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Economic Crises in the Results of the Non-Financial Corporations Sector in the Czech Republic[1]

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Abstract

In connection with the financial and subsequent economic crisis, the role of non-financial corporations is often discussed and the causes and effects of the crisis are analysed. Viewing two critical periods of economic development in the Czech Republic – the first in 1997–1998, and the second in 2009–2010 – we can see that non-financial corporations generated a high level of net borrowing in the first instance and, on the contrary, a high level of net lending in the second instance. Regardless of the different causes of the crises in the above-mentioned periods, a natural question arises: what kind of transformation took place in the economic behaviour of non-financial corporations between 1998 and 2008? Consequently, what was the source of their overall (and in a time of crisis, surprising) profit in the crisis years of 2009 and 2010. When analysing the economic behaviour of the non-financial corporations sector in the Czech Republic we will, naturally, base our considerations on the data from national accounts of the Czech Republic as published by the Czech Statistical Office and will also utilise the usual relative indices immediately implied by the national account ones, as well as indices whose construction is closer to the evaluation usual in corporate practice.

Keywords

Non-financial corporations, economic crisis, sector analysis

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INTRODUCTION

In connection with financial and subsequent economic crisis, the role of non-financial corporations is often discussed and the causes and effects of the crisis are analysed. It is certain that findings based on investigation of individual enterprises' problems will be different from those implied by macroeconomic analysis of non-financial corporations' data. Viewing two critical periods of economic development in

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the Czech Republic (namely, the first in 1997–1998, and the second in 2009–2010) we can see the non-financial corporations sector as the loser in the first instance and the winner in the second one if we measure their success in terms of net lending/net borrowing, as a summary indicator of their trade in both financial and non-financial transactions. Regardless of different causes of the crises in the above-mentioned periods, a natural question arises: what kind of transformation took place in the economic behaviour of non-financial corporations between 1998 and 2008? Consequently, what was the source of their overall (and in a time of crisis, surprising) profit in the crisis years of 2009 and 2010. When analysing the economic behaviour of the non-financial corporations sector in the Czech Republic we will, naturally, base our considerations on the data from national accounts of the Czech Republic as published by the Czech Statistical Office and will also utilise the usual relative indices immediately implied by the national account ones, as well as indices whose construction is closer to the evaluation usual in corporate practice. Both these groups of indices are complementary to each other within the description and analysis of the non-financial corporations' behaviour and enable us to get a better insight into the substance of the problem on which the present article is focused, namely: to identify, on the basis of the national account data, causes of the different economic position of Czech non-financial corporations in two critical periods of the Czech economy.

Before analysing the economic behaviour of the non-financial corporations sector on the basis of the national account data in the period from 1995 to 2010, let us recall important milestones of macroeconomic development in the Czech Republic.

1 DEVELOPMENT OF THE CZECH ECONOMY – ANNUAL DATA

There was a decrease of economic activity caused by the beginning of the economic transformation in the Czech Republic in the period after 1990. After this short (1991–1993) period, economic growth took place with a peak in 1995–1996, immediately followed by an economic crisis with decreasing GDP in 1997–1998. The causes of that crisis can be predominantly found in unsolved or unresolved problems of privatisation, slow restructuring of industry, uncertainty in the banking sector and, last but not least, strongly restrictive anti-inflation policies. In 2000, the economic development turned to growth, and the most successful years in the Czech Republic's economic development came.

Nevertheless, the gain in 2001–2004 and the subsequent boom in 2005–2007 were stages different from each other. The period 2001–2004 was distinguished by stable economic growth supported by a high rate of growth in industrial and constructional production, consumption by households and the general government, as well as gradual improvement of foreign-trade relationships including the terms of trade, significant strengthening of the Czech Crown and a stable or even slightly decreasing unemployment rate, lower inflation rate, and decreasing prices of industrial products. This positive development was, however, accompanied by a growing deficit of the state budget, doubling of the government debt, growing government deficit, and worsening of the yield balance. In the period of years 2005–2006, key factors of the growth were changed: foreign trade became the main factor of the year-to-year growth of the economy, amounting to six per cent growth of GDP, the Czech Crown continued to grow stronger, the government debt was stabilised, the government deficit was reduced, and the unemployment rate was decreasing. On the other hand, the loss on the current account of the balance of payments was getting higher, the terms of trade were getting worse, and households' indebtedness and consumption were growing.

In the beginning seven years of the 21st century, the Czech economy achieved a very favourable rate of growth, not only in comparison with the 1990s but also with the EU member countries. A characteristic feature distinguishing the economic development in the Czech Republic after 2000 from that in the 1990s was, specifically, the gradual improvement of foreign-trade relationships, which became the motor of the economic growth and replaced the traditional factors, i.e., households' consumption and investments. When characterising the evolution in that period, we must not forget the high rate of growth in the in-

dustrial and constructional production, the related domestic investments, an influx of export-oriented investments from abroad, and – last but not least – a certain degree of saturation by modern investments and technologies in 2000–2001.

The favourable results of the Czech Republic's economy were, however, injured by the signs of the worldwide financial crisis and later the economic recession in 2008–2010. In consequence of decreasing industrial and constructional production, investments into fixed capital were significantly reduced and both exports and imports went down. The Czech economy was able to maintain a positive trade balance despite the falling volume and rate of exchange of goods and services with foreign countries, and the Czech Crown was even slightly further strengthened. Negative results of production industries were only weakly reflected in the slowdown and subsequent stagnancy of the final consumption expenditure by households and the slowdown of the growth of households' indebtedness. An increase of the government deficit, a low level of economic activities and growing unemployment rate led to growth of the government debt rather high above the long-term level of about 30%, which was valid from 2003 to 2008.[4] Table 1 shows the year-to-year GDP growth in the Czech Republic in the relevant time period.

Table 1 GDP growth in the Czech Republic (in %)

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Year-to-year GDP growth (%)	6.2	4.5	–0.9	–0.2	1.7	4.2	3.1	2.1	3.8	4.7	6.8	7.0	5.7	3.1	–4.7	2.7

Note: GDP – gross domestic product.
Source: Czech Statistical Office (www.czso.cz)

Viewing the national economy of the Czech Republic via the data of institutional sectors it is obvious that, while the 1997–1998 crisis adversely affected non-financial corporations almost exclusively (with a net borrowing of 141.4 bln. CZK, while the general government's deficit was moderate: 68.2 bln. CZK, i.e., 3.6% GDP), the 2009 crisis made non-financial corporations "victorious" with a net lending of 95.8 bln. CZK. The largest value of deficit (measured as net borrowing) was suffered by the general government in 2009 (namely, 217.7 bln. CZK); all other sectors achieved net lending (even households got to a value of net lending five times higher than that of 2008), thus being able to compensate the public deficit to the total indebtedness of the national economy with respect to abroad amounting to 47.8 bln. CZK. The positive economic result achieved by the non-financial corporations in 2009 and then in 2010 (amounting to 50.7 bln. CZK) is surprising from two viewpoints: first, the Czech non-financial corporations thus achieved net lending for the first time after 1995 and, second, it was in a year of crisis[5] (with a 4.7% year-to-year drop of GDP in the Czech Republic).

2 ANALYSIS OF NON-FINANCIAL CORPORATIONS SECTOR

The non-financial corporations sector includes units – producers on the market whose main function is the production of goods and non-financial market services. From the national-economy point of view, it is the most important sector covering both public and private enterprises, cooperatives, etc., from all branches of the national economy except for financial, insurance and non-market services.[6] Proportion of this sector in GDP is dominant – its long-term value in the Czech Republic is about 55%.

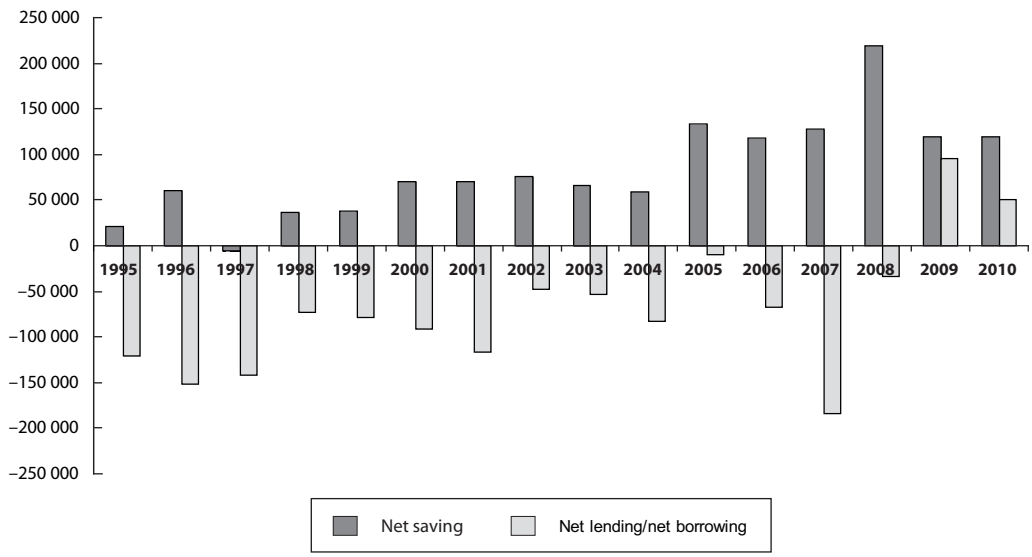
For analysis of the non-financial corporations' behaviour, relative indices are especially significant, since they eliminate the problem of current prices on the time scale and different currencies regard-

[4] For more detail see HINDLS et al, 2011.
[5] Figure 1 shows net lending / borrowing values of the non-financial corporations in the Czech Republic.
[6] For more detail see HRONOVÁ et al, 2009.

ing territorial comparisons. Apart from a number of structural indices, others are also used that can, to a certain extent, be understood as analogies of indices usual in corporate practice.[7] Such indices enable us to get a better insight into the specific features of the non-financial corporations sector, which cannot be identified in terms of the aggregate indices provided by the national accounts data due to their general definitions.

As already stated above, the evolution of economic results achieved by the non-financial corporations sector significantly reflected the general economic development of the Czech Republic as a whole, even more so in the period of the late 1990s crisis, brought about by exclusively domestic causes related to the uneven transformation process, as well as the 2009–2010 recession, which was caused by the worldwide financial and subsequent economic crisis. These economic-cycle stages were in a most pronounced way expressed in the balance of current transactions (net saving), and the non-financial corporations' economic result (net lending or net borrowing). Their development is shown in Figure 1.

Figure 1 Evolution of the net saving and net lending/net borrowing of the non-financial corporations in the Czech Republic (mil. CZK)



Source: Czech Statistical Office (www.czso.cz)

The data seen in Figure 1 imply that, in the growth years before the crisis the non-financial corporations reached the highest value of net borrowing (–151.2 bln. CZK in 1996, or –184.1 bln. CZK in 2007); this aspect was mainly caused by a high level of year-to-year investment growth (gross capital formation in the current prices), which was 23% in both instances. However, the response to signals indicating the approaching crisis was different in each such instance. At the end of the first decade of the 21st century, the non-financial corporations' response was relatively fast and flexible. They were able to create a high value of saving in 2008 (218.9 bln. CZK at a year-to-year increase of the gross saving rate by 4 percentage points); and, at a lower investment rate (by one percentage point) they achieved a decrease of the net bor-

[7] Cf., e.g., <http://epp.eurostat.ec.europa.eu/portal/page/portal/sector_accounts/detailed_charts/non-financial_corporations>.

rowing value to –33.6 bln. CZK (i.e., by 150 bln. CZK). On the other hand, the main reason for the high value of net borrowing (–141.4 bln. CZK) in the late 1990s was the current transaction balance (negative net saving) at a lower investment rate (with a year-to-year decrease of 4 percentage points). The principal difference in the non-financial corporations' behaviour was shown in the balance of current transactions as a response to the indication of the approaching crisis. Let us now have a closer look, from the viewpoint of the non-financial corporations' current transactions, at the dominant features of the above-mentioned difference between the two key periods of economic development in the Czech Republic.[8]

2.1 Value Added and Its Structure

For the non-financial corporations sector, the decisive data are given by the production account (creation of value added), and the generation of income account (the value structure of value added). The gross value added is a dominant index, which is also a logical basis for constructing most relative indices valid for the non-financial corporations sector. Let us first view the value structure – cf. Table 2.

Table 2 Value structure of GVA for the non-financial corporations in the Czech Republic (as percentages of GVA)

GVA components	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
CE	54.9	54.8	56.2	54.3	53.5	52.7	52.0	52.7	53.2	53.2	53.0	51.9	52.0	53.3	54.0	54.3
NTPI	–0.5	–0.4	–0.5	–1.3	–1.3	–1.4	–1.7	–1.2	–1.3	–1.0	–1.3	–1.2	–1.3	–1.3	–1.7	–1.4
GOS	45.6	45.6	44.3	47.0	47.9	48.7	49.7	48.5	48.0	47.8	48.4	49.3	49.3	48.0	47.7	47.1
GVA	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Note: GVA – gross value added, GOS – gross operating surplus, CE – compensation to employees, NTPI – net taxes on production and imports.
Source: Czech Statistical Office (www.czso.cz), our own calculations

The data shown in Table 2 imply that the proportion of compensation to employees in the gross value added was going down – from about 55% in the late 1990s to 52% in 2006 and 2007. In the years of the crisis, the compensation to employees grew faster than the value added. The periods under assessment are different from each other in this respect as well. While both net and gross value added of the non-financial corporations in current prices were growing in 1997 (with a year-to-year increase in the compensation to employees, which was even higher than the value added), both net and gross value added of the non-financial corporations showed a year-to-year decrease in 2009 (the net value added by 8.9% and the gross added value by 5.8%, both in current prices and at the average inflation rate of 2.8%) and the compensation to employees also went down (by 4.6% in current prices). In 2010 there was a stagnation of both net and gross value added while the compensation to employees grew moderately. However, the proportion of the compensation to employees in the gross value added did not get to the level of the

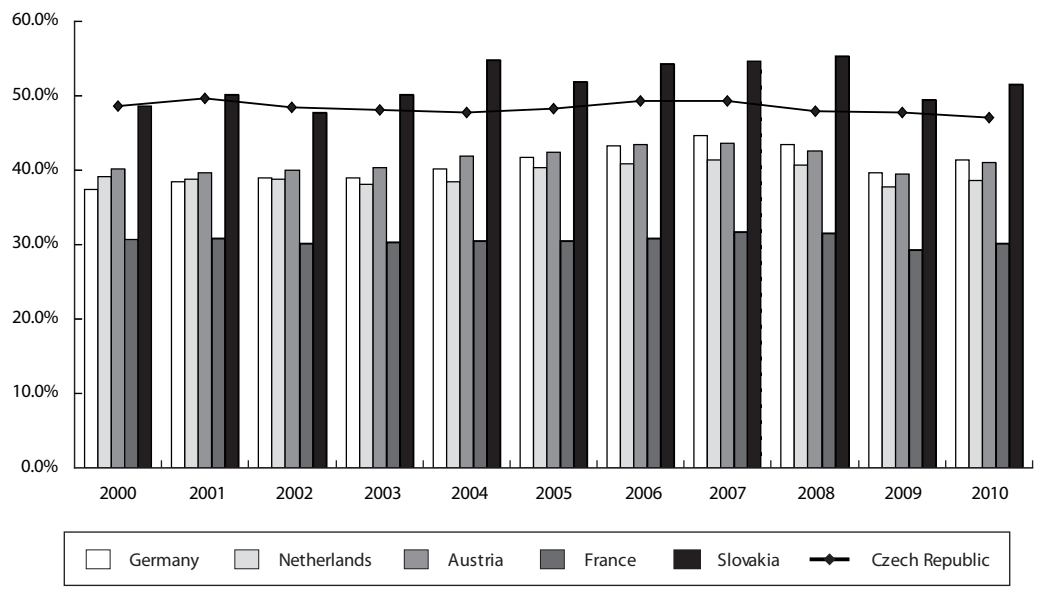
[8] A fast response by the non-financial corporations to the 2008 crisis and the subsequent improvement of their economic results is not specific only for the Czech non-financial corporations. A similar trend, i.e., net borrowing or its high value in 2008 and a changeover to net lending (even though the non-financial corporations always created net borrowing in the previous years) can be documented in other countries as well. Let us mention, for example, Slovakia, Austria or the Eurozone as a whole. In FRG, the non-financial corporations had been achieving net lending continuously since 2004; only in 2008 they got to net borrowing and then, in 2009, they created a value of net lending that was significantly higher than that of 2007. French non-financial corporations, which show a long term prevalence of net borrowing with its highest value in 2008, were only able to reduce that balance of non-financial operations in 2009 and 2010.

[9] For analyse of wages development see MAREK, 2010; for impact of the current economic crisis on employment see DUSPIVOVÁ, 2010.

late 1990s because of a higher profit share and a faster growth of received subsidies than the paid taxes on production and imports.

The proportion of the gross operational surplus in the gross value added, i.e., the profit share, is a dominant index for assessment of the non-financial corporations performance and ability to generate profit from the production, i.e., the capital income. The highest value of the profit share was achieved by the Czech non-financial corporations in 2001, and then in 2006 and 2007, i.e., always accompanied by a drop in the proportion of the compensation to employees to 52% due to the significant increase of the gross value added. In the crisis year, the profit share was falling due to the drop in the created (both gross and net) operational surplus; however this decrease was only seen in 1997 (and the profit share was growing after that), while the operational surplus stagnated in 2008 and then showed a year-to-year decrease (in the current prices) both in 2009 and in 2010. A natural consequence was the drop in the profit share. The years of recession or crisis are thus reflected in the decreasing profitability of the Czech non-financial corporations. However, the same conclusions may be drawn about the profit share in other EU countries – cf. Figure 2, even though the level of this index is different in the Czech Republic from the EU developed countries on a long-term basis.

Figure 2 Profit share (as percentage of GVA) in selected countries



Source: Czech Statistical Office (www.czso.cz), EUROSTAT, our own calculations

The non-financial corporations in the Czech Republic have a high value of profit share (45% to 49%, cf. Table 2) in comparison with the developed countries thanks to the low proportion of expense items (compensation to employees and net taxes on production and imports). The average value of profit share in EU-27 or EA-17 is 38% or 39%, respectively. Similar values of the profit share as in the Czech Republic can be seen for the non-financial corporations in Slovakia.

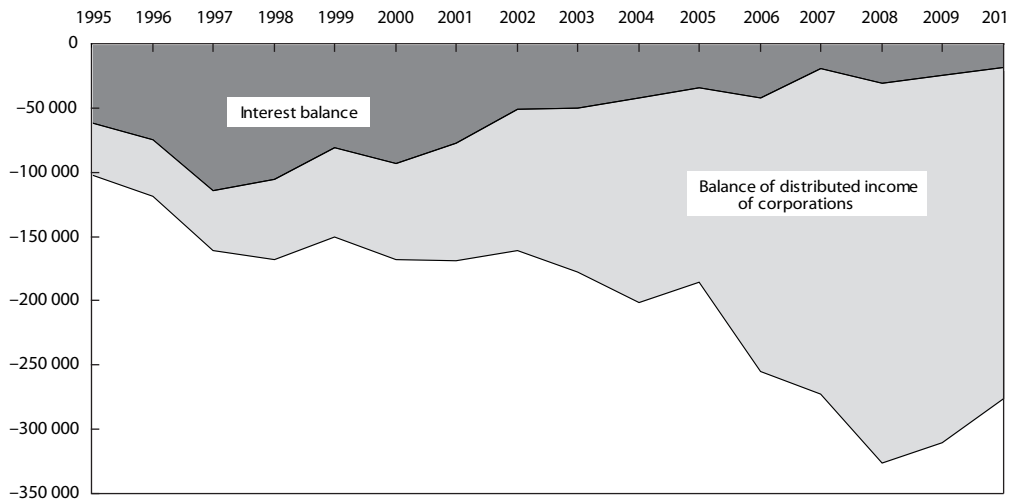
2.2 Distribution of Income Account

The non-financial corporations are on the losing side in the distribution described on the primary distribution of income account and the secondary distribution of income account – from the value added

or the operational surplus to the disposable income, which is also saving for the non-financial corporations, i.e., their own source for financing their investments.

In the primary distribution for the Czech non-financial corporations there is a considerable growth of negative balance of the property income; during the 1997–1998 crisis the interest balance was dominant (due to the high interest rate on credit and the growing indebtedness of the non-financial corporations, which were looking for financial sources mainly in the form of bank loans because of the insufficiently developed capital market). After the massive influx of (mainly foreign) investments, the main role was played by the balance of distributed income of corporations (in which dividend is a dominant tool) with its peak in the years of the 2008–2009 crisis.

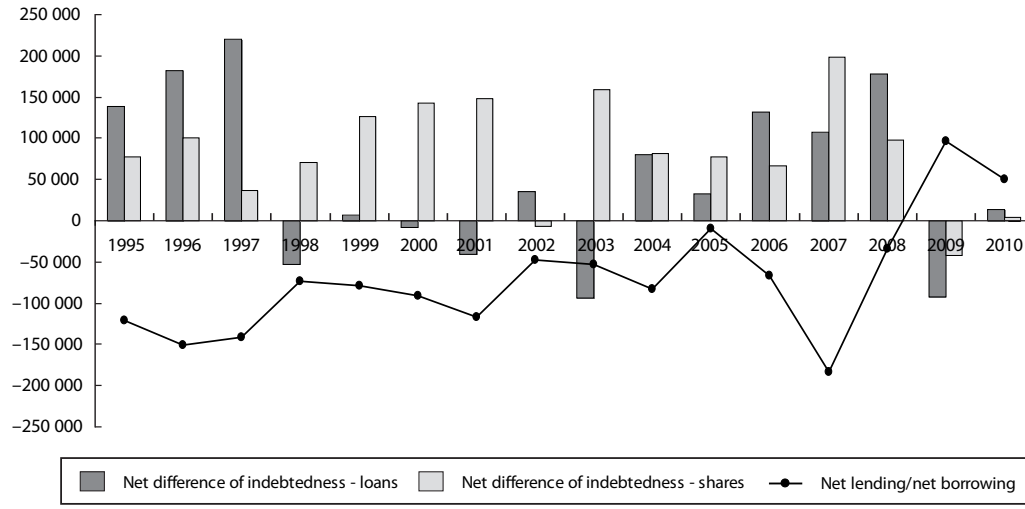
Figure 3 Balance of property income for the non-financial corporations in the Czech Republic (mil. CZK)



Source: Czech Statistical Office (www.czso.cz), EUROSTAT, our own calculations

Hence, the non-financial corporations were, in the first decade of the 21st century, trying to find financing resources in share emissions and to reduce their loan indebtedness. This trend can be proven by data from the financial account (cf. Figure 4). The said data enable us not only to explain the disproportion among the property income balance components, but also to identify the reasons for the substantial changes in the net lending/borrowing values in the two instances of crises. In 1995–1997, the non-financial corporations' indebtedness in the form of bank loans was growing with its peak in 1997; this trend was reflected in a high level of net borrowing in the said years (–151.2 bln. CZK in 1996 or –141.4 bln. CZK in 1997). In the following years this form of indebtedness was reduced and the non-financial corporations focused on looking for financing resources mainly by share emissions. A significant growth of indebtedness in the form of loans and shares and other equity occurred in 2006–2008. With the coming crisis the indebtedness was reduced by both a higher volume of paid-up loans in comparison with new ones, and a higher volume of paid-up shares in comparison with issued ones. Such factors together with the above-mentioned aspects of the non-financial transactions were among the reasons for on the one hand, the record value of net borrowing in 2007 (–184.1 bln. CZK) and, on the other hand, the record values of net lending in 2009 (95.8 bln. CZK) and 2010 (50.7 bln. CZK).

Figure 4 Net difference of indebtedness in the form of shares and other equity and loans for the non-financial corporations in the Czech Republic (mil. CZK)



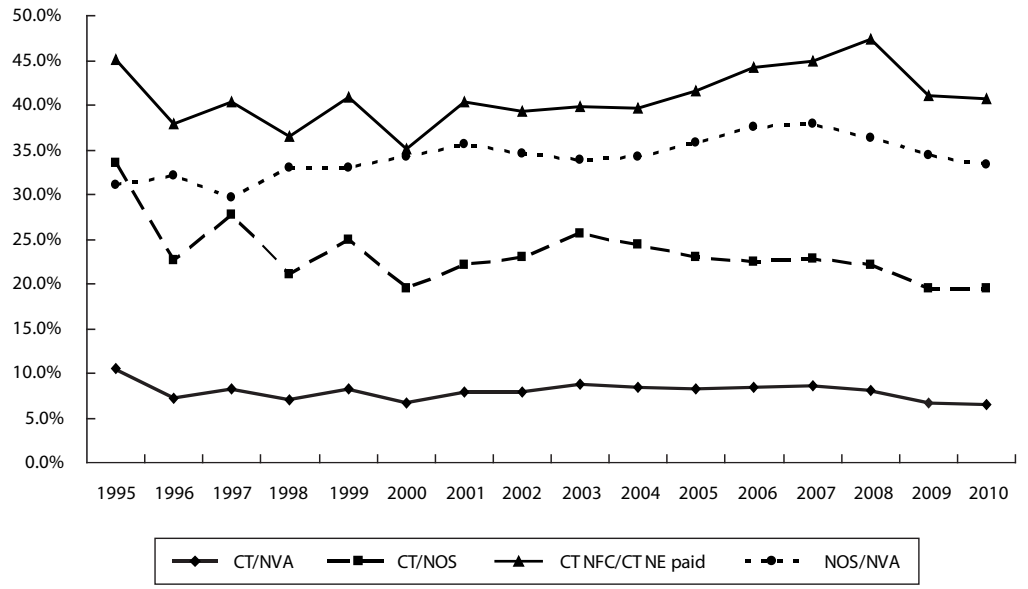
Source: Czech Statistical Office (www.czso.cz)

That view on the structure of the property income balance helped us identify the reasons for the high net borrowing in the years 1996 and 2007, even though it is obvious that both 1996 (with real GDP growth at 4.0%) and 2007 (with real GDP growth at 6.1%) were peaks of the economic growth. Let us now have a look at the development of other non-financial transactions.

Within the secondary distribution stage, the most important component of the non-financial corporations' account is represented by paid current taxes. Other transactions on the secondary distribution account (unfunded social benefits to employees and other current transfers) are of a limited importance with respect to their values and time evolution. Amounts of current taxes paid by the non-financial corporations naturally reflect the scope of the production and profitability, thus significantly responding to the stages of the economic cycle.

The current taxes include property and other taxes, mandatory one-sided payments, both financial and in-kind, payable on income and property of individuals and legal entities, taxes on dividends, interest, lottery prizes, etc. If we wish to study the time evolution of this index, we again have to construct a relative index describing the ratio between the paid current taxes and the net operational surplus (profit) or net value added. It turns out that the time evolution of relative indices is not identical: while the proportion of current taxes in the value added is more or less stable (from 10.4% in 1995 to 6.5% in 2010), the proportion of current taxes in the net operational surplus shows a higher year-to-year variability (with values from 33.6% in 1995 to 19.5% in 2010). That type of behaviour was especially seen in the 1990s, in which period the time evolution is copied of proportion of the current taxes paid by the non-financial corporations in the total current taxes paid in the national economy as a whole. In this connection, it is also worth mentioning that the net profit share of the non-financial corporations (proportion of the net operational surplus in the net value added) was moderately but continuously growing from 1997 to 2007. The considerations described above are summed up in Figure 5.

Figure 5 Selected relative indices for the non-financial corporations in the Czech Republic



Note: CT – current taxes on income, wealth, etc., NVA – net value added, NOS – net operating surplus, NFC – non-financial corporations, NE – national economy.
Source: Czech Statistical Office (www.czso.cz), our own calculations

If we compare the crises years 1997 and 2009 (i.e., the years characterised by a drop in GDP), then it is obvious that, while in 1997 the proportion of the current taxes paid by the non-financial corporations in their net operational surplus and in their net value added grew, and so did the proportion of the current taxes paid by the non-financial corporations in the corresponding national-economy value, the situation was opposite in 2009. For the sake of completeness, let us add that the net profit share went down in year-to-year comparison in both instances (by 2.5 percentage points in 1997 and by 2.0 percentage points in 2009).

Both the primary and the secondary distribution of income result in disposable income, which equals the saving in the case of non-financial corporations because they do not participate in the redistribution of income in-kind or in the final consumption. In the crisis year of 1997, the non-financial corporations suffered a loss from current transactions amounting to 5.6 bln. CZK, while they achieved a saving of 118.9 bln. CZK in 2009 even though it was a crisis year. The causes of this diametrically changed situation are given by the stages of income creation and distribution, as the analysis described above implies. In 1997, a year-to-year increase of the net value added occurred (by 7.2%); but compensation to employees was also increased (by 11.2%), as well as the (negative) balance of both primary and secondary income, at an inflation rate of 8.5%. In 2009, the net value added went down (by 8.0% year-to-year) as did the compensation to employees[10] (by 4.5%) at an annual inflation rate of 2.8%. The increase in the primary income's negative balance by 35 bln. CZK[11] was nearly compensated by a decrease of the sec-

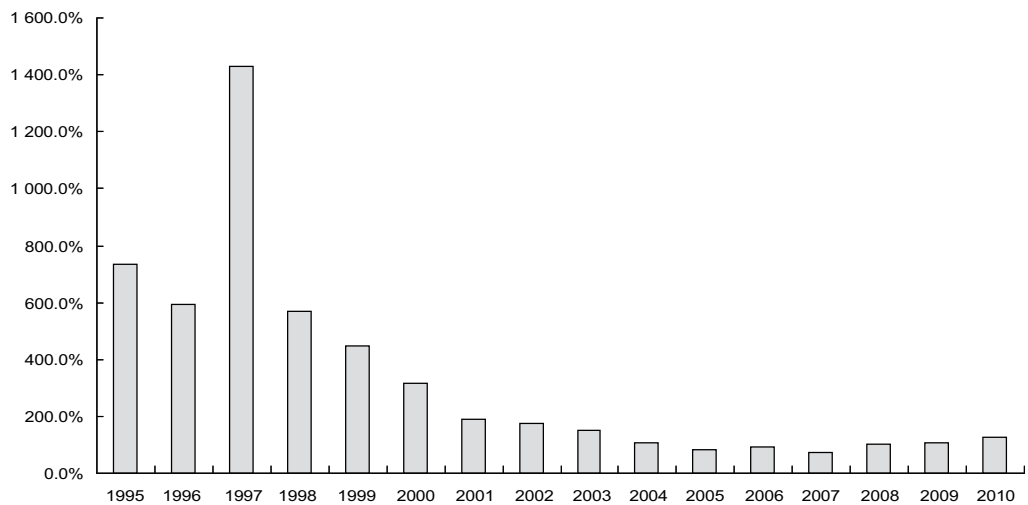
[10] By the way, 2009 was the only year in the period 1995–2010 in which the nominal value of compensation to employees was decreased.

