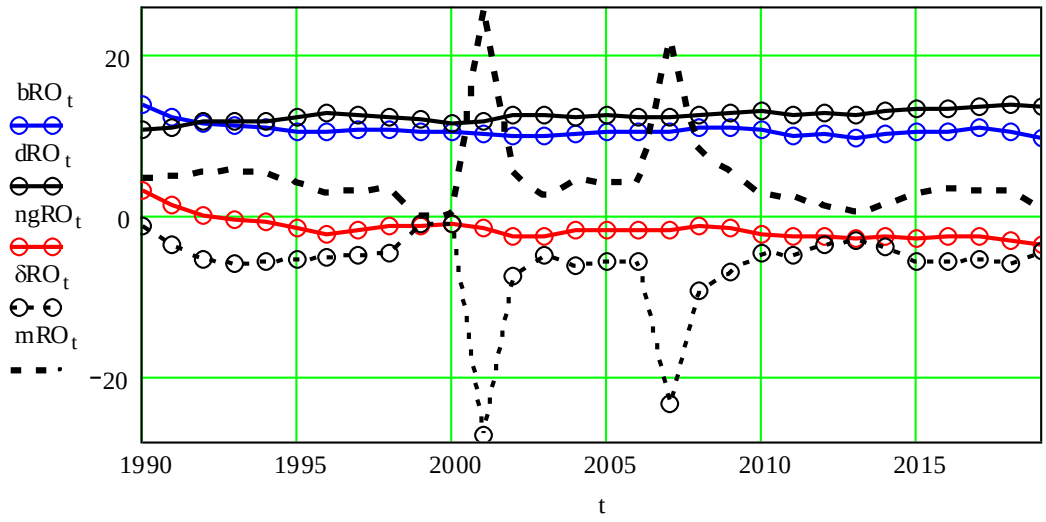

Figure 4

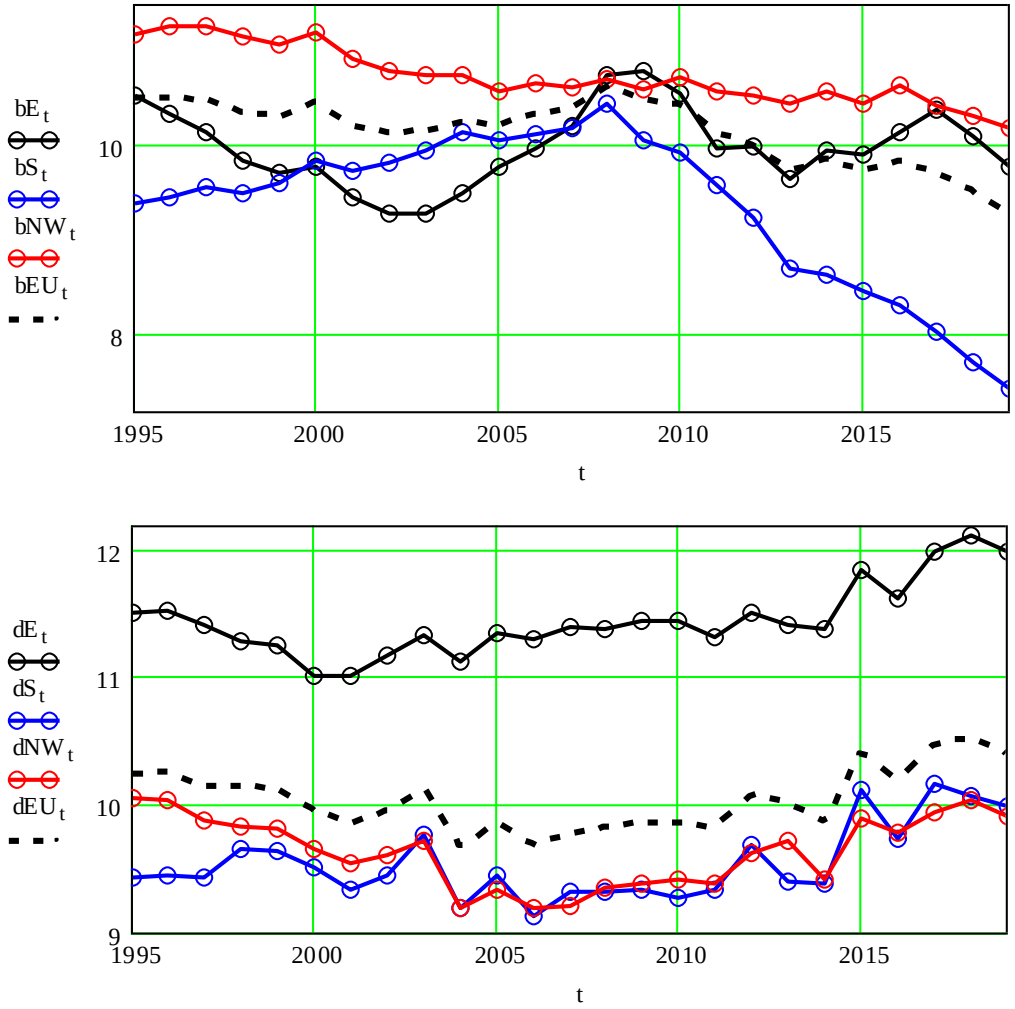

Figure 5

Together with a such unfavourable trend in the natural growth rate, the emigration rate (net of migration) increased dramatically, especially after 1989, to some record levels in 2001 (+25.7/1000) and in 2007 (+21.6/1000). In all years of the post-communist period, the rate of net migration was positive (meaning a large rate of emigration). Consequently, the migration trend adding to that of a negative natural growth rate, an accentuated negative trend emerged in dynamics of total population (thus the negative value of the variable δ) in 1990, is perpetuating after this year, with some very dangerous record values in some years, such as in 2001 (-27.4/1000) and in 2007 (-23.4/1000).

Regarding dynamics of demographic variables in EU, for the period 1995–2019, we can see, from Figure 5 (the natality rate, b, and mortality rate, d) and from Figure in Annex 5 (the natural growth rate of population, ng, rate of the registered change in population, δ, and respectively the rate of net migration, m) different patterns of convergence/ divergence. In these Figures, the trajectory for average value in Eastern group (E) is as a black solid line, that in Southern group (S) as a blue solid line, and that in Northern-Western group (NW) as a red solid line (the trajectory for the average EU level being as a simple black dashed line).

For instance, on a background of a general decreasing trend in natality rate, during the analysed period, there was a strong convergence process among the three component groups of countries until the beginning of global crisis in 2008, followed by an accentuated divergence (see the top graphical representation in Figure 5). Also, in matter of mortality rate, in all groups there was a general diminishing trend in the first part of the considered period followed by a general increasing trend in the second part of it.

