STATISTIKA

STATISTICS AND ECONOMY JOURNAL

VOL. **93** (2) 2013

CZECH STATISTICAL OFFICE

CONTENTS

ANALYSES

INFORMATION

About Statistika

The journal of Statistika has been published by the Czech Statistical Office since 1964. Its aim is to create a platform enabling national statistical and research institutions to present the progress and results of complex analyses in the economic, environmental, and social spheres. Its mission is to promote the official statistics as a tool supporting the decision making at the level of international organizations, central and local authorities, as well as businesses. We contribute to the world debate and efforts in strengthening the bridge between theory and practice of the official statistics. Statistika is a professional double-blind peer reviewed journal included in the List of Czech non-impact peer-reviewed periodicals (since 2008). Since 2011 Statistika has been published quarterly in English only.

Publisher

The Czech Statistical Office is an official national statistical institution of the Czech Republic. The Office main goal, as the coordinator of the State Statistical Service, consists in the acquisition of data and the subsequent production of statistical information on social, economic, demographic, and environmental development of the state. Based on the data acquired, the Czech Statistical Office produces a reliable and consistent image of the current society and its developments satisfying various needs of potential users.

Contact us

Journal of Statistika | Czech Statistical Office | Na padesátém 81 | 100 82 Prague 10 | Czech Republic
e-mail: statistika.journal@czso.cz | web: www.czso.cz/statistika_journal

Development of Input-Output Tables in the Czech Republic[1]

Jaroslav Sixta[2] | *University of Economics; Czech Statistical Office, Prague, Czech Republic*

Abstract

Input-output tables represent a powerful tool for economic analyses. Even the tradition of symmetric input-output tables is long in the Czech Republic, the number of skilled domestic users is relatively low. It means that they are widely used by foreign universities and research centers. It is partly due to the missing education in this area at universities and partly due to the insufficient information in Czech scientific journals. The aim of this paper is to briefly present a history and availability of Czech input-output tables and description of their possibilities for economic analyses. Since a very fast development of both economy and economics, the system of national accounts is being revised. It means that beside core sector accounts, input-output tables will be updated, as well.

Keywords

Input-output tables, material product system, system of national accounts, gross domestic product

JEL code

E01, C02, N01

INTRODUCTION

Input-output tables are one of the key parts of the System of National Accounts (SNA) since 1993 when an UN standard SNA 1993 was established. European modification ESA 1995 took over main principles and current input-output tables should be fully consistent with sector accounts. Implementation of input-output tables into national accounts was firstly introduced in SNA 1968. Input-output tables have a long history and they are tightly linked with famous Nobel Prize laureate W. Leontief since 1930s. They were originally designed as a tool for economic description and analysis and subsequently they have gained more purposes. Input-output tables currently cover classes of two[3] main models. The first class contained historically popular symmetric input-output Tables (SIOT) and the second class is covered by supply and use tables (SUT). Symmetric input-output tables have still the same group of users focusing on economic models. Contrary to them, supply and use tables are used mainly by statistical offices for checking data quality, commodity balancing and deflation.

Input-output tables offer a large amount of information about the economy and therefore they are very popular among the most qualified users (previously mainly abroad). Unfortunately, they were connected with central planning in socialist countries and they unreasonably lost a lot of their attractiveness

[1] This paper is prepared under the support of the project Historical Time Series of Gross Domestic Product of the Czech Republic of the Czech Science Foundation, project No. P402/10/1275.

[2] University of Economics, Faculty of Informatics and Statistics, nám. W. Churchilla 4, 130 67 Prague 3; Czech Statistical Office, Na padesátém 81, 100 82 Prague 10, Czech Republic. E-mail: sixta@vse.cz.

[3] Actually, there can be found three models in ESA 95, see ESA 95, § 9.01.

there. But even in post-communist countries they are slowly getting back to the centre of interest and this is probably due to the development in education of economics and nowadays computing possibilities. This article also should provide answers to some very frequent questions on the interpretation and explanation of modern input-output tables.

A complete and systematic description of the economy hidden in input-output tables predetermines SIOTs for different purposes. For example, original input-output tables for the Czech Socialist Republic (1973 and 1987) were used for the estimates of time series of Czech gross domestic product in period 1970–1989 (Sixta, Fischer, 2012). Similarly, they were also used in the revision of Czech national accounts done by the Czech Statistical Office in 2012, see Historical Yearbook of National Accounts (CZSO 2012).

1 HISTORY OF CZECH INPUT-OUTPUT TABLES

The history of input-output tables goes back to Tableau Économique prepared by F. Quesnay, theories of Adam Smith, Karl Marx and other economists but the current approach to input-output models is crucially connected with famous economist W. Leontief. W. Leontief compiled US input-output tables for 1919 and 1929 and his book Input-output Economics has become very famous, see Leontief (1986). He was awarded a Nobel Prize in economics in 1973 for the development of input-output method and its applications. Input-output tables were formally joined with national accounts within SNA 1968 framework applied in the West. Practically it was very complicated to compile input-output tables without advanced computers and compilation of input-output tables was done only in the most developed countries. Similarly in the Eastern Block, SIOTs were compiled for planning purposes, but they were based on different economic theories. Soviet system of economic statistics was applied in 1950s in socialist countries including Czechoslovakia.

In line with Marx theories, socialist measurement of economy was based on the division of economy into productive and non-productive activities. Productive activities were deeply described by the Material Product System (MPS) within Balances of National Economy (BNE). It means that SIOTs compiled in socialist countries were not comparable with the practice in the West.

The first input-output tables were compiled for Czechoslovakia for 1962 (96 products) and before compilation a lot of research work preceded. Since then in a five-year period SIOTs were compiled (1967, 1973, 1977, 1982, 1987). The first tables for the Czech Republic[4] were compiled for 1973 (89 products), subsequently in five-year period (1977, 1982, 1987).

National accounts were introduced in Czechoslovakia with the transformation of the country in 1990. Originally proposed ideas on combination of Balances of National Economy and System of National Accounts (Arvay, 1992) were abandoned. During the preparation for transformation of macroeconomic statistics, Czechoslovakia was divided and the first national accounts were compiled for the Czech Republic for 1992 (they were published in 1995; see Kieslichova, 2012). These national accounts contained both sector accounts and supply and use tables at purchasers' prices. Since the progress on compilation of national accounts was going on, the emphasis was put on the most demanded agenda as improvements in institutional sector accounts, construction of financial accounts and subsequently construction of balances of non-financial assets. Supply and use tables were compiled seldom; they were finished for 1995 and 1997.

Before the entry into the EU in 2004, a major revision of national accounts was done. This revision included time series of both sector accounts and supply and use tables for 1995–2003. Since then supply and use tables have become a standard tool for balancing and deflation in annual national accounts and symmetric input-output tables are compiled every five years. The first approaches to SIOT in the Czech Republic are described in Vavrla, Rojíček (2006).

[4] Official name was the Czech Socialist Republic since 1. 1. 1969.

Currently, national accounts have two parts. The first are sector accounts describing the creation, distribution and redistribution of values and the second part consists of input-output tables describing technical links and the process of production.

In September 2011, input-output tables started to be published in CZ-CPA and CZ-NACE that caused some complications to users.

2 THE ROLE OF INPUT-OUTPUT TABLES

Input-output tables play a key role in the description of production processes in the economy. Both supply and use tables and input-output tables can be used for analytical purposes but SUT are usually used mainly by national accountants while SIOTs are mainly requested by economists. Therefore supply and use tables are currently used mainly for:

a. Checking of quality of national accounts' aggregates,
b. Commodity balancing,
c. Statistical deflation.

Supply table is compiled at basic prices with the transformation into purchases' prices.[5] Use table is valued at purchasers' prices but there are several other matrices hidden behind. It means that there exist valuation matrices covering taxes, subsidies and trade and transport margins. Finally, it is possible to construct use table at basic prices. This hierarchical process of compilation is necessary for deflation and construction of symmetric input-output tables. SUTs are published both at current and previous years prices.

Symmetric input-output tables are compiled at basic prices every five years. Technically, they can be compiled annually but the process is demanding and the needs of the users (economists) are different to those of statisticians. The key role of SIOTs is to provide technical coefficients describing the input and structure of the economy.

Currently SIOTs are not compiled directly as it was before 1989 in MPS methodology (FSO, 1984). They are obtained by mathematical transformation from SUTs. They are two main types of tables:

a. Product-by-product tables,
b. Industry-by-industry tables.

Product-by-product tables describing the inputs by products for the production of products (intermediate consumption matrix) and final demand for products are usually preferred in the Czech Republic. Moreover, these tables were preferred in Czechoslovakia. Industry-by-industry tables describe output of industries that is used in industries for their output (in intermediate consumption matrix) and for final demand. Current situation of Czech macroeconomic statistics is generally not suitable for input-output tables and even worse for industry-by-industry tables. There are generally two main difficulties when reading Czech SIOTs. Both are connected with the definition of elementary statistical unit within national accounts. Czech national accounts are fully based on institutional units (IU) that are not deeper broken down by kind of activity units (KAU).[6] At first, it means that when a particular IU is divided between two, the level of output doubles because there were not counted intracompany sales. At second, the production of bigger IU is sometimes very heterogeneous and it causes problems when applying transformation methods. Since there are significant issues that may influence the "purity" of SIOTs, users should take into account these difficulties.