[11] A year-to-year increase of the negative balance of the primary income occurred in 2009, but the balance of primary income was lower by 86 bln. CZK in 2008 than in 2007.

ondary income's balance by 29 bln. CZK. Hence the year-to-year decrease in the saving of non-financial corporations was more pronounced in 1997 (from 60.2 bln. CZK to –5.5 bln. CZK) than in 2009 (from 218.8 bln. CZK to 118.8 bln. CZK). However, we should see the year-to-year drop of saving in 2009 as compared with 2008 (by 45.7%) in the context of a reduction of the primary income's negative balance in 2008 in comparison with 2007 (cf. Footnote 8); the saving in 2009 was thus lower than that in 2007 by mere 10 bln. CZK, while the net profit share of the non-financial corporations was higher in 2009 than in 1997 (by 4.5%), i.e., a lower income from business as related to the value added.

Now we are going to view the situation of the non-financial corporations in terms of indices whose definitions are close to those used in corporate practice. Namely, the net entrepreneurial income of the non-financial corporations, defined as the net value added plus subsidies and received property income (exclusive of rents and property income attributed to insurance policy holders) minus compensation to employees, taxes on production and imports, paid interest and paid rent. The net entrepreneurial income of non-financial corporations is also expressed as "after taxation", i.e., after deduction of current taxes. This net income index of the non-financial corporations is utilised to construct relative indices: net debt-to-income ratio after taxes and net return on equity after taxes. These two indices will help us illustrate the different positions of the Czech non-financial corporations in 1997 and in 2009.

Figure 6 Net debt-to-income ratio after taxes for the non-financial corporations in the Czech Republic (in %)



Source: Czech Statistical Office (www.czso.cz), EUROSTAT, our own calculations

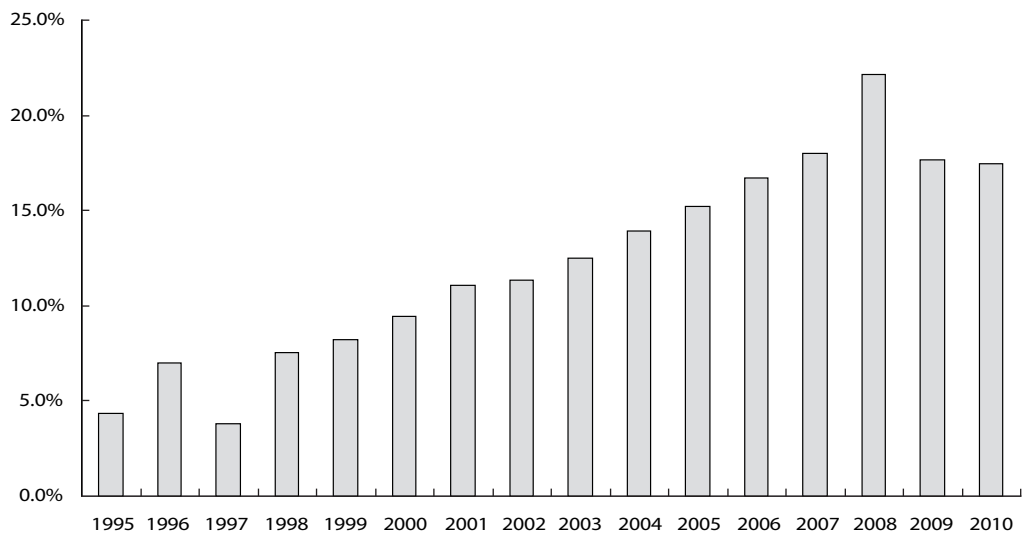
The net debt-to-income ratio after taxes is defined as a ratio where the net indebtedness as of the end of the year in the form of securities other than shares and loans[12] stands in the numerator and the net entrepreneurial income after taxes in the denominator. This index expresses the (in)ability of non-financial corporations to cover their current liabilities from operations. The data in Figure 6 unambiguously indicate the principal difference between the situations of the non-financial corporations in the Czech

[12] Namely, it is a difference between the liabilities at the end of the year in the form of securities other than shares, excluding financial derivatives and loans on the one hand and the financial assets in the form of currency and deposits, and of securities other than shares, excluding financial derivatives and loans on the other hand.

Republic in 1997 and 2009. While the level of the net debt-to-income ratio after taxes exceeded 1 400% in 1997, and was two-and-half higher than the year before, its value in 2009 was not significantly different form that of 2008, namely, it was equal to 109%, i.e., the same value as in 2004 when economic growth occurred. Reasons for the significant growth of the non-financial corporations' net debt-to-income ratio after taxes in the Czech Republic in 1997 included the year-to-year decrease of the net entrepreneurial income by one-half and an increase of the net indebtedness in the form of securities other than shares and loans by one-third. The decrease of the net income was mainly caused by an increase of the paid interest amount (by 36%, i.e., by 40 bln. CZK) and also a higher absolute increment of all other subtracted items (especially, compensation to employees) then the items included in the minuend (especially the net value added). The main reason for the net indebtedness of the non-financial corporations in 1997 was an increase of the indebtedness in the form of loans by 22%, i.e., 234 bln. CZK; and long-term loan indebtedness was growing faster than short-term indebtedness. Other items of financial assets and liabilities showed only small year-to-year changes. The high level of net indebtedness in the form of securities other than shares and loans in 1997 (858 bln. CZK) was never exceeded in the following years (its value was 536 bln. CZK in 2009).[13] A lack of financial resources and the necessity to focus on bank loans, for which the interest rates were high, can be viewed as the main cause of the economic problems of the non-financial corporations in 1997, and therefore also a substantial cause of the different economic results of the non-financial corporations in the 1997 and 2009 crises.

Another index which confirms the above-mentioned observations and is based on indices close to corporate practice is the net return on equity after taxes. The latter is defined as a ratio between the net entrepreneurial income after taxation and the net indebtedness in the form of shares and other equity.[14]

Figure 7 Net return on equity after taxes of the non-financial corporations in the Czech Republic (in %)



Source: Czech Statistical Office (www.czso.cz), EUROSTAT, our own calculations

[13] In this connection it should be recalled that the net indebtedness of non-financial corporations in the form of shares and other equity was in 2009 nearly twice as high as in 1997.

[14] The net indebtedness in the form of shares and other equity equals the difference between the payables and receivables in the form of shares and other equity as of the end of the year.

Figure 7 shows that, while the net return on equity after taxes of the non-financial corporations in the Czech Republic was between 3.8% (in 1997) and 9.4% (in 2000) in the 1990s, its values in the 2000s were substantially larger, ranging from 11.1% in 2001 to 22.2% in 2007. The exclusive reason for its decrease in 1997 was the above-mentioned decrease of net income. Profitability of the non-financial corporations in 2009 was even higher by one percentage point than its value in 2006, which was the year of the highest economic growth. A year-to-year decrease of the net return on equity after taxes in 2009 was caused, as already mentioned above, by a decrease of the net entrepreneurial income and an increase of the net indebtedness in the form of shares and other equity by 94 bln. CZK (after a decrease of the latter by more than 300 bln. CZK in 2008). On the basis of these considerations we can say that the situation of the non-financial corporations during the 2009–2010 crisis was completely different from that in the years 1997–1998. The indices close to those used in corporate practice helped us better understand the differences in results of current transactions achieved by the non-financial corporations that are recorded in the saving of the national accounts. Namely, the Czech non-financial corporations' negative results recorded on the national accounts in 1997 (negative saving and a high value of the net borrowing) were caused by their high indebtedness rate and low effectiveness. A substantial change in these parameters in the late 2000s brought to the Czech non-financial corporations a high value of saving and the net lending in 2009, the first year in which net lending had ever been achieved by non-financial corporations, despite the total decrease of the economy by 4.7%.

At the same time we can observe that the non-financial corporations responded in quite a flexible way in 2009 to external signals (of the coming financial and credit crisis) occurring as early as 2008 and, expecting the adverse situation in 2009, they strictly reduced all current expenses. Such a situation could not have been expected in 1997, when the crisis was caused by specific Czech conditions of an economic transformation and the outlook for 1997 was rather optimistic even at the end of 1996 (with an expected value of the GDP growth at 2%).

2.3 Accumulation

The reasons for different savings of the Czech non-financial corporations in 1997 and 2009, i.e., caused by the current transactions, were explained above. For the sake of completeness, this analysis will now be complemented by a view of accumulation, or non-financial investments. A relationship between the saving and the investments, reflected in the net lending/net borrowing, was already outlined in Figure 1, which implies that the significant decrease in saving in 2009 (to nearly one-half) made the non-financial corporations substantially reduce their investments (with a year-to-year decrease of the gross capital formation by 29.5%) in order to achieve the positive result amounting to a net lending value of 95.8 bln. CZK. On the other hand, the Czech non-financial corporations had negative saving of 5.6 bln. CZK in 1997 (for the reasons explained above) so that, even if the investments went down by 8.3%, a high net borrowing value of 141.4 bln. CZK occurred.[15] The steps in which the loss from non-financial operations had been accumulated in the 1990s and the opposite – the positive outcome of the same operations in the late 2000s – are documented in Table 3, based on the logic of the sector accounts.[16]

[15] The above-mentioned data must be understood in connection with the investment rate, equal to 38.2% in 1997 and to 25.4% in 2009.

[16] The following formula is valid: net value added – compensation to employees + balance of other primary income + balance of secondary income = net disposable income = net saving. Further: net saving + capital transfer balance – net capital formation = net lending / net borrowing.

Table 3 Balance values of the non-financial corporations' account in the Czech Republic (mil. CZK, current prices)

Index	1995	1996	1997	1998	2007	2008	2009	2010
Net value added	**611 887**	**738 806**	**792 131**	**873 264**	**1 729 843**	**1 825 087**	**1 677 081**	**1 680 603**
Compensation to employees	425 169	504 523	562 097	599 325	1 100 130	1 191 645	1 137 056	1 150 901
Balance of other primary income	–99 774	–117 032	–156 973	–159 395	–344 071	–258 226	–293 288	–284 188
Balance of secondary income	–66 139	–57 050	–78 635	–78 124	–158 253	–156 359	–127 887	–125 888
Net saving (= net disposable income)	**20 805**	**60 201**	**–5 574**	**36 420**	**127 389**	**218 857**	**118 850**	**119 626**
Balance of capital transfers	30 011	10 682	33 888	50 676	24 312	74 719	70 030	68 754
Net capital formation[17]	171 898	222 090	169 706	160 608	335 752	327 178	93 033	137 668
Net lending / net borrowing	**–121 082**	**–151 207**	**–141 392**	**–73 512**	**–184 051**	**–33 602**	**95 847**	**50 712**

Source: Czech Statistical Office (www.czso.cz), our own calculations

The reasons for the different economic results of the Czech non-financial corporations in the years of crises, i.e., a high value of net borrowing in 1997 and, on the other hand, a high value of net lending in 2009, can therefore be sought not only in the different levels of indebtedness and effectiveness, but also in different levels of investments.

CONCLUSIONS

The economic crises that occurred in the Czech Republic in the late 1990s and the late 2000s had different causes and effects. However, both slackened the pace of the national economy, which was expressed by a decrease of GDP: by 0.9% in 1997 and by 4.7% in 2009. The causes of the 1997–1998 crisis can exclusively be identified within the Czech economy; it was a crisis accompanying the economic transformation characterised by a hasty and not too well-thought-out privatisation, inconsistent restructuring of industry, unclear concept of the banking sector's development with a subsequent crash of many banks, and a too-restrictive monetary policy. All these factors together with significant investment activities of the non-financial corporations under the conditions of a lack of available financial means and practically non-existent capital market led to the problems in financing, expensive loans and a high level of non-financial corporations' indebtedness. Adding the low effectiveness of the Czech non-financial corporations into the mixture we can see why their current transactions resulted in a negative value (negative net saving); and the high investment rate contributed to the negative results of all non-financial transactions (and to the prevalence of a high net borrowing).

The 2009 crisis was caused by external factors; it came from the USA, first as a credit and financial crisis, which later grew into an economic crisis; but symptoms of an economic slowdown had already occurred in 2008. Warnings from the outside meant that the Czech non-financial corporations were ready for potential threats. From the macroeconomic viewpoint, that stage in 2009 meant a lower volume of

[17] Here: net capital formation = gross capital formation – consumption of fixed capital + acquisitions less disposals of non-financial non-produced assets.

paid wages and salaries (compensation to employees) due to the reduction of employment, a lower volume of both financial and non-financial investments, a higher volume of paid-up than received loans, and of paid-up than emitted shares. Overall effects were such that the non-financial corporations achieved net lending in the year of crisis (and for the first time since 1995), i.e., they created a surplus of resource.

Differences between the Czech non-financial corporations in the two crises, distant from each other in time, may be described with the aid of a number of relative indices immediately (i.e., in the definitions of both numerators and denominators) based on the national accounts' indices. Their values enabled us to explain the reasons for the loss from current transactions in 1997 and the surplus in 2009, but failed to express in detail the different economic conditions of the Czech non-financial corporations in either crisis. Such aspects were better identified by relative indices whose numerators and denominators are derived from the national accounts' indices so that their definitions and informative content were closer to assessment of economic performance that is usual in the corporate practice. In this way we revealed that the principal differences were given by the rate of indebtedness and by effectiveness. Values of these indices were significantly different for the years 1997 and 2009, which we investigated in this article.

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Financial Wealth Distribution in Revised Financial Accounts

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Abstract

Financial statistics undergo dynamic evolution as apparent consequence of their rising importance. Structure of assets, source of financing, price changes or net financial position, all these indicators can detect oncoming financial instability. Financial statistics as a logical extension of the national accounts provide such information. The aim of the following text is to present financial statistics, relation between particular accounts, the impact of extraordinary revision carried out in 2011, and also to analyse current wealth distribution as described by financial statistics.

Keywords

Financial statistics, revision, financial wealth, financing of activities

JEL code

C10, C82, E01

INTRODUCTION

Current economic crisis brought very important messages to both economic policy and statistics. First, to make picture of an economy more complete it is necessary to take into account wider range of indicators, not only GDP. Second, to assess financial stability or systemic risk appropriately, additional data should be collected and compiled, mainly information on sector breakdown of financial assets and liabilities (Cerutti, Claessens, McGuire, 2012). As a result, one of the main challenges for statisticians in the future is to improve quality and to extend financial statistics, due to their rising importance for management at the macroeconomic level.

Financial accounts (or statistics) are an inherent part and logical extension of non-financial accounts in national accounts. In other words, financial accounts represent "financial sphere" of this statistical system. Use of financial data can be very helpful for decision making, because it provides a *"snapshot of the economy...to make good forecasts of the effects of alternative policies in the short run*" (Arrow, 1957). Main contributions of this data sets lie especially in growth sustainability or financial stability assessment and as a base for economic policy decisions. But first it is important to understand the nature of these data sets; modest ambition of following text is to increase the awareness of strengths and weakness of financial statistics. Attention is paid only to stocks; the reason is that all methodological changes are first incorporated in the quantification of stocks with consequent impact on the flows (on quantification of transaction see: Plasil, Kalous, 2008).

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Before proceeding, a short comment should be made on the institutional background underlying compilation of financial statistics in the Czech Republic. CNB (Czech National Bank) is responsible for the accounts on quarterly basis (except government sector); on annual basis the compilation is falling to the CZSO (Czech Statistical Office). Because both institutions follow the same methodology (ESA 95), great attention is paid to harmonisation of these accounts. In fact, as far as methodology and data sources are concerned, these are shared by both institutions to a very high degree. But despite very close cooperation between CNB and CZSO, few differences still remain.

1 STRUCTURE OF THE ACCOUNTS

Financial accounts are natural part of national accounts forming financial sphere of the accounts. The financial sphere is formed by several accounts containing transactions with financial assets and liabilities, other changes in volume and prices, and stocks of these financial instruments. Sum of transactions, other changes in volume and prices determine the changes in stock, as expressed by stock-flow equation (Monetary and Financial Statistics Manual, 2006):

opening stock + financial transactions + revaluation + other changes in volume = closing stock.

Financial account, as a transaction account, contains two types of transactions. First, there are financial transactions having natural counterparty in the non-financial accounts, e.g. purchase of car is represented by transaction with goods (car) and by transfer of money (transaction with financial instrument). The second type of transaction can be called "pure" financial transaction containing especially changes in portfolio or liabilities without any counterparty in non-financial accounts. As an example, purchase of shares (with simultaneous decrease in account balance) can be mentioned.

Transactions directly influence amounts of stocks, but there are also other factors affecting value of assets and liabilities at the end of a year. First of all, stocks are valued at domestic currency and mostly at market prices (except deposits and loans). Thus, changes in market prices, interest rates or exchange rates can affect the value of financial wealth with possible impact on behaviour of economic units (wealth effect or balance sheet effect should be mentioned here; see Rybáček, 2009). Such price changes are concentrated on revaluation account together with non-financial assets price movements, no matter if these gains or losses are realized or unrealized; these gains and losses are called nominal holding gains and losses; as indicated by the position in the accounts, revaluation is not taken as a result of production process or distribution of income generated by productive activities.

Last type of changes in stock is called "other changes in volume" that are recorded in the separate account. As other changes in volume we can consider loan remission, writing off, differences between closing and opening balance surveyed by statistical questionnaires, reclassifications, allocation of SDR, etc. To some extent, amount of other changes also reflects the quality of statistics.

Financial instruments are classified according to their nature and liquidity. There are seven groups of instruments in the accounts:

- *Monetary gold and SDR (AF.1)* – this item is formed by gold used for monetary purposes (part of foreign exchange reserves) and fictive monetary unit issued by the IMF called special drawing rights (SDR); this item is valued at market prices,
- *Cash and deposits (AF.2)* – there are three sub-items – cash (domestic or foreign) circulating in the economy and issued by domestic central bank, then demand deposits and time deposits; these are the most liquid instruments in the portfolio of institutional units and these are valued at nominal values in CZK (impact of exchange rate is reflected),
- *Securities other than shares (AF.3)* – short-term and long-term debt securities (tradable) and derivatives are here included; all these instruments should be shown at market prices, but there is serious problem with primary accounting data usually not containing market prices of bonds; accounting practices also make problems to statistical treatment of financial derivatives,

- *Loans (AF.4)* – in this items non-tradable loans with maturity up to one year (AF.41) and with longer maturity (AF.42) are included; loans are priced at nominal values in CZK (impact of exchange rate changes are included),
- *Shares (AF.5)* – this item contains residual claims on the assets of the units issuing shares (stock companies, cooperatives, limited companies, shares funds, international institutions, etc.); there are different approaches to the evaluation of shares; quoted shares (AF.511) are recorded at market prices, prices of unquoted shares (AF.512) are based on a model simulating market conditions, other shares (AF.513) are valued at both market prices and nominal values; mutual shares funds (AF.52) are valued at market prices,
- *Insurance technical reserves (AF.6)* – funds (liabilities of insurance companies and pension funds) formed for risk management purposes within life and non-life insurance policy; technical reserves are priced at nominal values,
- *Other receivable / payable (AF.7)* – this item includes supply-buyer relationships and transaction (stock) when there is a timing difference between transactions in goods and service, distributive or financial transaction, and the corresponding payments; also this item is valued at nominal prices.

Financial accounts are constructed for all sectors of the economy, i.e. for non-financial corporations (S.11), financial corporations (S.12), government sector (S.13), households (S.14), non-profit institutions serving households (S.15) and the rest of the world (S.2). All items are balanced across these sectors; thus the result is sectoral structure of the financial accounts allowing for many analytical outputs.

2 EXTRAORDINARY REVISION

Revision undertaken in 2011 took the form of an extraordinary revision. Main reason for the revision was a new branch structure of the economy (NACE revision); with the branch-revision were associated also methodological changes which affected both non-financial and financial accounts. Thus, this revision offered a very exceptional opportunity to project methodological changes to all years and to make time series methodologically consistent as much as possible.

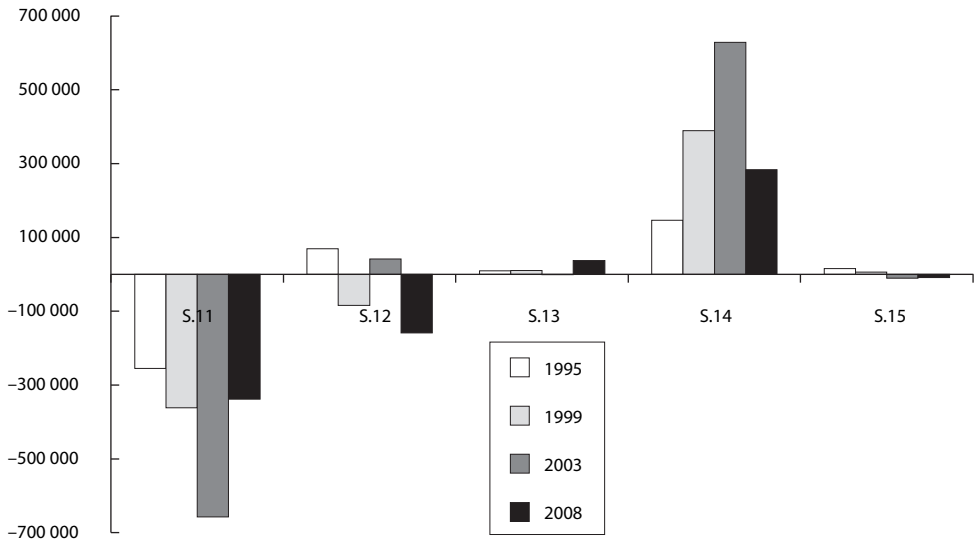
From financial statistics point of view, there were many objectives of revision. Below are mentioned the most important ones:

- *to make time series consistent* – financial accounts have been compiled from 2004, methodological changes were incorporated continuously. The revision was a very welcomed opportunity to make all data consistent;
- *to harmonize financial statistics as much as possible* – this point is closely connected with the previous one. At the end of a year, quarterly financial accounts of the CNB and annual financial accounts of the CZSO describe the same phenomenon – financial wealth and related flows. So, both institutions got very near to the aim to harmonize both statistics, the need of this cooperation is further emphasized by the sole position of the CNB as supervisor and regulator of financial sector. Many changes were already implemented in compilation of data from 2004 onwards, application of amended approaches to whole time series was an important part of the revision;
- *to incorporate the very new quantifications* – the matters in question are for example shares of households in cooperatives or so-called fictive units formed by non-residents for the purpose of house or land purchases in the domestic economy;
- *to incorporate completely new data sources* – these were used mainly for more proper allocation of instruments to counter-parties.

Due to revision, national wealth has not only been changed, but also redistributed among sectors. Figure 1 displays changes in financial wealth redistribution in selected years between sectors of domestic economy. Financial wealth is here defined as a difference between financial assets and liabilities

(B.90f). It is evident that most significant changes are obvious for non-financial corporations and households. Common reason for such changes is the new way of evaluation of shares in housing cooperatives.

Figure 1 Redistribution of net financial wealth (B.90f), in CZK million



Source: Czech Statistical Office

This adjustment was made because of a clear link between changes in dwelling prices and wealth of households as owners of these dwellings. In case of cooperatives, the impact of dwelling prices movements on the wealth is "intermediated" by the value of households´ *shares in cooperatives*. The heart of the revision was the adjustment of shares´ value to real market prices of dwellings. This resulted in the rise of shares value "issued" by non-financial corporations (with consequent decline in net financial wealth) and corresponding rise in the value of assets held by households. Table 1 shows the impact of this adjustment on the value of shares.[2]

Table 1 Rise in shares due to revaluation of shares in cooperatives, in CZK billion

1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
263	281	301	324	342	342	343	355	356	358	243	236	223	243	243	231

Source: Czech Statistical Office

Another reason for large change in liabilities of non-financial corporations (S.11) is specification of *non-financial assets owned by non-residents*. In line with the methodology, purchase of a dwelling or a land made by non-residents is connected with establishment of "notional unit" classified as a resident (non-financial corporation). On one hand, this unit is the only owner of non-financial asset, on the other hand, this unit is fully owned by non-resident. This adjustment resulted in rise of non-financial corporations´ liabilities with corresponding rise in the amount of assets (domestic liabilities) held by non-residents.

[2] Currently, sector classification of housing cooperatives is discussed at the international level.

Thus, the amount of non-financial assets owned by non-residents via notional units made the position of the Czech Republic worse, as far as net worth is concerned. Impact of this adjustment is shown in Table 2.

Table 2 Rise in shares due to revaluation of shares in cooperatives, in CZK billion

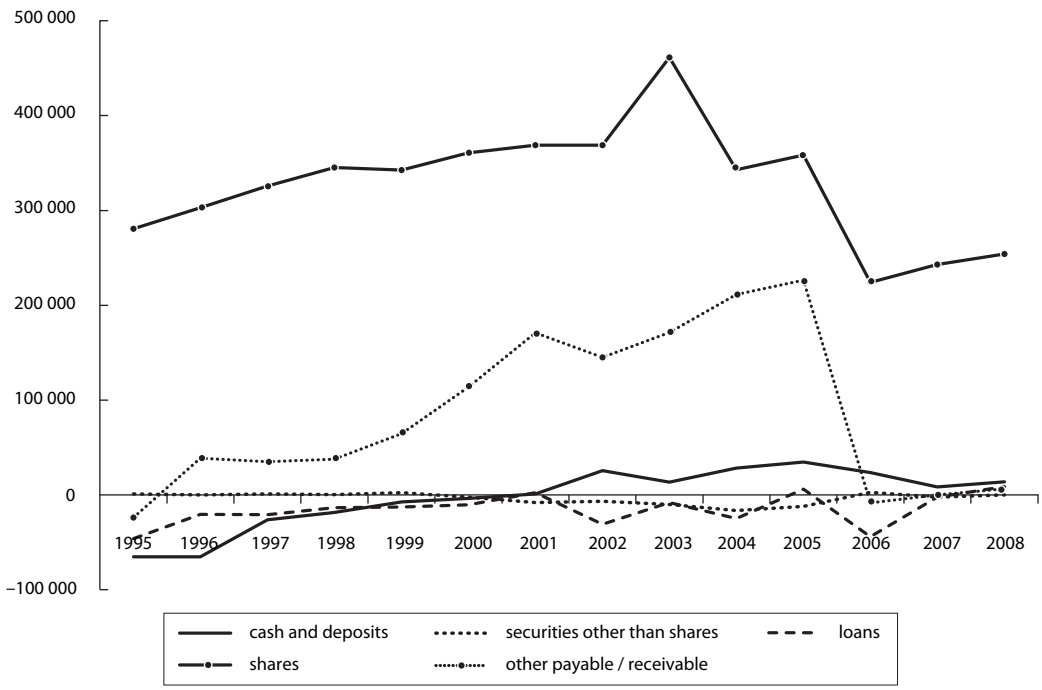
2003	2004	2005	2006	2007	2008	2009
25	26	27	30	38	46	51

Source: Czech Statistical Office

Big task in financial statistics is the amount of other payable or receivable (AF.7). In 2006, a new approach to quantification was implemented in case of households; now, this approach is applied to all years from 1993. In principle, estimation of *other payable or receivable of households* lies in combination of direct data sources and approximate threshold for share of AF.7 in total assets and liabilities of households. This threshold is based on the average from other countries at the similar economic level. Final amount should not deviate significantly from this "nominal anchor".

Because households comprises most important economic sector, we should go into more detail. Figure 2 displays changes in the financial wealth by instruments separately. As it is evident, that most important factors standing behind rise in households´ wealth are adjustment of shares (AF.5) and other payable and receivable (AF.7). Especially better reflection of rise in dwelling prices and bringing of other payable and receivable closer to reality were the main factors driving this important change.

Figure 2 Changes in financial wealth of households, in CZK million



Source: Czech Statistical Office

Also other methodological adjustments should be mentioned, especially *evaluation of gold and SDR*. Started in 2004, gold and SDR were valued at market prices in line with the balance of payment statistics; before 2004 these instruments were priced at historical prices according to accounting practises of the central bank. Market prices are now applied to the whole time series. Another change was *recording of repo operations*. In line with the methodology, if financial institutions are involved in this type of transaction, repurchase agreement is classified as other deposits (AF.29); in other cases, repurchase agreements are recorded as loans (AF.41). Data were applied to this rule.

Dynamic development of financial instruments put also a pressure on the statisticians to get new data sources. On the base of new data, *time series of derivatives*, one of the most troublesome instruments, was extended to 1995. Especially derivatives are financial instruments massively representing problems of national accounts with the primary data from business accounting. In the Czech accounting system these instruments are not considered to be financial asset or liability, but other payable or receivable. So, identification of derivatives in the business accounting for the national accounts purposes is very difficult.

Overall, the revision has considerably affected the net financial wealth mainly of non-financial corporations and households especially due to changes in shares estimation. Following table provides the overview of changes in assets, liabilities and net financial wealth of domestic sectors that are the results of the revision. Sharp breaks in some cases are caused mainly by elimination of methodological inconsistencies.