In order to identify some stages or regimes in the natality dynamics and to estimate their associate trajectories, we are returning to the level

of global economy in the period 1990–2019. Thus, by replacing the time with the income per capita (expressed as PPP), y, on horizontal axis, t, in Figure 3 and in Figures of Annex 4, we can see different patterns or regimes in dynamics of demographic variables, which are presented in Figure 6 (for natality, b, in top graph, and mortality, d, in bottom graph) and in Figure of Annex 6 (for the natural growth rate, ng, the rate of registered change in population, δ, and respectively the rate of net migration, m).

Again, in these Figures the real trajectories are black for the Low-income group (L), blue for the Middle-income group (M), and respectively red for the High-income group (H). Moreover, on these graphic representations are presented the real trajectories in case of Romania (bRO, dRO, ngRO, δRO, and respectively mRO).

In each of Figures, based on real data trajectories, marked by bold dots, three distinctive behavioural regimes are outlined in the dynamics of each demographic variable, depending on per capita income (noted as thousands of dollars PPP on the horizontal axis): 1) the black trajectories on the left side of the graphs (the group of low-income states per capita); 2) the blue trajectories in the middle part of the graphs (the group of states with middle income per capita); 3) the red trajectories on the right side of the graphs (the group of states with high per capita income). The trajectory in case of Romania is depicted in all graphs as a simple dashed line.

Unfavourable situation in its case is reflected by the gap comparing to the general trend at the global level. Thus, in Romania, the birth rate trajectory is located under the global trends and simultaneously the death rate trajectory is increasing becoming higher and higher than the global trends. Consequently, the natural growth of population is evolving to the values more and more negative.

In Romania, the deterioration of the demographic situation with some huge consequences in the future on the economy was decisively accentuated by the high rates of emigration, which means positive values for the net migration rate (to note that in case of the group with high income, H, during the considered period, permanently there were registered negative values of the rate of net migration).

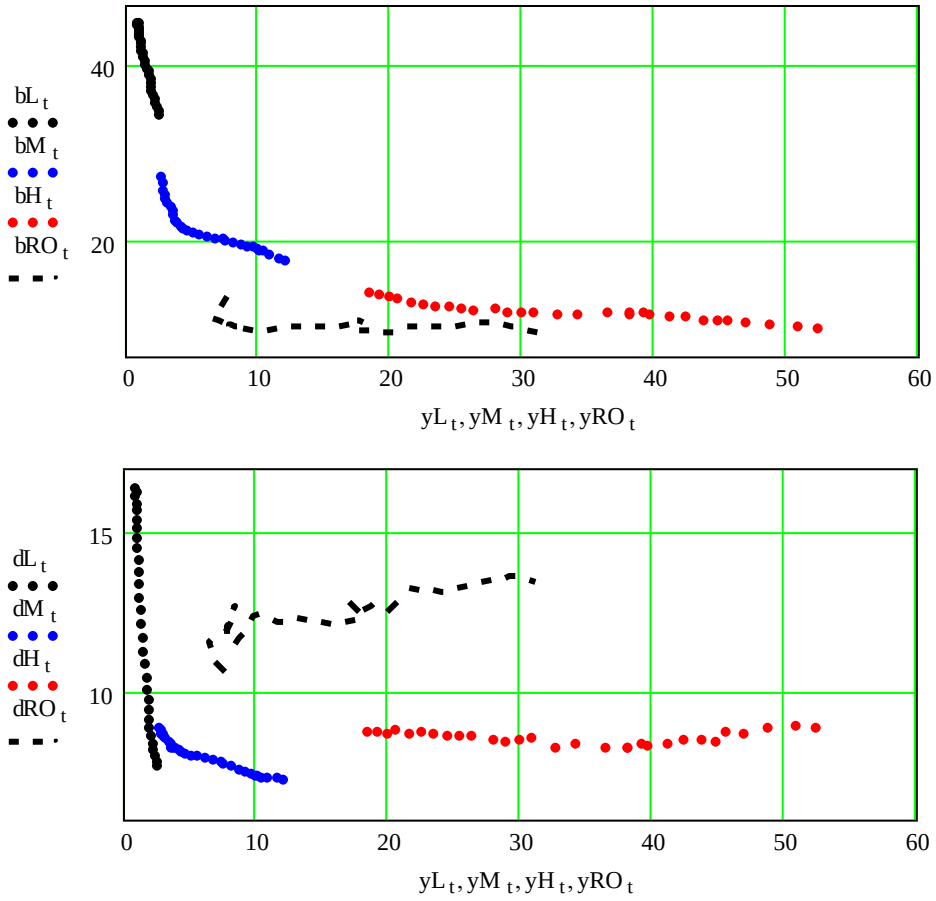

Figure 6

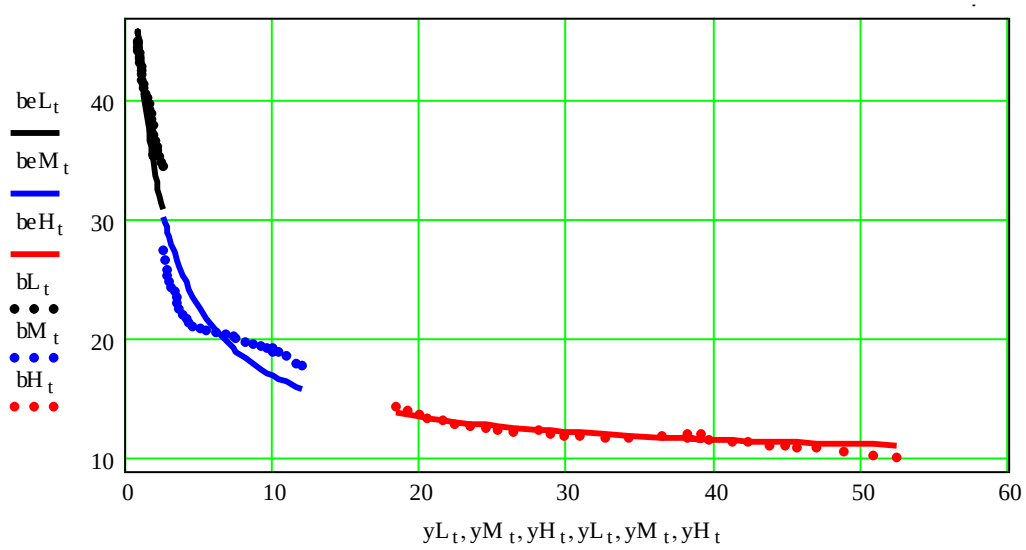

Figure 7

At the level of income groups in the world economy, in the case of the birth rate, it is observed that the transition from one regime to another seems to occur "naturally" when the level of development (expressed by per capita income) is increasing.

The first transition occurs by moving from the regime characteristic of economically underdeveloped states to that specific to the group of states with an average level of development (the transition from black trajectory to blue one).