3 CONSTRUCTION OF INPUT-OUTPUT TABLES

During the socialist time, SIOTs were constructed directly. It means that the key part - intermediate consumption was based on surveys. Structures of inputs for all activities were directly surveyed. Currently,

[5] Since national accounts' revision in 2011, imports are correctly valued at cif prices.
[6] Even this is requested by ESA 1995, most countries have problems with this definition.

the situation is different. Companies' costs are surveyed every five years and these data are sufficient for compilation of SUTs. Due to the heterogeneity of output, it is not possible to use cost structures for SIOTs. The Czech Statistical Office uses three methods for deriving SIOTs from SUTs,[7] see Table 1.

Table 1 Overview of the Czech SIOTs

SIOT type	Method	Description
Product-by-product	A	Product technology assumption (Model A); it is assumed that each product is produced in its own specific way, irrespective of the industry where it is produced.
	F	Almon method based on iterative procedures enabling to avoid negatives when applying product technology.
Industry-by-industry	D	Fixed product sales structure assumption, each product has its own specific sales structure, irrespective of the industry where it is produced.

Source: Eurostat (2008), own elaboration

Both methods A and D are based on matrix algebra and method F is an iterative procedure, details and formulas can be found in Eurostat (2008). SIOTs based on these models have been published since 2011. Before 2011, only product-by-product tables by product technology were compiled and published. The structure of input-output table is described in Table 2.

Table 2 Structure of Symmetric Input-Output Table, Product-by-product

<table>
<tr><th>Products (CZ-CPA)</th><th colspan="3">Final use
Vectors y</th><th>Total use at basic prices</th></tr>
<tr><td>Intermediate consumption
(product x product)</td><td>Final consumption expenditures by products</td><td>Gross capital formation by products</td><td>Export by products
(f.o.b prices.)</td><td>Total use by products</td></tr>
<tr><td colspan="5">Net taxes on products</td></tr>
<tr><td>Intermediate consumption at purchasers' prices</td><td>Final consumption expenditures at purchasers' prices</td><td>Gross capital formation at purchasers' prices</td><td>Export</td><td>Total use at purchasers' prices</td></tr>
<tr><td>Gross value added:
Compensation of employees
Other net taxes on production
Consumption of fixed capital
Net operating surplus and mixed income
Vectors w</td><td colspan="4"></td></tr>
<tr><td>Output at basic prices
Vector x</td><td colspan="4"></td></tr>
<tr><td>Import (c.i.f. prices)</td><td colspan="4"></td></tr>
<tr><td>Total resources at basic prices</td><td colspan="4"></td></tr>
<tr><td>Additional information:
Employment, capital stocks</td><td colspan="4"></td></tr>
</table>

Source: Hronova et al (2009)

Intermediate consumption matrix is labelled as the first quadrant, vector of final use (v) as the second quadrant and value added (w) as the third quadrant. Let's focus on product-by-product table then basic economic equations valid for all products can be written:

[7] All of the mentioned models are described in Eurostat I-O Manual, see Eurostat (2008).

$$
\begin{aligned}
X_1 &= a_{11}X_1 + a_{12}X_2 + a_{13}X_3 + \ldots\ldots\ldots\ldots + a_{1n}X_n + Y_1 \\
X_2 &= a_{21}X_1 + a_{22}X_2 + a_{23}X_3 + \ldots\ldots\ldots\ldots + a_{2n}X_n + Y_2 \\
&\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \\
X_n &= an_1X_1 + an_2X_2 + an_3X_3 + \ldots\ldots\ldots\ldots + a_{nn}X_n + Y_n ,
\end{aligned} \tag{1}
$$

where X_1 to X_n represent output of n products, a_{ij} are usually called technical coefficients, $a_{ij} = x_{ij}/X_j$ and they represent direct impacts on inputs when producing specific products. In matrix forms, following symbols and equation are usually used (details can be found in Leontief, 1986):

$$Ax + y = x . \tag{2}$$

It means that intermediates plus final demand have to be equal to the output.[8] For many models (see Eurostat Input-output Manual; Eurostat, 2008), following matrices represent the fist necessary steps. Simple static input-output model is expressed:

$$x = (I - A)^{-1}\, y , \tag{3}$$

where:

A – matrix of technical coefficients,

x – vector of output,

y – final use.

Matrix $(I - A)^{-1}$ is called Leontief inverse and the elements of the matrix can be interpreted as measures of indirect impacts of externally induced changes. SIOTs can be used for many models starting from simple static models, dynamic models and in recent years they are used within CGE models.[9] The detailed description of models can be found in Leontief (1986) and EUROSTAT (2008). Input-output models are very popular in developed countries. These models can be used for different purposes. The most simple, static model is often used for modeling of external shocks on the economy, mainly on output, value added, employment and prices.

3.1 How to read modern symmetric input-output table

It is clear that all products supplied in the economy have to be used for intermediate consumption or final use. When dealing with input-output models, it is more suitable to use separate tables for the use of domestic output and imported products. In other words, the effects should be distributed into domestic output and imports.

Due to a long separate development of input-output models and macroeconomic statistics there is a confusing terminology. Originally used term sector representing columns and rows in input-output table is not used. Nowadays sector is connected with the definition of institutional unit (e.g. company) and institutional sector. Rows and columns represent either products (formerly used term commodity) or industries in terms of kind of activity units. Beside that the term primary inputs represent the third quadrant, gross value added connected with labour inputs (compensation of employees), government (taxes and subsidies) and indirectly capital in broader sense (gross operating surplus and mixed income).

When reading the Czech tables (see Tables 3 and 4), it should be noted that the definition of statistical unit may cause high sensitivity of resulting SIOTs on changes in supply and use tables. This means that the so-called unbundling process of some companies leads to high figures on diagonal of intermediate consumption matrix; it is due to sub-deliveries between companies, see Jedličková et al (2009) From a brief

[8] This is simplified for the closed economy. If imports are taken into accounts, intermediates have to include both domestically produced products and imported products, see Eurostat (2008).

[9] Computable General Equilibrium models cover a large group of models, see Cardenete et al (2012).

look into SIOT it is clear that raw material products (CZ-CPA code B) are mainly imported, 133 CZK billion of total sources of 201.7 CZK billion. This product group contains mainly coal and crude oil and natural gas. Both gas and coal are consumed for electric energy, heat and gas production (CZ-CPA D). Crude oil is consumed in manufacturing industry; refinery is classified within manufacturing (CZ-CPA C). Some tonnes of coals are consumed by households, 2.6 CZK billion.

Table 3 Symmetric Input-Output Table 2005, I+III Quadrant

CZ-CPA section		Products according to the CZ-CPA sections							TOTAL
		A	B	C	D	E	F	G-S	
A	Products of agriculture, forestry, fishing	16.9	0.4	93.8	0.7	0.1	0.3	9.1	121.3
B	Mining and quarrying	0.3	2.8	111.9	62.2	0.4	7.3	0.9	185.9
C	Manufactured products	47.4	10.2	1 523.5	19.2	13.0	147.6	302.5	2 063.4
D	Electricity, gas, steam	1.2	2.8	41.2	85.2	0.8	2.7	48.0	181.8
E	Water supply, sewerage	0.2	0.3	15.1	2.2	18.0	0.9	11.8	48.5
F	Constructions, construction works	1.1	2.6	20.8	2.4	2.4	199.3	97.2	325.9
G–S	Services	18.3	14.0	392.2	28.7	17.5	151.0	1 150.0	1 771.6
P.2	**Intermediate consumption (basic pr.)**	**85.4**	**33.0**	**2 198.4**	**200.6**	**52.4**	**509.1**	**1 619.5**	**4 698.3**
D.21–D.31	**Net taxes on products**	**2.9**	**0.4**	**31.4**	**1.7**	**1.2**	**8.5**	**59.6**	**105.7**
P.2	**Intermediate consumption (purch. pr.)**	**88.2**	**33.4**	**2 229.8**	**202.3**	**53.6**	**517.6**	**1 679.1**	**4 804.0**
D.1	Compensations of employees	33.0	18.1	349.4	17.7	16.9	89.2	774.2	1 298.5
D.29–D.39	Other net taxes on production	–19.6	–1.5	–0.6	–1.1	0.4	0.2	–3.1	–25.2
K.1	Consumption of fixed capital	15.0	6.9	107.3	42.8	9.7	18.5	376.4	576.7
B.2n+B.3n	Net operating surplus, mixed income	40.2	11.1	227.4	30.5	7.4	96.9	544.2	957.7
B.1g	**Gross value added (basic prices)**	**68.6**	**34.7**	**683.5**	**90.0**	**34.4**	**204.8**	**1 691.8**	**2 807.8**
P.1	**Output (basic prices)**	**156.8**	**68.1**	**2 913.4**	**292.3**	**88.0**	**722.4**	**3 370.9**	**7 611.8**
P.7	**Import**	**36.5**	**133.6**	**1 547.0**	**5.5**	**6.1**	**4.6**	**207.5**	**1 940.7**
	Resources	**193.3**	**201.7**	**4 460.4**	**297.7**	**94.0**	**727.0**	**3 578.4**	**9 552.6**

Source: Czech Statistical Office (2012)

The table has to be symmetric, it means that the last column equals to the last row, formulas (1) are valid. Total use at basic prices has to be the same as total supplies at basic prices. The valuation differences between basic prices and purchasers' prices lie in net taxes on products that contain mainly value added tax, excise duties on alcohol, tobacco and fuels and subsidies on products covering mainly subsidies on public transport. Beside taxes and subsidies, trade and transport margins represent valuation difference on a product level. In reality, the price of service provided by the transporter and trader is paid in purchasers' value of a good. In input-output model it is assumed that both intermediate and final users buy separately goods and services connected with the purchase. To obtain a consistency of totals (government has to be taken into account), net taxes on products have to be added to intermediate consumption. In the third quadrant it means that gross value added is valued at basic prices and it can be computed as output at basic prices less intermediate consumption at purchasers' prices.