Table 3 Changes in assets, liabilities and net financial wealth, in CZK million

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Assets										
S.11	344 509	411 820	446 385	345 614	780 783	776 007	699 152	6 159	102 584	–162 965
S.12	–158 244	–256 434	–522 926	71 795	55 938	–11 103	–61 976	–89 653	–192 634	–69 217
S.13	10 000	9 189	1 361	882	–118	34 634	40 399	42 279	22 493	23 656
S.14	266 397	276 383	269 451	268 997	333 430	209 190	230 331	241 828	251 609	272 472
S.15	–336	–9 229	–5 694	–10 975	–17 635	–15 610	–13 229	–14 320	–19 326	–28 756
Liabiliaties										
S.11	706 109	943 003	897 141	942 031	1 438 231	1 043 026	1 058 487	189 739	345 997	174 730
S.12	–74 063	–287 593	–403 314	–73 377	14 687	182 109	184 050	–9 587	–89 166	89 853
S.13	–413	–1 467	200	–65	–30	–3	20	0	–40 320	–13 525
S.14	–122 908	–181 888	–266 099	–232 933	–294 995	–332 270	–383 055	43 708	4 768	–11 014
S.15	–6 428	–7 367	–5 714	–3 092	–7 365	–8 228	–3 709	–2 514	–10 584	–20 202
Change in net financial wealth										
S.11	–361 600	–531 183	–450 756	–596 417	–657 448	–267 019	–359 335	–183 580	–243 413	–337 695
S.12	–84 181	31 159	–119 612	145 172	41 251	–193 212	–246 026	–80 066	–103 468	–159 070
S.13	10 413	10 656	1 161	947	–88	34 637	40 379	42 279	62 813	37 181
S.14	389 305	458 271	535 550	501 930	628 425	541 460	613 386	198 120	246 841	283 486
S.15	6 092	–1 862	20	–7 883	–10 270	–7 382	–9 520	–11 806	–8 742	–8 554

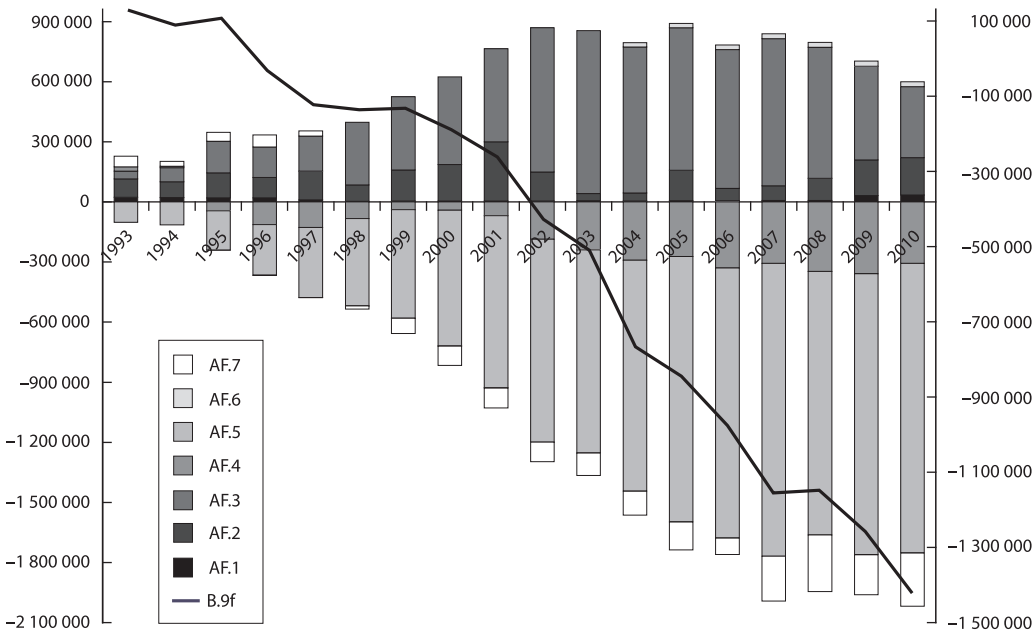
Source: Czech Statistical Office, own calculation

The important task is the relation between the national accounts and other external statistics. Aim of the revision was to bring the financial accounts and the balance of payments statistics closer to each other. This also caused changes in total position of the Czech economy in relation to the Rest of the

World. To be concrete, Figure 3 displays the revised relation as described by the item "net worth" of the economy (B.90f). Logic of this aggregate is the same like net international investment position in the balance of payment statistics.

In general, changing net financial position corresponds to profound changes in the Czech economy during the transition period.

Figure 3 Relation of the economy to the Rest of the World, in CZK million, B.9f (right axis), financial instruments (left axis)



Source: Czech Statistical Office

Changes during transitional period of the economy are most clearly reflected in the item AF.5 (shares and other equities), massive inflow of foreign capital brought significant changes in distribution of property rights. These investments in share capital and reinvested earnings stand behind deeply negative balance of the economy to the Rest of the World. This situation can indicate further consequences as a possibly outflow of money (dividends) paid out of current profit or accumulated profits (so-called super-dividends) abroad. Side-effect of capital inflow is also raising indebtedness (AF.4) due to loans provided within corporate groups. Even if there are many risks connected with high share of foreign owners, this cannot be perceived as negative on its own, but should be assessed on the basis of wider range of indicators or considerations. Massive inflow of foreign capital also caused a sharp increase of productivity, domestic real wages and consequently in the living standard.

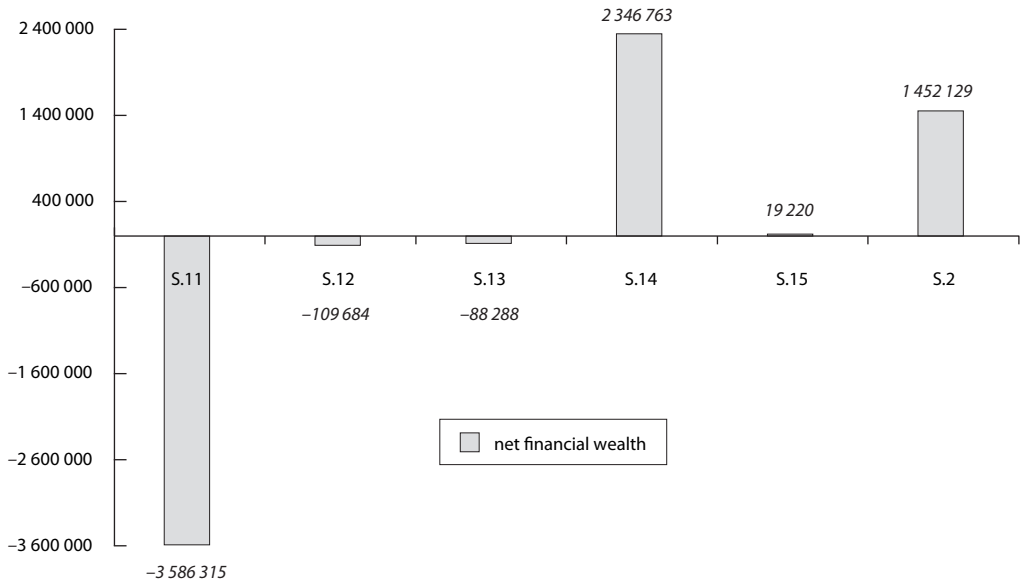
3 WEALTH DISTRIBUTIONS BETWEEN SECTORS

Estimations and quantifications mentioned above give us picture on financial position, financial wealth and its distribution in the society. This picture is very important for further considerations; creation and distribution of wealth is one of the main tasks of political economy. As was already mentioned, the distribution of wealth may result from financial flows connected with productive activity and re-

distribution of incomes, or other flows like changes in nominal or relative prices and other changes in volume. Now, we can proceed to analysis of financial wealth distribution, as displayed in the national accounts.

Figure 4 shows net financial position or net financial wealth in the economy expressed as a difference between financial assets and liabilities.

Figure 4 Distribution of net financial wealth between sectors, 2010[3]



Source: Czech Statistical Office

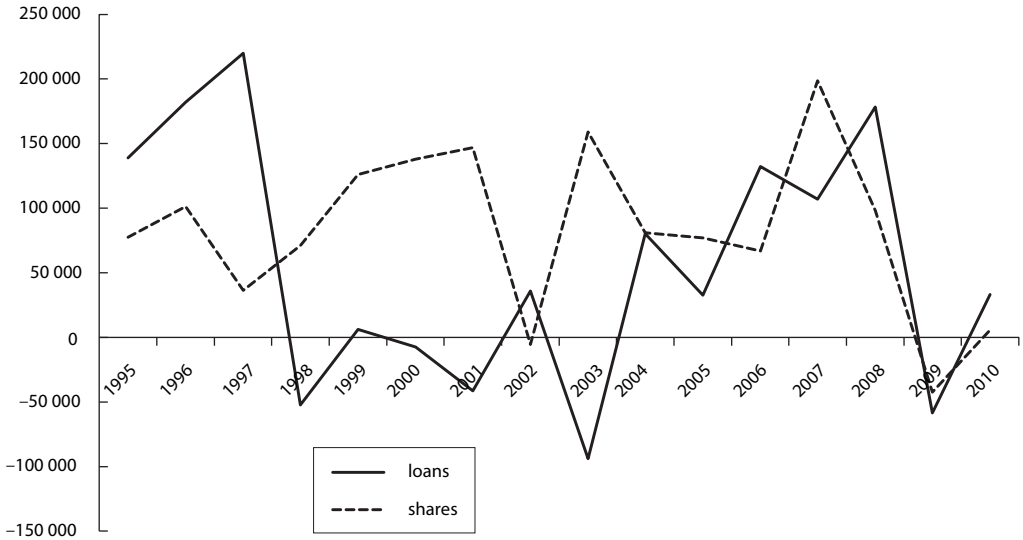
We shortly describe the situation of each economic sector. Deeply negative value of net financial wealth of non-financial corporations (S.11) is assigned mainly to the fact that these units transform financial liabilities (sources) particularly to non-financial assets.[4] It is thus more important to pay attention to the structure of liabilities, i.e. how activities of non-financial corporations are financed. Almost 50% of total liabilities are formed by shares (AF.5) which can be approximately compared to "own resources" in business accounting. The share of loans is only 17% and issuance of debt securities even smaller (4%). Large part of liabilities (29%) is represented by other payable, i.e. trade credits and other liabilities like outstanding wages or taxes.

But it would be rather misleading to claim that non-financial corporations raise funds mainly via issuance of shares. The amount of shares is very strongly affected by revaluation depending on economic results, so it is reasonable to compare transaction with shares and loans, i.e. how non-financial corporations raise funds.

[3] It is worth mentioning that total domestic net wealth is not equal to net financial wealth of the rest of the world (with opposite-sign). The reason is recording of monetary gold and SDR only on the asset side (of domestic financial institutions), i.e. with no counter-party. In other words, there is only owner of the financial assets, no debtor. Recording of monetary gold and SDR is exceptional in this respect.

[4] Two third of total assets are classified as non-financial assets.

Figure 5 Transactions with loans and shares, liabilities, in CZK million, non-financial corporations



Source: Czech Statistical Office

As is evident from Figure 5, there are no significant differences between transactions with loans and shares in last few years. So, the extent of loans and shares used for acquiring of financial resources is comparable. But, this analysis is just historical description; more general findings should be based on further connections like interest rate changes or financial market conditions.

The other part of "corporations sector" are the financial institutions. In fact, financial position of the *financial institutions sector (S12)* is almost balanced; concretely, total position is only slightly negative. More than 90% of total is formed by three dominant items:

- *securities other than shares* – financial institutions are predominant owners of domestic and foreign governments´ debts (especially long-term bonds),
- *loans* – S12 is the sector where money is issued via emissions activities of commercial banks,
- *shares* – mainly shares in the international monetary and non-monetary institutions like IMF, BIS, ECB, etc. held by the CNB, and shares in possession of investment funds.

From the liability side, structure is strongly affected by the nature of financial intermediation as a activity based on accepting deposits from units with free financial resources and providing these resources to the unit with lack of its own funds in comparison to its financial needs. Thus, amount of liabilities is strongly concentrated in the form of cash and deposits (AF.2) accounting for 64% of total liabilities. About 9% of liabilities are in the form of insurance technical reserves, which is specific instrument "issued" by insurance companies and pension funds. Shares amount only to 13% which fact creates a very different situation from that of non-financial corporations. Loans and debt securities amount to 12%. From this short analysis it is also evident that maturities of assets and liabilities are highly different; on average, liability should be repaid sooner than asset is due.

Net financial position of *government institution (S.13)* is similar to that of financial institutions. Assets are concentrated in the form of cash and deposits (AF.2 – 24% of total financial assets), shares (AF.5 – 52%) and other receivable (AF.7 – 18%). In case of shares, this situation is given by number of public units established by governmental units but classified outside the government sector (CEZ, Czech rail-

ways, Czech post, EGAP, CMZRB, etc.). Structure of liabilities is also quite simple. Three quarters of all liabilities are in the form of bonds (AF.3). Bonds emission is the dominant way how net borrowing of government is financed. Loans (AF.4) have only secondary importance, about 11% of liabilities. The rest is attributed to the other payable (AF.7), i.e. about 14%.

Now we approach the most important sector in the economy, *households*. Households sector is very often the object of an empirical examination (see for example Hendershott, Lemmon, 1975; Smidková, Allen, 1998; Ramb, Scharnagl, 2011). First, we look at the liability side. There are only two ways in the national accounts, how activities of households can be financed – via loans (AF.4) or other payable (AF.7). In the Czech Republic, households loans[5] amount to 90% of total liabilities. It is worth to mention that for further investigation of indebtedness sustainability it is important to have the information on the currency structure, maturity, counter-party, etc. This information is not directly provided by the national accounts, but particularly by the statistical system of the central bank.

Diversification of household´s assets is considerably wider than in case of liabilities. Households´ financial assets are mostly held in form of cash and deposits (AF.2, about 56%). Shares are the second-most-important form of assets (AF.5, 27%), especially shares in cooperatives, in companies quoted on the market, but also shares in mutual funds, limited companies or companies not quoted on the market. Share of bonds (AF.3) is almost negligible (1%), even if this situation can change in future due to policy of the Ministry of finance. Altogether, insurance technical reserves (AF.6) comprise large part of total assets (14%), but compared to most developed European countries (about 35%), this share is quite low.

In total, portfolio of Czech households is more strongly concentrated in comparison to households in the Western Europe. Significant difference can be identified in case of bonds; Czech households keep only 1% of total financial assets in form of bonds, but 6% is invested by households in other European countries. As a consequence of these structural differences, share of cash and deposits (AF.2) on total financial assets is much lower in the Western Europe (30%) than in the Czech Republic. This situation can be connected especially with habits spread in the society, risk-aversion and carefulness of general public.

Situation of *non-profit institutions serving households (S.15)* is very similar to previous case. Substantial difference on the assets side can be seen in case of insurance technical reserves (AF.6), the share is considerably lower (1%) in comparison to households. This is related mainly to the participation of households in pension programmes of pension funds. On the liability side, the situation is almost identical as in the case of households, as far as way of financing and shares on total liabilities are concerned.

CONCLUSION

Financial statistics representing "financial sphere" of the national accounts is going through very dynamic development as a reflection of economic-policy needs. Frame of financial accounts was presented, as well as current situation in the Czech national accounts and its institutional background. We discussed the content and results of the national accounts revision carried out in 2008.

Main conceptual adjustments incorporated during the revision were presented, as well as results of the revision. The revision led to quite significant movements in the wealth distributions, mainly due to more accurate linkage of households to non-financial corporations via shares. As a result, net financial wealth concentration in households´ sector was amplified. Also the structure of assets and liabilities of particular sectors was analysed, i.e. how activities of the sectors are financed and in which assets the units invest.

In is worth to add, that next revision is planned for 2014 and this revision will reflect new manual of the national accounts – ESA 2010 – that will enter into force in the coming months. Main changes in the financial accounts will take the form of financial items renumbering and recording of some types of guaranties as a financial asset (or liability).

[5] No matter of the purpose of the loan, i.e. consumption, dwelling, etc.

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Ranking the EU Countries Based on Indicators of Sustainable Development

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Abstract

Some synthetic measures of sustainable development (SD) for European Union (EU) countries are investigated. Rankings of EU countries are performed and compared. An "expert" method of ranking objects as projected on a "bad-good" axis is analyzed and compared with method based on Euclidean distances from hypothetical "best" point in multidimensional indicators' space. Conclusions with regard to SD level of individual countries are drawn and some suggestions about adequacy of certain SD indicators are made.

Keywords

Sustainable development, SD indicators, ranking, ranks correlation, multiple criteria

JEL code

Q01

INTRODUCTION

Growing consciousness of dangers, that degradation of our environment is connected with, as well as growing ethical level of political discourse, has brought a still growing interest in the subject of sustainable development (SD). Sustainable development, according to the definition of World Commission on Environment and Development (WCED), better known as the Brundtland Commission, is such a development that "meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987). This definition covers the quality of life of contemporary people as well as preservation of natural capital to enable future generations to benefit the same level of well-being. The European Union Sustainable Development Strategy is based on a seven key challenges: climate change and clean energy; sustainable transport; sustainable consumption and production; conservation and management of natural resources; public health; social inclusion, demography and migration; global poverty and sustainable development challenges (Council of the European Union, 2006).

There exists a plenty of sets of sustainable development indicators (see e.g. Bell, Morse, 2008), to that extent, that all attempts to establish a "proper" one has been called "the sustainability indicator industry" (King et al., 2000). Here, we will choose indicators used by European Council to monitor progresses in the implementation of the EU Sustainable Development Strategy (EU, 2011).

Although there are controversies regarding relevance of aggregation of indicators (see e.g. Ebert, Welsh, 2004), there are still many attempts to construct one synthetic measure of sustainable develop-

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ment level, based on various sets of indicators (Hak, Moldan, Dahl, 2007). Many of these indices are weighted averages of individual indicators (e.g. Esty et al., 2005, Van de Kerk, Manuel, 2008), however, there are also more advanced approaches, e.g. based on fuzzy logic (Phillis, Grigoroudis, Kouikoglou, 2011) or principal component analysis (Hosseini, Kaneko, 2011).

In this paper we rank European Union countries according to the level of their sustainable development, taking indicators proposed by European Council and using a few different methods. We take values for 2007 year for the purpose of further extending analysis to variables not available yet for later periods. We compare rankings obtained by different methods. It appears, that according to all used methods Sweden is the top country, while Poland is one of four worst countries. Czech Republic ranks from 17th to 22nd (in a group of 27 countries).

We investigate here also applicability of an "expert" method of ranking objects. This method can be used in the situation, when one cannot be sure, which variables are favorable and which are unfavorable ones, while can be pretty sure, which object (here: country) has overall "good" characteristics and which one "bad" characteristics. To this end we compare results obtained by this method with results obtained by ranking countries according to the distance from the hypothetical ideal point in indicators' space.

This paper is organized as follows. In the following section indicators taken into account will be introduced and their values for EU countries for year 2007 will be given. The next four sections will demonstrate a few different methods of ranking countries. In section 6 these methods will be compared and some conclusions will be given. The last section will contain summary of the paper.

1 INDICATORS OF SUSTAINABLE DEVELOPMENT

According to European Council, there are more than 100 sustainable development indicators, eleven of which "have been identified as headline indicators. They are intended to give an overall picture of whether the European Union has achieved progress towards sustainable development in terms of the objectives and targets defined in the strategy" (Eurostat, 2012). From ten theme-groups seven have one headline indicator, two – two headline indicators, while one has no such an indicator. Thus there are in sum eleven headline indicators. These groups and headline indicators are presented in the Table 1 below. In the third column the symbols of indicators, that will be used in what follows, are placed and in the fourth column there are units, in which data is presented in official reports.

Table 1 Theme-groups and headline indicators of sustainable development

Theme	Headline indicator	Symbol of indicator	Units
Socio-economic development	Growth rate of real GDP per capita	SDI1	%
Sustainable consumption and production	Resource productivity	SDI2	EUR / kg
Social inclusion	People at-risk-of-poverty or social exclusion	SDI3	%
Demographic changes	Employment rate of older workers	SDI4	%
Public health	Healthy life years and life expectancy at birth, by gender	SDI5	years
Climate change and energy	Greenhouse gas emissions	SDI6	%
	Share of renewable energy in gross final energy consumption	SDI7	%
Sustainable transport	Energy consumption of transport relative to GDP	SDI8	%
Natural resources	Common bird index		%
	Fish catches taken from stocks outside safe biological limits: Status of fish stocks managed by the EU in the North-East Atlantic		%
Global partnership	Official development assistance as share of gross national income	SDI9	%
Good governance	No headline indicator		

Source: EUROSTAT (http://epp.eurostat.ec.europa.eu/portal/page/portal/sdi/indicators)

In what follows we will deal with indicators SDI1-9 for 27 countries of EU based on the data for year 2007, omitting common bird index and status of fish stocks, as there is no data available for them. For interpretation simplicity we will change percentages to decimal fractions and transform SDI3, SDI6, SDI8 by: (to turn unfavorable features into favorable ones). In what follows the notion will denote the value of indicator for country . The values of indicators will be rescaled to range from 0 to 1. From amongst a few possibilities, we have chosen the following procedure of rescaling that will be applied:

$$x_i^k = \frac{\tilde{x}_i^k - \tilde{x}_i^{\min}}{\tilde{x}_i^{\max} - \tilde{x}_i^{\min}}, \tag{1}$$

where $\tilde{x}_i^{\min} = \min\{\tilde{x}_i^k\}$ and $\tilde{x}_i^{\max} = \max\{\tilde{x}_i^k\}$.

Rescaled and transformed data is presented in Table 2.

Table 2 Values of normalized sustainable development indicators for year 2007

	SDI1	SDI2	SDI3	SDI4	SDI5	SDI6	SDI7	SDI8	SDI9
Austria	0.26	0.30	0.94	0.24	0.80	0.54	0.60	0.31	0.51
Belgium	0.15	0.32	0.84	0.14	0.73	0.68	0.06	1.00	0.43
Bulgaria	0.64	0.00	0.00	0.34	0.02	0.87	0.20	0.58	0.00
Cyprus	0.29	0.12	0.76	0.66	0.69	0.00	0.07	0.97	0.07
Czech Republic	0.49	0.07	0.96	0.42	0.45	0.79	0.16	0.30	0.06
Denmark	0.05	0.26	0.94	0.73	0.49	0.64	0.41	0.47	0.86
Estonia	0.65	0.03	0.83	0.76	0.28	0.94	0.38	1.00	0.02
Finland	0.42	0.16	0.93	0.64	0.80	0.54	0.65	0.80	0.38
France	0.11	0.40	0.89	0.23	1.00	0.66	0.23	0.95	0.37
Germany	0.21	0.38	0.86	0.55	0.75	0.77	0.20	0.99	0.36
Greece	0.32	0.20	0.69	0.33	0.64	0.42	0.18	0.85	0.13
Hungary	0.02	0.11	0.67	0.11	0.16	0.77	0.13	0.31	0.02
Ireland	0.24	0.12	0.80	0.61	0.67	0.45	0.07	0.67	0.56
Italy	0.00	0.35	0.74	0.13	0.93	0.57	0.11	0.63	0.15
Latvia	1.00	0.04	0.53	0.70	0.00	1.00	0.67	0.68	0.00
Lithuania	0.98	0.07	0.68	0.60	0.08	0.96	0.32	0.64	0.06
Luxembourg	0.43	1.00	0.96	0.08	0.69	0.63	0.04	0.51	0.99
Malta	0.25	0.48	0.89	0.00	0.69	0.28	0.00	0.88	0.10
Netherlands	0.30	0.59	0.96	0.54	0.72	0.63	0.06	0.63	0.86
Poland	0.62	0.06	0.56	0.03	0.40	0.70	0.16	0.00	0.05
Portugal	0.15	0.11	0.76	0.54	0.69	0.37	0.50	0.55	0.18
Romania	0.59	0.00	0.32	0.31	0.05	0.88	0.42	0.87	0.01
Slovakia	0.98	0.08	0.84	0.17	0.23	0.87	0.16	0.86	0.03
Slovenia	0.57	0.08	0.93	0.12	0.66	0.54	0.35	0.65	0.07
Spain	0.10	0.18	0.80	0.39	0.94	0.23	0.21	0.59	0.36
Sweden	0.15	0.39	1.00	1.00	0.80	0.68	1.00	0.92	1.00
United Kingdom	0.13	0.57	0.81	0.70	0.64	0.74	0.03	0.89	0.33

Source: Own calculations based on EUROSTAT (http://epp.eurostat.ec.europa.eu/portal/page/portal/sdi/indicators)

Let us briefly analyze the nature of various indicators. The first one, growth rate of gross domestic product per capita is probably the most controversial one. As it does not reflect non-marketed environmental and social capital, it is often criticized as a measure of welfare (see, e.g., Arrow et al., 1995, Galbraith, 1958, Sen, 1976). Moreover, SDI1, together with SDI6 and SDI8 are relative values. They thus measure the development of any phenomenon rather than this phenomenon itself. It may be considered "unjust" to take them into account while appraising individual countries. For example, a country with smaller emission of greenhouse gases both in base and examined year may be characterized by an index of worse value than another country emitting more greenhouse gases both in base and in examined year. In case of any measured variable a country lasting in an "optimal" state will come fall worse than the country still approaching this optimal state.

The other problem concerning SD indicators that will be mentioned here is how to treat SD indicators: as all of them having the same significance or to choose some weights? In particular, most of themes, instead of two, have just one headline indicator. As for "climate change" and "natural resources", both of them are characterized by two leading indicators: however, there is no data available for the two latter. One could put a question, whether wouldn't it be more appropriate to take some average of the two former, not to overweight the influence of "climate change"? Aware of the fact, that the problem of "weighting" indicators has not even approached its final solution, we will treat in what follows all indicators equally. As for two headline indicators for the same theme ("climate changes"), SDI6 and SDI7, we suppose that it would be proper to treat each of them on an equal footing with all the others, as the themes themselves are chosen arbitrarily and, on the other hand, correlation between SDI6 and SDI7 has not too large value, 0.21. However, we will also check the influence of taking one averaged indicator, instead of two distinct ones, on the final result.

2 MEASURES OF SUSTAINABLE DEVELOPMENT BASED ON INDIVIDUAL RANKS

First of all let us check how the ranking of particular countries depends on an indicator that ranking is done with respect to. Table 3 shows these rankings according to 9 indicators in question. No matter, whether raw or normalized data is used here, as linear and positive transformations do not change the ranks of values. Note, that here and hereafter the rank 1 refers to the "worst" country while rank 27 – to the "best" one.

Table 3 Ranks of UE countries according to sustainable development indicators

	Ranks according to								
	SDI1	SDI2	SDI3	SDI4	SDI5	SDI6	SDI7	SDI8	SDI9
Austria	13	18	23	10	23	8	24	4	22
Belgium	8	19	15	7	20	16	4	26	21
Bulgaria	23	1.5	1	13	2	22	14.5	8	1.5
Cyprus	14	12	9	22	16.5	1	6	24	10.5
Czech Republic	19	6	25	15	9	21	10	2	8.5
Denmark	3	17	22	25	10	13	21	5	24.5
Estonia	24	3	14	26	7	25	20	27	4.5
Finland	17	14	20	21	23	9	25	16	20
France	5	23	19	9	27	14	17	23	19
Germany	10	21	17	18	21	20	14.5	25	17.5
Greece	16	16	7	12	11.5	5	13	17	13
Hungary	2	10	5	4	5	19	9	3	4.5
Ireland	11	13	11.5	20	14	6	7	14	23
Italy	1	20	8	6	25	10	8	11	14
Latvia	27	4	3	24	1	27	26	15	1.5
Lithuania	25.5	7	6	19	4	26	18	12	8.5
Luxembourg	18	27	24	3	16.5	12	3	6	26
Malta	12	24	18	1	16.5	3	1	20	12
Netherlands	15	26	26	16.5	19	11	5	10	24.5
Poland	22	5	4	2	8	17	11.5	1	7
Portugal	8	11	10	16.5	16.5	4	23	7	15
Romania	21	1.5	2	11	3	24	22	19	3
Slovakia	25.5	9	16	8	6	23	11.5	18	6
Slovenia	20	8	21	5	13	7	19	13	10.5
Spain	4	15	11.5	14	26	2	16	9	17.5
Sweden	8	22	27	27	23	15	27	22	27
United Kingdom	6	25	13	23	11.5	18	2	21	16

Source: Own calculations

The correlation between ranks according to different indicators are shown in Table 4, below diagonal. They reflect Pearson correlation coefficients, also shown in Table 4, above diagonal.

Table 4 Spearman rank (below diagonal, normal font) and Pearson (above diagonal, italics) correlations

	SDI1	SDI2	SDI3	SDI4	SDI5	SDI6	SDI7	SDI8	SDI9
SDI1	**1**	*–0.42*	*–0.36*	*0.02*	*–0.71*	*0.55*	*0.16*	*–0.03*	*–0.45*
SDI2	–0.62	**1**	*0.49*	*–0.12*	*0.54*	*–0.17*	*–0.26*	*0.12*	*0.71*
SDI3	–0.2	0.6	**1**	*0.13*	*0.66*	*–0.31*	*0.05*	*0.11*	*0.55*
SDI4	0.04	–0.09	0.09	**1**	*–0.05*	*0.09*	*0.52*	*0.33*	*0.29*
SDI5	–0.62	0.72	0.54	–0.07	**1**	*–0.67*	*–0.08*	*0.18*	*0.51*
SDI6	0.49	–0.46	–0.25	0.17	–0.64	**1**	*0.21*	*–0.06*	*–0.15*
SDI7	0.21	–0.41	–0.01	0.43	–0.05	0.2	**1**	*0.03*	*0.17*
SDI8	0.01	0.18	0.03	0.31	0.19	0.08	–0.04	**1**	*0.01*
SDI9	–0.55	0.81	0.71	0.14	0.75	–0.51	–0.08	0.02	**1**

Source: Own calculations

It is intuitively understandable, that some of these measures correlate negatively, as caring of temporary economical or social welfare may be not in agreement in concern for ecological goals. Thus, also the ranks of countries according to some pairs of indicators also correlate negatively. The simplest idea of building some aggregate measure of sustainable development that takes into account all nine indicators is just to calculate an average rank for each country. The results of such ranking are shown in Table 5. First column contains the ranks while the four following columns – the names of countries in the order that take into regard all indicators (second column); all but the first one (third column); all indicators, two belonging to the same theme group averaged (fourth column); and all indicators excluding relative ones (fifth column).

Table 5 Ranks of UE countries according to averaged ranks of individual variables. Italics denote countries ex aequo

Rank	All indicators	Without GDP dynamics	SDI6 and SDI7 averaged	Without dynamical indicators
1	Hungary	Poland	Poland	Bulgaria
2	Poland	Hungary	Bulgaria	*Hungary*
3	Bulgaria	Bulgaria	Hungary	*Poland*
4	Italy	Romania	Romania	Romania
5	Romania	Greece	Latvia	Slovakia
6	Malta	Malta	Lithuania	Latvia
7	Greece	*Czech Republic*	Slovakia	Lithuania
8	Portugal	*Slovenia*	Czech Republic	Greece
9	*Spain*	Slovakia	Slovenia	Malta
10	*Cyprus*	Lithuania	Greece	Czech Republic
11	Czech Republic	Cyprus	Portugal	Estonia
12	Slovenia	Latvia	Italy	Cyprus
13	Ireland	Italy	Malta	Slovenia
14	Slovakia	Portugal	Cyprus	Italy
15	Lithuania	Ireland	*Ireland*	Belgium
16	Latvia	Spain	*Spain*	Ireland
17	*Luxembourg*	Luxembourg	Estonia	United Kingdom
18	*United Kingdom*	Estonia	Luxembourg	Portugal
19	Belgium	Belgium	Austria	Luxembourg
20	Denmark	United Kingdom	Belgium	Spain
21	Austria	Austria	United Kingdom	Germany
22	Estonia	Denmark	Denmark	France
23	Netherlands	Netherlands	Netherlands	Netherlands
24	France	Finland	Finland	Denmark
25	Germany	France	France	Austria
26	Finland	Germany	Germany	*Finland*
27	Sweden	Sweden	Sweden	*Sweden*

Source: Own calculations

Average rank is a rather crude measure, as ranks according to individual indicators do not take into account the degree of advantage of one country over another. For example, thousandfold advantage in respect of one indicator of a country A over a country B may be compensated by a little, say, twofold, advantage in respect of another indicator of the country B over the country A. To construct ranking that takes whole the information available into account, a concept of "ideal points" will be introduced.