The second transition consists in the transition from the regime characteristic of the middle-developed states to the one specific to the developed states (the transition from the blue trajectory to the red one).

Based on econometric analysis, we estimated a model that allows a smooth transition between the empirical trends corresponding to the three groups of states. Thus, based on the empirical data, in order to build a model for simulating the birth rate dynamics, dependent of the per capita income, we identified a simple regression equation for the variable b:

$$b(y) = (a + b * y) / (c + d * y) + u$$

where a, b, c and d are the estimated parameters, and u – the residue.

By applying this regression equation, specific to the natality rate, we obtained the trajectory of the estimated values beL, beM, and respectively beH, corresponding to any value of per capita income, y, recorded in the analysed period in case of each group of states. The estimated values of the regression parameters are as follows:

$$a = 35.14418799,\ b = 3.409189333,$$
$$c = 0.5113586842 \text{ and } d = 0.3581813024$$

The result of estimation model is shown graphically in Figure 7. The theoretical curve, estimated according to per capita income values, is shown by the segments of the continuous trajectory having the following colours: black (for the group of states L), blue (for the group M) and red (for the group H), as parts of the global theoretical trajectory, compared to the data actually recorded (represented by the three sets of points (in turn black, blue and red).

The detailed data for demographic variables and per capita income, both collected from international sources and those computed by us, are presented in Tables of Annex 7 for global economy and of Annex 8 for EU.

SELECTED REFERENCES

Ahmed, H. (2014). "The socio-economic and political impacts of youth bulge: The case of Sudan". *Journal of Social Science Studies*. 1 (2): 224–235.

Albu, L. L. (2019). *Trends in FDI and its role in Development and Convergence*, Working Papers of Institute for Economic Forecasting 190612, Institute for Economic Forecasting.

International Organization for Migration (2008). *World Migration 2008: Managing Labour Mobility in the Evolving Global Economy*. Hammersmith Press. pp. 440. ISBN 978-92-9068-405-3.

Madsen, E. L., Daumerie, B., Hardee, K. (2010). "The effects of age structure on development". *Policy and Issue Brief, Population Action International*.: 1–4.

Raileanu-Szeles, M., Albu, L. (2015). "Nonlinearities and divergences in the process of European financial integration", *Economic Modelling*, Elsevier, vol. 46(C), pages 416-425.

Simon, C., Belyakov, A. O., Feichtinger, G. (2012). "Minimizing the dependency ratio in a population with below-replacement fertility through immigration". *Theoretical Population Biology*. ***82*** *(3): 158–169.*