The third quadrant offers an income approach to gross domestic product and composition of gross value added. Contrary to sector accounts, in product-by-product tables the interpretation of industries is different. It shows the composition of value added for individual products instead of industries. In industry-by-industry tables, interpretation is the same as in sector accounts. Compensation of employees contains wages and social contributions (mainly paid by employers). Other net taxes on products consist of taxes connected with production[10] (road tax, real estate tax, environmental taxes etc.) and subsidies for covering of the loss. Agricultural subsidies are shown in Table 3, column A and row other net taxes on production, –19.6 CZK billion (sign minus means that obtained subsidies exceeded paid taxes). Consumption of fixed capital represents depreciation of fixed capital in national accounts; see Sixta (2007) or Krejčí (2010). Net operating surplus and net mixed income represent the operating profit from production of the product.

Table 4 Symmetric Input-Output Table 2005, I+III Quadrant

Household final consumption expenditure	Final consumption expend. of general government and NPISHs	Gross fixed capital formation	Changes in inventories incl. valuables	Exports (FOB)	Final use, total	Used resources, total
P.3		P.51	P.52 + P.53	P.6		
37.7	0.1	3.8	3.9	26.5	72.1	193.3
2.6	0.0	0.0	–4.9	18.2	15.8	201.7
392.2	36.2	305.3	23.0	1 640.3	2 397.0	4 460.4
97.9	0.0	0.0	–1.2	19.2	115.9	297.7
23.5	1.8	0.0	1.1	19.1	45.5	94.0
2.1	0.1	393.5	–0.3	5.8	401.1	727.0
794.9	650.4	73.0	1.5	287.0	1 806.8	3 578.4
1 351.0	**688.7**	**775.5**	**23.0**	**2 016.1**	**4 854.3**	**9 552.6**
164.7	0.7	29.1	–1.8	9.7	202.5	308.2
1 515.7	**689.4**	**804.6**	**21.3**	**2 025.9**	**5 056.8**	**9 860.8**

Source: Czech Statistical Office (2012)

3.2 Specific issues of Czech SIOTs

Currently, there can be identified some deviations of Czech tables from other countries. Historically, Czech SIOTs are based on national concept. That means that export covers non-residents' purchases in the Czech Republic (mainly tourism) and import contain expenditures of Czech residents abroad. EUROSTAT and some other countries prefer domestic concept. It means that households' consumption covers non-residents purchases and it does not cover residents' purchases abroad.

There are significant issues connected with energy products (CZ-CPA 35). Due to the nature of elementary unit defined in the Czech national accounts, so called unbundling process (Jedličková et al, 2009) would have caused overestimation of output and intermediate consumption. Therefore so-called

[10] It should be emphasised that these items cover only taxes connected with production. It means that income taxes, property taxes etc are treated differently in national accounts (within distribution and redistribution of income).

consolidation adjustment is done and output of energy (both electricity and natural gas) is considered only for the first part ("producer") of distribution chain. All other units connected with purchasing, selling and distribution are regarded as trades instead of producers. This caused that diagonal figure in intermediate costs matrix of SIOT (consumption of energy for production of energy) significantly decreased. Due to a complicated system of accounting and extend of these issues, this figure cannot be fully presented as technical consumption of energy because it still may contain some transactions that were not fully consolidated. Beside the general problems with energy, there is an important deviation from official statistical classification (CZ-CPA) in CPA 352 (distribution of natural gas). Strictly according to classification, this product should contain the service connected with transport and distribution of gas to users. The gas itself should be classified under the product (062). The situation is complicated because of the data availability and the process of production. It is assumed a model based on one-step process of production. Mainly imported gas (062) is consumed in industry of CZ-CPA 352 for the production of final product 352 that is used by customers in intermediate consumption or final use.

Specific services like installation costs (CPA 33) were introduces to gross fixed capital formation (GFCF). This item covers costs associated with the installation of machinery. It is somehow similar to trade margin but directly recorded in GFCF. The good original though of statisticians is significantly damaged by the inability to obtain such figures in practice. Actually, output of these services is predominantly given by the units (=companies) that are specialised for these services. If the installation service is a part of producers' services, then there is no distinction between the product itself and the service provided on both sides (seller and customer).

The revision of the statistical classifications (CZ-NACE and CZ-CPA) brought new challenges for both compilers and users of input-output tables. Especially, the section (E) is newly defined. It separately contains water (36), sewerage (37), waste management (38) and remediation activities (39).

4 COMPARISON WITH HISTORIC SIOT FOR 1973

The first SIOT for the Czech Republic compiled for 1973 was prepared in the dimension of 416 products. These figures were aggregates for publication into the dimension of 89 × 89 and 28 × 28. The key principle was very similar to nowadays practice and SIOT was linked to the core balances of national income. Contrary to balances of national income, some services even regarded as non-productive were counted in SIOTs (communications and public transport), see Sixta, Fischer (2011). Current SIOTs should be fully comparable to core sector accounts. Aggregated version of original SIOT in MPS methodology is presented in Table 5.

The structure of original SIOT is the same as nowadays. The first quadrant covered only material products and some services for production of material sphere. Therefore service like education and health were not recorded. The second quadrant covered final use in similar sense to nowadays definition except social consumption. This column is rather intermediate consumption of government units in national accounts' methodology. As in the whole system, only material products (goods and some services) were covered and the definition of indicators slightly differed from SNA.[11] Transfers with Slovakia substituted export and import from and to Slovakia. This item was recorded net and on the use side. Specific issues were losses and differences mainly connected with losses in inventories. Significant differences can be found in the third quadrant where indicator called other net production covers costs of non-productive services purchased by productive sphere, social costs paid for employees and some other items excluded from intermediate consumption or profit. Therefore the item called profit cannot be interpreted as operating surplus.

[11] For example, gross investment is not fully comparable to gross fixed capital formation.

Table 5 SIOT, Czech Socialist Republic 1973, Current Prices, CSK mil.

Industry	Intermediate consumption (IC)				TOTAL (IC)	Personal con-sumption	Social con-sumption	Invest-ment + invento-ries	Export	Transfers with Slovakia	Losses and differen-ces
	Agric.	Industry	Constr.	Services							
Agricul.	20 837	34 629	129	60	55 655	11 673	1 866	2 742	1 575	–1 249	1 553
Industry	17 602	302 596	28 775	23 864	372 838	121 141	24 006	36 826	73 255	4 130	–1 502
Constr.	503	2 706	1 923	2 306	7 437	697	7 455	54 440	918	–70	–101
Services	2 690	39 115	6 414	9 420	57 638	8 963	1 650	1	18 037	0	–214
Total IC	41 631	379 045	37 242	35 650	493 568	142 473	34 977	94 008	93 785	2 811	–263
Depreciation	2 626	14 687	1 241	7 132	25 686						
Wages	20 058	52 079	14 066	23 427	109 630						
Other net production	4 558	30 481	9 343	14 014	58 396						
Profit	–2 013	48 590	7 097	917	54 591						
Sales tax	99	38 469	1	0	38 568						
Gross value added	25 329	184 306	31 747	45 490	286 872						
Output	66 960	563 351	68 989	81 141	780 440						
Import	6 854	67 342	1 787	4 934	80 918						
Resources	73 814	630 694	70 776	86 075	861 358						

Source: Czech Statistical Office

Historical SIOTs were also used for the project aimed at estimates of GDP for 1970–1989, see Sixta, Fischer (2010). SIOTs were used for identification of adjustments and industrial structures. Moreover, it is intended to publish SIOTs both for 1973 and for 1987 in SNA methodology as a subsequent result of this project in 2013.