3 MEASURES OF SUSTAINABLE DEVELOPMENT BASED ON DISTANCE FROM "IDEAL POINT"

In order to define "ideal points" we need to use rescaled data. In this case, as all indicators have been transformed to become favorable and to range from 0 to 1, the hypothetical "worst" point in the 9-dimensional space is (0, 0, 0, 0, 0, 0, 0, 0, 0), and the hypothetical "best" point – (1, 1, 1, 1, 1, 1, 1, 1, 1). Note, that none of them refers to any existing country, as they reflect the worst and the best values of all nine indicators chosen from the whole set of EU countries. For example, point (0, 0, 0, 0, 0, 0, 0, 0, 0) is characterized by the value of growth rate of GDP due to Italy, resource productivity value due to Bulgaria and Romania and so on (compare values 0 and 1 in Table 2). The ranking of countries proposed here will be based on the distance of particular countries from the "worst" point: the greater value of this distance the "better" the country is and the higher will be its rank. Note, that in this case it is possible not only to determine the rank of a given country but also to quantify it: that is, to calculate the distances between subsequent countries.

We will use here two metrics. One is taxicab metrics (known also as city block distance or Manhattan distance) and the second – Euclidean metrics. In the first case a distance between and countries is given by:

$$d_M^{kl} = \sum_{i=1}^{D} \left| x_i^k - x_i^l \right|, \tag{2}$$

and the distance of a country from the "worst" point (0, 0, 0, 0, 0, 0, 0, 0, 0):

$$d_M^{k0} = \sum_{i=1}^{D} x_i^k, \tag{3}$$

where denotes the dimensionality, that is, the number of variables taken into account.

The Euclidean distance between countries and is given by:

$$d_E^{kl} = \sqrt{\sum_{i=1}^{D} \left(x_i^k - x_i^l \right)^2}, \tag{4}$$

and distance of a country from the "worst" point:

$$d_E^{k0} = \sqrt{\sum_{i=1}^{D} \left(x_i^k \right)^2}. \tag{5}$$

Tables 6 and 7 present results: ranking (with distances from the theoretical "worst" point) of EU countries carried out according to Manhattan and Euclidean distances, respectively. Note, that the distances are given as values relative to the maximum possible distance (that is, the distance between "worst" and "best" points). This relative distances will be denoted by $\tilde{d}_{M,E}^{kl}$. Taking into regard Manhattan distances the maximum distance equals to 9 while taking all indicators into account; without GDP it equals to 8; 7 while averaging two indicators belonging to the same theme group; and 6 while omitting indicators of relative character. That is, $\tilde{d}_M^{k0} = d_M^{k0}/D$. In the case of Euclidean distances maximum value equals to 3 (while taking all indicators into account); without GDP it equals to $\sqrt{8}$; $\sqrt{7}$ while averaging two indicators belonging to the same theme group; and $\sqrt{6}$ while omitting indicators of relative character. In this case, $\tilde{d}_E^{k0} = d_E^{k0}/\sqrt{D}$.

Table 6 Ranks of UE countries with respect to Manhattan distance

	All indicators		Without GDP dynamics		SDI6 and SDI7 averaged		Without dynamical indicators	
	Country	dist.	Country	dist.	Country	dist.	Country	dist.
1	Hungary	0.26	Poland	0.24	Bulgaria	0.21	Bulgaria	0.09
2	Poland	0.29	Bulgaria	0.25	Poland	0.22	Romania	0.18
3	Bulgaria	0.29	Hungary	0.29	Hungary	0.26	Hungary	0.20
4	Romania	0.38	Romania	0.36	Romania	0.31	Poland	0.21
5	Malta	0.40	Czech Rep.	0.40	Czech Rep.	0.39	Slovakia	0.25
6	Italy	0.40	Slovakia	0.41	Slovakia	0.39	Lithuania	0.30
7	Cyprus	0.40	Malta	0.42	Lithuania	0.40	Latvia	0.32
8	Czech Rep.	0.41	Cyprus	0.42	Latvia	0.40	Czech Rep.	0.35
9	Greece	0.42	Slovenia	0.42	Slovenia	0.42	Malta	0.36
10	Spain	0.42	Lithuania	0.43	Greece	0.45	Greece	0.36
11	Portugal	0.43	Greece	0.43	Malta	0.45	Slovenia	0.37
12	Slovenia	0.44	Italy	0.45	Italy	0.47	Estonia	0.38
13	Ireland	0.47	Latvia	0.45	Portugal	0.47	Cyprus	0.39
14	Slovakia	0.47	Spain	0.46	Cyprus	0.47	Italy	0.40
15	Belgium	0.48	Portugal	0.46	Spain	0.50	Belgium	0.42
16	Lithuania	0.49	Ireland	0.50	Estonia	0.51	Portugal	0.46
17	Austria	0.50	Belgium	0.52	Austria	0.52	Ireland	0.47
18	Latvia	0.51	Austria	0.53	Ireland	0.53	Spain	0.48
19	France	0.54	Estonia	0.53	Belgium	0.55	UK	0.51
20	UK	0.54	UK	0.59	Denmark	0.61	Germany	0.52
21	Denmark	0.54	France	0.59	France	0.61	France	0.52
22	Estonia	0.54	Denmark	0.60	Finland	0.61	Austria	0.56
23	Germany	0.56	Germany	0.61	UK	0.62	Finland	0.59
24	Netherlands	0.59	Finland	0.61	Germany	0.62	Denmark	0.61
25	Finland	0.59	Luxembourg	0.61	Luxembourg	0.65	Netherlands	0.62
26	Luxembourg	0.59	Netherlands	0.62	Netherlands	0.66	Luxembourg	0.63
27	Sweden	0.77	Sweden	0.85	Sweden	0.85	Sweden	0.86

Source: Own calculations

Table 7 Ranks of UE countries with respect to Euclidean distance from the ideal "worst" point

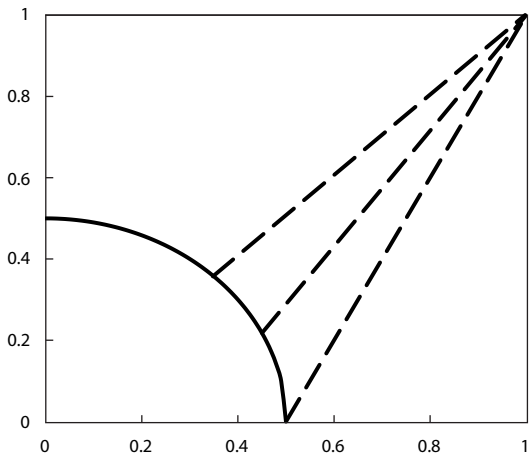
	All indicators		Without GDP dynamics		SDI6 and SDI7 averaged		Without dynamical indicators	
	Country	dist.	Country	dist.	Country	dist.	Country	dist.
1	Hungary	0.37	Poland	0.35	Poland	0.31	Bulgaria	0.16
2	Poland	0.39	Hungary	0.39	Bulgaria	0.33	Romania	0.25
3	Bulgaria	0.43	Bulgaria	0.40	Hungary	0.34	Poland	0.29
4	Greece	0.48	Romania	0.49	Romania	0.44	Hungary	0.29
5	Portugal	0.48	Greece	0.50	Czech Rep.	0.48	Slovakia	0.37
6	Romania	0.50	Czech Rep.	0.51	Lithuania	0.49	Lithuania	0.40
7	Czech Rep.	0.50	Portugal	0.51	Slovakia	0.51	Greece	0.43
8	Spain	0.50	Slovenia	0.52	Greece	0.52	Latvia	0.45
9	Italy	0.51	Lithuania	0.53	Portugal	0.52	Czech Rep.	0.47
10	Malta	0.52	Spain	0.53	Latvia	0.53	Slovenia	0.49
11	Slovenia	0.53	Italy	0.54	Slovenia	0.53	Estonia	0.50
12	Ireland	0.53	Slovakia	0.54	Italy	0.55	Malta	0.50
13	Cyprus	0.53	Malta	0.54	Spain	0.56	Cyprus	0.50
14	Austria	0.55	Cyprus	0.55	Malta	0.57	Belgium	0.51
15	Belgium	0.58	Ireland	0.55	Ireland	0.58	Italy	0.51
16	Lithuania	0.60	Austria	0.58	Austria	0.58	Portugal	0.52
17	Denmark	0.60	Latvia	0.58	Cyprus	0.59	Ireland	0.55
18	Slovakia	0.60	Belgium	0.61	Belgium	0.62	Spain	0.56
19	UK	0.61	Denmark	0.64	Estonia	0.63	Germany	0.56
20	Germany	0.63	UK	0.64	UK	0.65	UK	0.58
21	France	0.63	Estonia	0.65	Denmark	0.65	France	0.60
22	Finland	0.63	Finland	0.65	Finland	0.66	Austria	0.62
23	Latvia	0.64	Germany	0.66	Germany	0.66	Finland	0.64
24	Netherlands	0.64	France	0.66	France	0.68	Denmark	0.66
25	Estonia	0.65	Netherlands	0.67	Netherlands	0.69	Netherlands	0.69
26	Luxembourg	0.68	Luxembourg	0.71	Luxembourg	0.73	Luxembourg	0.75
27	Sweden	0.82	Sweden	0.87	Sweden	0.87	Sweden	0.89

Source: Own calculations

While dealing with Manhattan distance it is clear, that the distance of any point from the "worst" point determines uniquely its distance from the "best" one:

$$d_M^{k1} = \sum_{i=1}^{D} \left|1 - x_i^k\right| = D - \sum_{i=1}^{D} x_i^k = D - d_M^{k0} = D\left(1 - \tilde{d}_M^{k0}\right). \quad (6)$$

Figure 1 Line of equal Euclidean distance to (0, 0) (solid line) and different distances to (1, 1) (dashed lines as examples)



Source: Own construction

Thus, the ranking determined by the distance from the "worst" point will be strictly the same as the one determined by the distance from the "best" one (note, that in this case the smaller distance the higher position of the country in the ranking).

However, as we are dealing here with a space with more than one dimension, Euclidean distance from the "worst" point does not determine its distance from the "best" one. There may exist, for example, two points of the same distance from the "worst" point but with different distances to the "best" point (see Figure 1 for an example in two dimensions). Using Euclidean metrics, the distances from the second ideal point should also be taken into regard. Let us check the ranking of the countries while taking the distance from the "best" ideal point into regard.

Table 8 Ranks of EU countries with respect to Euclidean distance from "best" point

	All indicators		Without GDP dynamics		SDI6 and SDI7 averaged		Without dynamical indicators	
	Country	dist.	Country	dist.	Country	dist.	Country	dist.
1	Hungary	0.79	Bulgaria	0.81	Bulgaria	0.81	Bulgaria	0.92
2	Bulgaria	0.77	Poland	0.80	Poland	0.78	Romania	0.83
3	Poland	0.76	Hungary	0.76	Romania	0.74	Hungary	0.83
4	Romania	0.70	Romania	0.72	Hungary	0.74	Poland	0.82
5	Cyprus	0.69	Slovakia	0.69	Latvia	0.70	Slovakia	0.79
6	Malta	0.69	Cyprus	0.69	Slovakia	0.67	Latvia	0.75
7	Italy	0.67	Malta	0.68	Lithuania	0.65	Lithuania	0.74
8	Czech Rep.	0.66	Czech Rep.	0.67	Czech Rep.	0.64	Malta	0.73
9	Slovakia	0.65	Lithuania	0.66	Slovenia	0.63	Czech Rep.	0.72
10	Spain	0.64	Latvia	0.66	Estonia	0.60	Slovenia	0.71
11	Slovenia	0.63	Slovenia	0.65	Malta	0.58	Estonia	0.69
12	Greece	0.63	Greece	0.62	Italy	0.55	Cyprus	0.68
13	Lithuania	0.62	Italy	0.62	Cyprus	0.55	Italy	0.68
14	Latvia	0.62	Estonia	0.60	Greece	0.55	Greece	0.68
15	Portugal	0.61	Spain	0.60	Portugal	0.54	Belgium	0.65
16	Belgium	0.61	Portugal	0.58	Austria	0.51	Spain	0.59
17	Ireland	0.59	Belgium	0.57	Spain	0.50	Ireland	0.59
18	Estonia	0.58	Ireland	0.56	Belgium	0.48	Portugal	0.59
19	France	0.56	Luxembourg	0.53	Ireland	0.45	France	0.57
20	Austria	0.55	Austria	0.52	France	0.44	Luxembourg	0.56
21	UK	0.54	France	0.51	Finland	0.44	UK	0.55
22	Denmark	0.53	UK	0.49	Luxembourg	0.42	Germany	0.54
23	Luxembourg	0.53	Germany	0.47	Denmark	0.41	Austria	0.50
24	Germany	0.52	Denmark	0.46	Germany	0.39	Finland	0.48
25	Netherlands	0.48	Finland	0.45	UK	0.36	Netherlands	0.48
26	Finland	0.47	Netherlands	0.45	Netherlands	0.30	Denmark	0.46
27	Sweden	0.37	Sweden	0.25	Sweden	0.27	Sweden	0.26

Source: Own calculations

The Euclidean distance from point (1, 1, 1, 1, 1, 1, 1, 1, 1) reads:

$$d_E^{k1} = \sqrt{\sum_{i=1}^{D}\left(1 - x_i^k\right)^2}. \tag{7}$$

Table 8 presents results: ranking (with distances from the theoretical "best" point) of EU countries carried out according to Euclidean metrics. As in the case before, the distances are given as a fraction of the maximum possible distance, $\tilde{d}_E^{k1} = d_E^{k1}/\sqrt{D}$.

It can be seen, that the ranking according to the distance from the "best" point is different from that established by the distance from the "worst" point. The simplest joined measure of "goodness" of the country may be obtained by simple averaging these two distances (or, to be precise, $\tilde{d}_E^{k0}$ and $1 - \tilde{d}_E^{k1}$). The results are contained in Table 9.

Table 9 Ranks of UE countries with respect to average Euclidean distance from the "worst" and "best" points

	All indicators		Without GDP dynamics		SDI6 and SDI7 averaged		Without dynamical indicators	
	Country	dist.	Country	dist.	Country	dist.	Country	dist.
1	Hungary	0.29	Poland	0.28	Bulgaria	0.26	Bulgaria	0.12
2	Poland	0.31	Bulgaria	0.29	Poland	0.26	Romania	0.21
3	Bulgaria	0.33	Hungary	0.31	Hungary	0.30	Hungary	0.23
4	Romania	0.40	Romania	0.38	Romania	0.35	Poland	0.24
5	Malta	0.42	Czech Rep.	0.42	Latvia	0.41	Slovakia	0.29
6	Italy	0.42	Slovakia	0.42	Lithuania	0.42	Lithuania	0.33
7	Cyprus	0.42	Malta	0.43	Czech Rep.	0.42	Latvia	0.35
8	Czech Rep.	0.42	Cyprus	0.43	Slovakia	0.42	Greece	0.37
9	Greece	0.43	Slovenia	0.44	Slovenia	0.45	Czech Rep.	0.38
10	Spain	0.43	Greece	0.44	Greece	0.48	Malta	0.39
11	Portugal	0.44	Lithuania	0.44	Portugal	0.49	Slovenia	0.39
12	Slovenia	0.45	Italy	0.46	Italy	0.50	Estonia	0.40
13	Ireland	0.47	Latvia	0.46	Malta	0.50	Cyprus	0.41
14	Slovakia	0.48	Portugal	0.47	Estonia	0.51	Italy	0.42
15	Belgium	0.49	Spain	0.47	Cyprus	0.52	Belgium	0.43
16	Lithuania	0.49	Ireland	0.50	Spain	0.53	Portugal	0.47
17	Austria	0.50	Belgium	0.52	Austria	0.53	Ireland	0.48
18	Latvia	0.51	Estonia	0.52	Ireland	0.56	Spain	0.48
19	France	0.53	Austria	0.53	Belgium	0.57	UK	0.51
20	UK	0.53	France	0.58	Finland	0.61	Germany	0.51
21	Denmark	0.53	UK	0.58	France	0.62	France	0.52
22	Estonia	0.54	Luxembourg	0.59	Denmark	0.62	Austria	0.56
23	Germany	0.56	Denmark	0.59	Germany	0.63	Finland	0.58
24	Luxembourg	0.58	Germany	0.59	UK	0.64	Luxembourg	0.60
25	Netherlands	0.58	Finland	0.60	Luxembourg	0.66	Denmark	0.60
26	Finland	0.58	Netherlands	0.61	Netherlands	0.69	Netherlands	0.61
27	Sweden	0.73	Sweden	0.81	Sweden	0.80	Sweden	0.82

Source: Own calculations

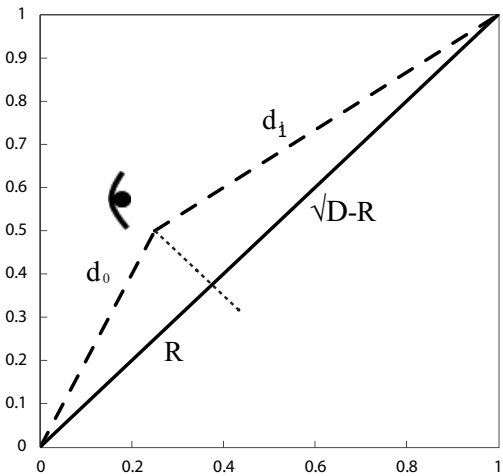
However, dealing with Euclidean metrics probably more "natural" will be averaging not $\tilde{d}_E^{k0}$ and $1 - \tilde{d}_E^{k1}$, but rather, $\left(\tilde{d}_E^{k0}\right)^2$ and $1 - \left(\tilde{d}_E^{k1}\right)^2$. This will be the subject of the following section.

4 MEASURE OF SUSTAINABLE DEVELOPMENT BASED ON DISTANCE ON "WORST-BEST" AXIS

According to the previous section, while evaluating a certain country with respect to the level of its sustainable development two aspects should be taken into regard: its distance from the totally worst state and its distance to ideally best state. In the context of Euclidean metrics it would mean averaging $\left(\tilde{d}_E^{k0}\right)^2$ and $1 - \left(\tilde{d}_E^{k1}\right)^2$. Let us investigate, what such averaging is equivalent to.

Let us take an axis passing points {0} and {1} in D-dimensional space. Let us have in that space any other point, $\{x\}$, fulfilling: $0 \le x_1, x_2, \ldots, x_D \le 1$. The length of perpendicular projection of vector $\vec{x}$ on the line $\vec{1}$, denoted by R, may be obtained as follows (see Figure 2 for illustration in 2D):

Figure 2 Perpendicular projection of vector $\vec{x}$ on the vector $\vec{1}$ in two dimensions



Source: Own construction

$$(d_E^0)^2 - R^2 = (d_E^1)^2 - \left(\sqrt{D} - R\right)^2, \quad (8)$$

and

$$R = \left[D + (d_E^0)^2 - (d_E^1)^2\right] / \left[2\sqrt{D}\right]. \quad (9)$$

Dealing with distances rescaled by the maximum possible distance $\sqrt{D}$ one gets:

$$\tilde{R} = \left[\left(\tilde{d}_E^0\right)^2 + 1 - \left(\tilde{d}_E^1\right)^2\right] / 2. \quad (10)$$

Thus, averaging $\left(\tilde{d}_E^{k0}\right)^2$ and $1 - \left(\tilde{d}_E^{k1}\right)^2$ is strictly the same as projecting the vector determined by points {0} and {x} on the line going through points {0} and {1}.

Having this geometrical interpretation in mind, let us proceed with ranking countries according to distance from "worst" ideal point on the "worst-best" axis. The results are shown in Table 10.

Table 10 Ranks of UE countries with respect to their distance from the "worst" point on the "worst-best" axis

	All indicators		Without GDP dynamics		SDI6 and SDI7 averaged		Without dynamical indicators	
	Country	dist.	Country	dist.	Country	dist.	Country	dist.
1	Hungary	0.26	Poland	0.24	Bulgaria	0.23	Bulgaria	0.09
2	Poland	0.29	Bulgaria	0.25	Poland	0.24	Romania	0.18
3	Bulgaria	0.29	Hungary	0.29	Hungary	0.28	Hungary	0.20
4	Romania	0.38	Romania	0.36	Romania	0.32	Poland	0.21
5	Malta	0.40	Czech Rep.	0.40	Latvia	0.39	Slovakia	0.25
6	Italy	0.40	Slovakia	0.41	Lithuania	0.40	Lithuania	0.30
7	Cyprus	0.40	Malta	0.42	Slovakia	0.41	Latvia	0.32
8	Czech Rep.	0.41	Cyprus	0.42	Czech Rep.	0.41	Czech Rep.	0.35
9	Greece	0.42	Slovenia	0.42	Slovenia	0.44	Malta	0.36
10	Spain	0.42	Lithuania	0.43	Greece	0.48	Greece	0.36
11	Portugal	0.43	Greece	0.43	Portugal	0.49	Slovenia	0.37
12	Slovenia	0.44	Italy	0.45	Italy	0.50	Estonia	0.38
13	Ireland	0.47	Latvia	0.45	Malta	0.50	Cyprus	0.39
14	Slovakia	0.47	Spain	0.46	Estonia	0.52	Italy	0.40
15	Belgium	0.48	Portugal	0.46	Cyprus	0.52	Belgium	0.42
16	Lithuania	0.49	Ireland	0.50	Spain	0.53	Portugal	0.46
17	Austria	0.50	Belgium	0.52	Austria	0.54	Ireland	0.47
18	Latvia	0.51	Austria	0.53	Ireland	0.56	Spain	0.48
19	France	0.54	Estonia	0.53	Belgium	0.57	UK	0.51
20	UK	0.54	UK	0.59	Finland	0.62	Germany	0.52
21	Denmark	0.54	France	0.59	Denmark	0.63	France	0.52
22	Estonia	0.54	Denmark	0.60	France	0.63	Austria	0.56
23	Germany	0.56	Germany	0.61	Germany	0.64	Finland	0.59
24	Netherlands	0.59	Finland	0.61	UK	0.64	Denmark	0.61
25	Finland	0.59	Luxembourg	0.61	Luxembourg	0.68	Netherlands	0.62
26	Luxembourg	0.59	Netherlands	0.62	Netherlands	0.69	Luxembourg	0.63
27	Sweden	0.77	Sweden	0.85	Sweden	0.84	Sweden	0.86

Source: Own calculations

5 MEASURE OF SUSTAINABLE DEVELOPMENT BASED ON DISTANCE ON "BAD-GOOD" AXIS

All methods of ranking described in the previous sections have the same restriction: one has to determine, which variable is favorable and which one is not, for sustainable development. If we have variables that *define* sustainable development then there is no problem with that question. However, often it may be not so clear. The method used in this section to rank countries according to their level of sustainable development is based on the a priori experts' knowledge. This knowledge, however, relates not to the favorable or unfavorable character of certain variables, but to the overall result. Namely, it is enough to know, which country may be regarded as a one that deserves to be called "the best" or at least "good", and which one is retarded with respect to sustainable development, that is, "the worst" or at least – "bad". Such two countries will establish a certain axis – "bad-good" axis. The coordinates of the remaining countries will be projected on this axis and the distances from the "bad" country will be calculated. However, it may occur, that applying this procedure some country or countries will turn out to be worse that the "bad" one, in the sense, that its distance to the "good" country will be larger than the "bad-good" countries distance. The country which distance from the "good" one will be the largest will be treated as "the worst" one. On the other hand, the country, which distance from the "bad" country will be the largest, will be called "the best" one (Ostasiewicz, 1986). In this section we will "forget" for a moment our knowledge about indicators, use "experts'" method to obtain ranking of the countries and then compare it with results got in the previous section, while embodying the awareness of indicators' character.

Table 11 Dependence of ordering of countries on units in which variables were measured, while using variables with units

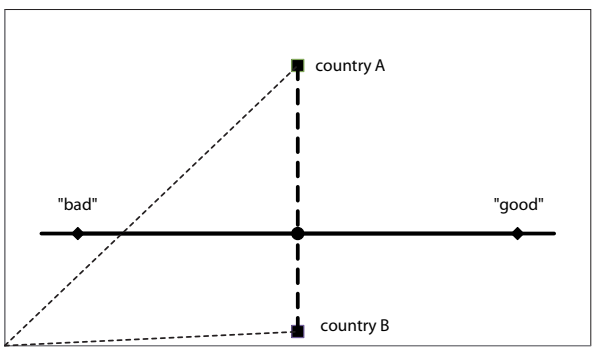
Rank	SDI2 in EUR / kg units	SDI2 in eurocents / tone units	SDI2 solely
1	Bulgaria	Bulgaria	Bulgaria
2	Romania	Romania	Romania
3	Poland	Estonia	Estonia
4	Hungary	Latvia	Latvia
5	Lithuania	Poland	Poland
6	Slovakia	Czech Rep.	Czech Rep.
7	Latvia	Lithuania	Lithuania
8	Belgium	Slovenia	Slovenia
9	Czech Rep.	Slovakia	Slovakia
10	Luxembourg	Hungary	Hungary
11	Italy	Portugal	Portugal
12	Estonia	Cyprus	Cyprus
13	UK	Ireland	Ireland
14	Germany	Finland	Finland
15	France	Spain	Spain
16	Holand	Greece	Greece
17	Greece	Denmark	Denmark
18	Slovenia	Austria	Austria
19	Ireland	Belgium	Belgium
20	Malta	Italy	Italy
21	Denmark	Germany	Germany
22	Austria	Sweden	Sweden
23	Portugal	France	France
24	Spain	Malta	Malta
25	Finland	United Kingdom	United Kingdom
26	Sweden	Netherlands	Netherlands
27	Cyprus	Luxembourg	Luxembourg

Source: Own calculations

Using this method we have to use normalized data instead of raw data, as in the latter case the results would depend on the units used to measure a certain quantity. Indeed, let us see the difference in rankings of countries while measuring SDI2 in EUR / kg or eurocent / tone. The results in Table 11 show, that the rankings are quite different. It is worth noticing that the second one is identical to the ranking of countries according to the SDI2 solely (see Table 3). Thus, taking units 10^5 times smaller acted as if putting 10^5 weight on this variable, causing the whole data being dominated by it. On the other hand, the decision, which variables have been treated as favorable and which one as unfavorable does not matter here, as it does not change the ranking.

The question, how to rescale variables in the context of this method is not a simple one. Let us assume, that there not exist such a country, that is better than all the others in respect of all variables; and that there not exist such a country, that is worse than all the others in respect of all variables. If they existed, it would be the case described in previous section, with this advantage, that points {0} and {1} would not be "ideal" but real ones. Still, such case is strongly improbable, thus, let us proceed with excluding it in this section. If we rescale variables like in Table 2, taking as minimum and maximum the least and the largest values amongst data, the vector $\vec{x}_G - \vec{x}_B$ will consists from different values as its components. Let us assume, that there exist such a variable that its value for "good" country is strictly the same as its value for "bad" country. In such case this variable falls out of the analysis and the countries with favorable value of this particular variable are undervalued. Figure 3 pictures a 2D example. Countries A and B are projected to the same point, although their properties in the dimension, in which coordinates of "bad" and "good" countries are these same, are apparently different. What follows, such a rescaling still put weight on particular variables; the weight is the larger, the larger is the difference of values of this variable for "good" and "bad" countries.

Figure 3 Falling out of analysis these variables, which values for "bad" and "good" countries are equal



Source: Own construction

The opposite idea of rescaling: taking value of "bad" country as minimum and value of "good" country as maximum (all components of the vector $\vec{x}_G - \vec{x}_B$ will be equal to 1), arises strictly opposite problem. There arises weights, which are the larger the smaller difference of values of a certain variable between "good" and "bad" country.

Still another problem arises when we have to choose a "good" country and a "bad" one. Even if we can trust our expert that he / she will choose properly, and even if "good" country will be the best one, and "bad" will be the worst one, there still may occur serious misleading biases, if the best country is not better than the worst country in respect of all variables. Let us assume, that "good" country is better than the "bad" one in respect of all but one variable. Thus, vector $\vec{x}_G - \vec{x}_B$ will point at the desirable direction in respect of all but this one dimension. What follows, the country which strong point resides in the favorable value of this particular variable will be treated very "unjust", as its strongest in fact point will become its strongest weakness; and the more favorable value of this variable the worse rank this country will get.

In order to deal with all mentioned above difficulties let us rank countries with both kinds of rescaling and with two different set of variables. The scaling performed by taking the least value amongst data as minimum and the largest as a maximum will be abbreviated in what follows as Scaling1 (S1), and the

scaling performed by taking the value of "bad" country as the minimum and the value of "good" country as a maximum by Scaling2 (S2). Whole set of variables will be denoted by Variables1 (V1) and set of variables without these of relative character by Variables2 (V2). Such choice of the second set of variables is dictated by the last problem mentioned in the previous paragraphs, that is, the problem with finding such a pair of countries that the "good" one is better in respect of all variables than the "bad" one. If we presume, that the growth of GDP is favorable and dynamics of greenhouse gases emissions and use of energy relative to GDP are unfavorable, it occurs, that even Sweden, that wins all rankings performed above, has less favorable values of SDI1 and SDI6 than Bulgaria, which often appears as the worst country in EU.

S1V1 case

First, let us examine ranking of countries imposed by projecting all nine coordinates on "bad-good" axis, with variables scaled by the first described above method. Despite the fact, that "the best" Sweden is not "better" than three the worst (due to rankings in previous sections) countries (Bulgaria, Poland, Hungary) in respect to all variables, there exist six pairs of countries that fulfil this condition. These are: Estonia and Bulgaria (Bu-E), Lithuania and Bulgaria (Bu-Li), Sweden and Denmark (D-S), Germany and Hungary (H-G), France and Italy (I-Fr) and Finland and Portugal (P-F). (There exists also the seventh one, Sweden and Portugal, where Sweden is better or equal to Portugal in respect of all variables: we exclude this pair from our analysis because of impossibility to rescale the case in the S2 way, what we will be prompted to do for comparison of results). Thus we obtain six rankings with distances of particular countries from the first ("worst") one. Spearman rank correlations between different rankings are placed in Table 12 below diagonal, while Pearson correlation coefficients also in the same table, above diagonal. One can see, that these values are quite large, no less than 0.47 (Spearman) and 0.66 (Pearson correlation).

Table 12 Spearman rank (below diagonal, normal font) and Pearson (above diagonal, italics) correlations between orderings obtained by different choices of "bad" and "good" countries (S1V1case)

	Bu-E	**Bu-Li**	**D-S**	**H-G**	**I-Fr**	**P-F**
Bu-E	**1**	*0.816861*	*0.86919*	*0.922976*	*0.886461*	*0.743297*
Bu-Li	0.575702	**1**	*0.718511*	*0.659511*	*0.797197*	*0.869104*
D-S	0.849206	0.593407	**1**	*0.862284*	*0.917956*	*0.840779*
H-G	0.893773	0.466422	0.737485	**1**	*0.916693*	*0.722551*
I-Fr	0.815629	0.767399	0.794872	0.842491	**1**	*0.924664*
P-F	0.582418	0.899878	0.69475	0.535409	0.998462	**1**

Source: Own calculations

However, if we take axis determined by countries, which are at first glance in clear relation worse-better, but some indicators of "better" country has less favorable values than those of "worse" country, the coefficient may obtain such small values as 0.10 (0.05) of Pearson (Spearman) correlations, while comparing rankings appointed by axis "Romania-Belgium" and "Portugal-Finland", or 0.39 (0.38) of Pearson (Spearman) correlations, comparing rankings of "Bulgaria-Luxembourg" and "Denmark-Sweden" axes.