Annex 1

1	Albania	41	Finland	81	Nepal
2	Algeria	42	France	82	Netherlands
3	Angola	43	Gabon	83	New Zealand
4	Argentina	44	Gambia, The	84	Niger
5	Australia	45	Germany	85	Norway
6	Austria	46	Ghana	86	Oman
7	Bahrain	47	Greece	87	Pakistan
8	Bangladesh	48	Guatemala	88	Panama
9	Belgium	49	Guinea-Bissau	88	Panama
10	Belize	50	Guyana	89	Papua New Guinea
11	Benin	51	Haiti	90	Paraguay
12	Bhutan	52	Honduras	91	Peru
13	Bolivia	53	Hungary	92	Philippines
14	Botswana	54	Iceland	93	Poland
15	Brazil	55	India	94	Portugal
16	Bulgaria	56	Indonesia	95	Qatar
17	Burkina Faso	57	Iran, Islamic Rep.	96	Romania
18	Burundi	58	Ireland	97	Rwanda
19	Cameroon	59	Israel	98	Saudi Arabia
20	Canada	60	Italy	99	Senegal
21	Central African Republic	61	Jamaica	100	Sierra Leone
22	Chad	62	Japan	101	Solomon Islands
23	Chile	63	Jordan	102	Spain
24	China	64	Kenya	103	Sri Lanka
25	Colombia	65	Korea, Rep.	104	Sudan
26	Comoros	66	Lao PDR	105	Sweden
27	Congo, Dem. Rep.	67	Lebanon	106	Switzerland
28	Congo, Rep.	68	Lesotho	107	Tanzania
29	Costa Rica	69	Libya	108	Thailand
30	Cote d’Ivoire	70	Luxembourg	109	Togo
31	Cyprus	71	Madagascar	110	Trinidad and Tobago
32	Denmark	72	Malawi	111	Tunisia
33	Dominican Republic	73	Malaysia	112	Turkey
34	Ecuador	74	Maldives	113	Uganda
35	Egypt, Arab Rep.	75	Mali	114	United Arab Emirates
36	El Salvador	76	Malta	115	United Kingdom
37	Equatorial Guinea	77	Mauritius	116	United States
38	Eswatini	78	Mexico	117	Uruguay
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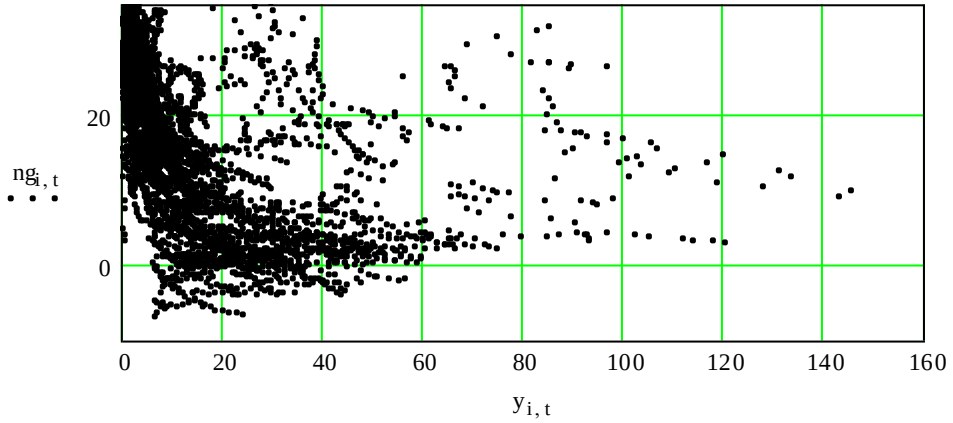
Annex 2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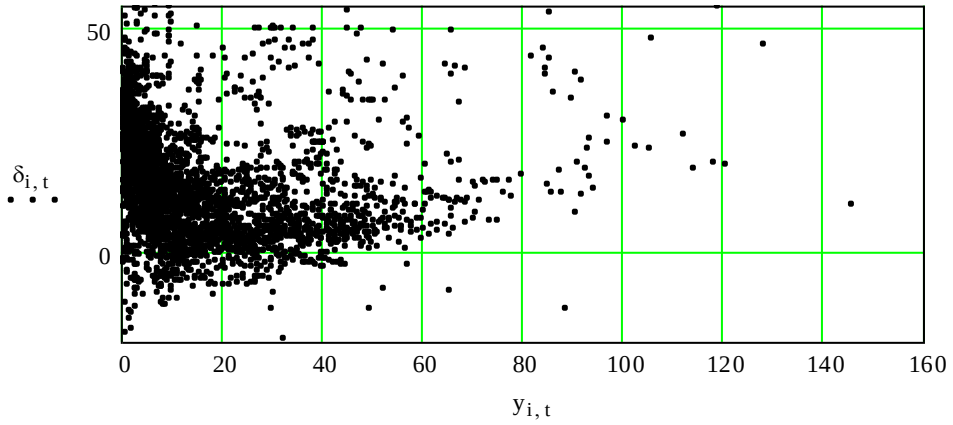
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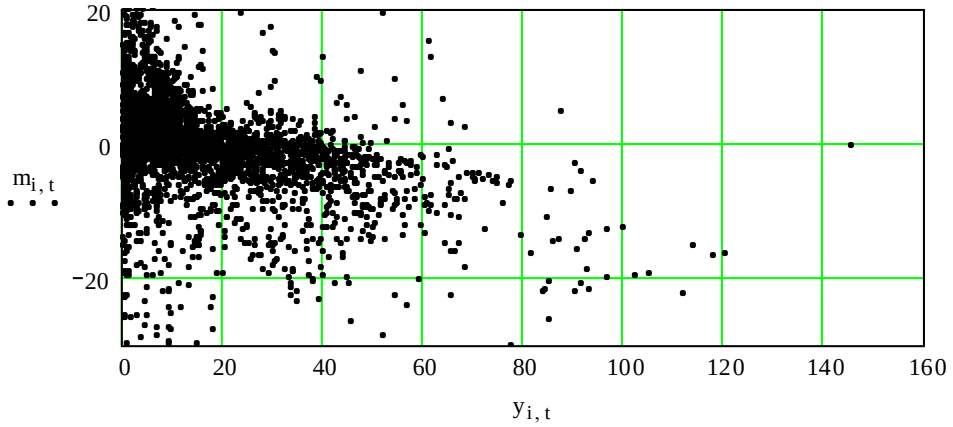
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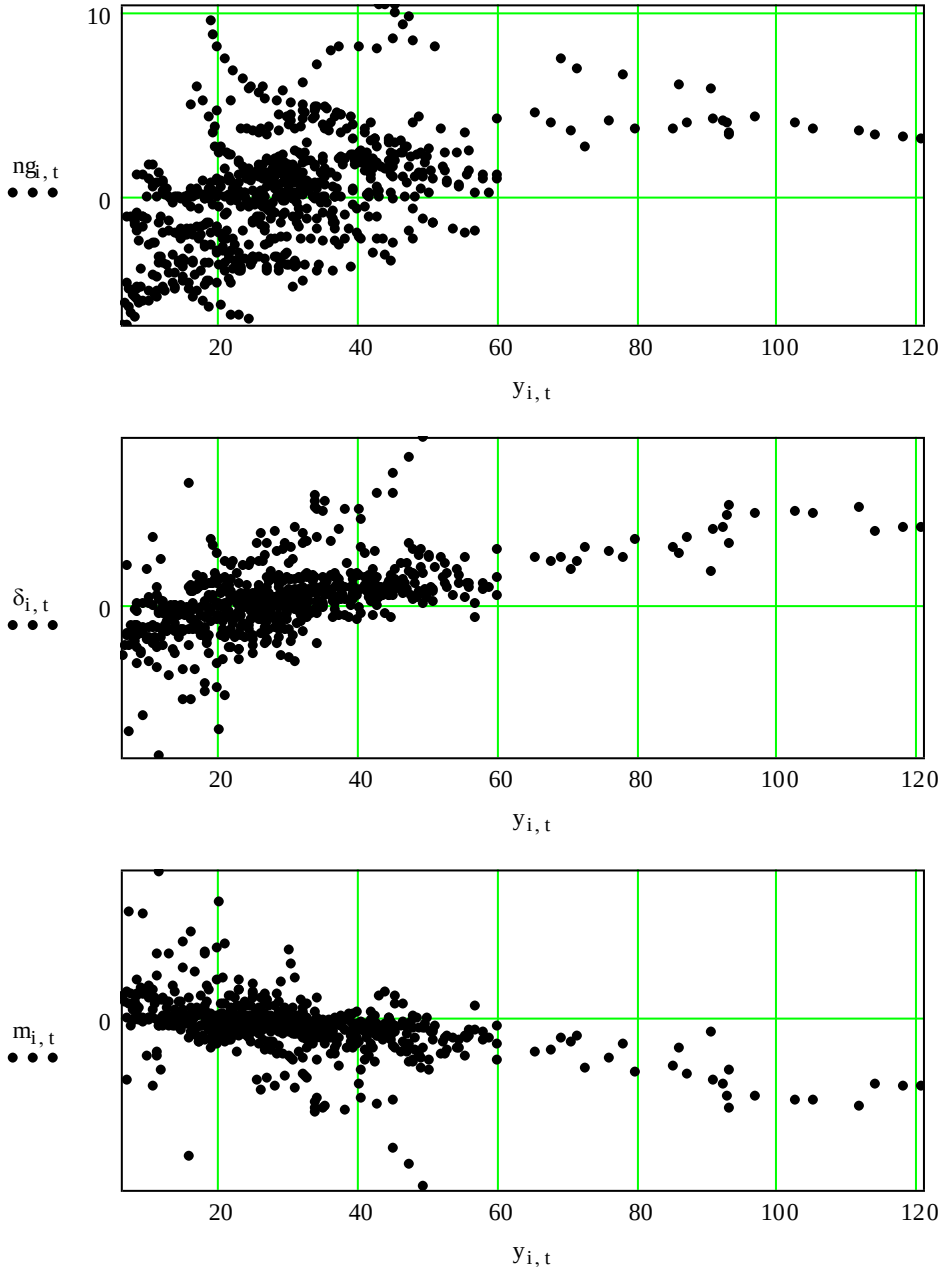
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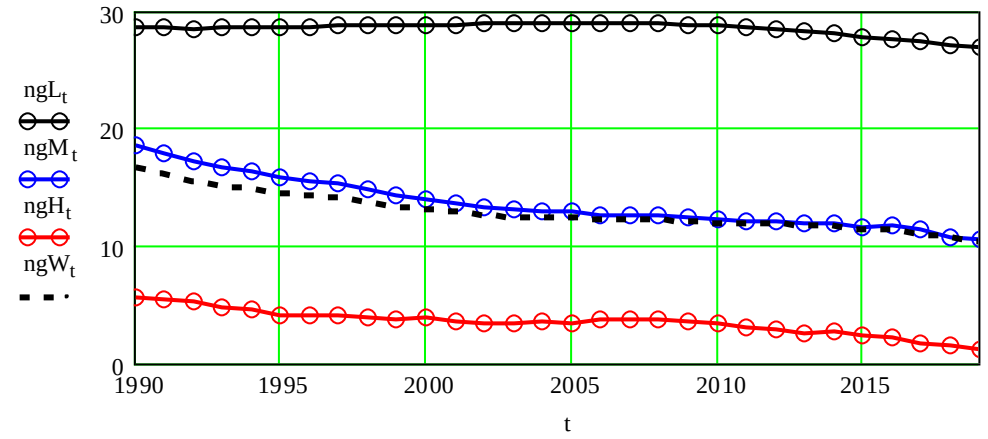
Annex 4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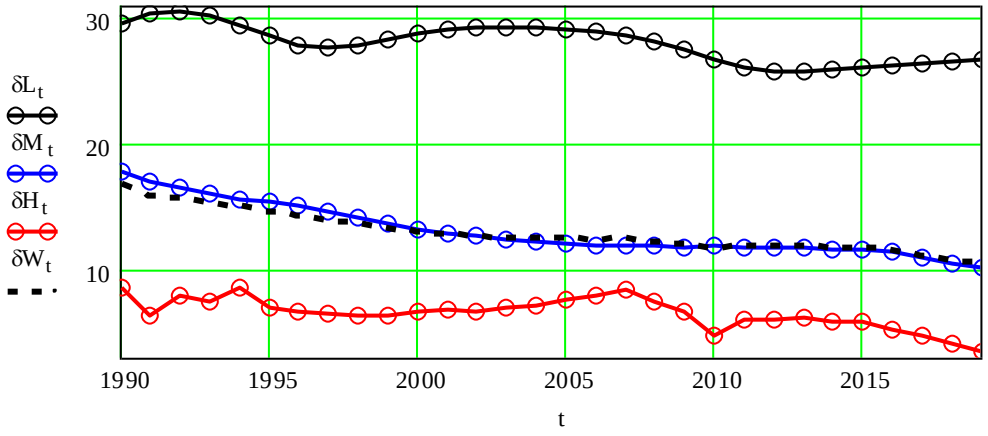
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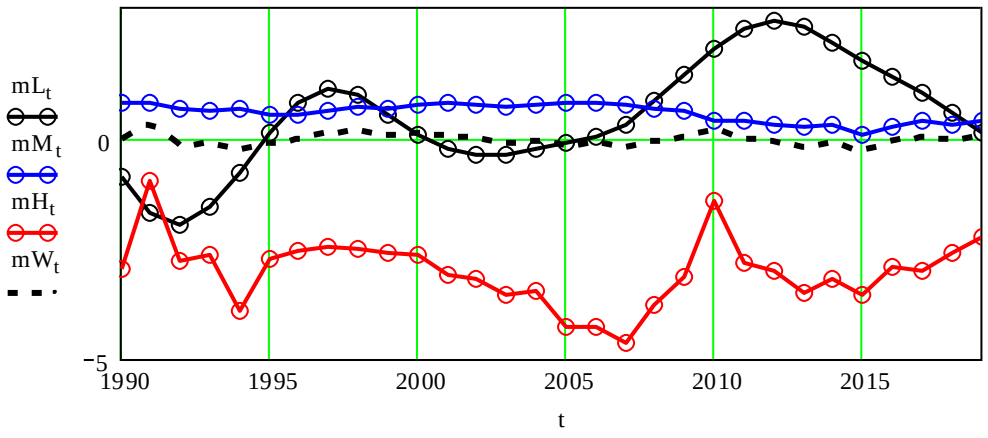
10
1990
1995
2000
2005
2010
2015
t