5 SNA 2008 AND ESA 2010 IMPACT ON INPUT-OUTPUT TABLES

SNA 2008 introduced changes in the system of national accounts and practically all parts of the system are affected. Even very reasonable changes from the economic point of view, practically they are very difficult for compilation. It is most seen in the methodology of national accounts where the development of economic theory is far away from practical possibilities of statistical offices. SNA 2008 (UN, 2010) is going to be transformed into European standard, ESA 2010 that will be applied in 2014. It is a justifiable question whether the changes in methodology (even at least partly forced by the change of society and globalisation) will lead to higher quality of data and to the increase of international comparability. Supply and use tables and symmetric input-output tables will be significantly updated due to following changes:[12]

a. *Goods for processing* will no longer be recorded as import or export. It means that goods imported to the country for processing (e.g. sewing dresses from fabric) is currently recorded in import and

[12] Originally there were proposed more changes in SNA. Also capital services were intended to be a part of non-market output and therefore SIOTs would have to be adjusted (Sixta, Fischer, 2008).

[13] This is a difference from business accounting.

intermediate consumption[13] of the producer (provider of sewing services) and after the processing, final product is exported. When SNA 2008 and ESA 2010 are put into practice, only services relating to processing will be recorded. It means that technical coefficients will be changed because it will be possible to provide a service without any material (intermediate consumption will decrease).

b. *Merchanting* and different treatment of *re-export* may influence the interpretation of export column. Merchanting means trading abroad when resident unit buys and sells goods. According to SNA 2008 it means that not only trade margin should be recorded but also the purchase and sell of goods. Unfortunately it seems that purchases and sales should be recorded in export only and it may lead to negatives when traders suffered a loss from trading abroad. Re-export means that goods can be exported after it was imported before. It is assumed that units trading with some goods can re-export them. Actually it means that goods can be exported even it is not produced in the exporter's country.
c. *Capitalisation of expenditures on research and development* will cause changes between intermediate consumption and gross fixed capital formation. Very similar impact can be expected from *capitalisation of military assets*.
d. There can be identified also other changes in SNA methodology that may at least partly influence SIOTs. It can be caused due to the changes in assets boundaries, definition in productive activities, etc.

CONCLUSION

Input-output tables covering both supply and use tables and symmetric input-output tables represent a standard part of national accounts in the Czech Republic. Both sets of tables compiled by the Czech Statistical Office are going to be more and more popular and the demand of their users is rising. Along with the increase with the users' needs on data, users' demand on information is rising as well. Unfortunately, Wassily Leontief's famous theory that forms the core of the modern methods of measurement of economic development is not generally well known and it is at least partly due to issues lectured at universities. This is a pity because there is a high availability of input-output tables for the Czech Republic and these tables are mainly used by foreign users like economic schools and research centres. A long history and tradition of Czech economic statistics offers a unique possibility for studying of the Czech economy in a long perspective.

Even SIOTs compiled before 1989 were based on Material System Product, they can provide a lot of information relating to Czech economy. These tables can be used directly for studying material part of the economy or these obsolete SIOTs can be transformed into SNA methodology. Tradition of a good statistics in former Czechoslovakia means that data from balances of national income and original SIOTs can provide unbiased valuable information applicable for many purposes, as they were used for GDP estimates, see Sixta, Fischer (2012).

References

ARVAY, J. The Material Product System (MPS): A Retrospective. *Twenty-second General Conference of the International Association for Research of Income and Wealth* (IARIW), Switzerland, 1992.

CARDENETE, M. A., GUERRA, A., SANCHO, F. *Applied General Equilibrium*. Heidelberg, 2012.

CZECH STATISTICAL OFFICE. *Historical Year Book of National Accounts 1990–2010* [online]. Prague: CZSO, 2012. <http://www.czso.cz/csu/2012edicniplan.nsf/publ/5013-12-n_2012>.

EUROSTAT. E*uropean System of Accounts – ESA 1995*. Luxembourg, Office for Official Publications of the European Communities, 1996.

EUROSTAT. Eurostat Manual of Supply, Use and Input-Output Tables. *Methodologies and working papers*. Luxembourg: Eurostat, 2008.

FEDERAL STATISTICAL OFFICE OF CZECHOSLOVAKIA. *Methods of the Compilation of Sources and Uses of Global Product and National Income.* Prague, 1984.

HRONOVÁ, S., FISCHER, J., HINDLS, R., SIXTA, J. *Národní účetnictví – nástroj popisu globální ekonomiky* (National Accounting – a Tool for Describtion of the Global Economy). Prague: C. H. Beck, 2009.

JEDLIČKOVÁ, E., KONVIČKA, S., MUSIL, P., SIXTA, J. Nové metody deflace HDP (New Methods of the GDP Deflation). *Statistika*. 2009/3, pp. 193–206.

KIESLICHOVÁ, K. *Historický vývoj systému input-output tabulek na území České republiky* (Historical Development of the Input-output Tables in the Czech Republic). Diploma Thesis. Prague: University of Economics, 2012.

KREJČÍ, I. Computation of the Stocks and Consumption of Fixed Capital with use of Markov Chain. *Proceedings of the 28th International Conference on Mathematical Methods in Economic*. České Budějovice, 2010.

LEONTIEF, W. *Input-Output Economics*, 2nd ed. New York: Oxford University Press, 1986.

SIXTA, J. Odhady spotřeby fixního kapitálu (Estimates of the Fixed Capital Consumption). *Statistika*, 2007/2, pp. 156–163.

SIXTA, J., FISCHER, J. Estimates of the Historical GDP Series for the Czech Republic (1970–2008): Methodological issues. *Statistical Days.* Ljubljana, 2010.

SIXTA, J., FISCHER, J. Gross Domestic Product of the Czech Republic in 1970–1990. *Input Output 2012.* Bratislava: Ekonomická univerzita, 2012, p. 155.

SIXTA, J., FISCHER, J. Retrospective Measures of GDP Using Input-output Tables for Former Czechoslovakia [online]. *19th International Input-Output Conference.* Alexandria, 2011. <http://www.iioa.org/files/conference-2/279_20110429111_Paper_sixta_fischer_IO.pdf>.

SIXTA, J., FISCHER, J. Statistical Models in National Accounts – Capital Services. *IASC 2008.* Yokohama: Japanese Society of Computational Statistics, 2008.

UNITED NATIONS. *System of National Accounts 1968 – SNA 1968.* New York: UN, 1968.

UNITED NATIONS. *System of National Accounts 1993 – SNA 1993.* New York: UN, 1993.

UNITED NATIONS. *System of National Accounts 2008 – SNA 2008.* New York: UN, 2010.

VAVRLA, L., ROJÍČEK, M. Sestavování symetrických input-output tabulek a jejich aplikace (Compilation of Symmetric Input-output Tables and their Applications). *Statistika,* 2006/1, pp. 28–43.

Understanding Government Consumption

Lenka V. Půlpánová[1] | *University of Economics, Prague, Czech Republic*

Abstract

Government final consumption represents one of the key indicators provided by national accounts, but at the same time one with relatively problematic economic interpretation. The concept of government final consumption expenditure involves a number of conventions. As a result, its economic and statistical character differs from other final expenditure components in total economy like household consumption or investment. The article explains how government final consumption expenditure and actual final consumption are defined and valued in national accounts, describes the borderline between individual and collective consumption expenditure and examines the relation between government final consumption expenditure and government total expenditure. The concepts are illustrated in quantitative terms on the example of the Czech Republic.

Keywords

General government sector, government final consumption expenditure, government actual final consumption, individual consumption, collective consumption, government expenditure

JEL code

C82, E21, E23, H50

INTRODUCTION

National accounts (the 1993 SNA and the ESA 1995) introduced two concepts of final consumption – final consumption expenditure and actual final consumption. These concepts are relevant for three sectors – general government, households and non-profit institutions serving households (NPISHs). Other sectors in the national economy have neither final consumption expenditure nor actual final consumption by convention.

Government final consumption expenditure represents one of the key indicators provided by national accounts. First, it is an important component of total GDP when derived by the expenditure approach. Second, breaking down government final consumption expenditure into individual and collective components is important for the estimation of government actual consumption. Moreover, government final consumption expenditure on individual goods and services forms a part of actual final consumption of the households sector. Therefore, the analysis of various government consumption aggregates is a vital element of many economic and fiscal analyses.

Nonetheless, it is important to stress that government final consumption expenditure is an accounting construct. Compilation of consumption aggregates for the general government sector in national accounts involves several accounting conventions as well as imputations which are not always intuitive for data users. Sound knowledge of the specific concepts employed and national circumstances are essential

[1] University of Economics, Prague, nám. W. Churchilla 4, 130 67 Prague 3, Czech Republic. E-mail: lenka.pulpanova@vse.cz.

for avoiding possible misinterpretation of statistical data. Furthermore, government final consumption expenditure is sometimes confused with government current or total expenditure, although these economic concepts substantially differ in their scope.