Then, let us compare rankings obtained here with the one determined by projecting coordinates of countries on the "worst-best" axis (passing and points, see Table 10, first column). Correlations between the latter and six different rankings obtained by different pairs of "bad" and "good" countries, are contained in Table 13. The last row containes correlations between "worst-best" ranking and averaged results of six rankings obtained in this section. As weights put on particular variables depend on differences between "good" and "bad" country, thus they depend on the choice of these countries. One may

expect, that averaging over some number of rankings will lead toward convergence of ranking countries. Indeed, correlation between averaged results and "worst-best" ranking have greater values than the greatest of individual correlations.

Table 13 Correlations between "worst-best" ordering and six orderings obtained by different choices of "bad" and "good" countries (S1V1 case)

Results from "worst-best" axis method with	Pearson correlation	Spearman correlation
Bu-E	0.867508	0.760684
Bu-Li	0.865563	0.84127
D-S	0.891673	0.799145
H-G	0.866789	0.752747
I-Fr	0.963081	0.935897
P-F	0.930545	0.888278
averaged	0.966085	0.943223

Source: Own calculations

S2V1 case

Now, let us examine, whether the second kind or rescaling variables will change obtained results. It may be seen at a first glance, that these results are much more diversified, while taking different pairs of countries. Table 14 shows Pearson and Spearman correlations between each pair, and some of them are even negative. Spearman rank correlations between six different rankings and ranking determined by ideal "worst-best" axis can also obtained as small vales as 0.1. However, Spearman correlation between averaged ranks and "worst-best" ranks has much larger value, 0.90 (see Table 15). It seems, that discrepancies of rankings cancel out one another, tending to the ranking of "worst-best" axis. Still, this correlation is worse that correlation with "worst-best" ranking obtained with the former method of scaling.

Table 14 Spearman rank (below diagonal, normal font) and Pearson (above diagonal, italics) correlations between orderings obtained by different choices of "bad" and "good" countries (S2V1case)

	Bu-E	Bu-Li	D-S	H-G	I-Fr	P-F
Bu-E	**1**	*0.230366*	*0.748422*	*0.543692*	*0.447433*	*0.303369*
Bu-Li	0.076313	**1**	*0.576669*	*–0.11878*	*0.936355*	*0.963217*
D-S	0.745421	0.483516	**1**	*0.62824*	*0.760821*	*0.643899*
H-G	0.557387	–0.28083	0.541514	**1**	*0.057643*	*–0.08958*
I-Fr	0.409035	0.887057	0.765568	0.051282	**1**	*0.975404*
P-F	0.125153	0.971306	0.551893	–0.20024	0.92735	**1**

Source: Own calculations

Table 15 Correlations between "worst-best" ordering and six orderings obtained by different choices of "bad" and "good" countries (S2V1 case)

Results from "worst-best" axis method with	Bu-E	Bu-Li	D-S	H-G	I-Fr	P-F	Averaged
Spearman correlation	0.5159	0.8126	0.8083	0.1044	0.9512	0.8449	0.8987

Source: Own calculations

S1S2 comparison

As it was stated above, S1 scaling puts the larger weight on a certain variable the larger difference of values of this variable between "good" and "bad" country. On the other hand, S2 scaling put the larger weight the smaller difference between values of a variable. Averaging over some set of rankings and distances is expected to result in canceling out overestimation and underestimation of the influence of a given variable. Indeed, as was shown in previous paragraphs, such averaged results both in S1 and in S2 cases better correlate with ideal "worst-best" axis results. Now let us check whether averaging not over some set of results within S1 / S2 scaling but rather over S1 and S2 results will lead to rankings that will be in better agreement with "worst-best" axis results. Table 16 presents Pearson and Spearman correlations for rankings obtained by averaging (geometric mean) distances resulting from S1 and S2 scaling. One can see, that these correlations are indeed larger than correlations obtained within both S1 and S2 scaling.

Table 16 Correlations between "worst-best" ordering and six orderings obtained by different choices of "bad" and "good" countries (geometric mean of S1 and S2 scaling, V1 case)

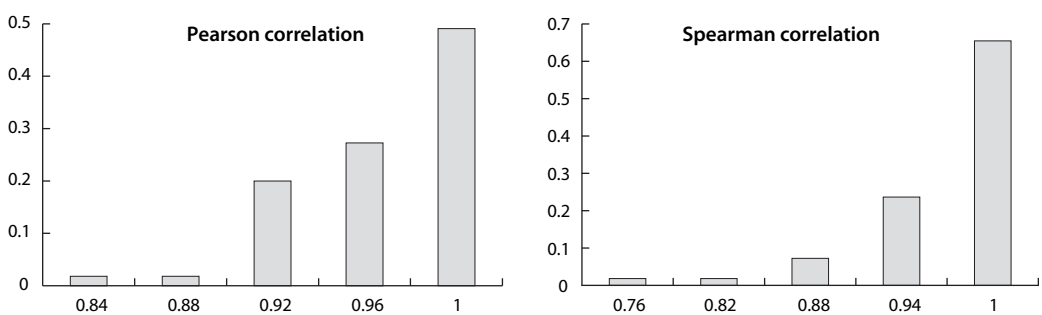
Results from "worst-best" axis method with	Pearson correlation	Spearman correlation
Bu-E	0.887909	0.885226
Bu-Li	0.973164	0.964591
D-S	0.931021	0.937118
H-G	0.840714	0.882784
I-Fr	0.988949	0.977411
P-F	0.989428	0.976190

Source: Own calculations

S1V2 case

Let us proceed to the case of reduced set of variables, that is, without relative ones. Here we use the first method of scaling, which has proved to be more self-consistent and converging toward "worst-best" axis method. Again, we will use these pairs of countries, which are in the same relation worse-better in regard to all non-relative six variables. Such pairs are much more numerous than in the case of all nine variables, as there are 55 of them (59, including those pairs, for which some variables have the same value). They will not be listed here. Nor will we put here correlations between individual pairs of them. Pearson and Spearman correlations between different pairs and "worst-best" result are pictured in Figure 4. As for Pearson correlation the minimum value equals 0.801, maximum value 0.998, with average value equal to 0.947. Minimum value of Spearman rank correlation is 0.700, the maximum value 0.995, and the average value equal to 0.940.

Figure 4 Pearson and Spearman correlations between individual "bad-good" orderings and "worst-best" one



Source: Own construction

If we average all 55 results for all different pairs of "bad" and "good" countries, the Pearson and Spearman correlations will be equal to 0.997 and 0.992 respectively. This is a bit worse result than the best one of set of correlations for individual countries but much better than the average one (see Table 17).

Table 17 Correlations for individual and averaged orderings, S1V2 case

		Pearson	Spearman
Individual results	Worst	0.801	0.700
	Best	0.998	0.995
	Average	0.947	0.940
Averaged result		0.998	0.992

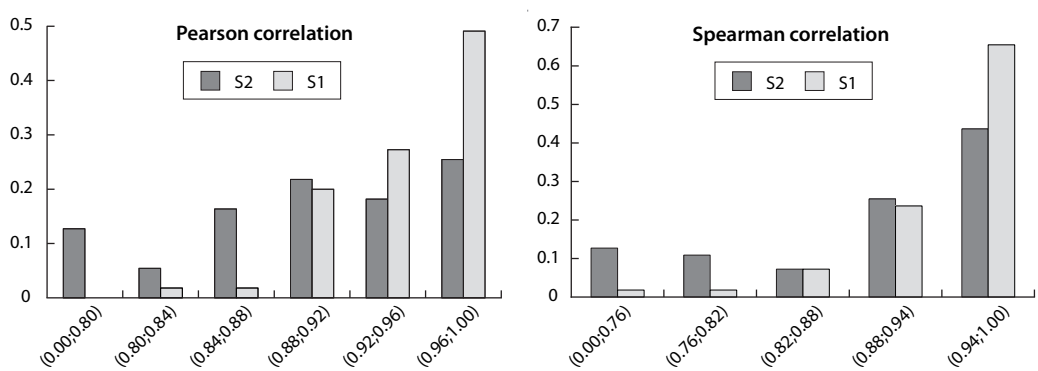
Source: Own calculations

The procedure of averaging seems to be a converging one. We have divided all results into randomly chosen 27 and 28-elements sets, and averaged distances within each set. The Pearson correlations equal to 0.997 and 0.996. Moreover, averaging distances of six worst results (those, for which Pearson correlation was less than 0.9) we got correlation equal to 0.948. Thus, averaging of rankings obtained by different choices of "bad" and "good" countries one gets ranking that converges to the ranking obtained by fixing ideal "worst-best" axis. The importance of this phenomenon lies in the fact, that using method of designing "bad" and "good" country one has not to know which variable is in fact favorable and which one is not. Contrary, this knowledge is essential while settling ideal "worst" and "best" point.

S2V2 case

Although we have already seen, that S2 scaling behaves much worse than S1 one (in the sense of self-converging) we investigate here this case for comparison purpose and to show the possibility of averaging S1 and S2 scaling. Indeed, both Spearman and Pearson correlations have worse values for S2 case (as compared with S1 case, see Figure 5).

Figure 5 Pearson and Spearman correlations between individual "bad-good" orderings and "worst-best" one for S2 and S1 cases



Source: Own construction

The averaged value of Pearson correlations between S2 rankings and ideal "worst-best" case for the whole set of 55 values equals to 0.892 (compare the value 0.947 for S1 case – 6% worse). However, after averaging results the Pearson correlation rises to 0.987 (as compared with 0.998 in S1 case – 1% worse).

Thus, averaging causes lessening the advantage of S1 scaling from 6 to 1 percent of correlation value. As for Spearman correlation, average value of 55 correlations equals to 0.880 (6% worse that the value 0.940 of S1 case), but after averaging it rises to 0.982, what means diminishing the advantage of S1 scaling to 1% of 0.992 value in S1 case. The best, worst, averaged correlations and correlations after averaging are collected for S2V2 case in Table 18.

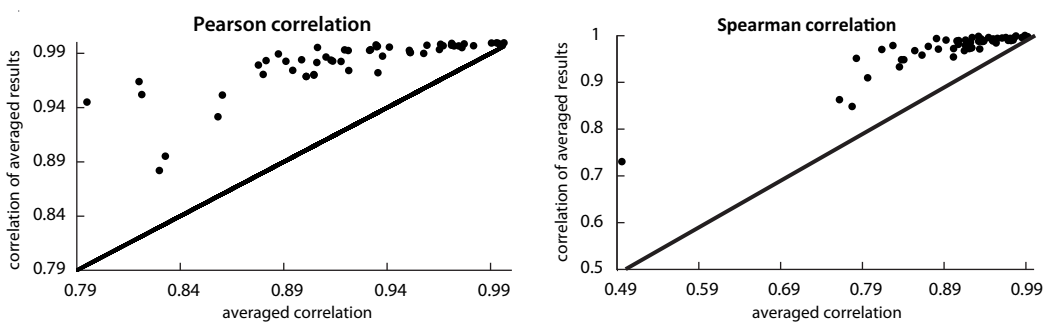
Table 18 Correlations for individual and averaged orderings, S2V2 case

		Pearson	Spearman
Individual results	Worst	0.500	0.261
	Best	0.995	0.990
	Average	0.892	0.880
Averaged result		0.987	0.982

Source: Own calculations

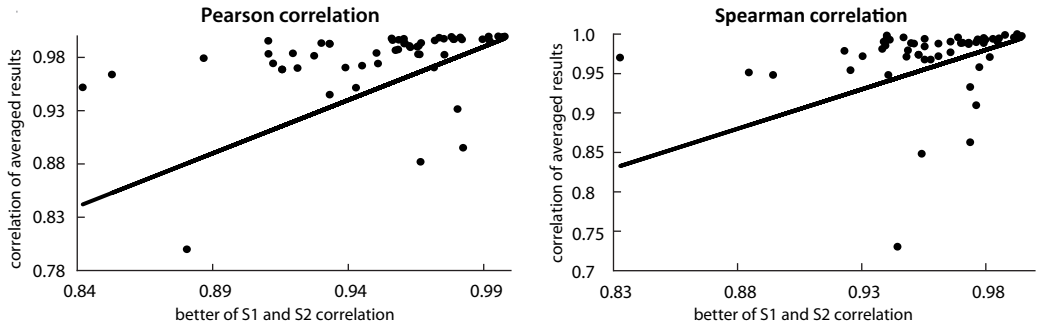
Although averaging results causes convergence of S2 results toward ideal "worst-best" results, they are still worse than S1 results. Let us argue that there is another potential benefit of using S2 scaling method. While having many pairs of "bad" and "good" countries the most efficient strategy to establish the ranking seems to be averaging rankings resulting from S1 scaling method. However, if our "expert" is not able to suggest numerous enough set of such pairs, the method cannot be applied. It seems, that in such case the use of both S1 and S2 scaling may be helpful. Let us compare the following results: For a given choice of "bad" and "good" country let us calculate correlations of S1 scaling result with ideal "worst-best" one; S2 scaling result with ideal "worst-best" one; averaged value of the two mentioned above and correlation of averaged S1-S2 result (taking geometric mean of each pair of distances) with ideal "worst-best" one. Figures 6 and 7 show obtained results. Figure 6 presents dependences of averaged S1 and S2 correlations versus correlations of averaged results. It occurs, that all points lie above solid $y = x$ line, that is, all correlations for averaged results are better than averaged value of the two, calculated according to S1 and S2 scaling. However, it is not so profitable, as it may occur, as the smaller value of S1 and S2 correlations lowers the averaged correlation. Thus, we check how the correlations of averaged results are related to the better of two S1 and S2 values of correlations. This is pictured in Figure 7. One can see, that most of points lie above $y = x$ line. Thus, in most cases, taking into regard both of S1 and S2 scaling improve results (as if claiming to obtain ideal "worst-best" ranking). However, in about 10%, averaging results causes their receding from "worst-best" ranking.

Figure 6 Correlations of averaged S1 and S2 results versus averaged value of correlations for S1 and S2 case



Source: Own construction

Figure 7 Correlations of averaged S1 and S2 results versus averaged value of correlations for S1 and S2 case



Source: Own construction

6 DISCUSSION

In previous sections we have used a few methods of ranking EU countries according to their level of sustainable development. Let us compare results of three of them, namely: averaged rank method (AR), Manhattan distance from the ideal worst point method (MD) and a distance on "worst-best" axis method (ED).

From Tables 19–22 it may be seen, that methods MD and ED gives exactly the same results for three cases, excluding the case of averaging variables SDI6 and SDI7. Spearman correlations between AR ranking and the two others equal to 0.944 (all variables); 0.943 (all but the first variable); 0.960 and 0.962 (averaged variables SDI6 and SDI7); 0.966 (without a variables). Thus the last set of variables ensures the most consistent results while using various methods of ranking.

Table 19 Ranks of countries with respect to all variables

	Ranks according to		
	AR	**MD**	**ED**
Austria	21	17	17
Belgium	19	15	15
Bulgaria	3	3	3
Cyprus	9.5	7	7
Czech Rep.	11	8	8
Denmark	20	21	21
Estonia	22	22	22
Finland	26	25	25
France	24	19	19
Germany	25	23	23
Greece	7	9	9
Hungary	1	1	1
Ireland	13	13	13
Italy	4	6	6
Latvia	16	18	18
Lithuania	15	16	16
Luxembourg	17.5	26	26
Malta	6	5	5
Netherlands	23	24	24
Poland	2	2	2
Portugal	8	11	11
Romania	5	4	4
Slovakia	14	14	14
Slovenia	12	12	12
Spain	9.5	10	10
Sweden	27	27	27
UK	17.5	20	20

Source: Own calculations

Table 20 Ranks of countries with respect to all variables but the first one

	Ranks according to		
	AR	**MD**	**ED**
Austria	21	18	18
Belgium	19	17	17
Bulgaria	3	2	2
Cyprus	11	8	8
Czech Rep.	7,5	5	5
Denmark	22	22	22
Estonia	18	19	19
Finland	24	24	24
France	25	21	21
Germany	26	23	23
Greece	5	11	11
Hungary	2	3	3
Ireland	15	16	16
Italy	13	12	12
Latvia	12	13	13
Lithuania	10	10	10
Luxembourg	17	25	25
Malta	6	7	7
Netherlands	23	26	26
Poland	1	1	1
Portugal	14	15	15
Romania	4	4	4
Slovakia	9	6	6
Slovenia	7,5	9	9
Spain	16	14	14
Sweden	27	27	27
UK	20	20	20

Source: Own calculations

Table 21 Ranks of countries with respect to all variables but the first one, SDI6 and SDI7 averaged

	Ranks according to		
	AR	**MD**	**ED**
Austria	19	17	17
Belgium	20	19	19
Bulgaria	2	1	1
Cyprus	14	14	15
Czech Rep.	8	5	8
Denmark	22	20	21
Estonia	17	16	14
Finland	24	22	20
France	25	21	22
Germany	26	24	23
Greece	10	10	10
Hungary	3	3	3
Ireland	15.5	18	18
Italy	12	12	12
Latvia	5	8	5
Lithuania	6	7	6
Luxembourg	18	25	25
Malta	13	11	13
Netherlands	23	26	26
Poland	1	2	2
Portugal	11	13	11
Romania	4	4	4
Slovakia	7	6	7
Slovenia	9	9	9
Spain	15.5	15	16
Sweden	27	27	27
UK	21	23	24

Source: Own calculations

Table 22 Ranks of countries with respect to variables without dynamical ones

	Ranks according to		
	AR	**MD**	**ED**
Austria	19	17	17
Belgium	20	19	19
Bulgaria	2	1	1
Cyprus	14	14	15
Czech Rep.	8	5	8
Denmark	22	20	21
Estonia	17	16	14
Finland	24	22	20
France	25	21	22
Germany	26	24	23
Greece	10	10	10
Hungary	3	3	3
Ireland	15.5	18	18
Italy	12	12	12
Latvia	5	8	5
Lithuania	6	7	6
Luxembourg	18	25	25
Malta	13	11	13
Netherlands	23	26	26
Poland	1	2	2
Portugal	11	13	11
Romania	4	4	4
Slovakia	7	6	7
Slovenia	9	9	9
Spain	15.5	15	16
Sweden	27	27	27
UK	21	23	24

Source: Own calculations

Now, let us appoint "absolute winners" and "absolute losers", defined as these countries, which are in the first / last five countries in rankings based on all methods used and all sets of variables included. The very first of absolute winners is Sweden, as it is the best country according to all methods of ranking. Besides Sweden, also Netherlands are among first five in all possible rankings. As for the worst ones, four countries: Hungary, Poland, Bulgaria and Romania appear repeatedly among worst five. Table 23 shows the differences between averaged ranks and averaged (and normalized) values for set of best (Sweden, Netherlands) and worst (Hungary, Poland, Bulgaria, Romania) countries. It occurs, that for SDI1 and SDI6 these differences are negative, that is, suggesting advantage of the second set of countries. It may be concluded, that these two variables are probably not the best indicators of sustainable development. Note, that both of them have relative character. The third relative variable, SDI8, is characterized by a comparatively small advantage of best over worst countries. However, removing it from analysis would be a controversial step, as its logical consequence would be removal also SDI7 variable, characterized by even smaller advantage. Yet, SDI7 denotes the share of renewable energy in energy consumption, and it seems to be one of essential indicators of sustainable development. As for Czech Republic, it ranks from 17^{th} to 22^{nd}. It is always better then four above mentioned worst countries and is in the midst of ranking for co-called post-communist countries. According to ranking excluding relative variables, which seems most preferably one, Czech Republic has 17^{th} to 19^{th} rank, according to various methods.

Table 23 Differences between averaged ranks and averaged values for set of best and worst countries

Difference between averaged:	SDI1	SDI2	SDI3	SDI4	SDI5	SDI6	SDI7	SDI8	SDI9
Ranks	–5.00	19.50	23.50	14.00	17.00	–7.50	2.00	8.25	22.00
Values	–0.24	00.45	00.59	00.57	00.60	–0.15	0.30	0.33	00.91

Source: Own calculations

SUMMARY AND CONCLUSIONS

In this paper we were trying to rank European Union countries according to the level of their sustainable development. The task in not straightforward, as there exist many indicators of sustainable development, each of which may have units completely different from the others, and different impact (weight) on the generally perceived sustainable development. We have chosen here nine main indicators, representing different groups of indicators, for which data for 2007 year was available. We have decided also not to make a differs among various indicators as regarding their impact on SD, thus to take all of them with equal weight. We have normalized these variables, taking the range of variability of each one as the range of it.

Using different methods we have ranking countries of EU. The simplest method relies on joint (or averaged) ranks in respect to all indicators. Another method ranks countries according to their distances from ideal "worst" and "best" points. The advantage of Manhattan distance is that ranking established by distances of the countries from the worst point is the same as the ranking obtained by counting distances of the countries to the best point. That is not, however, in the case of Euclidean distance. As ranking determined by distance from worst point may be different from ranking with regard to distance to the best point, we have decided to average this two distances. It appears, that such procedure is equivalent to calculating the distance from the worst point of the perpendicular projection on the axis designed by worst and best points.

Although some of SD indicators may be questionable, it seems easy to establish worst and best points in this case, as by definition sustainable development indicators should indicate the level of sustainable development. However, in cases when we cannot appoint ideal points (for example, if we do not know, which variable is favorable and which one is not) we can use a "good-bad" point method. Using data, we have shown, that averaging over a few such axes we get results converging to "worst-best" method. Moreover, we have shown, that in most cases one can obtain good results with averaging over two kinds of scaling methods, what may be helpful if we have not many "good-bad" axis at hand.

All rankings appointed Sweden as an absolute "winner", as this country occurs as the best one no matter which method of ranking is used. Also, Netherland are always one of the best five countries. On the other hand, four countries, namely, Hungary, Poland, Bulgaria and Romania appears repeatedly as one of the worst five countries (in varying order). Czech Republic is always within third best quarter.

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Analyse of Principles of Corporate Social Responsibility in Food Industry in the Slovak Republic

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Abstract

The aim of the paper analyses the complexity of term corporate social responsibility from historical and present points of view, to deal with individual principles of corporate social responsibility and to map out the present situation in Slovakia. The object of practical part was to analyse the implementation of principles of corporate social responsibility in food industry. The main part is focused on the evaluation of the survey of corporate social responsibility conducted among companies in Slovakia.

Keywords

Company and its environment, corporate social responsibility, stakeholder, Cronbach alpha coefficient

JEL code

C83, L21

INTRODUCTION

In recent years, the philosophy of socially responsible business has shown more and more awareness and interest in the company and business. It contributes significantly to the changes in society related to globalization, which brings new challenges for businesses. The pace of change is gaining ever greater speed and causes inequality in social, economic and environmental areas between regions. In this process of change an important role is assigned to businesses and therefore the issue of corporate social responsibility becomes a topical issue. The public, represented by governments, international organizations and NGOs, hoped to change the orientation of firms from short-term goals to long-term goals, motivate them to promote sustainable development, to increase the awareness and consideration of the consequences of their impacts on society. Corporate Social Responsibility provides a systematic concept that facilitates an integration of environmental, social, economic and ethical criteria into management strategies and decisions in companies. The philosophy allows you to reduce waste production, energy consumption, costs, strengthen brand value of the company and to ensure a higher quality of life.

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1 BIBLIOGRAPHY

1.1 Corporate social responsibility

One of the most frequently asked questions which are similar also for all individuals and organisations dealing with CSR issues is the obvious – just what does ‚Corporate Social Responsibility' mean anyway? Is it a stalking horse for an anti-corporate agenda? Something which, like original sin, you can never escape?

Different organisations have framed different definitions – although there is a considerable common ground between them. Mallen Baker (2004) offers the definition that CSR is about how companies manage the business processes to produce an overall positive impact on society.

Take the following illustration.

Companies need to respond to two aspects of their operations. 1. The quality of their management – both in terms of people and processes (the inner circle). 2. The nature and quantity of their impact on society in various areas.

Figure 1 Illustration of the Corporate Social Responsibility

Source: www.mallenbaker.net

Outside stakeholders show an increasing interest in the activity of the company. Most look at the outer circle – what the company has actually done, good or bad, in terms of its products and services, in terms of its impact on the environment and on local communities, or how it treats and develops its workforce. Among various stakeholders especially financial analysts focus inreasingly – as well as past financial performance – on the quality of management as an indicator of presumable future performance.

The World Business Council for Sustainable Development in its publication *Making Good Business Sense* by Lord Holme and Richard Watts, used the following definition: „*Corporate Social Responsibility is the continuing commitment by business to behave ethically and contribute to economic development while improving the quality of life of the workforce and their families as well as of the local community and society at large.*"

Traditionally, in the United States, CSR has been defined much more in terms of a philanphropic model. Companies make profits, unhindered except by fulfilling their duty to pay taxes. Then, they allocate a certain share of the profits to charitable causes. It is seen as tainting the act for the company to receive any benefit from the giving.

The European model is much more focused on operating the core business in socially responsible way, complemented by investment in communities for solid business case reasons. Social responsibility becomes an integral part of the wealth creation process – which if managed properly should enhance the competitiveness of business and maximise the value of wealth creation to society.

When times get hard, there is the incentive to practice CSR more and better – if it is a philanphropic exercise which is peripheral to the main business, it will always be the first thing to go when push comes to shove.

But as with any process based on the collective activities of communities of human beings (as companies are) there is no ‚one size fits all'. In different countries, there will be different priorities, and values

that will shape how business act. And even the observations above are changing over time. The US has growing numbers of people looking towards core business issues.

CSR definition used by Business for Social Responsibility is: Operating a business in a manner that meets or exceeds the ethical, legal, commercial and public expectations that society has of business.

On the other hand, the European Commission hedges its bets with two definitions wrapped into one: A concept whereby companies decide voluntarily to contribute to a better society and a cleaner environment. A concept whereby companies integrate social and environmental concerns in their business operations and in their interaction with their stakeholders on a voluntary basis.

When you review each of these, they broadly agree that the definition now focuses on the impact of how you manage your core business. Some go further than others in prescribing how far companies go beyond managing their own impact on the area of performance specifically outside that focus to make a contribution to the achievement of broader societal goals. It is a key difference, when many business leaders feel that their companies are ill equipped to pursue broaders societal goals, and activists argue that companies have no democratic legitimacy to take such roles. That particular debate will continue.

1.2 The development of the corporate social responsibility (CSR) in Slovakia

The concept of CSR in Slovakia began to emerge in the second half of the 90's, when the Slovak economy has undergone the reform and began the process of integration into European and North Atlantic economic, political and security structures. At that time, the number of investors brought from their countries trade policy guidelines and principles of corporate social responsibility as part of their business.

Luknič (1994), who was the author of the first Slovak publication dedicated to issues of business ethics argues that corporate social responsibility, is considered a „social contract between businesses and communities in which they operate entrepreneurship's difference operators". In his view, a manager is parceived as principal of the company, liable to the consumer. Manager there represents responsibility to employees, shareholders, but also the public as well as the environment. In 1995, Slovakia introduced a certified Environmental Management System (EMS) according to international standard ISO 14001. Application of EMS in Slovakia was confirmed by foreign accredited certification agency. Two years later, the products at our market was first labelled as „Environmentally friendly products" under the National Program evaluation of environmentally friendly products.

In 2005, the first Slovak publication on the CSR, „Corporate Social Responsibility: An overview of the basic principles and examples" was published. This work offered the definition of benefits of corporate social responsibility for each interesting group. In this work the contribution of CSR to the public especially in social cohesion, harmonization of public policy objectives with the objectives of businesses and nonprofit organizations, public education, reduced unemployment, a greater number of stable companies that are able to stay on the market, phase out the regulatory requirements, increasing customer satisfaction, creation of new markets, improving the reputation of companies cutting costs, benefits, and many other innovations were indentified. The company's responsible business brings several benefits: it allows for risk management, helping to increase profits, costs reduction, support of innovation, helping companies to maintain legitimacy, helping to build trust and brand, enabling better management of human resources and for attracting investors.

Smreková a Palovičová (1994) in their work point out the fact that „business in free market conditions is particularly focused on efforts to maximize profits." They deal with the question of whether morality has no chance in such conditions. In purely economic terms a measure of business success is considered efficiency, profits and profitability and moral requirements seem to be inappropriate. Costs of implementing and maintaining the CSR are in this sense regarded as additional to be from a purely economic way of thinking excluded. Remišová (2004) states that profits should not be the only priority for business.

Managers should strive for other achievements, not only in respect of the company as a whole but also at the level of social policy towards the emloyees and in many other aspects.

Remišová (2011) even argues that if a company is in a situation where there is a conflict between ethics and profit, it should prefer ethics to profit from the viewpoint of ethical rationality. The company has always maintained so as to not infringe positive relationships with stakeholders, because the company is not alone in society, but is intertwined with a variety of links with internal and external stakeholders.

The aim of this paper is based on information available to analyze social responsibility of businesses operating on the Slovak market in the food industry. The focus is placed mainly on companies' access to different areas of the CSR, assessment of their involvement and detailed analysis of the differences between the approaches taken by companies.

2 METHODS

To obtain data on corporate social responsibility in Slovakia a questionnaire survey was conducted. Interviewed enterprises were operating in the food industry in Slovakia. The preparation of the questionnaire was preceded by the study of the field of accessible, particularly foreign literature, but not least it was supplemented by the information obtained from Internet sources and expert articles devoted to this subject.

The questionnaire consists of two main parts, first part consists of the identification of issues and the second part is divided into three groups of questions focused on different areas of the CSR. Before the polling was conducted a pre-test on a sample of ten respondents, the questionnaire was subsequently modified. In this paper we will analyse only one part of questionnaire policy towards community.

The questionnaire has a lot of scaling issues (Likert scales), because we have to evaluate the reliability analysis of scales used. For the calculation of internal consistency we used Cronbach alpha coefficient which was calculated as follows:

$$\alpha = \frac{K}{K-1}\left(1 - \frac{\sum_{i=1}^{K}\sigma_{Y_i}^2}{\sigma_X^2}\right), \tag{1}$$

where K is the number of items in the scale, σ_x^2 variance of the observed total test score and σ_{Yi}^2 represents the deviation of the i-th component of the current sample of individuals. The rating scale is based on examining correlations between individual items (measurements) in relation to the variability of items (Reynaldo, 1999).

Commonly accepted rule for a description of the internal consistency Cronbach alpha coefficient by the following:

Table 1 Values of Cronbach alpha coeficient

Cronbach alpha coefficient	internal consistency
α ≥ 0.9	excellent
0.9> α ≥ 0.8	good
0.8> α ≥ 0.7	acceptable
0.7> α ≥ 0.6	debatable
0.6> α ≥ 0.5	bad
0.5> α	unacceptable

Source: Tull Donald (1990)

The results obtained from the questionnaires were properly prepared and evaluated with the help of software MS Word, MS Excel and SAS. With them were results transformed in text and graphic form to clarify the reason of the facts.