mL_t
mM_t
mH_t
mW_t
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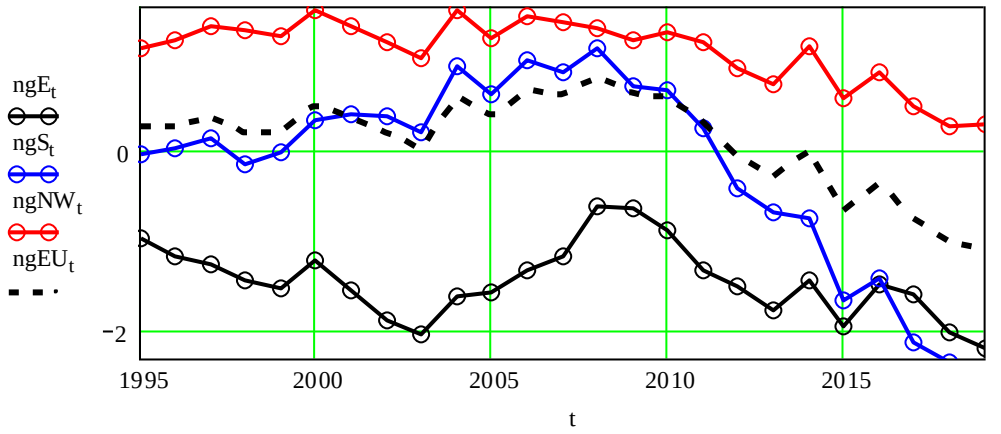
−5
1990
1995
2000
2005
2010
2015
t