The article examines how government consumption aggregates are constructed in national accounts and connected with government output and social transfers in kind. It also describes how government final consumption expenditure is split in consumption expenditure on individual and collective goods and services – the topic which is not thoroughly described in national accounts manuals. In addition, it shows the link between government final consumption expenditure and government total expenditure. Main factors behind developments of government final consumption expenditure, its breakdowns and the link with government total expenditure are presented in a case study dedicated to the Czech Republic. Finally, the paper mentions some of the revisions proposed in the 2008 SNA and the forthcoming ESA 2010 which have an impact on the government consumption aggregates.

1 GOVERNMENT FINAL CONSUMPTION EXPENDITURE IN NATIONAL ACCOUNTS

Government final consumption expenditure (P.3) was defined in national accounts (the ESA 1995) as "expenditure incurred by the general government sector on goods or services that are used for the direct satisfaction of individual needs or wants (individual consumption goods and services) or expenditure on the collective needs of members of the community (collective consumption services)" and this general definition was similar to that included in the 1993 SNA. Government final consumption expenditure is then incurred by all subsectors of the general government sector, i.e. by the central, state and local government as well as by the social security funds.

The concept of final consumption expenditure is based on the final bearer of the expenditure and not on the unit undertaking the initial expenditure. It means that e.g. consumption expenditure initially made by households, which is then reimbursed by units from the general government sector, is treated as final consumption expenditure of the general government sector. It should be stressed that government final consumption expenditure includes also expenditure measured indirectly (imputed).

Components of government final consumption expenditure were defined in the original ESA 1995 (published as regulation (EC) 2223/1996, see Eurostat, 1996, paragraph 3.79) in rather general terms as "the value of goods and services produced by general government itself (other than own account capital formation and sales)" plus "purchases by general government of goods and services produced by market producers that are supplied to households without any transformation as social transfers in kind". Such a definition was comprehensible for data compilers and national accounts specialist, but it did not provide a completely clear picture to data users about all individual components included there. In addition, it was not possible to derive government final consumption expenditure as a combination of elementary ESA transactions due to several missing breakdowns which were not shown (but implicitly considered) in national accounts.

This issue was approached in 2000. The ESA 1995 was amended in order to define government revenue and expenditure (regulation (EC) 1500/2000) and this revision brought more detailed classifications for some transactions. Thanks to revised and more detailed classifications for other non-market output (P.13) and social transfers in kind (D.63) in the revised ESA 1995, a precise definition of government final consumption expenditure could be introduced (this revision was not included in the 1993 SNA).

The revised ESA 1995 then defined government final consumption as "(a) the value of the goods and services produced by general government itself (P.1) other than own-account capital formation (corresponding to P.12) and sales, i.e. market output (P.11) and payments for the other non-market output (P.131); plus (b) purchases by general government of goods and services produced by market producers that are supplied to households, without any transformation, as social transfers in kind

(D.6311 + D.63121 + D.63131).[2] This implies that general government just pays for goods and services that the sellers provide to households".

As a result, government final consumption expenditure (P.3) was clearly defined on the basis of the ESA transactions:

Government final consumption expenditure (P.3) = (a) [total output (P.1) – market output (P.11) – output for own final use (P.12)] + (b) social transfers in kind via market producers (D.6311 + D.63121 + D.63131). (1)

However, the definition of government final consumption expenditure provided by the (revised) ESA 1995 in 2000 is not self-explanatory and deserves some further considerations.

1.1 Government output and government final consumption expenditure

In order to explain the first part of government final consumption expenditure (P.3) under indent (a) in the ESA 1995 revised definition mentioned above, it is necessary to consider different types of output produced by the general government sector and mention conventions used for valuation of government non-market output.

Government output (P.1) in the production account consists of three types. First, there is market output (P.11) which is produced by market establishments (of non-market institutional units classified in the general government sector) at economically significant prices. Second, there is output for own final use (P.12), i.e. government own account capital formation (included then in government capital formation). Finally, the last component of government output is called other non-market output (P.13), which is after the ESA 1995 revision in 2000 split in two components – payments for the other non-market output (P.131), i.e. output sold at economically insignificant prices, and other non-market output, other (P.132)[3] which is provided completely free and typically represents the major portion of total government output.

In the ESA 1995 there are a few specific conventions applied to valuation of non-market output, valuation of total output of non-market producers (establishments) and valuation of total output of a non-market institutional unit.

Government non-market output is valued as a sum of its production costs comprising compensation of employees (D.1), intermediate consumption (P.2), consumption of fixed capital (K.1), other taxes on production payable (D.29), less other subsidies on production receivable (D.39). For all institutional units included in the general government sector the following identity holds:

Total output (P.1) = compensation of employees (D.1) + intermediate consumption (P.2) + consumption of fixed capital (K.1) + other taxes on production (D.29 payable) – other subsidies on production (D.39 receivable) + net operating surplus of market establishments (B.2n). (2)

Non-market output provided free (P.132) is derived residually, i.e. any sales of goods and services produced by the general government sector (P.11 + P.131) plus own account capital formation (P.12) are deducted from total government output (P.1). Amount of non-market output provided free (P.132) is then "imputed" in the government accounts as a resource.

Non-market output provided free (P.132) = total output (P.1) – market output (P.11) – output for own final use (P.12) – payments for the other non-market output (P.131). (3)

---

2 Further in the text and tables referred as "social transfers in kind via market producers".

3 Further in the text and tables referred as "non-market output provided free".

Both market output (P.11) and other non-market output which are sold in the market (P.131) have counterparts in other sectors as intermediate consumption of enterprises or as final consumption of households. On the other hand, non-market output provided free (P.132) is also furnished to other sectors as non-market services and in some cases as goods. However, these goods and services are not recorded in the accounts of benefiting sectors. The reason is that there is no mechanism in place how to effectively allocate such government expenditure on goods and services to those who use them as they are not marketed and there is no suitable price for them.

Therefore, by convention, non-market goods and services produced by the government units and provided at economically insignificant prices (equal to P.132) are shown as final consumption (and never as intermediate consumption) of the general government sector itself, i.e. they form the first part of government final consumption expenditure (P.3), which is recorded on the uses side in the use of disposable income account of the general government sector.

1.2 Social transfers in kind provided via market producers

To explain the second part of government final consumption expenditure (P.3) under indent (b) in the ESA 1995 revised definition, for short called social transfers in kind via market producers (D.6311 + D.63121 + D.63131), it is helpful to have a look at the issue of social transfers in kind (D.63).

The classification of social transfers in kind was extended in 2000 in the context of the already abovementioned regulation (EC) 1500/2000 defining government revenue and expenditure, i.e. this new classification clearly depicted which social transfers in kind are treated as government expenditure (and which they are not). According to the revised classification, social transfers in kind were newly broken down by type of producer, see Figure 1. First, it shows products (goods and services) treated as social transfers in kind which are purchased by the general government sector from market producers and delivered to households without any transformation (D.6311 + D.63121 + D.63131). These social transfers in kind then form the second part of the government final consumption expenditure (P.3) in equation 1.

Figure 1 Social transfers in kind (D.63) in the ESA 1995 (as amended in 2000)

Social transfers in kind (D.63)	Social transfers in kind (D.63) alternative presentation
Social benefits in kind (D.631) Social security benefits, reimbursements (D.6311) Other social security benefits in kind (D.6312) Provided by market producers (D.63121) Provided by non-market producers (D.63122) Social assistance benefits in kind (D.6313) Provided by market producers (D.63131) Provided by non-market producers (D.63132) Transfers of individual non-market products (D.632)	(1) Social transfers in kind (related to *expenditure* on products supplied to households) via *market* producers (D.6311 + D.63121 + D.63131) (2) Social transfers in kind (related to products supplied to households) via *non-market* producers (D.63122 + D.63132 + D.632)

Source: Compiled by the author, based on regulation (EC) 1500/2000 amending the ESA 1995

Second, the revised classification indicates which goods and services are delivered in the form of social transfers in kind by non-market producers (D.63122 + D.63132 + D.632),[4] i.e. directly by the nonmarket units of the general government sector and supplied to households. These transfers in kind are imputed in the government accounts and the way in which they enter government final consumption expenditure is explained in the following chapter 2.

Social transfers in kind (D.63) cover neither social security benefits which are provided under government social insurance schemes nor social assistance paid in cash which are both classified under another

[4] Further in the text referred as "social transfers in kind via non-market producers".

item – social benefits other than social transfers in kind (D.62). Finally, there are no social transfers in kind with the rest of the world, by convention.

2 GOVERNMENT INDIVIDUAL AND COLLECTIVE FINAL CONSUMPTION EXPENDITURE

National accounts define two types of government final consumption expenditure (P.3) – individual consumption expenditure (P.31) and collective consumption expenditure (P.32):

Government final consumption expenditure (P.3) = government individual consumption expenditure (P.31) + government collective consumption expenditure (P.32). (4)

As regards individual consumption expenditure, the ESA 1995 (paragraph 3.81) defines it as follows: "goods and services for individual consumption (individual goods and services) are acquired by a household and used to satisfy the needs and wants of members of that household". The value of individual goods and services increases with a number of households and it is assumed that other sectors (enterprises) do not benefit from these goods and services.