3 RESULTS

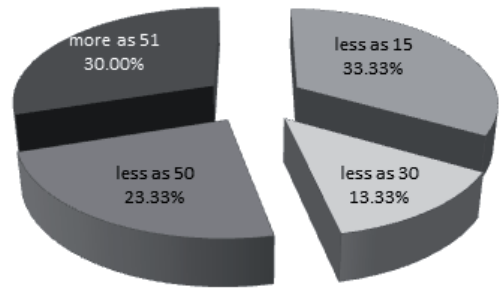
3.1 The structure of the companies involved in querying

Our survey on CSR in the food business in Slovakia has involved with 30 companies, among which were represented as small and medium-sized and large enterprises. The questionnaire was prepared to answer

most small businesses with less than 15 employees (33.33%). They were followed by large companies with more than 51 employees (30.00%) and whose work has significantly impinged on the environment and the community in which they operate. Smaller businesses are represented by less than 50 employees (23.33%) and lowest proportion were companies with less than 30 workers (13.33%).

Using the chi square test of good compliance, in determining the H0 hypothesis, which asserts that the sample is representative at the level of significance alpha 0.05, we conclude that H0 thus do not reject that our sample is representative at the significance level alpha 0.05 and therefore results obtained from our questionnaire have statistical significance.

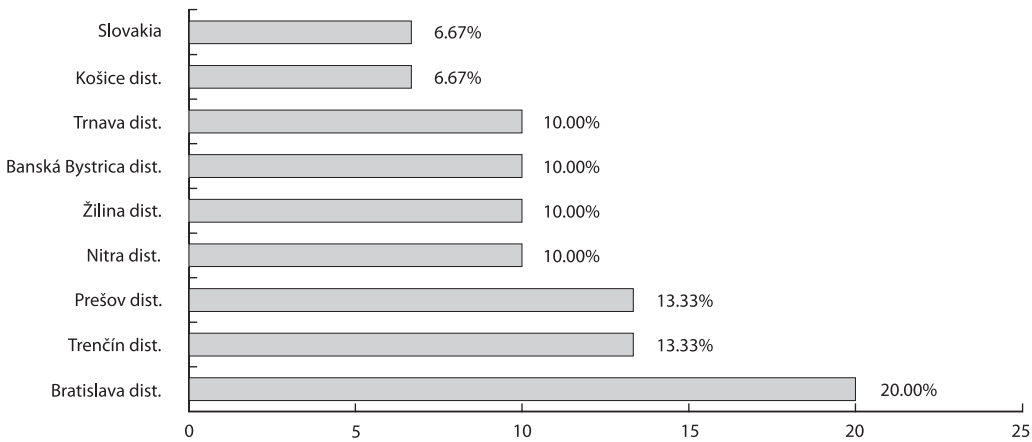
Figure 2 Number of employees



Source: Own calculation

Most companies that participated in the survey, operate in Bratislava region (20%), followed by enterprises from Trencin (13.33%) and Prešov (13.33%). Equal representations in the form of 10% of businesses have Nitra, Žilina and Banská Bystrica district. The smallest firms have representation from the Kosice region (6.67%) and companies that have branches of their companies in various regions of Slovakia.

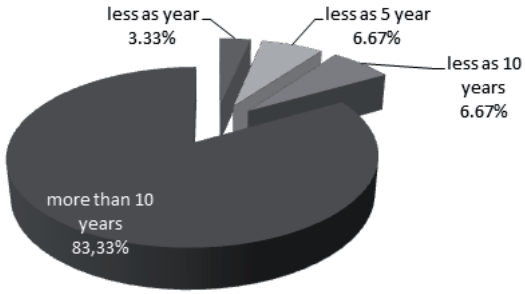
Figure 3 County companies' activity



Source: Own calculation

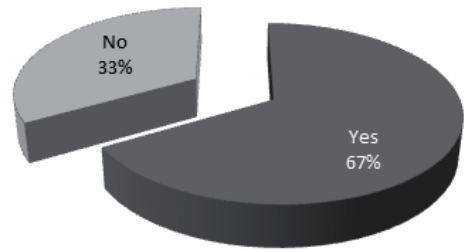
More than 80% of the companies that responded to the questionnaire, has been operating for over 10 years. These are companies that have built up a stable market position and built a positive relationship with their customers and suppliers. Their long-term successful operation is largely associated with customer loyalty. Only 17% of companies operating in the market less than 10 years, of which only 3% of the companies that participated in the survey are the market „newcomers" and not look back on more than one year activities.

Figure 4 Duration of company's activity in the market



Source: Own calculation

Figure 5 Cooperation with foreign buyers and suppliers



Source: Own calculation

67% of surveyed companies have suppliers from abroad. The same percentage also has companies' customers from abroad, while the rest of the companies (33%) are business partners only in the country.

Based on Chi-square test square contingency we investigated whether the partnership with suppliers from abroad is directly related to the company size. Established hypothesis argued that there is no demonstrable difference between the size of the company and whether their business partners are beyond the borders of Slovakia. We conclude that there is no demonstrable relationship between enterprise size and their partnerships with suppliers from abroad.

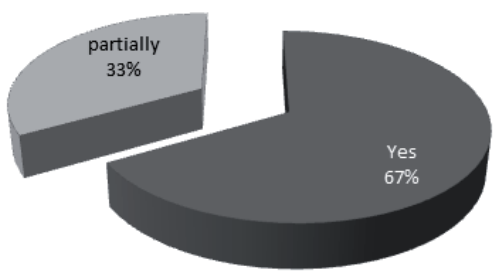
Therefore, we can say that foreign suppliers are both large companies and small businesses that participated in the survey. Similar results were obtained for the customers, because the answers to these two questions are different.

3.2 Policy towards community

If a company wants to build a positive perception in the area of its operation, it should seek closer contact with its surroundings. The more a company will do for your community, the better perception it will receive from a given community. One way how to contribute to the development of the community is the manner how the company operates a shop in the area. This company provides sales to other businesses that are located in the vicinity and thus reduces the costs associated with transportation.

This fact is known to most of the observed companies, while only 67% of companies are trying to buy the site of operation. The remaining 33% of shops in your area are seeking the site only in part which may be due to the limited capabilities of potential suppliers operating in the area of companies.

Figure 6 Efforts to shopping at the site of the company

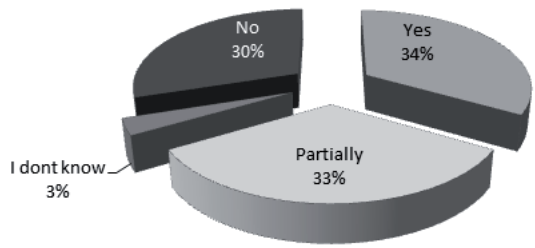


Source: Own calculation

The company can develop the local community by providing education and job training for future graduates, who may later become valuable employees of their company. 34% of companies have opportunity to gain younger prospective employees aware of their surroundings and therefore provides the opportunity to practice any job training. 33% of the companies provide for future graduates of such an opportunity only partially, 3% of companies know the following question and answer portion of the remaining companies (30%) does not provide these options.

Valuable contribution of the company is undoubtedly mainly donations and financial assistance to organizations that decide to support from its surroundings. A positive finding is that 60% of companies provide regular financial support to projects and local community Activity ends. Most companies under survey provide support and assistance to children's homes, kindergartens and primary schools involved in the project a good angel, promoting sports and cultural events in the region and develop many other activities to support the entities of their environment.

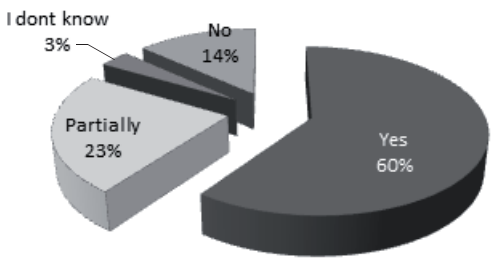
Figure 7 Providing education and practice opportunities for future graduates



Source: Own calculation

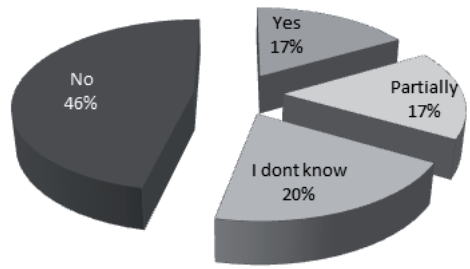
Almost ¼ of companies perform similar activities in part, the most dedicated donations to raffles for balls or other cultural events. 3% of companies cannot answer this question and 14% in any of the options support the local community does not pay.

Figure 8 Providing regular financial support for community development



Source: Own calculation

Figure 9 Information of surrounding about the effects of activities on a social environment



Source: Own calculation

The information about implications for social work and business environment should also be interested in surroundings. These data reveal other players from around and form a view about how the company approaches the observed areas.

Nearly half of companies (46%) do not provide the information of this nature. Only 17% of companies inform their surroundings on the effects of their activities on social environment. This applies mainly to companies that provide internship opportunities and job training for people from the neighborhood.

The same proportion of companies provides the information of this nature only in part, to some extent and 20% could not answer the question.

Table 2 Result of the Cornbach alpha coeficient

Cronbach Coefficient Alpha	
Variables	Alpha
Raw	0.7
Standardized	0.6

Source: Own calculation

Our aim was to determine whether individual responses, preferences can be considered reliable and whether the research findings are relevant in their entirety. Accuracy can be divided into two dimensions: validity and reliability. Validity is a match between what we want to measure and what we mea-

sured. Reliability is the reliability with which an instrument measures what is measured. The tool can be reliable but may not be valid. It cannot be valid without the sound.

With Cronbach alpha coefficient, we found sufficient internal consistency scale (alpha = 0.7) between the questions focused on the company policy to the community.

4 DISCUSSION

In recent years, the philosophy of socially responsible business gets more and more awareness and interest in the company and business. It significantly contributes to the changes in society related to globalization, which brings new challenges for businesses. The pace of change is gaining ever greater speed and causes inequality in social, economic and environmental areas, between regions. In this process of change plays an important role businesses and therefore comes to the fore the issue of corporate social responsibility. The public, represented by governments, international organizations and NGOs, hoped to change the orientation of firms in short-term goals for long-term goals, motivates them to promote sustainable development, to the awareness and consideration of the consequences of their actions on society. Corporate Social Responsibility provides a systematic concept that facilitates the integration of environmental, social, economic and ethical criteria into management strategies and decisions in companies. Allows you to reduce waste production, energy consumption, reduce costs, strengthen brand value of the company and ensures a higher quality of life.

CONCLUSION

Responsibility of companies is understood mainly the effort to reach sustainable business and to generate funds for its development. The fact that some companies are nowadays engaged beyond their commitments, it is not surprising. These businesses understand that if society expects from them, taking into account a number of interest groups and of participation in the sustainable development of society, the adoption of CSR philosophy helps them to fulfil the commitments.

The survey among Slovak enterprises operating in the food industry showed that firms will wish to bring their activities to the recognition of the company. The survey was conducted between large and small enterprises and, while it may be argued that the concept of CSR can be applied in any size company. Some companies have adopted the concept of CSR, although it ultimately has a positive impact on reducing their costs while projects are beneficial to both parties, corporate social responsibility approach is justified.

ACKNOWLEDGEMENT

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How Many Secondary School Students and Leavers Will there Be in the Next 20 Years?

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Abstract

The article analyzes the impact of the low number of births at the turn of the millennium in the Czech Republic on the number of students and leavers of secondary schools finished by the school leaving exam. The drop in births mentioned followed in lower number of students admitted to secondary schools at present time. The analysis based on available data until 2011 is supplemented by the estimate of the development in next two decades based on authors' demographic projection of the population of the Czech Republic (see Fiala, Langhamrová, Průša, 2011). In this decade we can expect decline in the annual numbers of leavers (taking school leaving exam) by almost 25% and a return to present values is not expected until the late twenties. The annual number of leavers taking school leaving exam will thus be in three years lower than the present annual numbers or students registered for daytime tertiary education courses. The universities and technical colleges should probably have to reduce the number of students.

Keywords

Age structure, secondary school, school leaving exam, student, school leaver, population projection

JEL code

I29, J11

INTRODUCTION

The irregular development of the number of live births in the Czech Republic is the main cause of the irregularities in the age structure of the population. The alternation of numerically stronger and weaker birth generations appears after the appropriate lapse of time in the alternation of larger and smaller numbers of potential pupils or students of the appropriate levels of education.

This article deals with the influence and consequences of the drop in the number of births in the Czech Republic in the second half of the nineties on the number of students and leavers of secondary schools finished with the school-leaving exam in the past 10 years and expected further development in the years up to 2030. This is a forecast from the pure demographic point of view, it does not suppose any possible changes in the system of secondary education which can be predicted very difficult at present time.

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1 METHODOLOGICAL NOTES AND DEMOGRAPHIC DEVELOPMENT

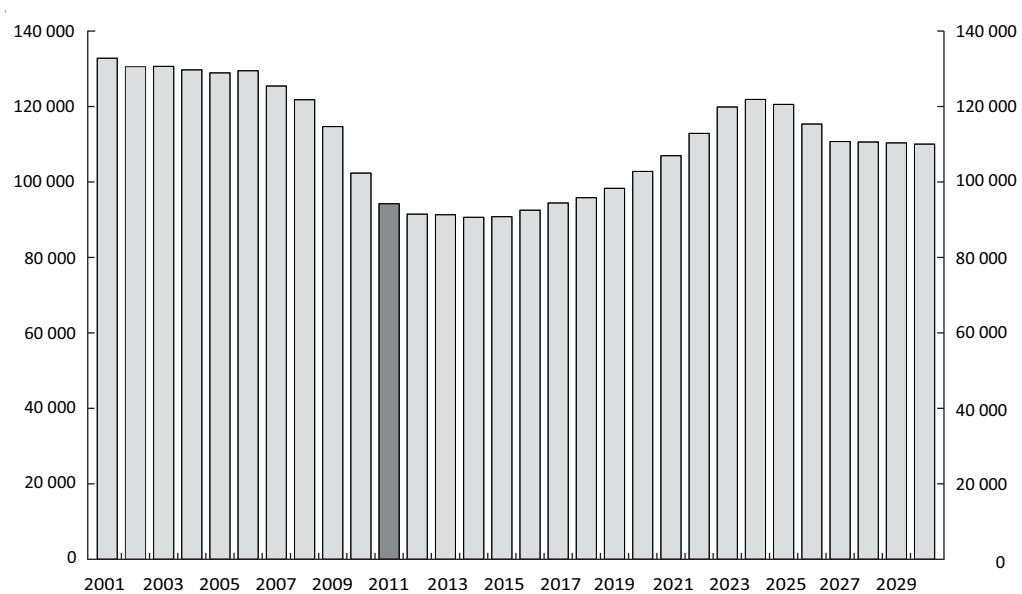
Obligatory school attendance in the Czech Republic begins at the start of the school year following the date on which the child reaches the age of six. This means that in each calendar year all the children who have reached their sixth birthday by 31st August should start attending elementary school. Cases where a child starts school a year early are quite exceptional. On the other hand it is possible to defer school attendance (usually by one year), this possibility is utilized by the parents of slightly less than 20% of children. As the months of July and August make up roughly 17% of the year, we often assume for the sake of simplicity that in each calendar year it is those children who have reached the age of 6 years by 30th June who start school, whereas children born in July and August always start a year later, in other words at the age of 7 years. Such assumption was employed, for instance, in Langhamrová, Fiala (2009).

In calculating the estimated number of pupils on the basis of the age structure of the population we therefore consider the age structure of the population in each year as of 1st July – the so-called mid-year population – and assume that all children who were 6 on 1st July of the given year began attending school on 1st September.

In the normal course of school attendance (i.e. without interruption or the repeating of a year) it emerges from these assumptions that 11-year-olds may transfer to an 8-year grammar school and 13-year-olds to a 6-year grammar school. Secondary education at a 4-year grammar school or a secondary vocational school with school-leaving exam begins at the age of 15 years and the age of secondary school leavers with school leaving exam (in other words those with potential interest in starting university studies) is 19 years.

The estimate of the trend in the development of the number of potential students in the first year of four-year secondary schools will therefore be based mainly on the development trend of the numbers of 15-year-olds; the estimate of the trend in the development of the number of potential students in the first year of a bachelor's degree course or a 4-6-year master's degree course of study at universities will then be based on the development trend of the number of 19-year-olds before the start of the appropriate school year.

Figure 1 Development of the number of 15-year-olds (as of 1st July each year)

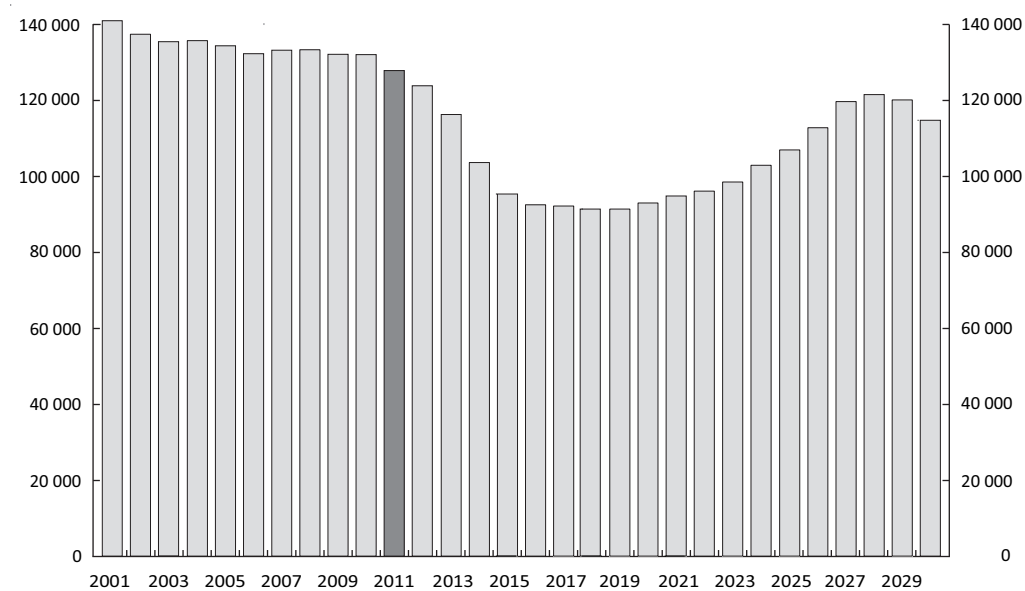


Source: Up to 2010: Czech Statistical Office (CZSO, 2012), from 2011: own projection (Fiala, Langhamrová, Průša, 2011)

In 2011 the number of 15-year-olds was already almost at its minimum and in further years it will stagnate or drop only slightly. In the twenties an increase may be expected, but the number of 15-year-olds will probably no longer reach such high values as at the beginning of this millennium. It can therefore be assumed that in future years the number of those interested in daytime studies at secondary schools will no longer be much lower than in the 2011 / 2012 school year, and that in roughly 5 years time the number of students interested in secondary school studies should gradually begin to rise with each year. Development after 2025 depends first and foremost on how the number of births develops in the next few years in the Czech Republic. It is highly probable, however, that there will again be a continuing decline (see Figure 1).

The development of the number of 19-year-old persons (those potentially interested in the daytime form of university studies) is naturally roughly 4 years "behind" the development of the number of 15-year-olds. In the next 5 years one can therefore expect a relatively rapid decline and a gradual increase will not occur until in around 10 years' time, and even then the numbers of 19-year-olds will probably not reach the values from the beginning of this century. At the end of the twenties one may expect that the number of persons of this given age will again decline (see Figure 2).

Figure 2 Development of the number of 19-year-olds (as of 1st July each year)



Source: Up to 2010: Czech Statistical Office (CZSO, 2012), from 2011: own projection (Fiala, Langhamrová, Průša, 2011)

2 DEVELOPMENT OF THE NUMBERS OF STUDENTS IN SECONDARY SCHOOLS WITH SCHOOL-LEAVING EXAM FROM 2002

The numbers of 15-year-olds can be regarded as the (very rough) upper estimates of the numbers of potential students for the first year classes of four-year secondary schools, similarly the numbers of 19-year-olds can be regarded as the upper estimates of potential students of the first years of bachelor degree courses or 4-6-year master degree courses. Neither secondary nor tertiary education is obligatory and only part of the population will participate in it. On the other hand some admitted students (especially at tertiary education) are older than the usual age of study. The condition for admission to the majority

of secondary schools or universities is not only the successful completion of the appropriate education of the lower level, but at some schools also the taking of entry examinations.

A condition for admission to university is the taking of the school-leaving examination. In our analysis we therefore concentrate only on the development of the number of students and leavers of secondary schools finished with the school-leaving examination, which are the grammar schools (8-year, 6-year and 4-year) and the vocational secondary schools.

More than 95% of students (see ÚIV, 2012) study at secondary schools finished with the school-leaving exam in the daytime form of study. Because of this fact we shall analyze the numbers of students of this form of study only. We consider the age as of 31st December (not of 1st September) of the appropriate year *t*.

We can see (Table 1) that most newly admitted students are of the age usual for beginning to study the appropriate type of school (i.e. 15–16 years for the four-year grammar schools and the vocational secondary schools with school-leaving exam, 13–14 years for the six-year grammar schools or 11–12 years for the eight-year grammar schools). Almost no students are younger but some students are of higher age. Most of the students admitted have not repeated any year at elementary school and entered secondary education immediately after completion of basic school attendance, or directly after completing the 5th year of elementary school (8-year grammar schools), or directly after completing the 7th year of elementary school (6-year grammar schools).

For each age interval we calculate the relation of the number of newly admitted students to the number of all persons according to the formula:

$$a_{t,x} = \frac{S_{t,x}^{(adm)}}{S_{t,x}}, \tag{1}$$

where:

$S_{t,x}^{(adm)}$ is the number of students of the age *x* admitted in the year *t*,

$S_{t,x}$ is the number of persons of the age *x* in the year *t*. See Table 2.

Table 1 Newly admitted students by age

Age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
4years study (grammar and vocational schools)										
–13	–	–	9	1	1	–	–	–	–	–
14	53	61	15	49	6	9	9	9	11	16
15	39 258	40 718	39 501	39 791	41 428	38 104	38 241	33 853	29 105	27 592
16	32 493	32 491	33 960	33 857	37 142	36 773	36 899	36 799	31 956	29 181
17	2 312	2 160	2 234	2 323	2 711	3 208	2 848	3 064	3 013	2 557
18	837	799	975	921	786	862	867	978	956	848
19	494	439	510	612	465	480	445	585	614	542
20	239	367	325	205	155	210	204	251	306	319
21+	–	–	–	170	211	272	265	333	467	522
Total	75 686	77 035	77 529	77 929	82 905	79 918	79 778	75 872	66 428	61 577

Table 1 Newly admitted students by age — Continued

Age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
6year grammar schools										
–11	–	–	–	–	1	–	–	1	–	–
12	1	1	1	22	1	3	3	1	–	3
13	1 026	1 113	1 026	1 150	1 178	1 199	1 213	1 221	1 146	1 209
14	887	937	1 005	1 043	1 021	1 127	1 122	1 109	1 021	997
15	23	22	63	24	21	16	34	18	20	11
16	1	1	3	2	2	5	2	2	1	–
17	–	–	–	–	–	–	–	–	–	–
18	–	–	–	–	–	–	1	–	–	–
19	–	–	1	–	–	–	–	–	–	–
Total	1 938	2 074	2 099	2 241	2 224	2 350	2 375	2 352	2 188	2 220
8year grammar schools										
–10	30	68	79	80	22	8	35	12	18	19
11	4 965	4 895	4 919	4 910	4 678	4 714	4 834	4 831	4 676	4 954
12	4 499	4 567	4 545	4 824	4 546	4 632	4 271	4 284	4 338	4 152
13	101	78	120	54	148	95	48	65	35	50
14	6	3	4	7	6	8	7	1	2	2
15	2	–	1	2	1	1	–	–	–	1
16	–	–	–	–	–	–	–	–	–	–
17	–	–	–	–	–	–	–	–	–	–
18	–	–	–	–	–	–	–	–	–	–
19	–	–	–	–	–	–	–	2	–	–
20	–	–	–	–	–	–	–	1	–	–
21+	–	–	–	–	–	–	–	15	–	–
Total	9 603	9 611	9 668	9 877	9 401	9 458	9 195	9 211	9 069	9 178

Source: Yearbook of Institute for Information in Education (ÚIV 2011), year 2011: Ministry of Education, Youth and Sports (MŠMT 2012)

The drop in the number of persons of the appropriate age in the population naturally does not necessarily have to result in an appropriate drop in the number of newly admitted students. In the numerically weaker generations admission to the more attractive schools (which undoubtedly includes schools ending with school-leaving exam) may be slightly easier and the ratio $a_{t,x}$ of the number of students admitted to the total number of persons of the appropriate age may be higher.

Table 2 bears witness to this. Whereas in 2002 roughly only 3.87% of 11-year-olds entered the 8-year grammar schools, from the year 2007 this share was more than 5%. The proportion of 16-year-olds entering the 4-year study rose gradually from 24.64% to over 30%.

Table 2 Proportions of newly admitted students from the whole population (in %)

Age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
4years study (grammar and vocational schools)										
–13	–	–	0.01	0.00	0.00	–	–	–	–	–
14	0.04	0.05	0.01	0.04	0.00	0.01	0.01	0.01	0.01	0.02
15	30.30	30.92	30.92	30.58	32.14	31.23	31.45	31.40	30.02	30.15
16	24.64	25.05	25.76	26.47	28.53	28.44	30.15	30.19	29.57	30.03
17	1.72	1.64	1.72	1.76	2.11	2.45	2.19	2.49	2.46	2.36
18	0.62	0.59	0.74	0.71	0.59	0.67	0.66	0.75	0.77	0.69
19	0.37	0.32	0.38	0.46	0.35	0.36	0.34	0.44	0.47	0.44
20	0.17	0.27	0.24	0.15	0.12	0.16	0.15	0.19	0.23	0.24
21+	–	–	–	0.12	0.15	0.20	0.19	0.24	0.35	0.39
6year grammar schools										
–12	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	–	0.00
13	0.81	0.86	0.80	0.95	0.97	1.12	1.26	1.34	1.26	1.33
14	0.68	0.73	0.77	0.81	0.84	0.93	1.04	1.15	1.12	1.09
15+	0.02	0.02	0.05	0.02	0.02	0.01	0.03	0.02	0.02	0.01
8year grammar schools										
–10	0.02	0.06	0.07	0.08	0.02	0.01	0.04	0.01	0.02	0.02
11	3.87	4.04	4.07	4.59	4.88	5.20	5.32	5.33	5.22	5.45
12	3.48	3.56	3.74	3.99	4.25	4.81	4.69	4.71	4.78	4.63
13	0.08	0.06	0.09	0.04	0.12	0.09	0.05	0.07	0.04	0.06
14+	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.00	0.00	0.00

Source: Own calculation

Each year about ten thousands of students are repeating some year of study. See Table 3.

Table 3 Students repeating some year of study

Year of study	2006	2007	2008	2009	2010	2011
1st year	3 386	4 133	4 253	4 251	4 537	4 507
2nd year	2 436	2 816	2 878	2 898	3 243	3 647
3rd year	2 085	2 507	2 336	2 745	2 900	3 238
4th year	1 032	1 063	1 093	1 187	1 399	1 568
5th year	34	31	33	21	38	40
6th year	29	35	30	30	36	48
7th year	37	34	46	46	83	55
8th year	17	18	32	21	35	38
Total	9 056	10 637	10 701	11 199	12 271	13 141

Source: Yearbook of Institute for Information in Education (ÚIV 2011), year 2011: Ministry of Education, Youth and Sports (MŠMT 2012)

The proportion of students repeating in the year t the year of study y is:

$$r_{t,y} = \frac{R_{t,y}}{S_{t-1,y}}, \tag{2}$$

where $S_{t,y}$ ($R_{t,y}$) is the number of students studying (repeating) in the school year t / (t + 1) the y-th year of study. The numbers of repeaters are not distinguished according to the lengths of study. Because the proportions of repeaters in 1st – 4th years of study are several times higher than those in 5st – 8th years we have supposed that proportion of repeaters in 1st – 4th years in 6year or 8year grammar schools are as low as in higher years of study. See Table 4.

Table 4 Proportion of students repeating a year of study (in %)

Year of study	2006	2007	2008	2009	2010	2011
4years study (grammar and vocational schools)						
1st year	4.22	4.86	5.17	5.19	5.82	6.56
2nd year	3.20	3.70	3.61	3.79	4.26	5.01
3rd year	2.80	3.41	3.16	3.58	3.90	4.37
4th year	1.43	1.45	1.51	1.65	1.86	2.14
6year grammar schools						
1st year	0.30	0.26	0.25	0.12	0.20	0.33
2nd year	0.30	0.26	0.25	0.12	0.20	0.33
3rd year	0.30	0.26	0.25	0.12	0.20	0.33
4th year	0.30	0.36	0.26	0.29	0.32	0.45
5th year	0.42	0.40	0.53	0.52	0.96	0.63
6th year	0.18	0.21	0.37	0.25	0.40	0.44
8year grammar schools						
1st year	0.30	0.26	0.25	0.12	0.20	0.33
2nd year	0.30	0.26	0.25	0.12	0.20	0.33
3rd year	0.30	0.26	0.25	0.12	0.20	0.33
4th year	0.30	0.26	0.25	0.12	0.20	0.33
5th year	0.30	0.26	0.25	0.12	0.20	0.33
6th year	0.30	0.36	0.26	0.29	0.32	0.45
7th year	0.42	0.40	0.53	0.52	0.96	0.63
8th year	0.18	0.21	0.37	0.25	0.40	0.44

Source: Own calculation

Not every student admitted completes his studies successfully. This can be seen from the data on the number of students in the individual years of study (see Table 5). We record $S_{t,y}$, or $S_{t,leav}$, the numbers of students who entered year of study y in calendar year t or who successfully completed their studies in the year t.

For each year we record:

the ratios of the number of students in first years (excluding repeaters) to the number of students admitted,

$$p_{t,1} = \frac{S_{t,1} - R_{t,1}}{S_{t,adm}}, \tag{3}$$

the ratios of the number of students of a certain year of study y (excluding repeaters) in the given year t to the number of students of the preceding year of study in the previous year:

$$p_{t,y} = \frac{S_{t,y} - R_{t,y}}{S_{t-1,y-1}}, \tag{4}$$

and finally the ratios of the number of leavers in a given year *t* to the number of students of final year of study in the previous year:

$$p_{t,leav} = \frac{S_{t,leav}}{S_{t-1,n}}, \tag{5}$$

(where *n* is the final year of study in the appropriate school).