Annex 5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ngNW_t
ngEU_t
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1995
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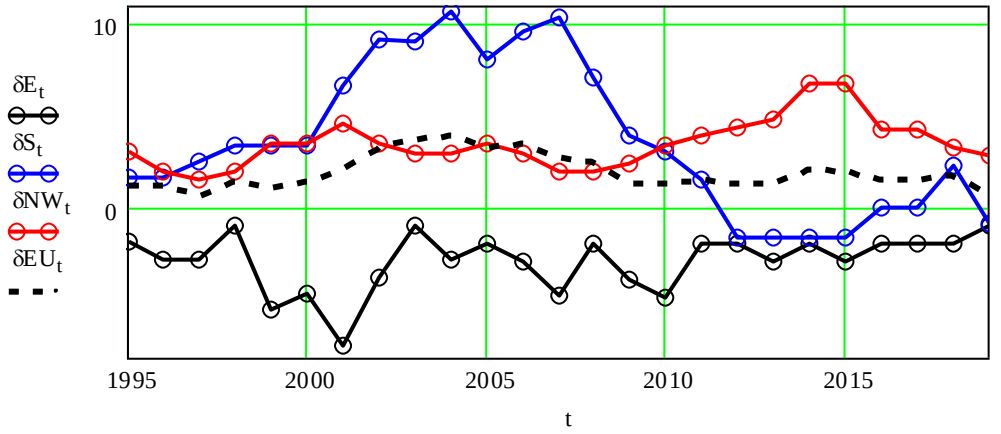
2005
2010
2015
t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δS_t
δNW_t
δEU_t
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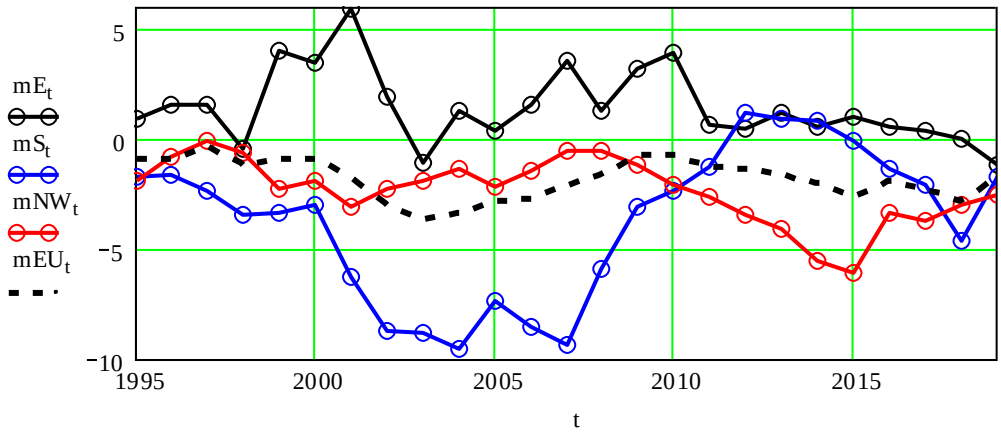
1995
2000
2005
2010
2015
t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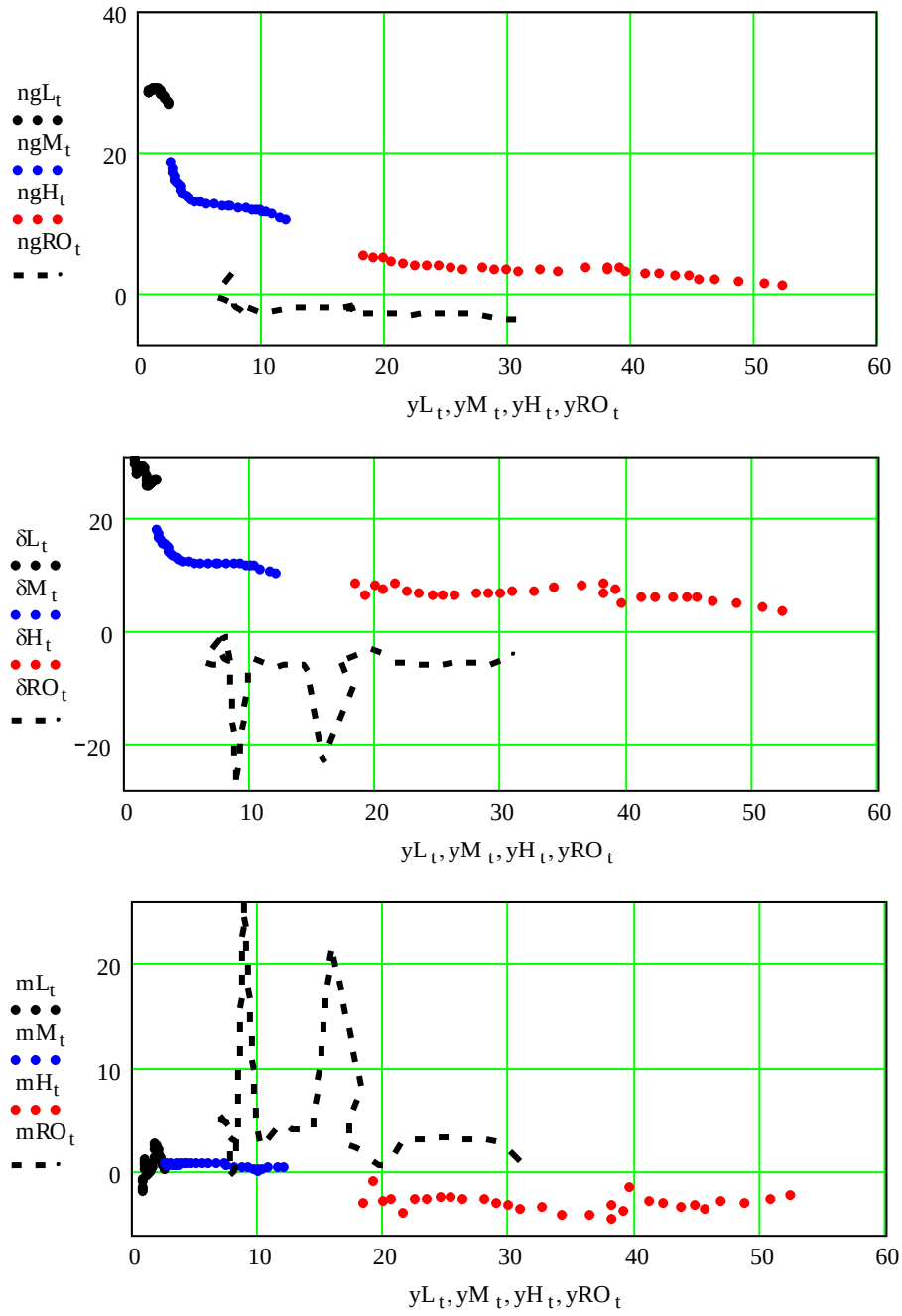
mS_t
mNW_t
mEU_t
5
0
−5
−10
1995
2000
2005
2010
2015
t

Annex 6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ngM_t
ngH_t
ngRO_t
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0 10 20 30 40 50 60
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δL_t
δM_t
δH_t
δRO_t
20
0
−20
0 10 20 30 40 50 60
yL_t, yM_t, yH_t, yRO_t
mL_t
mM_t
mH_t
mRO_t
20
10
0
0 10 20 30 40 50 60
yL_t, yM_t, yH_t, yRO_t