In contrast, the ESA 1995 definition of collective consumption expenditure (paragraph 3.83) postulates: "services for collective consumption (collective services) are provided simultaneously to all members of the community or all members of a particular section of the community, such as all households living in a particular region". From these collective services may benefit also other sectors – they cannot be uniquely attributed to households. The link between a number of beneficiaries (households and others) is only indirect.

The original ESA 1995 stated that the distinction between individual and collective consumption expenditure should be preferably based on the classification of the functions of government (COFOG). However, at the time when the ESA 1995 was adopted, COFOG 1980 was still in force. Although COFOG 1980 was a detailed classification of government functions (see UN, 1980), it did not clearly indicate which classes or groups of government functions were supposed to be treated as individual or collective. Therefore, the ESA 1995 (similarly to the 1993 SNA) only provisionally suggested the possible division between individual and collective functions.

Revised COFOG 1999 was finally issued in 2000 by the United Nations and included a new classification structure composed of 10 basic divisions, further broken down into 69 groups and 125 classes of government functions (see UN, 2000). COFOG 1999 unambiguously distinguished which classes (as well as groups) of government functions shall be treated as individual or collective and the classification was adopted in the ESA 1995 in 2002 (as regulation (EC) 359/2002, replacing the former COFOG 1980).

Individual consumption expenditure (P.31) includes in particular expenditure on goods and services related to health, education or social protection. Expenditure on research and development, general administration of overall government policies, regulation, dissemination of general information and statistics are not included here, as they are treated as collective consumption expenditure. Individual consumption expenditure incurred by the general government sector is then considered as "consumed" by the households sector only (and thus forms a part of actual final consumption of the household sector).

Collective consumption expenditure (P.32) then contains consumption expenditure on goods and services which cannot be univocally attributed either to households or enterprises. It involves for example expenditure on services related to defence, public order and safety, economic affairs, environment protection, housing and community amenities, etc. Collective consumption expenditure covers further research and development, general administration of overall government policies, regulation, dissemination of general information and statistics and expenditure not elsewhere classified.

The ESA 1995 (as well as the 1993 SNA) provides general definitions for these two consumption aggregates, but they do not explain the exact mechanism how to derive government individual and collective consumption expenditure from government final consumption expenditure as defined in equation 1. When practically calculating individual and collective parts of government final consumption expenditure using COFOG 1999, it is necessary to take into account all elementary components included in the definition of government final consumption expenditure. Government final consumption expenditure from equation 1 can be expressed on the basis of its elementary components (while considering also equations 2 and 3) as follows:

Government final consumption expenditure (P.3) = compensation of employees (D.1) + intermediate consumption (P.2) + consumption of fixed capital (K.1) + other taxes on production (D.29 payable) – other subsidies on production (D.39 receivable) + net operating surplus (B.2n) – market output (P.11) – output for own final use (P.12) – payments for the other non-market output (P.131) + social transfers in kind via market producers (D.6311 + D.63121 + D.63131). (5)

In principle, each element included in government final consumption expenditure in equation 5 should be cross-classified by function (at the COFOG group level) in order to obtain individual and collective parts of final consumption expenditure and such a cross-classification should done for all units (or establishments) classified in the general government sector.

First, in equation 5 the last component – social transfers in kind via market producers (D.6311 + D.63121 + D.63131) – is always cross-classified by government functions which have an individual character and thus always treated as a constituent of individual consumption expenditure (P.31).

Second, also other components in equation 5, which correspond to the value of non-market output provided free (P.132), have to be also cross-classified by function for all units (establishments), i.e. either by individual or collective functions. It means that the individual and collective amounts have to be determined and the collective one is then considered as government collective consumption expenditure (P.32). The residual amount is classified by individual functions and regarded as social transfers in kind via (government) non-market producers (D.63122 + D.63132 + D.632), see Figure 1.

Sum of social transfers in kind via market producers (D.6311 + D.63121 + D.63131) and social transfers in kind via non-market producers (D.63122 + D.63132 + D.632) then gives the total amount of social transfers in kind (D.63) which is equal to government individual consumption expenditure (P.31):

Government individual consumption expenditure (P.31) = social transfers in kind via market producers (D.6311 + D.63121 + D.63131) + social transfers in kind via non-market producers (D.63122 + D.63132 + D.632) = social transfers in kind (D.63). (6)

As regards the effects on the government main balancing item net lending (+)/borrowing (–) (B.9), the imputed amount of non-market output provided free (P.132) on the resources side is counterbalanced on the uses side by collective consumption expenditure (P.32) plus a part of individual consumption expenditure equal to social transfers in kind via non-market producers (D.63122 + D.63132 + D.632). These transactions thus do not have any impact on the government net lending (+)/borrowing (–) (B.9), alternatively called government surplus (+)/deficit (–).

Non-market output provided free (P.132) = government collective consumption expenditure (P.32) + social transfers in kind via non-market producers (D.63122 + D.63132 + D.632). (7)

On the contrary, social transfers in kind via market producers (D.6311 + D.63121 + D.63131) are in principle not "imputed" (these are accompanied by actual monetary flows) and represent elements of government expenditure (see chapter 4) having an impact on the government balancing item net lending (+)/borrowing (–) (B.9).

3 GOVERNMENT ACTUAL CONSUMPTION

Actual final consumption (P.4) refers to acquisitions of consumption of goods and services regardless of who pays for them. In general, actual final consumption is divided between individual (P.41) and collective consumption (P.42). In national accounts actual individual consumption is attributed only to the households sector, therefore the general government sector (and NPISHs) do not have any actual individual consumption (P.41 = 0). Government actual consumption (P.4) thus contains only actual collective consumption (P.42).

The difference between final consumption expenditure (P.3) and actual consumption (P.4) lies in the treatment of particular goods and services financed by the general government sector and provided to households as social transfers in kind (D.63). These social transfers in kind are in reality "consumed" by households and thus they are an element of actual individual consumption of households.

Government actual consumption (P.4) is derived from government final consumption expenditure (P.3) by subtracting the value of social transfers in kind (D.63), which are equal to individual consumption expenditure (P.31), and it is therefore equal to government collective consumption expenditure (P.32):

Government actual final consumption (P.4) = government actual collective consumption (P.42) = government final consumption expenditure (P.3) – social transfers in kind (D.63) = government collective consumption expenditure (P.32). (8)

4 RELATION BETWEEN GOVERNMENT FINAL CONSUMPTION EXPENDITURE AND GOVERNMENT EXPENDITURE

4.1 Definition of government expenditure in the ESA 1995

Government final consumption expenditure (P.3) represents a significant portion of government total expenditure (TE), however, the relation between these two aggregates is relatively complex.

As already mentioned above, the definition of government total revenue and expenditure was not originally included in the ESA 1995. It was introduced in 2000 together with the more detailed classification of other non-market output (P.13) and social transfers in kind (D.63) which allowed derivation of government revenue and expenditure from the sequence of the non-financial accounts, closed by the balancing item net lending (+)/borrowing (–) (B.9). Government total expenditure was defined on the basis of the ESA 1995 transactions, see left column in Figure 2 (for a detailed description on the derivation of government revenue and expenditure from the government non-financial accounts, see Půlpánová, V., 2010 or 2012).

Government expenditures by convention mostly cover actual (not imputed) expenditures,[5] i.e. certain items like consumption of fixed capital or social transfers in kind via non-market producers (D.63122 + D.63132 + D.632) are thus not included in the definition of government expenditure.

Government expenditure can be further divided in current expenditure and capital expenditure. Government consumption expenditure belongs by its nature under current expenditure. Current expenditure in Figure 2, in addition includes also other important items which are not embraced in government final consumption expenditure, for example property income payable (D.4) (in particular interest), social benefits other than social transfers in kind (D.62) or other current transfers payable (D.7).

[5] Apart from employers' imputed social contributions (D.122) under compensation of employees (D.1).

Figure 2 Government total expenditure

Government total expenditure (TE) as defined in the (revised) ESA 1995	Government total expenditure (TE) alternative presentation
Current expenditure Intermediate consumption (P.2) Compensation of employees (D.1) Social transfers in kind via market producers (D.631 + D.63121 + D.63131)	*Final consumption expenditure* (P.3) Individual consumption expenditure (P.31) Collective consumption expenditure (P.32) *Adjustment*
Other taxes on production, payable (D.29) Property income (D.4) Social benefits other than social transfers in kind (D.62) Subsidies, payable (D.3) Current taxes on income, wealth, etc. (D.5) Other current transfers, payable (D.7) Adjustment for the change in net equity of households in pension funds reserves (D.8)	*Remaining current expenditure*
Capital expenditure Capital transfers, payable (D.9) Gross capital formation (P.5) Acquisitions less disposals of non-produced non-financial assets (K.2)	*Capital expenditure*

Source: Compiled by the author, based on regulation (EC) 1500/2000 amending the ESA 1995

Government total expenditure also comprises capital expenditure like capital transfers payable (D.9), gross fixed capital formation (P.51), i.e. acquisitions less disposal of fixed assets, changes in inventories (P.52) and acquisitions less disposals of valuables (P.53). Finally, capital expenditure includes acquisitions less disposals of non-produced non-financial assets (K.2).