Table 5 Numbers of students and leavers at individual types of secondary schools with school-leaving exam

Year of study	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
4year grammar schools										
Admitted	13 746	14 603	14 776	15 123	15 830	14 664	14 688	13 472	12 262	11 740
1st year	13 819	14 676	14 868	15 221	15 928	14 779	14 781	13 559	12 360	11 830
2nd year	13 708	13 692	14 503	14 588	14 932	15 569	14 510	14 490	13 287	12 174
3rd year	12 457	13 564	13 599	14 412	14 486	14 747	15 451	14 458	14 411	13 237
4th year	12 915	12 276	13 389	13 463	14 271	14 342	14 588	15 260	14 284	14 176
Leavers	11 586	12 768	12 108	13 360	13 249	13 975	14 037	14 145	14 007	13 560
6year grammar schools										
Admitted	1 938	2 074	2 099	2 241	2 224	2 350	2 375	2 352	2 188	2 220
1st year	1 942	2 079	2 101	2 256	2 227	2 355	2 378	2 355	2 198	2 230
2nd year	1 772	1 965	2 101	2 105	2 254	2 237	2 333	2 392	2 350	2 199
3rd year	1 741	1 717	1 882	2 069	2 054	2 144	2 167	2 266	2 243	2 186
4th year	1 826	1 676	1 684	1 841	2 006	1 984	2 078	2 064	2 118	2 126
5th year	2 034	1 791	1 681	1 675	1 863	1 993	1 951	2 064	2 014	2 093
6th year	2 550	1 988	1 755	1 631	1 641	1 819	1 947	1 931	2 003	1 990
Leavers	2 525	2 412	1 967	1 713	1 622	1 608	1 852	1 915	1 849	1 952
8year grammar schools										
Admitted	9 624	9 626	9 682	9 890	9 401	9 458	9 195	9 211	9 069	9 178
1st year	9 631	9 631	9 691	9 897	9 405	9 468	9 205	9 216	9 074	9 182
2nd year	9 541	9 647	9 627	9 734	9 890	9 390	9 451	9 209	9 212	9 108
3rd year	9 443	9 483	9 576	9 572	9 652	9 790	9 229	9 329	9 083	9 131
4th year	9 593	9 385	9 418	9 550	9 537	9 589	9 734	9 138	9 235	9 035
5th year	9 666	9 096	8 937	8 995	9 228	9 037	9 124	8 956	8 354	8 435
6th year	9 823	9 448	8 844	8 713	8 768	9 018	8 722	8 790	8 629	8 081
7th year	10 735	9 733	9 328	8 767	8 593	8 649	8 853	8 614	8 722	8 482
8th year	8 358	10 602	9 663	9 269	8 715	8 537	8 542	8 811	8 580	8 647
Leavers	3 412	8 473	10 619	10 236	9 130	8 610	8 395	8 439	8 342	8 350
Vocational schools										
Admitted	62 247	62 778	63 138	62 838	67 075	65 254	65 090	62 400	54 166	49 837
1st year	63 345	63 952	64 283	64 066	68 420	66 845	66 815	63 971	55 806	51 434
2nd year	57 222	59 831	60 562	60 425	60 406	63 391	61 572	61 040	58 814	50 585
3rd year	52 735	54 950	57 728	58 743	58 179	58 155	60 859	59 307	58 887	56 311
4th year	50 903	50 859	53 167	56 096	57 054	55 963	56 079	58 478	56 987	56 577
Leavers	49 493	48 407	48 649	50 542	53 050	53 429	52 657	52 101	50 604	46 263
All schools										
Leavers total	67 016	72 060	73 343	75 851	77 051	77 622	76 941	76 600	74 802	70 125

Source: Yearbook of Institute for Information in Education (ÚIV 2011), year 2011: Ministry of Education, Youth and Sports (MŠMT 2012)

The values of the ratios are in Table 6. Some times their values are a little bit higher than 100%, it can be caused by migration.

We may consider $p_{t,y}$ as the estimate of the so-called coefficients of progress, i.e. the probability that a student in year t will progress from the $(y - 1)$-th to the y-th year of study; $p_{t,leav}$ is then the estimate of the probability that a student of the final year will successfully complete his studies (i.e. will take the school-leaving examination) in year t. Students may of course to repeat some year of study or to move from one school to another school in the course of their studies.

From this table there can be seen relatively clearly the reduction in the proportion of leavers in last two years in vocational schools.

Table 6 Coefficients of progress in individual types of secondary schools with school-leaving exam (in %)

Year of study	2003	2004	2005	2006	2007	2008	2009	2010	2011
4year grammar schools									
1st year	96.5	96.4	96.5	96.6	95.5	95.4	94.9	94.4	93.9
2nd year	95.9	95.8	95.0	95.0	94.3	94.4	94.3	93.4	93.1
3rd year	96.4	96.5	96.7	96.5	95.5	96.2	95.8	95.6	94.9
4th year	97.1	97.4	97.6	97.7	97.6	97.4	97.2	96.8	96.2
Leavers	98.9	98.6	99.8	98.4	97.9	97.9	97.0	91.8	94.9
6year grammar schools									
1st year	100.0	99.8	100.4	99.8	100.0	99.9	100.0	100.2	100.1
2nd year	100.9	100.8	99.9	99.6	100.2	98.8	100.5	99.6	99.7
3rd year	96.6	95.5	98.2	97.3	94.9	96.6	97.0	93.6	92.7
4th year	96.0	97.8	97.6	96.7	96.2	96.7	95.	93.2	94.4
5th year	97.6	99.8	99.0	100.8	99.0	97.8	98.9	96.6	98.2
6th year	97.5	97.8	96.8	97.8	97.5	97.3	98.7	96.7	98.4
Leavers	94.6	98.9	97.6	99.4	98.0	101.8	98.4	95.8	97.5
8year grammar schools									
1st year	99.8	99.8	99.8	99.7	99.9	99.9	99.9	99.8	99.7
2nd year	99.9	99.7	100.1	99.6	99.6	99.6	99.9	99.8	100.0
3rd year	99.1	99.0	99.1	98.9	98.7	98.0	98.6	98.4	98.8
4th year	99.1	99.0	99.4	99.3	99.1	99.2	98.9	99.8	99.1
5th year	94.5	94.9	95.2	96.3	94.5	94.9	91.9	91.2	91.0
6th year	97.4	96.9	97.2	97.2	97.4	96.3	96.1	96.0	96.3
7th year	98.6	98.3	98.7	98.2	98.3	97.7	98.2	98.3	97.7
8th year	98.6	99.1	99.2	99.2	99.1	98.4	99.3	99.2	98.7
Leavers	101.4	100.2	105.9	98.5	98.8	98.3	98.8	94.7	97.3
Vocational schools									
1st year	97.6	97.5	97.6	98.0	97.3	97.3	97.0	96.2	95.9
2nd year	91.6	91.7	91.0	91.3	89.4	88.7	87.9	87.9	85.4
3rd year	93.4	93.9	94.3	93.6	93.0	93.1	92.8	92.7	91.4
4th year	95.1	95.4	95.9	95.8	94.8	95.0	94.6	94.3	94.0
Leavers	95.1	95.7	95.1	94.6	93.6	94.1	92.9	86.5	81.2

Source: Own calculation on basis of data in Table 3 and 5

3 ESTIMATE OF THE DEVELOPMENT OF THE NUMBER OF SCHOOL-LEAVERS WITH SCHOOL-LEAVING EXAM UP TO 2030

What will be the future development of the number of secondary school leavers, meaning those potentially interested in university studies? To what extent will the influence of the weak generations be felt? On the basis of the above-mentioned calculations it is possible to make an estimate of the development of the number of students and leavers of secondary schools in further years (projection of such type has

been published e.g. in Doucek et al., 2012). The development in 2010 and 2011 indicate that the proportions of admitted students are ceasing to grow and the proportions of repeaters as well as the proportion of students who will continue to a higher year and also the proportions of leavers are relatively stable or even decreasing. In the calculation of the estimated numbers of future students we shall assume, for the sake of simplicity that the given proportions will remain the same as in 2011 for future years. The estimate of numbers of students and leavers in the following years will be carried out according to the following equations:

estimate of the number of students admitted:

$$S_{t,adm} = \sum_{x} S_{t,x} \quad a_{2011,x} \,, \tag{6}$$

estimate of the number of first-year students:

$$S_{t,1} = S_{t,adm} \quad p_{2011,1} + S_{t-1,1} \quad r_{2011,1} \,, \tag{7}$$

estimate of the number of students in higher years of study:

$$S_{t,y} = S_{t-1,y-1} \quad p_{2011,y} + S_{t-1,y} \quad r_{2011,y} \,, \tag{8}$$

and estimate of the number of school leavers:

$$S_{t,leav} = S_{t-1,n} \quad p_{2011,leav} \,, \tag{9}$$

where n is the final year of study in the appropriate school.

Table 7 Expected development of the number of 10–21-year-old persons in the Czech Republic in the years 2011–2030

Age	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
10	92 757	94 525	95 509	99 441	104 451	107 712	116 291	121 669	120 228	119 022
11	90 830	92 858	94 630	95 617	99 551	104 559	107 816	116 390	121 765	120 321
12	89 612	90 933	92 964	94 740	95 730	99 661	104 665	107 918	116 489	121 860
13	90 857	89 721	91 045	93 080	94 860	95 846	99 774	104 774	108 025	116 592
14	91 303	90 980	89 850	91 179	93 218	94 994	95 977	99 901	104 898	108 144
15	91 510	91 463	91 147	90 024	91 358	93 394	95 166	96 145	100 065	105 057
16	97 162	91 739	91 702	91 397	90 284	91 614	93 644	95 412	96 386	100 301
17	108 384	97 493	92 088	92 068	91 778	90 660	91 985	94 010	95 772	96 742
18	122 917	108 801	97 937	92 556	92 557	92 263	91 140	92 460	94 479	96 236
19	124 248	123 432	109 352	98 520	93 168	93 163	92 863	91 735	93 047	95 060
20	132 117	125 066	124 285	110 244	99 448	94 079	94 055	93 736	92 589	93 881
21	134 372	133 107	126 100	125 357	111 357	100 540	95 149	95 100	94 755	93 583
Age	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
10	117 240	115 823	114 391	112 941	111 468	109 950	108 483	107 037	105 567	104 033
11	119 112	117 328	115 907	114 472	113 019	111 544	110 022	108 552	107 103	105 631
12	120 414	119 202	117 415	115 991	114 553	113 098	111 619	110 095	108 622	107 170
13	121 959	120 510	119 295	117 505	116 079	114 638	113 179	111 698	110 170	108 694
14	116 707	122 071	120 619	119 401	117 608	116 178	114 734	113 272	111 788	110 257
15	108 300	116 858	122 217	120 761	119 540	117 743	116 310	114 863	113 398	111 910
16	105 288	108 526	117 078	122 432	120 972	119 747	117 946	116 509	115 057	113 588
17	100 650	105 631	108 863	117 409	122 756	121 292	120 062	118 256	116 815	115 359
18	97 200	101 103	106 077	109 303	117 841	123 183	121 714	120 479	118 669	117 223
19	96 809	97 767	101 662	106 629	109 848	118 377	123 711	122 237	120 996	119 180
20	95 874	97 603	98 541	102 415	107 361	110 559	119 066	124 379	122 886	121 626
21	94 849	96 815	98 519	99 431	103 278	108 196	111 367	119 847	125 131	123 614

Source: Own population projection (Fiala, Langhamrová, Průša, 2011)

The estimated number of persons of the appropriate age in the years 2011–2030 was taken from a demographic projection (Fiala, Langhamrová, 2011), Czech Statistical Office variant (see Table 7). The results of the estimate of the expected number of students and leavers of secondary schools with school-leaving exam are shown in the table Table 8.

Table 8 Expected development of the number of students of secondary schools with school-leaving exam in the years 2011–2030

Year of study	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
4year grammar schools										
Admitted	11 740	11 354	11 278	11 173	11 165	11 342	11 561	11 728	12 020	12 540
1st year	11 830	11 433	11 336	11 231	11 216	11 382	11 597	11 769	12 054	12 560
2nd year	12 174	11 625	11 228	11 117	11 014	10 995	11 148	11 357	11 527	11 801
3rd year	13 237	12 130	11 560	11 159	11 036	10 933	10 910	11 055	11 259	11 429
4th year	14 176	13 044	11 954	11 382	10 984	10 857	10 755	10 731	10 870	11 069
Leavers	13 560	13 457	12 383	11 348	10 805	10 427	10 307	10 210	10 187	10 319
6year grammar schools										
Admitted	2 220	2 201	2 207	2 248	2 294	2 327	2 391	2 500	2 599	2 749
1st year	2 230	2 211	2 217	2 258	2 305	2 338	2 401	2 511	2 610	2 761
2nd year	2 199	2 230	2 212	2 217	2 259	2 305	2 338	2 402	2 511	2 611
3rd year	2 186	2 046	2 074	2 058	2 062	2 101	2 144	2 175	2 234	2 336
4th year	2 126	2 072	1 940	1 966	1 950	1 955	1 991	2 032	2 061	2 117
5th year	2 093	2 101	2 049	1 918	1 943	1 928	1 932	1 968	2 008	2 037
6th year	1 990	2 068	2 076	2 024	1 896	1 920	1 905	1 909	1 944	1 984
Leavers	1 952	1 939	2 015	2 023	1 973	1 848	1 871	1 856	1 860	1 895
8year grammar schools										
Admitted	9 178	9 349	9 541	9 679	9 942	10 398	10 812	11 434	12 126	12 301
1st year	9 182	9 353	9 545	9 683	9 946	10 402	10 815	11 437	12 129	12 306
2nd year	9 108	9 216	9 387	9 580	9 719	9 982	10 439	10 854	11 478	12 172
3rd year	9 131	9 028	9 134	9 305	9 495	9 633	9 893	10 346	10 758	11 375
4th year	9 035	9 082	8 980	9 085	9 254	9 444	9 581	9 839	10 289	10 699
5th year	8 435	8 253	8 295	8 203	8 298	8 452	8 625	8 751	8 986	9 396
6th year	8 081	8 156	7 982	8 022	7 933	8 024	8 173	8 340	8 462	8 689
7th year	8 482	7 945	8 016	7 846	7 883	7 797	7 885	8 031	8 195	8 315
8th year	8 647	8 410	7 880	7 947	7 779	7 816	7 730	7 817	7 962	8 125
Leavers	8 350	8 415	8 185	7 668	7 734	7 571	7 606	7 523	7 608	7 748
Vocational schools										
Admitted	49 837	48 200	47 877	47 430	47 396	48 148	49 076	49 786	51 026	53 231
1st year	51 434	49 578	49 146	48 690	48 627	49 345	50 280	51 023	52 261	54 455
2nd year	50 585	46 441	44 649	44 191	43 778	43 704	44 313	45 142	45 817	46 908
3rd year	56 311	48 680	44 560	42 742	42 244	41 846	41 760	42 313	43 095	43 746
4th year	56 577	54 147	46 921	42 893	41 098	40 592	40 206	40 118	40 635	41 381
Leavers	46 263	45 930	43 957	38 091	34 821	33 364	32 953	32 640	32 568	32 988
All schools										
Leavers total	70 125	69 742	66 540	59 131	55 333	53 209	52 737	52 229	52 224	52 950
Index with relation to 2011 (%)	100.0	99.5	94.9	84.3	78.9	75.9	75.2	74.5	74.5	75.5

Table 8 Expected development of the number of students of secondary schools with school-leaving exam in the years 2011–2030 Continued

Year of study	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
4year grammar schools										
Admitted	13 034	13 742	14 566	14 838	14 727	14 566	14 384	14 216	14 042	13 861
1st year	13 058	13 755	14 574	14 883	14 799	14 643	14 461	14 292	14 118	13 936
2nd year	12 286	12 773	13 447	14 243	14 571	14 510	14 361	14 184	14 018	13 847
3rd year	11 697	12 169	12 652	13 312	14 097	14 442	14 398	14 255	14 082	13 916
4th year	11 237	11 499	11 958	12 433	13 079	13 847	14 196	14 162	14 024	13 854
Leavers	10 508	10 668	10 916	11 352	11 803	12 416	13 146	13 477	13 444	13 313
6year grammar schools										
Admitted	2 914	2 955	2 923	2 886	2 847	2 812	2 777	2 741	2 704	2 667
1st year	2 927	2 968	2 937	2 899	2 860	2 825	2 789	2 753	2 716	2 680
2nd year	2 761	2 927	2 968	2 937	2 900	2 861	2 826	2 790	2 754	2 717
3rd year	2 428	2 568	2 722	2 761	2 732	2 697	2 661	2 628	2 595	2 562
4th year	2 213	2 301	2 433	2 580	2 617	2 590	2 557	2 523	2 491	2 460
5th year	2 092	2 187	2 274	2 404	2 549	2 586	2 560	2 528	2 494	2 463
6th year	2 013	2 067	2 161	2 246	2 375	2 518	2 555	2 530	2 497	2 464
Leavers	1 933	1 961	2 014	2 106	2 189	2 315	2 454	2 490	2 465	2 434
8year grammar schools										
Admitted	12 171	12 016	11 855	11 709	11 562	11 413	11 261	11 109	10 960	10 811
1st year	12 177	12 022	11 861	11 715	11 568	11 419	11 267	11 114	10 966	10 817
2nd year	12 351	12 222	12 068	11 906	11 759	11 612	11 462	11 309	11 156	11 007
3rd year	12 063	12 242	12 115	11 962	11 802	11 657	11 510	11 362	11 210	11 059
4th year	11 312	11 996	12 176	12 051	11 899	11 739	11 595	11 449	11 302	11 151
5th year	9 771	10 331	10 955	11 121	11 008	10 869	10 723	10 591	10 458	10 323
6th year	9 085	9 447	9 988	10 591	10 753	10 645	10 511	10 370	10 242	10 114
7th year	8 538	8 926	9 282	9 812	10 405	10 567	10 463	10 331	10 192	10 067
8th year	8 244	8 464	8 848	9 201	9 726	10 314	10 476	10 374	10 243	10 106
Leavers	7 907	8 023	8 237	8 611	8 954	9 465	10 037	10 195	10 095	9 968
Vocational schools										
Admitted	55 330	58 336	61 833	62 988	62 518	61 835	61 061	60 349	59 610	58 840
1st year	56 611	59 634	63 184	64 524	64 162	63 483	62 697	61 962	61 206	60 418
2nd year	48 836	50 773	53 450	56 615	57 918	57 673	57 082	56 381	55 719	55 040
3rd year	44 771	46 577	48 426	50 953	53 955	55 277	55 111	54 563	53 899	53 265
4th year	42 009	42 986	44 705	46 480	48 894	51 768	53 071	52 943	52 426	51 790
Leavers	33 594	34 104	34 897	36 292	37 733	39 693	42 026	43 084	42 980	42 560
All schools										
Leavers total	53 942	54 756	56 064	58 361	60 680	63 888	67 662	69 246	68 985	68 275
Index with relation to 2011 (%)	76.9	78.1	79.9	83.2	86.5	91.1	96.5	98.7	98.4	97.4

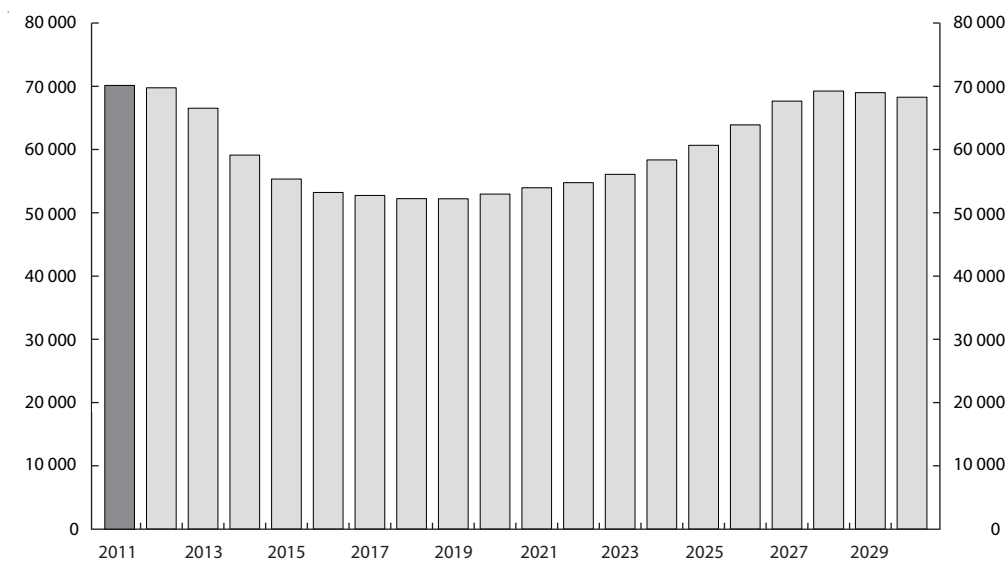
Source: Year 2011: Ministry of Education, Youth and Sports (MŠMT 2012), since 2012: own calculation of projection

It is evident that the number of newly admitted students will no longer decline to any marked extent, on the contrary they might again begin to rise as a result of the growth in the number of birds in the Czech Republic since the year 2000. Naturally only on the assumption that the capacity of secondary schools will increase in keeping with the growing number of persons completing elementary school education.

The situation is quite different, however, in the case of the number of students graduating. Whereas in the years 2012 and 2013 it can be assumed that the school-leaving examination will be taken every year by around 70 000 students, in the second half of this decade the annual number of leavers will be only around 55 000, which is almost a quarter less than in 2011. Renewed growth will not take place for another 10 or so years and only at the end of the twenties can it be expected that the annual numbers of leavers will again reach roughly the present level, i.e. around 70 000.

This fact will naturally influence the number of those interested in university studies. In 2011 more than 80 000 students were for the first time registered for daytime bachelor degree courses or 4–6-year master degree courses at universities. About 53 000 of them were 20 years old or younger (see MŠMT 2012). While in 2014 it is expected that the number of secondary school leavers with school leaving exam will be slightly below 60 000 and it will drop to about 53 000, it may be assumed that the number of first-registered university students will begin to decline in further years. See Figure 3.

Figure 3 Expected development of the number of secondary school leavers with school-leaving exam



Source: Own calculation

CONCLUSION

Whereas the number of those interested in studying at secondary schools with school-leaving exam will probably not now drop too much and in the future might even begin to rise, the annual number of leavers will drop considerably in the next few years. A relatively strong drop can be expected in 2014 and a further drop after 2016. At the turn of the teens and twenties the annual number of secondary school leavers may be roughly 25% lower than it is at present, and a stronger revival cannot be expected until the second half of the twenties when the annual numbers of secondary school leavers might again draw close to present values.

With regard to the fact that the annual numbers of secondary school leavers will be lower from 2014 than the present annual numbers of first-time registered day students in bachelor and 4–6-year master degree courses of recent years, one may probably anticipate a decline in the number of students in the first years of universities.

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Improved Classes of Estimators for Ratio of Two Means with Double Sampling the Non Respondents

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Abstract

In this paper, we have considered the problem of estimation of ratio of two population means (R) using multivariate auxiliary characters with known population means under incomplete information. Following Tripathi (1970) and Tripathi and Chaturvedi (1979), general classes of estimators for estimating R using multi-variate auxiliary characters under incomplete information have been proposed and their properties are studied. The expressions of the conditions for attaining minimum mean square error of the proposed classes of estimators have been derived and the minimum values of their mean square errors are given. The justification for using the proposed classes of estimators has been given efficiently with the help of theoretical and empirical studies.

Keywords

Ratio, auxiliary characters, bias, mean square error, incomplete information

JEL code

C83

INTRODUCTION

The estimation of the ratio of two population means using multivariate auxiliary characters has been widely used in the different field of science and humanities. The problem of estimation of ratio of two population means using one and multi variate auxiliary characters with known population means have been studied by Hartley and Ross (1954), Singh (1965), Tripathi (1970), Tripathi and Chaturvedi (1979) and Khare (1991). But in most of the sample surveys based on mail questionnaire or related to human population, we often find incomplete information due to the occurrence of non-response. To reduce the effect of non-response in such situations, Hansen and Hurwitz (1946) first suggested the method of sub-sampling on the non-responding group and suggested an unbiased estimator for estimating the

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population mean by using the information available from responding and non-responding group. Later on, using the technique of Hansen and Hurwitz (1946), some estimators for estimating the population mean using auxiliary characters with known and unknown population means have been proposed by Rao (1986, 1990), Khare and Srivastava (1993, 1995, 1997, 2000), Khare and Sinha (2002, 2009) and Singh and Kumar (2009). Toutenberg and Srivastava (1998) have considered the problem of estimating the ratio of two population means in sample survey when some observations are missing due to random non-response while Khare and Sinha (2004) have proposed classes of estimators for the estimation of finite population ratio using two phase sampling scheme in presence of non-response.

In this paper, we have proposed two general classes of estimators using multi-auxiliary characters with known population means under different situations of non-response and studied their properties. The superiority of the proposed classes of estimators has been shown through theoretical and empirical comparisons.

1 THE PROPOSED CLASSES OF ESTIMATORS

Let Y_{il} $(i = 1,2)$ and X_{jl} $(j = 1,2,\dots,p)$ be the non-negative value of l^{th} unit of the study characters y_i $(i = 1,2)$ and the auxiliary characters x_j $(j = 1,2 \dots,p)$ for a population of size N with population means $\bar{Y}_i$ $(i = 1,2)$ and $\bar{X}_j$ $(j = 1,2,\dots,p)$. Let n be the size of the sample drawn from the population of size N using simple random sampling without replacement (SRSWOR) scheme of sampling and it has been observed that n_1 units respond and n_2 units do not respond in the sample of size 'n'. In this procedure, the whole population is supposed to be consisting of two non-overlapping strata of N_1 responding and N_2 $(= N - N_1)$ non-responding units, though they are not known in advance. The stratum weights of responding and non-responding groups are given by $W_1 = \frac{N_1}{N}$ and $W_2 = \frac{N_2}{N}$ and their estimates are respectively given by $\widehat{W}_1 = \frac{n_1}{n}$ and $\widehat{W}_2 = \frac{n_2}{n}$. In this problem, we have considered that the responding and non-responding units are same for the study and auxiliary characters. Further by making extra effort, a subsample of size r $(= n_2 / k, k > 1)$ from n_2 non-responding units has been drawn by using SRSWOR method of sampling. Now, following Hansen and Hurwitz (1946) technique, the unbiased estimator for estimating the population mean using $(n_1 + r)$ observations on y_i $(i = 1,2)$ characters is given by:

$$\bar{y}_i^* = \frac{n_1}{n}\,\bar{y}_{i(1)} + \frac{n_2}{n}\bar{y}'_{i(2)}\,; \qquad i = 1,2, \tag{1}$$

and the variance of the estimator $\bar{y}_i^*$ upto the order (n^{-1}) is given by:

$$V(\bar{y}_i^*) = \frac{1-f}{n}S_i^{*2} + \frac{W_2(k-1)}{n}S_{i(2)}^{*2}\,; \qquad i = 1,2, \tag{2}$$

where $f = \frac{n}{N}$, $W_i = \frac{N_i}{N}$, $\bar{y}_{i(1)}$ and $\bar{y}'_{i(2)}$ $(i = 1,2)$ are the sample means of characters y_i based on n_1 and r units and S_i^{*2} and $S_{i(2)}^{*2}$ are the population mean square errors of y_i for the entire population and non-responding part of the population.

Similarly, the estimator $\bar{x}_j^*$ $(j = 1,2 \dots p)$ for estimating the population mean $\bar{X}_j$ is given by:

$$\bar{x}_j^* = \frac{n_1}{n}\,\bar{x}_{j(1)} + \frac{n_2}{n}\,\bar{x}'_{j(2)}. \tag{3}$$

Let $\hat{R}\left(=\frac{\bar{y}_1^*}{\bar{y}_2^*}\right)$ denotes a conventional estimator for estimating the ratio of two population means $R\left(=\frac{\bar{Y}_1}{\bar{Y}_2}\right)$. So we have proposed two different classes of estimators for estimating R utilizing the multi-auxiliary characters with known population means in two different situations.

1.1 $\bar{X}_1, \bar{X}_2, \ldots, \bar{X}_p$ known and there are incomplete information on y_i $(i = 1, 2)$ and x_j $(j = 1, 2, \ldots p)$

In this case, we observe that n_1 units respond for y_1, y_2 and $x_1, x_2, \ldots, x_p$ in the sample of size n and $\bar{X}_j$'s $(j = 1,2, \ldots, p)$ are known. We now propose a class of estimators t_r for estimating the ratio of two population means (R) using multi-auxiliary characters $x_1, x_2, \ldots, x_p$ with their respective known population means in presence of non-response as:

$$t_r = g(m, \boldsymbol{u}'), \tag{4}$$

such that $$g(R, \boldsymbol{e}') = R; \qquad g_1(R, \boldsymbol{e}') = \left(\frac{\partial}{\partial m}\, g(m, \boldsymbol{u}')\right)_{(R, \boldsymbol{e}')} = 1, \tag{5}$$

where $m = \frac{\bar{y}_1^*}{\bar{y}_2^*}$, $u_j = \frac{\bar{x}_j^*}{\bar{X}_j}$; $(j = 1, 2, \ldots p)$, $\boldsymbol{u}$ and $\boldsymbol{e}$ denote the column vectors $(u_1, u_2, \ldots, u_p)'$ and $(1, 1, \ldots, 1)'$ respectively.

1.2 $\bar{X}_1, \bar{X}_2, \ldots, \bar{X}_p$ known and incomplete information on y_i $(i = 1, 2)$ but complete information on x_j $(j = 1, 2, \ldots p)$ available in the sample

In this case we observe that n_1 units respond on y_1, y_2 but there is complete information on $x_1, x_2, \ldots, x_p$ in the sample of size n (see Rao, 1986) and $\bar{X}_j$'s $(j = 1, 2, \ldots, p)$ are known. In such case we propose a class of estimators t_r^* for estimating the ratio of two population means (R) using multi-auxiliary characters $x_1, x_2, \ldots, x_p$ with their known population means in presence of non-response as:

$$t_r^* = h(m, \boldsymbol{\omega}'), \tag{6}$$

such that $$h(R, \boldsymbol{e}') = R; \qquad h_1(R, \boldsymbol{e}') = \left(\frac{\partial}{\partial m} h(m, \boldsymbol{\omega}')\right)_{(R, \boldsymbol{e}')} = 1, \tag{7}$$

where $\boldsymbol{\omega}$ denotes the column vector $(\omega_1, \omega_2, \ldots, \omega_p)'$ and $\omega_j = \frac{\bar{x}_j}{\bar{X}_j}$, $(j = 1, 2, \ldots p)$.

The functions $g(m, \boldsymbol{u}')$ and $h(m, \boldsymbol{\omega}')$ satisfy the following conditions:

(i) For any sampling design, whatever be the sample chosen, $(m, \boldsymbol{u}')$ [or $(m, \boldsymbol{\omega}')$] assumes value in a bounded, closed convex subset D_r [or D_r^*] of the $p + 1$ dimensional real space containing the point $(R, \boldsymbol{e}')$.