Annex 7

	yW	yL	yM	yH	bW	bL	bM	bH	dW	dL	dM	dH	ngW	ngL	ngM	ngH	δW	δL	δM	δH	mW	mL	mM	mH
1990	5.541	0.898	2.646	18.355	25.879	44.932	27.406	14.243	9.226	16.330	8.850	8.727	16.653	28.603	18.556	5.516	16.684	29.502	17.782	8.474	-0.031	-0.899	0.773	-2.958
1991	5.744	0.912	2.743	19.176	25.214	44.736	26.557	13.994	9.162	16.234	8.771	8.708	16.052	28.503	17.785	5.286	15.729	30.211	16.981	6.284	0.323	-1.708	0.804	-0.998
1992	5.913	0.903	2.815	19.952	24.582	44.543	25.750	13.746	9.078	16.079	8.683	8.626	15.504	28.464	17.067	5.120	15.646	30.427	16.417	7.906	-0.142	-1.963	0.650	-2.787
1993	6.075	0.911	2.917	20.544	24.182	44.349	25.279	13.395	9.099	15.870	8.684	8.769	15.083	28.479	16.596	4.626	15.204	30.047	15.979	7.306	-0.122	-1.568	0.617	-2.679
1994	6.307	0.916	3.022	21.518	23.804	44.150	24.816	13.134	9.009	15.628	8.599	8.674	14.795	28.521	16.217	4.460	15.060	29.314	15.545	8.414	-0.265	-0.793	0.673	-3.954
1995	6.562	0.954	3.166	22.432	23.368	43.936	24.297	12.800	8.954	15.367	8.529	8.720	14.414	28.569	15.769	4.080	14.527	28.458	15.266	6.821	-0.113	0.110	0.502	-2.742
1996	6.855	0.997	3.349	23.425	23.079	43.700	23.925	12.672	8.846	15.085	8.420	8.641	14.233	28.615	15.504	4.031	14.272	27.809	15.004	6.613	-0.039	0.805	0.501	-2.582
1997	7.146	1.035	3.515	24.493	22.750	43.436	23.507	12.521	8.743	14.778	8.315	8.580	14.007	28.658	15.191	3.941	13.916	27.522	14.578	6.403	0.091	1.136	0.613	-2.463
1998	7.286	1.054	3.541	25.324	22.337	43.142	22.985	12.356	8.661	14.445	8.229	8.575	13.676	28.697	14.756	3.781	13.518	27.711	14.033	6.308	0.159	0.987	0.723	-2.527
1999	7.548	1.077	3.683	26.350	21.912	42.822	22.444	12.213	8.622	14.090	8.193	8.610	13.290	28.731	14.251	3.603	13.231	28.199	13.611	6.199	0.059	0.533	0.640	-2.596
2000	8.006	1.106	3.936	28.019	21.677	42.478	22.099	12.319	8.592	13.719	8.213	8.458	13.085	28.759	13.886	3.861	12.976	28.696	13.134	6.503	0.109	0.063	0.752	-2.643
2001	8.282	1.159	4.124	28.929	21.329	42.119	21.712	11.966	8.513	13.335	8.150	8.391	12.816	28.784	13.562	3.574	12.768	29.023	12.762	6.680	0.048	-0.240	0.800	-3.105
2002	8.577	1.190	4.333	29.864	21.071	41.747	21.397	11.818	8.481	12.935	8.119	8.459	12.590	28.812	13.278	3.359	12.615	29.218	12.546	6.547	-0.024	-0.406	0.733	-3.188
2003	8.949	1.237	4.627	30.875	20.859	41.367	21.109	11.824	8.426	12.522	8.060	8.532	12.433	28.846	13.049	3.292	12.543	29.239	12.346	6.868	-0.109	-0.394	0.703	-3.576
2004	9.550	1.307	5.059	32.595	20.703	40.978	20.916	11.744	8.291	12.098	7.982	8.225	12.412	28.881	12.933	3.518	12.469	29.118	12.201	7.003	-0.057	-0.238	0.733	-3.485
2005	10.160	1.402	5.533	34.192	20.570	40.577	20.755	11.665	8.272	11.669	7.960	8.365	12.298	28.908	12.795	3.300	12.437	29.024	12.012	7.574	-0.140	-0.116	0.783	-4.274
2006	10.983	1.499	6.150	36.395	20.422	40.160	20.517	11.857	8.191	11.242	7.921	8.210	12.231	28.918	12.596	3.647	12.357	28.906	11.815	7.921	-0.127	0.012	0.781	-4.274
2007	11.745	1.611	6.782	38.175	20.341	39.727	20.391	11.965	8.119	10.824	7.853	8.243	12.222	28.903	12.538	3.722	12.409	28.589	11.783	8.379	-0.186	0.314	0.754	-4.657
2008	12.286	1.702	7.308	39.138	20.232	39.280	20.252	11.967	8.071	10.424	7.804	8.326	12.161	28.856	12.448	3.641	12.217	28.033	11.769	7.418	-0.057	0.823	0.679	-3.777
2009	12.260	1.755	7.535	38.129	20.036	38.825	20.060	11.707	7.958	10.049	7.707	8.236	12.078	28.776	12.352	3.471	12.033	27.350	11.739	6.614	0.045	1.426	0.613	-3.144
2010	12.911	1.850	8.112	39.560	19.809	38.368	19.799	11.570	7.888	9.703	7.635	8.282	11.922	28.665	12.164	3.288	11.703	26.634	11.755	4.719	0.219	2.031	0.409	-1.431
2011	13.595	1.878	8.714	41.182	19.629	37.912	19.609	11.380	7.802	9.387	7.540	8.331	11.827	28.525	12.069	3.049	11.839	26.047	11.703	5.885	-0.013	2.478	0.366	-2.835
2012	14.135	1.827	9.237	42.309	19.514	37.461	19.480	11.324	7.748	9.097	7.468	8.453	11.766	28.364	12.012	2.871	11.838	25.704	11.716	5.903	-0.072	2.660	0.296	-3.032
2013	14.657	1.903	9.673	43.676	19.304	37.016	19.283	11.003	7.684	8.829	7.405	8.476	11.619	28.187	11.879	2.527	11.802	25.670	11.648	6.027	-0.183	2.516	0.230	-3.500
2014	15.038	2.074	9.962	44.832	19.217	36.575	19.175	11.035	7.624	8.582	7.363	8.407	11.593	27.993	11.812	2.628	11.687	25.850	11.532	5.839	-0.094	2.143	0.279	-3.212
2015	15.185	2.136	10.040	45.602	18.965	36.138	18.876	10.931	7.620	8.355	7.317	8.705	11.345	27.783	11.559	2.225	11.637	26.032	11.478	5.790	-0.292	1.751	0.082	-3.565
2016	15.610	2.249	10.370	46.892	18.949	35.707	18.889	10.825	7.570	8.150	7.280	8.660	11.379	27.557	11.609	2.165	11.439	26.156	11.358	5.093	-0.059	1.401	0.251	-2.928
2017	16.262	2.332	10.885	48.781	18.629	35.281	18.540	10.524	7.567	7.965	7.258	8.836	11.062	27.316	11.281	1.688	11.062	26.314	10.897	4.722	0.001	1.002	0.384	-3.034
2018	17.061	2.438	11.565	50.812	18.169	34.857	17.991	10.286	7.558	7.797	7.254	8.888	10.612	27.061	10.737	1.398	10.651	26.498	10.419	4.025	-0.039	0.563	0.318	-2.627
2019	17.640	2.529	12.065	52.368	17.897	34.435	17.691	10.040	7.525	7.643	7.236	8.853	10.372	26.793	10.455	1.186	10.360	26.669	10.052	3.414	0.012	0.124	0.403	-2.228
2020	17.112	2.524	11.816	50.572																				

Source: Author's computation based on World Bank data.