4.2 Government expenditure and final consumption expenditure

Government total expenditure (TE) can be expressed as listed in the (revised) ESA 1995, see the left column in Figure 2, or alternatively including government final consumption expenditure (P.3) as shown in the right column of Figure 2, which is a way more convenient for some economic analysis. However, the link between government total expenditure (TE) or more precisely between current expenditure on one hand and government final consumption expenditure (P.3) on the other hand is not intuitive. The reason is that government final consumption expenditure is an accounting convention (closely linked to government production of non-market goods and services, etc.) and cannot be simply expressed as a mere regrouping of selected government current expenditure.

When comparing the list of government current expenditure, see the left column in Figure 2, with components of final consumption expenditure as enumerated in equation 5, it is evident that these components only partly overlap and government total expenditure does not include a number of items which are necessary to compile government final consumption expenditure. The overlap lies in three main categories – intermediate consumption (P.2), compensation of employees (D.1) and social transfers in kind via market producers (D.631 + D.63121 + D.63131).

As a result, the alternative presentation of government expenditure showing government final consumption expenditure, see the right column in Figure 2, has to include an “adjustment” item in order to keep the value of government total expenditure unchanged.

Final consumption expenditure (P.3) + adjustment = intermediate consumption (P.2) + compensation of employees (D.1) + social transfers in kind via market producers (D.631 + D.63121 + D.63131). (9)

The adjustment item from equation 9 then includes following flows (transactions and other flows) from the government accounts:

Adjustment = – consumption of fixed capital (K.1) – other taxes on production (D.29 payable) + other subsidies on production (D.39 receivable) – net operating surplus (B.2n) + market output (P.11) + output for own final use (P.12) + payments for the other non-market output (P.131). (10)

5 GOVERNMENT FINAL CONSUMPTION EXPENDITURE AND GOVERNMENT TOTAL EXPENDITURE IN THE CZECH REPUBLIC

Data on government final consumption expenditure and total expenditure are regularly compiled by the Czech Statistical Office. As the most convenient source of these data can be perceived the two tables of the ESA 1995 transmission programme – the ESA 1995 table 2 (general government main aggregates compiled at T+3 and updated at T+9 months) and the ESA 1995 table 11 (general government expenditure by function compiled at T+12 months). Both tables include data not only for the general government sector as a whole, but also by sub-sector (the central government, the local government and the social security funds).

In general, any changes in the institutional coverage of the general government sector due to reclassification of some units in/out of the general government sector, inclusions of newly created non-market units controlled by the government, methodological revisions (see examples below) or enhancing data sources, have an impact on flows included in government final consumption expenditure.

Table 1 Components of government final consumption expenditure (P.3), in CZK billion

	Relation	2006	2007	2008	2009	2010	2011
Total government output (P.1)	1 = 2 +…+ 5	602.7	633.9	663.7	694.4	683.8	667.9
Compensation of employees (D.1)	2	252.4	268.6	279.6	292.9	285.6	279.7
Intermediate consumption (P.2)	3	211.4	218.7	227.9	238.3	234.8	224.0
Consumption of fixed capital (K.1)	4	138.3	145.5	153.7	161.3	160.6	160.6
Other (D.29–D.39+B.2n)	5	0.6	1.1	2.5	1.9	2.7	3.6
Market output and output for own final use (P.11+P.12)	6	20.7	21.6	24.7	25.1	27.3	25.9
Payments for the other non-market output (P.131)	7	61.4	73.6	78.2	79.0	71.4	76.6
Non-market output provided free (P.132)	8 = 1 – 6 – 7	520.5	538.8	560.8	590.2	585.1	565.3
Social transfers in kind via market producers (D.6311+D.63121+D.63131)	9	173.5	187.1	198.6	219.0	222.4	227.6
Government final consumption expenditure (P.3)	10 = 8 + 9	694.0	725.9	759.4	809.3	807.5	792.9
Government final consumption expenditure (P.3), as percentage of GDP	11 = 12 + 13 + 14	20.7	19.8	19.7	21.5	21.3	20.6
Central government	12	7.8	7.5	7.3	8.0	7.7	7.3
Local government	13	7.7	7.2	7.2	7.7	7.6	7.5
Social security funds	14	5.1	5.1	5.2	5.9	5.9	5.9

Source: Czech Statistical Office (ESA 1995 table 2, published 31.10.2012), own calculations

Table 1 indicates components of government final consumption expenditure in recent years for the Czech Republic while employing equations 1, 2 and 3 from chapter 1. First, it shows the identity from equation 2 using the convention on valuation of government non-market output as a sum of production costs. Non-market output provided free (P.132) is derived residually as in equation 3. Second part of government final consumption expenditure is presented by social transfers in kind via market producers (D.6311 + D.63121 + D.63131). Government final consumption (P.3) is then composed of these two main components, as in equations 1, which defines government final consumption expenditure as described in the (revised) ESA 1995.

Compensation of employees (D.1) covers wages and salaries and employers' social security contributions (including imputed social contributions). These amounts encompass only employees working for the units included in the general government sector.

Intermediate consumption (P.2) consists of goods and services consumed as inputs in production process (e.g. energy, material, costs of using rented fixed assets). In addition, expenditures on military equipment which is not used for civilian purpose are included here. Sales of such military equipment are then recorded as negative intermediate consumption. Intermediate consumption includes also financial intermediation services indirectly measured (FISIM). Allocation of FISIM was implemented in Czech national accounts within the occasional revision carried out in 2006 when part of interest (D.41) was reclassified as intermediate consumption (P.2) which increased government final consumption expenditure (although leaving government total expenditure untouched).

Consumption of fixed capital (K.1) is currently estimated according to the perpetual inventory method (PIM) for which the complete stocks of fixed assets owned by the general government sector are necessary as well as the probable average economic life by type of asset. Figures on consumption of fixed capital were substantially revised in 2004 as the stock of government fixed capital was enlarged to include assets owned by the general government sector as roads, highways and railway tracks. The Czech Statistical Office at the same time implemented the standard PIM. This revision had a considerable impact on government final consumption expenditure in absolute terms, but it did not influence government total expenditure (TE) or net lending (+)/borrowing (–) (B.9) of the general government sector.

Social transfers in kind via market producers (D.6311 + D.63121 + D.63131) include mainly health care expenditure of health insurance companies (included in the social security funds sub-sector). For a detailed description of flows included in Table 1 for the Czech Republic, see e.g. GNI inventory in Czech Statistical Office (2006) or explanatory notes attached to the ESA 1995 Table 2.

Share of non-market output provided free (P.132) in government final consumption expenditure (P.3) is above 70% and gradually decreases in time while share of social transfers in kind via market producers (D.6311 + D.63121 + D.63131) is less than 30% and has an increasing tendency. In 2010 and in particular in 2011 government final consumption expenditure declined in absolute terms. In the long term, share of government consumption expenditure in GDP has oscillated around 21%.

Government final consumption expenditure (P.3) is broken down into individual (P.31) and collective final consumption expenditure (P.32). Such a split is done according to the (revised) ESA 1995 on the basis of COFOG 1999 for the years 2004 up to now. Due to some incomplete government data sources by function, approximation methods were developed for the years 1995–2003 using in particular the branch classification (NACE). These data have been then revised applying functional classification.

Government final consumption expenditure (P.3) by function, i.e. classified in 10 basic divisions which are further split up into 69 detailed groups, is available within the ESA 1995 transmission programme in the ESA 1995 table 11.[6] From this table can be derived individual (P.31) and collective final consump-

[6] The ESA 1995 table 11 includes not only government final consumption expenditure, but all government expenditures cross-classified by function (on a group level).

tion expenditure (P.32) as each of these 69 groups of government functions is by convention deemed either as individual or collective.

Table 2 shows government individual consumption expenditure on goods and services (P.31) by function (on a division level). These consumption expenditures relate to the following areas – health, recreation, culture and religion (but only for recreational, sporting and cultural services), education and social protection. Final consumption expenditure on research and development, general administration, regulation, dissemination of general information and statistics incurred in these areas are not included in the figures in Table 2 because they are treated as government collective consumption expenditure.