(ii) In D_r [or D_r^*], the function $g(m, \boldsymbol{u}')$ [or $h(m, \boldsymbol{\omega}')$] is continuous and bounded.

(iii) The first and second partial derivatives of $g(m, \boldsymbol{u}')$ [or $h(m, \boldsymbol{\omega}')$] exist and are continuous and bounded in D_r [or D_r^*].

Here $[g_1(m, \boldsymbol{u}'), g_2(m, \boldsymbol{u}')]$ and $[h_1(m, \boldsymbol{\omega}'), h_2(m, \boldsymbol{\omega}')]$ denote the first partial derivatives of $g(m, \boldsymbol{u}')$ and $h(m, \boldsymbol{\omega}')$ with respect to $[m, \boldsymbol{u}']$ and $[m, \boldsymbol{\omega}']$ respectively. The second partial derivatives of $g(m, \boldsymbol{u}'), h(m, \boldsymbol{\omega}')$ with respect to $\boldsymbol{u}'$ and $\boldsymbol{\omega}'$ are denoted by $g_{22}(m, \boldsymbol{u}'), h_{22}(m, \boldsymbol{\omega}')$ and first partial derivatives of $g_2(m, \boldsymbol{u}')$ and $h_2(m, \boldsymbol{\omega}')$ with respect to m are denoted by $g_{12}(m, \boldsymbol{u}')$ and $h_{12}(m, \boldsymbol{\omega}')$.

It may be seen that the bias and mean square error of the estimators t_r and t_r^* will always exist under the regularity conditions imposed on $g(m, \boldsymbol{u}')$ and $h(m, \boldsymbol{\omega}')$.

Now expanding $g(m, \boldsymbol{u}')$ and $h(m, \boldsymbol{\omega}')$ about the point $(R, \boldsymbol{e}')$ using Taylor's series upto second partial derivatives and using the condition (5) and (7) we have:

$$t_r = R + (m - R) + (\boldsymbol{u} - \boldsymbol{e})' g_2(R, \boldsymbol{e}') + \frac{1}{2}\{(m - R)^2 g_{11}(m^*, \boldsymbol{u}^{*\prime}) + 2(m - R)(\boldsymbol{u} - \boldsymbol{e})' g_{12}(m^*, \boldsymbol{u}^{*'}) + (\boldsymbol{u} - \boldsymbol{e})' g_{22}(m^*, \boldsymbol{u}^{*'})(\boldsymbol{u} - \boldsymbol{e})\}, \tag{8}$$

and

$$t_r^* = R + (m - R) + (\boldsymbol{\omega} - \boldsymbol{e})' h_2(R, \boldsymbol{e}') + \frac{1}{2}\{(m - R)^2 h_{11}(m^*, \boldsymbol{\omega}^{*\prime}) + 2(m - R)(\boldsymbol{\omega} - \boldsymbol{e})' h_{12}(m^*, \boldsymbol{\omega}^{*'}) + (\boldsymbol{\omega} - \boldsymbol{e})' h_{22}(m^*, \boldsymbol{\omega}^{*'})(\boldsymbol{\omega} - \boldsymbol{e})\}, \tag{9}$$

where $m^* = R + \phi_r(m - R)$, $\boldsymbol{u}^* = \boldsymbol{e} + \boldsymbol{\phi}_1(\boldsymbol{u} - \boldsymbol{e})$, $\boldsymbol{\omega}^* = \boldsymbol{e} + \boldsymbol{\phi}_2(\boldsymbol{\omega} - \boldsymbol{e})$ such that, $0 < \phi_r, \phi_{1j}, \phi_{2j} < 1$ and $\boldsymbol{\phi}_1$ and $\boldsymbol{\phi}_2$ are the $(p \times p)$ diagonal matrix having ϕ_{1j} and ϕ_{2j} as their j^{th} diagonal elements.

2 BIAS AND MEAN SQUARE ERROR (MSE) OF t_r AND t_r^*

From (8) and (9), the expressions for bias and mean square error of t_r and t_r^* for any sampling design upto the terms of order (n^{-1}) are given by:

$$Bias(t_r) = Bias(\hat{R}) + E(\hat{R} - R)(\boldsymbol{u} - \boldsymbol{e})' g_{12}(m^*, \boldsymbol{u}^{*'}) + \frac{1}{2} E(\boldsymbol{u} - \boldsymbol{e})' g_{22}(m^*, \boldsymbol{u}^{*'})(\boldsymbol{u} - \boldsymbol{e}), \quad (10)$$

$$MSE(t_r) = MSE(\hat{R}) + 2E(\hat{R} - R)(\boldsymbol{u} - \boldsymbol{e})' g_2(R, \boldsymbol{e}') + E\big(g_2(R, \boldsymbol{e}')\big)'(\boldsymbol{u} - \boldsymbol{e})(\boldsymbol{u} - \boldsymbol{e})' g_2(R, \boldsymbol{e}'), \quad (11)$$

$$Bias(t_r^*) = Bias(\hat{R}) + E(\hat{R} - R)(\boldsymbol{\omega} - \boldsymbol{e})' h_{12}(m^*, \boldsymbol{\omega}^{*'}) + \frac{1}{2} E(\boldsymbol{\omega} - \boldsymbol{e})' h_{22}(m^*, \boldsymbol{\omega}^{*'})(\boldsymbol{\omega} - \boldsymbol{e}), \quad (12)$$

$$MSE(t_r^*) = MSE(\hat{R}) + 2E(\hat{R} - R)(\boldsymbol{\omega} - \boldsymbol{e})' h_2(R, \boldsymbol{e}') + E\big(h_2(R, \boldsymbol{e}')\big)'(\boldsymbol{\omega} - \boldsymbol{e})(\boldsymbol{\omega} - \boldsymbol{e})' h_2(R, \boldsymbol{e}'). \quad (13)$$

The mean square error of t_r and t_r^* will attain their minimum values if:

$$g_2(R, \boldsymbol{e}') = -(E(\boldsymbol{u} - \boldsymbol{e})(\boldsymbol{u} - \boldsymbol{e})')^{-1} E(\hat{R} - R)(\boldsymbol{u} - \boldsymbol{e}), \quad (14)$$

and

$$h_2(R, \boldsymbol{e}') = -(E(\boldsymbol{\omega} - \boldsymbol{e})(\boldsymbol{\omega} - \boldsymbol{e})')^{-1} E(\hat{R} - R)(\boldsymbol{u} - \boldsymbol{e}), \quad (15)$$

respectively. By putting the value of $g_2(R, \boldsymbol{e}')$ from (14) in (11) and $h_2(R, \boldsymbol{e}')$ from (15) in (13), the minimum values of mean square error of t_r and t_r^* are given by:

$$MSE(t_r)_{min.} = MSE(\hat{R}) - E(\hat{R} - R)(\boldsymbol{u} - \boldsymbol{e})'(E(\boldsymbol{u} - \boldsymbol{e})(\boldsymbol{u} - \boldsymbol{e})')^{-1} E(\hat{R} - R)(\boldsymbol{u} - \boldsymbol{e}), \quad (16)$$

and

$$MSE(t_r^*)_{min.} = MSE(\hat{R}) - E(\hat{R} - R)(\boldsymbol{\omega} - \boldsymbol{e})'(E(\boldsymbol{\omega} - \boldsymbol{e})(\boldsymbol{\omega} - \boldsymbol{e})')^{-1} E(\hat{R} - R)(\boldsymbol{\omega} - \boldsymbol{e}). \quad (17)$$

To derive the expressions for bias mean square error of the proposed estimator t_r and t_r^* under SRSWOR upto the order (n^{-1}), we assume that:

$\bar{y}_i^* = \bar{Y}_i + \bar{\epsilon}_i$, $\bar{x}_j^* = \bar{X}_j + \bar{\epsilon}_j'$ such that $E(\bar{\epsilon}_i) = E(\bar{\epsilon}_j') = 0; (i = 1, 2\,;\ j = 1, 2, \ldots p)$.

Let $A = [a_{jj'}]$ and $A_0 = [a_{0jj'}]$ are two $p \times p$ positive definite matrix such that:

$$a_{jj'} = \frac{1-f}{n}\rho_{jj'} C_j C_{j'} + \frac{W_2(k-1)}{n}\rho_{jj'(2)} C_j' C_{j'}' \quad \text{and} \quad a_{0jj'} = \rho_{jj'} C_j C_{j'} \quad \forall\ j \neq j' = 1, 2, \ldots, p.$$

Also let $\boldsymbol{q} = (q_1, q_2, \ldots, q_p)'$ and $\boldsymbol{q}_{(2)} = (q_{1(2)}, q_{2(2)}, \ldots, q_{p(2)})'$ are two column vectors such that:

$$q_j = C_j\{\rho_{1j}^* C_1^* - \rho_{2j}^* C_2^*\}, \quad \text{and} \quad q_{j(2)} = C_j'\{\rho_{1j(2)}^* C_1^{*\prime} - \rho_{2j(2)}^* C_2^{*\prime}\},$$

where $C_j^2 = \frac{S_j^2}{\bar{X}_j^2}$, $C_j'^2 = \frac{S_{j(2)}^2}{\bar{X}_j^2}$, $C_i^{*2} = \frac{S_j^{*2}}{\bar{Y}_i^2}$, $C_i^{*\prime 2} = \frac{S_{i(2)}^{*2}}{\bar{Y}_i^2}$, $\quad \forall\ i = 1, 2; \quad j = 1, 2, \ldots p.$

Here S_j^2 and $S_{j(2)}^2$ denote the mean square error of x_j for the entire and non-responding part of the population. Let $\rho_{jj'}$, ρ_{ij}^* are the correlation coefficients between $(x_j, x_{j'})$ and (y_i, x_j) respectively for the entire population and $\rho_{jj'(2)}$, $\rho_{ij(2)}^*$ are the correlation coefficients between $(x_j, x_{j'})$ and (y_i, x_j) for the non-responding group of the population.

Hence, the expressions of bias and mean square error of t_r and t_r^* upto the terms of order (n^{-1}) under SRSWOR method of sampling are given by:

$$Bias(t_r) = Bias(\hat{R}) + R\left(\frac{1-f}{n}\boldsymbol{q} + \frac{W_2(k-1)}{n}\boldsymbol{q}_{(2)}\right)' g_{12}(m^*, \boldsymbol{u}^{*'}) + \frac{1}{2}\, trace\, \boldsymbol{A}\, g_{22}(m^*, \boldsymbol{u}^{*'}), \quad (18)$$

$$MSE(t_r) = MSE(\hat{R}) + \big(g_2(R, \boldsymbol{e}')\big)' \boldsymbol{A} g_2(R, \boldsymbol{e}') + 2R\left(\frac{1-f}{n}\boldsymbol{q} + \frac{W_2(k-1)}{n}\boldsymbol{q}_{(2)}\right)' g_2(R, \boldsymbol{e}'), \quad (19)$$

$$Bias(t_r^*) = Bias(\hat{R}) + \left(\frac{1-f}{n}\right)\left[R\boldsymbol{q}'h_{12}(m^*, \boldsymbol{\omega}^{*\prime}) + \frac{1}{2}\, trace\, \boldsymbol{A}_0\, h_{22}(m^*, \boldsymbol{\omega}^{*\prime})\right], \tag{20}$$

$$MSE(t_r^*) = MSE(\hat{R}) + \left(\frac{1-f}{n}\right)\left[\left(h_2(R, \boldsymbol{e}')\right)' \boldsymbol{A}_0\, h_2(R, \boldsymbol{e}') + 2R\boldsymbol{q}'h_2(R, \boldsymbol{e}')\right], \tag{21}$$

where:

$$Bias(\hat{R}) = R\left[\frac{1-f}{n}\{C_2^{*2} - \rho C_1^* C_2^*\} + \frac{W_2(k-1)}{n}\{C_2^{*\prime 2} - \rho_{(2)} C_1^{*\prime} C_2^{*\prime}\}\right], \tag{22}$$

and $$MSE(\hat{R}) = R^2\left[\frac{1-f}{n}\{C_1^{*2} + C_2^{*2} - 2\rho C_1^* C_2^*\} + \frac{W_2(k-1)}{n}\{C_1^{*\prime 2} + C_2^{*\prime 2} - 2\rho_{(2)} C_1^{*\prime} C_2^{*\prime}\}\right]. \tag{23}$$

The conditions for which $MSE(t_r)$ and $MSE(t_r^*)$ will attain minimum values are given by:

$$g_2(R, \boldsymbol{e}') = -R\boldsymbol{A}^{-1}\left(\frac{1-f}{n}\boldsymbol{q} + \frac{W_2(k-1)}{n}\boldsymbol{q}_{(2)}\right), \tag{24}$$

and $$h_2(R, \boldsymbol{e}') = -R\, \boldsymbol{A}_0^{-1}\boldsymbol{q} \tag{25}$$

respectively. Substituting the values of $g_2(R, \boldsymbol{e}')$ and $h_2(R, \boldsymbol{e}')$ from (24) and (25) in (19) and (21), we obtain the expressions of minimum mean square error of t_r and t_r^* as:

$$MSE(t_r)_{min.} = MSE(\hat{R}) - R^2\left\{\left(\frac{1-f}{n}\boldsymbol{q} + \frac{W_2(k-1)}{n}\boldsymbol{q}_{(2)}\right)' \boldsymbol{A}^{-1}\left(\frac{1-f}{n}\boldsymbol{q} + \frac{W_2(k-1)}{n}\boldsymbol{q}_{(2)}\right)\right\}, \tag{26}$$

and $$MSE(t_r^*)_{min.} = MSE(\hat{R}) - R^2\frac{1-f}{n}\boldsymbol{q}'\, \boldsymbol{A}_0^{-1}\boldsymbol{q}. \tag{27}$$

3 SOME MEMBERS OF THE PROPOSED CLASSES OF ESTIMATORS

Since so many members of the proposed classes of estimators t_r and t_r^* may be possible. So following the lines of Khare and Sinha (2009), we have given some members of t_r and t_r^* which are denoted by $[T_{r1}, T_{r2}, T_{r3}]$ and $[T_{r1}^*, T_{r2}^*, T_{r3}^*]$ as:

$$T_{r1} = m\, exp\left[\sum_{j=1}^{p} \theta_{1j} log u_j\right], \tag{28}$$

$$T_{r2} = m\sum_{j=1}^{p} W_j\, u_j^{\theta_{2j}/W_j}, \qquad \sum_{i=1}^{p} W_j = 1, \tag{29}$$

$$T_{r3} = \sum_{j=1}^{p}\left[W_j u_j^{\theta_{3j}/W_j}\right]\left[m + \beta_{1j}^*(u_j - 1)\right], \tag{30}$$

$$T_{r1}^* = m\, exp\left[\sum_{j=1}^{p} \alpha_{1j} log\omega_j\right], \tag{31}$$

$$T_{r2}^* = m\sum_{j=1}^{p} W_j\omega_j^{\alpha_{2j}/W_j}, \qquad \sum_{i=1}^{p} W_j = 1, \tag{32}$$

and $$T_{r3}^* = \sum_{j=1}^{p}\left[W_j\omega_j^{\alpha_{3j}/W_j}\right]\left[m + \beta_{2j}^*(\omega_j - 1)\right]. \tag{33}$$

Here all the estimators discussed from (28) to (33) satisfy the conditions given in (5) and (7) accordingly. Hence the estimators $[T_{r1}, T_{r2}, T_{r3}]$ and $[T_{r1}^*, T_{r2}^*, T_{r3}^*]$ will attain the minimum mean square errors equal to the expressions given in (26) and (27) if their optimum values of the constants are calculated by (24) and (25) respectively. Sometimes the values of parameters in the optimum values of the constants are not known then one may estimate them on the basis of the sample values or may use past data. Reddy (1978) has shown that such values are not only stable overtime and region but also don't affect the mean square error of the estimators upto the terms of order n^{-1} (Srivastava and Jhajj, 1983).

4 COMPARISONS OF EFFICIENCY

(i) From (26) and (27), we get:

$$MSE(\hat{R}) - MSE(t_r) = R^2 \left\{ \left(\frac{1-f}{n}\boldsymbol{q} + \frac{W_2(k-1)}{n}\boldsymbol{q}_{(2)} \right)' \boldsymbol{A}^{-1} \left(\frac{1-f}{n}\boldsymbol{q} + \frac{W_2(k-1)}{n}\boldsymbol{q}_{(2)} \right) \right\} \geq 0$$

and $MSE(\hat{R}) - MSE(t_r^*) = R^2 \frac{1-f}{n} \boldsymbol{q}' \boldsymbol{A}_0^{-1} \boldsymbol{q} \geq 0.$

(ii) Whatever be the estimator belonging to the class of estimators $t_r = g(m, \boldsymbol{u})$, the minimum mean square error will be same as given in (26). Similarly the estimator belonging to the class of estimators $t_r^* = h(m, \boldsymbol{\omega}')$ will also have minimum mean square error as given in (27).

(iii) On comparing the estimator t_r with $\hat{R}$ in terms of precision, we find that

$MSE(t_r) < MSE(\hat{R})$ iff:

$$-MSE(\hat{R}) < (g_2(R, \boldsymbol{e}'))' \boldsymbol{A} g_2(R, \boldsymbol{e}') + 2R \left(\frac{1-f}{n}\boldsymbol{q} + \frac{W_2(k-1)}{n}\boldsymbol{q}_{(2)} \right)' g_2(R, \boldsymbol{e}') < 0. \quad (34)$$

(iv) Similarly by comparing t_r^* with respect to $\hat{R}$ in terms of precision, we see that

$MSE(t_r^*) < MSE(\hat{R})$ iff:

$$-MSE(\hat{R}) < \left(\frac{1-f}{n} \right) [(h_2(R, \boldsymbol{e}'))' \boldsymbol{A}_0 + 2R\boldsymbol{q}'] h_2(R, \boldsymbol{e}') < 0. \quad (35)$$

(v) The applicable range for the values of the constants involved in t_r and t_r^* for the better efficiency of t_r and t_r^* with respect to $\hat{R}$ can be obtained by (34) and (35).

(vi) For $W_2 = 0$, i.e. when we have complete information on study characters as well as on the auxiliary characters, then under the optimum conditions, the estimators t_r and t_r^* are equally efficient to the class of estimators proposed by Khare (1991) for R. It shows that all the members of t_r and t_r^* attain minimum mean square error for one, two or p-auxiliary characters as described in (26) and (27) if the conditions (24) and (25) are satisfied respectively.

(vii) However it is very difficult to observe the nature of relative efficiency (R. E.) of t_r with respect to t_r^* for p-auxiliary characters due to the involvement of various parameters in it. But in case of one auxiliary character (say x_j) we find that R. E.(t_r) with respect to t_r^* increases for the higher values of $\frac{\rho_{2j}^*}{\rho_{1j}^*}$, $\frac{\rho_{1j(2)}^*}{\rho_{1j}^*}$ and for the lower value of $\frac{\rho_{2j(2)}^*}{\rho_{1j(2)}^*}$, failing which t_r^* will be more efficient than t_r. So one can have a choice for using t_r or t_r^* under the different situations.

5 AN EMPIRICAL STUDY

109 Village / Town / ward wise population of urban area under Police-station – Baria, Tahasil – Champua, Orissa, India has been taken under consideration from District Census Handbook, 1981, Orissa, published by Govt. of India. The last 25% villages (i.e. 27 villages) have been considered as non-response group of the population. Here we have taken the study characters and auxiliary characters as follows:

y_1 : Number of literate persons in the village,
y_2 : Number of main workers in the village,
x_1 : Number of non-workers in the village,
x_2 : Total population of the village and
x_3 : Number of cultivators in the village.

For this population, we have:

$\bar{Y}_1$= 145.3028	$\bar{Y}_2$= 165.2661	$\bar{X}_1$= 259.0826	$\bar{X}_2$= 485.9174	$\bar{X}_3$= 100.5505
C_1^*= 0.7666	C_2^* = 0.6828	C_1= 0.7645	C_2 = 0.6590	C_3 = 0.7314
$C_1^{*\prime}$ = 0.6899	$C_2^{*\prime}$ = 0.5769	C_1' = 0.5429	C_2' = 0.4877	C_3' = 0.5678

ρ_{11}^*= 0.905	ρ_{12}^* = 0.905	ρ_{13}^* = 0.648	ρ_{21}^* = 0.819	ρ_{22}^* = 0.908	ρ_{23}^* = 0.841
$\rho_{11(2)}^*$ = 0.875	$\rho_{12(2)}^*$ = 0.871	$\rho_{13(2)}^*$ = 0.382	$\rho_{21(2)}^*$ = 0.746	$\rho_{22(2)}^*$ = 0.907	$\rho_{23(2)}^*$ = 0.785
ρ_{12}= 0.946	ρ_{13} = 0.732	ρ_{23} = 0.801	$\rho_{12(2)}$ = 0.905	$\rho_{13(2)}$ = 0.488	$\rho_{23(2)}$ = 0.654
		ρ = 0.816	$\rho_{(2)}$ = 0.787		

The present problem is to estimate the ratio of the two population means i.e. $R(= \bar{Y}_1 \,/\, \bar{Y}_2)$ using x_1, x_2 and x_3. The estimators:

$$T_{r1} = m\, exp\left[\sum_{j=1}^{p} \theta_{1j} log u_j\right],$$

and

$$T_{r1}^* = m\, exp\left[\sum_{j=1}^{p} \alpha_{1j} log \omega_j\right],$$

which are the member of the classes of estimator t_r and t_r^* respectively have been considered for comparing their relative efficiency with respect to $\hat{R}$.

The optimum values of the constants [θ_{1j} and α_{1j}] and relative efficiency of T_{r1} and T_{r1}^* with respect to $\hat{R}$ for the different values of sub-sampling fraction $1 \,/\, k$ have been given in Table 1.

DISCUSSION AND CONCLUSION

It has been observed from Table 1 that the estimators T_{r1} and T_{r1}^* are more efficient than $\hat{R}$ for all the different values of the sub-sampling fraction $(1 \,/\, k)$. The mean square error of T_{r1} and T_{r1}^* decreases as the sub-sampling fraction and the numbers of auxiliary characters increase. It has also been observed from the Table 1 that the relative efficiency of T_{r1} and T_{r1}^* increases when numbers of auxiliary characters increase. On comparing the relative efficiency of T_{r1} and T_{r1}^* with respect to $\hat{R}$, we observe that R. E.(T_{r1}^*) with respect to $\hat{R}$ increases as sub-sampling fraction increases but R. E.(T_{r1}) with respect to $\hat{R}$ decreases as sub-sampling fraction increases. This is due to the fact that $MSE\left(\hat{R}\right)$ decreases at a faster rate than $MSE(T_{r1})$ as sub-sampling fraction increases. Since T_{r1} and T_{r1}^* are the particular members of the proposed classes of estimators t_r and t_r^* respectively, so on the basis of theoretical and empirical discussions we may recommend the use of t_r and t_r^* in the case of large sample surveys.

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Table 1 Optimum values of the constants and relative efficiency [R. E. (.)] in % of T_{r1} and $T_r^*{}_1$ with respect to R [Figures in the parenthesis give MSE(–) in 10^{-5}]

Estimators	Auxiliary character(s)	$N = 109,\ n = 30$											
		$n = 1/k$											
		1 / 4				1 / 3				1 / 2			
		Optimum values of constants			R. E.	Optimum values of constants			R. E.	Optimum values of constants			R. E.
$\hat{R}$	–				100.00 (722)				100.00 (605)				100.00 (489)
	x_1	θ_{11}= –0.2260			113.17 (638)	θ_{11} = –0.2136			112.45 (538)	θ_{11}= –0.1976			111.39 (439)
T_{r1}	x_1, x_2	θ_{11}= –0.9389	θ_{12}= 0.8677		140.47 (514)	θ_{11}= –0.9063	θ_{12}= 0.8446		137.50 (440)	θ_{11}= –0.8617	θ_{12}= 0.8117		137.97 (365)
	x_1, x_2, x_3	θ_{11}= –0.7205	θ_{12}= 0.1958	θ_{13}= 0.5264	224.22 (322)	θ_{11}= –0.7184	θ_{12}= 0.2059	θ_{13}= 0.5162	213.03 (284)	θ_{11}= –0.7146	θ_{12}= 0.2203	θ_{13}= 0.5135	199.59 (245)
	x_1	α_{11}= –0.1761			104.94 (688)	α_{11}= –0.1761			105.96 (571)	α_{11}= –0.1761			107.47 (455)
T_{r1}^*	x_1, x_2	α_{11}= –0.7963	α_{12}= 0.7604		113.17 (638)	α_{11}= –0.7963	α_{12}= 0.7604		116.12 (521)	α_{11}= –0.7963	α_{12}= 0.7604		120.74 (405)
	x_1, x_2, x_3	α_{11}= –0.7064	α_{12}= 0.2427	α_{13}= 0.4734	129.39 (558)	α_{11}= –0.7064	α_{12}= 0.2427	α_{13}= 0.4734	137.19 (441)	α_{11}= –0.7064	α_{12}= 0.2427	α_{13}= 0.4734	150.46 (325)

Source: Own construction

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Recent Publications and Events

New Publications of the Czech Statistical Office

DUBSKÁ, D., FERENC, J., KAMENICKÝ, J., MLÁDEK, T. *Tendence a faktory makroekonomického vývoje a kvality života v České republice v roce 2011* (Trends and Factors of the Macroeconomic Development and Quality of Life in the Czech Republic in 2011) [online]. Prague: CZSO, 2012. <http://www.czso.cz/csu/2012edicniplan.nsf/p/1101-12>.

Inovační aktivity podniků v České republice v letech 2008–2010 (Innovative Activities of Enterprises in the Czech Republic 2008–2010). Prague: CZSO, 2012.

Other Selected Publications

CES VSEM. *Konkurenční schopnost České republiky 2010–2011* (Competitiveness of the Czech Republic 2010–2011). Prague: Linde, 2011.

DEY, D. K, RAO, C. R. *Essential Bayesian Models.* Amsterdam, New York, Oxford: Elsevier, 2011.

FRANKE, A. *Statistiky cestovního ruchu* (Tourism Statistics). Prague: Wolters Kluwer CR, 2012.

FRANKE, A. *Zmírňování regionálních disparit prostřednictvím rozvoje cestovního ruchu* (Reducing of Regional Disparities through the Development of Tourism). Prague: Wolters Kluwer CR, 2012.

International Yearbook of Industrial Statistics 2012. Vienna: UNIDO, 2012.

UN. *National Accounts Statistics: Analysis of Main Aggregates,* 2010. New York: UN, 2011.

WTO. *A Practical Guide to Trade Policy Analysis.* Geneva: WTO, 2012.

Conferences

The ***20th International Conference on Computational Statistics (COMPSTAT 2012)*** took place ***from 27 to 31 August 2012 in Limassol, Cyprus***. The conference aimed to bring together researchers and practitioners to discuss recent developments in computational methods, methodology for data analysis and applications in statistics. More information available at: *http://www.compstat2012.org.*

As usually during the last holiday week (this year ***from 30 to 31 August 2012***) the ***15th International Scientific Conference AMSE 2012 (Applications of Mathematics and Statistics in Economy)*** was held in the campus of the ***Technical University in Liberec, Czech Republic***. The conference, attended by 60 experts from three countries (Poland, Slovakia, the Czech Republic), was organized by the University of Economics in Prague. In the rich programme of the conference, organized in two sections, 40 contributions were presented from the fields of applications of statistics and mathematics (problems of poverty measurement, analysis, wages and employment, measuring the effectiveness of social services, input-output analysis, models of risk and insurance, etc.) as well as from the theory of statistics (cluster analysis, Bayesian approach, Conjoint analyse, etc.). The introductory lecture was delivered by prof. Rudolf Zimka: *"Is it possible to secure intergenerational equity in an economy with exhaustible resources?"* The next international conference AMSE 2013 will take place from 29 to 30 August 2013 in the High Tatras, Slovakia. More information available at: *http://amse2012.vse.cz*.

The ***ROBUST 2012 Conference*** was held ***from 9 to 14 September 2012 in Němčičky, Czech Republic***, organized by the Czech Statistical Society, the Group for Computational Statistics of the Czech Mathematical Society, the Union of Czech Mathematicians and Physicists and the Department of Probability and Mathematical Statistics, Faculty of Mathematics and Physics, Charles University in Prague. The conference was devoted to selected trends in mathematical statistics, probability theory and data analysis. More information available at: *www.robust.nipax.cz*.

6th International Days of Statistics and Economics took place ***from 13 to 15 September 2012*** in the building of the ***University of Economics in Prague***, ***Czech Republic***, organized by the Department of Statistics and Probability and the Department of Microeconomics of the University of Economics, Prague, Czech Republic, Faculty of Business Economics, University of Economics with seat in Košice, Slovakia and the ESC Rennes International School of Business. The aim of the Conference was to present and discuss current problems of Statistics, Demography, Economics and Management and their mutual interconnection. More information available at: *http://msed.vse.cz/conference*.

The ***Statistical Week 2012*** took place ***from 18 to 21 September 2012*** at the ***Vienna University of Technology, Austria,*** organized by the German and Austrian Statistical Societies and the Association of German Municipal Statisticians. More information available at: *http://www.statistische-woche.de/en*.

5th International Scientific Conference – Quality of Life and Sustainable Development was held ***from 20 to 21 September 2012 in Wrocław, Poland***, organized by the Wrocław University of Economics. More information available at: *http://www.qol2012.ue.wroc.pl/en/index.htm*.

The ***Applied Statistics 2012 International Conference*** took place ***from 23 to 26 September 2012 in Ribno***, ***Slovenia***, organized by the Statistical Society of Slovenia and the University of Ljubljana in cooperation with the Statistical Office of Slovenia. More information available at: *http://conferences.nib.si/AS2012*.

98th DGINS (Directors General of the National Statistical Institutes) Conference and ***14th ESSC (Conference and the Meeting of the European Statistical System Committee)*** were held ***from 24 to 26 September 2012 in Prague, Czech Republic***. The topics of this year's event were "Meeting new needs on statistics for green economy" and "Coordination of statistics and geospatial information". The conference was organised by the Czech Statistical Office. More information available at: *www.czso.cz/dgins2012*.

The Czech Statistical Office (CZSO) has also the honour to host the ***5th EFGS (European Forum for Geostatistics) 2012 Conference***, which will take place ***from 24 to 26 October 2012*** in the Czech Association of Scientific and Technical Societies Headquarters in the historical centre of ***Prague, Czech Republic***. The conference is organised by the European Forum for Geostatistics and the Czech Statistical Office. The European Forum for Geostatistics (EFGS) represents a professional network of experts contributing within the framework of the European Statistical System to creation of a common geostatistical data infrastructure and to best practices in collecting, producing and disseminating georeferenced statistics. More information available at: *http://www.czso.cz/efgs/efgs2012.nsf/i/home*.

Papers
We publish articles focused at theoretical and applied statistics, mathematics and statistical methods, econometrics, applied economics, economic, social and environmental analyses, economic indicators, social and environmental issues in terms of statistics or economics, and regional development issues.

The journal of *Statistika* has the following sections:
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