Annex 8

	yEU	yE	yS	yNW	bEU	bE	bS	bNW	dEU	dE	dS	dNW	ngEU	ngE	ngS	ngNW	δEU	δE	δS	δNW	mEU	mE	mS	mNW
1995	19.294	9.135	20.765	24.110	10.504	10.518	9.379	11.176	10.248	11.496	9.422	10.047	0.256	-0.977	-0.043	1.129	1.180	-1.820	1.693	3.066	-0.924	0.842	-1.737	-1.937
1996	20.005	9.674	21.505	24.872	10.505	10.328	9.444	11.243	10.252	11.519	9.433	10.037	0.253	-1.192	0.011	1.206	1.179	-2.735	1.691	2.038	-0.926	1.543	-1.680	-0.832
1997	20.852	10.038	22.443	25.910	10.482	10.127	9.546	11.243	10.142	11.406	9.422	9.873	0.340	-1.279	0.125	1.371	0.706	-2.742	2.532	1.525	-0.366	1.463	-2.407	-0.154
1998	21.693	10.410	23.315	26.965	10.343	9.835	9.490	11.139	10.145	11.274	9.645	9.820	0.199	-1.439	-0.155	1.319	1.412	-0.917	3.367	2.030	-1.213	-0.522	-3.522	-0.711
1999	22.594	10.747	24.252	28.134	10.310	9.713	9.603	11.065	10.123	11.253	9.625	9.800	0.186	-1.540	-0.022	1.265	1.175	-5.505	3.356	3.546	-0.988	3.965	-3.378	-2.281
2000	23.978	11.485	25.741	29.751	10.448	9.771	9.827	11.194	9.951	11.006	9.496	9.649	0.497	-1.236	0.331	1.545	1.408	-4.613	3.344	3.534	-0.911	3.377	-3.013	-1.989
2001	25.036	12.162	26.950	30.865	10.207	9.439	9.721	10.916	9.851	11.003	9.330	9.540	0.356	-1.564	0.391	1.376	2.109	-7.414	6.667	4.527	-1.753	5.850	-6.276	-3.151
2002	25.692	12.871	27.556	31.440	10.130	9.277	9.806	10.784	9.946	11.166	9.440	9.597	0.185	-1.889	0.366	1.187	3.274	-3.735	9.106	3.505	-3.089	1.846	-8.740	-2.319
2003	26.403	13.697	28.252	32.048	10.147	9.284	9.950	10.726	10.125	11.321	9.764	9.707	0.022	-2.037	0.186	1.019	3.730	-0.937	9.024	2.994	-3.708	-1.100	-8.838	-1.975
2004	27.749	14.920	29.397	33.546	10.251	9.499	10.124	10.728	9.667	11.119	9.190	9.189	0.584	-1.620	0.934	1.539	3.948	-2.814	10.569	2.985	-3.364	1.194	-9.635	-1.446
2005	29.109	16.195	30.532	35.040	10.221	9.761	10.050	10.568	9.859	11.348	9.441	9.332	0.361	-1.588	0.609	1.236	3.238	-1.881	8.045	3.472	-2.877	0.294	-7.436	-2.236
2006	31.018	17.840	32.117	37.247	10.333	9.958	10.123	10.661	9.686	11.290	9.126	9.192	0.648	-1.332	0.997	1.469	3.459	-2.828	9.577	2.966	-2.811	1.496	-8.580	-1.497
2007	32.809	19.539	33.479	39.314	10.385	10.206	10.175	10.609	9.771	11.396	9.319	9.206	0.614	-1.190	0.856	1.404	2.757	-4.726	10.277	1.971	-2.144	3.536	-9.421	-0.568
2008	33.632	20.846	33.722	40.195	10.632	10.743	10.437	10.697	9.829	11.379	9.318	9.348	0.803	-0.635	1.119	1.350	2.521	-1.899	7.042	1.968	-1.717	1.264	-5.923	-0.618
2009	32.328	20.319	32.190	38.609	10.472	10.782	10.043	10.583	9.857	11.440	9.335	9.371	0.615	-0.659	0.708	1.213	1.371	-3.806	3.885	2.455	-0.757	3.147	-3.177	-1.242
2010	33.352	20.950	32.646	40.158	10.439	10.542	9.914	10.719	9.850	11.435	9.259	9.410	0.590	-0.893	0.655	1.308	1.370	-4.776	3.096	3.428	-0.780	3.882	-2.441	-2.120
2011	34.620	22.170	32.949	42.009	10.131	9.973	9.576	10.562	9.823	11.317	9.335	9.372	0.308	-1.345	0.241	1.190	1.596	-1.919	1.543	3.904	-1.288	0.575	-1.302	-2.715
2012	35.084	22.954	32.750	42.687	10.016	9.977	9.239	10.526	10.078	11.497	9.674	9.616	-0.062	-1.520	-0.436	0.910	1.365	-1.923	-1.541	4.375	-1.428	0.403	1.105	-3.465
2013	36.284	23.937	33.298	44.361	9.734	9.638	8.697	10.432	10.020	11.411	9.393	9.715	-0.286	-1.772	-0.695	0.717	1.364	-2.890	-1.543	4.840	-1.650	1.118	0.848	-4.123
2014	37.323	24.960	33.908	45.617	9.846	9.935	8.631	10.559	9.862	11.375	9.381	9.407	-0.016	-1.441	-0.750	1.152	2.043	-1.932	-1.546	6.744	-2.059	0.492	0.796	-5.592
2015	38.481	26.110	34.852	46.841	9.731	9.889	8.451	10.445	10.409	11.838	10.116	9.883	-0.677	-1.950	-1.665	0.562	2.039	-2.904	-1.548	6.699	-2.716	0.955	-0.117	-6.136
2016	40.847	27.842	37.392	49.334	9.832	10.135	8.302	10.621	10.188	11.618	9.724	9.773	-0.357	-1.483	-1.422	0.848	1.582	-1.942	0.000	4.278	-1.939	0.459	-1.422	-3.430
2017	43.175	30.039	39.347	51.898	9.710	10.371	8.029	10.414	10.473	11.977	10.162	9.931	-0.763	-1.606	-2.133	0.483	1.580	-1.946	0.000	4.259	-2.343	0.340	-2.133	-3.776
2018	45.118	32.212	40.935	53.897	9.501	10.101	7.708	10.300	10.522	12.118	10.057	10.034	-1.022	-2.017	-2.349	0.266	1.803	-1.949	2.326	3.299	-2.824	-0.068	-4.675	-3.032
2019	46.728	34.170	42.097	55.582	9.280	9.777	7.424	10.168	10.400	11.982	9.977	9.896	-1.120	-2.205	-2.552	0.272	0.675	-0.977	-0.773	2.818	-1.795	-1.228	-1.779	-2.546
2020	44.428	33.268	38.595	53.306																				

Source: Author's computation based on World Bank data.