Table 2 Government individual consumption expenditure (P.31) by function, in CZK billion

	Relation	2006	2007	2008	2009	2010	2011
Health	1	172.3	187.0	198.9	219.6	222.1	226.1
Recreation, culture and religion	2	14.8	15.4	16.5	18.2	19.2	19.1
Education	3	136.8	141.1	145.4	151.1	149.8	147.3
Social protection	4	20.9	19.7	18.9	21.6	18.4	19.7
Individual consumption expenditure (P.31)	5 = 1 +...+ 4	344.8	363.2	379.6	410.5	409.5	412.1
Individual consumption expenditure (P.31), as percentage of GDP	6	10.3	9.9	9.9	10.9	10.8	10.7

Note: Individual consumption expenditure (P.31) equals social transfers in kind (D.63).
Source: Czech Statistical Office (ESA 1995 table 11, published 31.12.2012), own calculations

Table 3 Government collective consumption expenditure (P.32) by function, in CZK billion

	Relation	2006	2007	2008	2009	2010	2011
General public services	1	76.7	80.2	81.5	104.0	98.5	98.4
Defence	2	42.5	42.5	42.3	41.4	39.9	37.9
Public order and safety	3	74.5	78.9	82.7	84.0	84.9	78.5
Economic affairs	4	112.9	117.3	125.1	107.6	110.7	97.2
Environment protection	5	16.7	17.0	17.8	25.3	26.4	26.1
Housing and community amenities	6	7.1	7.1	7.8	11.3	12.1	11.5
Health	7	7.6	8.2	9.6	10.6	10.7	9.8
Recreation, culture and religion	8	2.0	2.1	2.6	3.4	3.1	2.9
Education	9	2.3	2.2	3.0	3.2	3.0	10.2
Social protection	10	7.0	7.2	7.5	8.1	8.5	8.4
Collective consumption expenditure (P.32)	11 = 1 +...+ 10	349.2	362.7	379.8	398.8	398.0	380.8
Collective consumption expenditure (P.32), as percentage of GDP	12	10.4	9.9	9.9	10.6	10.5	9.9

Note: Government collective consumption expenditure (P.32) equals government actual final consumption (P.4).
Source: Czech Statistical Office (ESA 1995 table 11, published 31.12.2012), own calculations

Table 3 then shows government collective consumption expenditure (P.32) by function (on a division level). First, collective consumption expenditure refers to general public services (e.g. legislative, financial, fiscal or external affairs, basic research), defense (e.g. military and civilian), public order and safety, economic affairs (includes e.g. transport, agriculture, commercial and labour affaires), environment protection, housing and community amenities, and also recreation, culture and religion (only for broadcasting, publishing, religious and other community services). Data for these areas include also consumption expenditure on research and development, general administration, regulation, dissemination of general information and statistics. Second, government collective consumption expenditure covers furthermore expenditure concerning health, education and social protection, but only as regards their research and development, general administration, regulation, etc. (see above).

Share of government individual (P.31) and collective consumption expenditure (P.32) in government consumption expenditure (P.3) is relatively stable and only slightly fluctuates around 50%. Amounts of government individual and collective consumption expenditure are currently not fully consistent in the ESA 1995 tables 2 and the ESA 1995 table 11, particularly for the years 1995–2003.[7] The data in the ESA 1995 table 11 for individual and collective consumption expenditure will be updated by the Czech Statistical Office in order to fully align with these breakdowns shown in the ESA 1995 table 2.

Table 4 captures the alternative presentation of government total expenditure (TE) for the Czech Republic, i.e. contains government final consumption expenditure (P.3). This presentation requires that an adjustment item is included in the breakdown of government total expenditure (its content is described in equation 10). Remaining current expenditures cover in particular social benefits other than social transfers in kind (D.62), which are paid to households usually in cash (e.g. pension, employment or sick leave benefits, etc.), furthermore, property income payable (D.4), especially interest payments (D.41), subsidies (D.3), other current transfers payable (D.7), other taxes on production (D.29) and taxes on income and wealth (D.5) payable by the general government sector.

Table 4 Government expenditure showing final consumption expenditure, in CZK billion

	Relation	2006	2007	2008	2009	2010	2011
Final consumption expenditure (P.3)	1 = 2 + 3	694.0	725.9	759.4	809.3	807.5	792.9
Individual (P.31)	2	344.8	363.2	379.6	410.5	409.5	412.1
Collective (P.32)	3	349.2	362.7	379.8	398.8	398.0	380.8
Adjustment	4	–56.7	–51.5	–53.3	–59.1	–64.6	–61.7
Taxes, payable (D.29+D.5)	5	3.2	3.6	2.6	2.2	2.5	3.1
Property income, payable (D.4)	6	35.4	39.9	39.5	47.5	51.1	52.6
Social benefits other than social transfers in kind (D.62)	7	408.0	456.3	476.8	509.3	517.8	526.9
Subsidies, payable (D.3)	8	60.2	60.8	62.3	74.7	71.3	79.8
Other current transfers, payable (D.7)	9	44.0	49.7	56.3	57.1	60.6	63.7
Capital transfers, payable (D.9)	10	119.3	78.5	104.3	89.9	91.9	87.1
Gross capital formation (P.5)	11	150.2	148.7	175.3	192.5	163.5	140.9
Net acquisitions of non-produced non-financial assets (K.2)	12	–50.7	–9.0	–39.7	–43.8	–39.9	–32.2
Government total expenditure (TE)	13 = 1 + 4 +…+ 12	1 407.0	1 503.1	1 583.5	1 679.6	1 661.8	1 653.2
Government total expenditure (TE), as percentage of GDP	14	42.0	41.0	41.1	44.7	43.7	43.0

Note: Transactions in D.4, D.7 and D.9 within each sub-sector and also between sub-sectors are consolidated (eliminated).
Source: Czech Statistical Office (ESA 1995 table 2, published 31.10.2012), own calculations

7 Total amounts of government final consumption expenditure (P.3) in the ESA 1995 table 2 and the ESA 1995 table 11 are consistent.

Capital expenditure covers capital transfers (D.9), gross fixed capital formation (P.5) dominated by gross fixed capital formation (P.51) and finally acquisitions less disposals of non-produced non-financial assets (K.2). The latter item includes e.g. transactions in land, but in the last few years particularly transactions in intangible non-produced assets like sales of radio spectra (UMTS licenses) or sales of emission permits.

It should be stressed that by convention government expenditure (TE) comprises disposals of non-financial assets which reduce government expenditure, sometimes to a great extent as it has been the case in the Czech Republic. Thus for the purpose of fiscal analysis it would be preferable to show large and well identifiable sales of non-financial assets (perceived by many economists as government revenue) as memorandum items in order to enable a proper assessment of the evolution of government expenditure. Sector accounts compiled by the Czech Statistical Office are very detailed and such information can be extracted from them. Unfortunately, these data are not available within the ESA 1995 transmission programme and thus EU countries cannot be compared in this respect.

Finally, elements of government final consumption expenditure (P.3) and government total expenditure (TE), shown in Table 1 and Table 4, are also provided by the Czech Statistical Office on a quarterly basis within the ESA 1995 transmission programme (the ESA 1995 table 25 – quarterly non-financial accounts of general government) and compiled regularly at T+3 months.

6 GOVERNMENT CONSUMPTION IN 2008 SNA AND ESA 2010

Changing economic environment, further research in national accounting and increasing needs of data users induced revisions of the national accounts standards. In 2009 the 1993 SNA was succeeded by the 2008 SNA. Also the European version of national accounts – the still valid ESA 1995 – will be replaced in 2014 by the forthcoming ESA 2010 (currently planned to be formally approved in 2013).

The definition of government final consumption expenditure in the 2008 SNA somewhat changed and newly includes non-market services provided by the central bank. This revision is linked to an agreement to show non-market output of the central bank which represents non-market services – in particular monetary policy services and possibly also supervisory services. As the 2008 SNA kept the convention that non-financial and financial corporations (including the central bank) do not have any final consumption, these non-market activities are considered as acquisitions of collective services by the general government sector and shown in the government accounts. Such a flow is then counterbalanced by a current transfer from the central bank to the general government sector. The ESA 2010 however did not accept this revision and thus it will methodologically differ from the 2008 SNA in this respect.

The 2008 SNA did not introduce any further split of non-market output and therefore, government consumption is defined in more general terms. In contrast, the ESA 2010 will keep the detailed classification of non-market output as it is deemed necessary for many purposes. Furthermore, both recent national accounts manuals simplified the classification structure of social transfers in kind (D.63) which are newly split up only into two basic items: social transfers in kind – non-market production (D.631) and social transfers in kind – purchased market production (D.632), similarly to the alternative presentation of social transfers in kind shown in Figure 1.

Constituents of final consumption expenditure will be affected by methodological revisions introduced in both national accounting systems. For example, the boundary of fixed assets was broadened in the 2008 SNA and the ESA 2010 and covers e.g. intellectual property rights (including research and development, databases, etc.) or weapons system. As a result, military expenditure on weapons systems (e.g. vehicles, aircrafts) as well as items delivered by these systems will be reclassified from intermediate consumption to gross fixed capital formation. Also research and development, which were previously treated as a part of intermediate consumption, will be recognized as gross fixed capital formation. Consumption of fixed capital will need to be estimated for all these newly included fixed assets. However, the ESA 2010 will apparently include a provision that reclassification of research and development will only be implemented once a sufficient degree of harmonization and reliability is achieved by EU countries.

During the preparation of the 2008 SNA, an extensive discussion took place on cost of capital services in relation to non-financial assets owned by government units (and other non-market producers). In the 1993 SNA as well as in the ESA 1995, services from assets used in non-market production were reflected solely in output as consumption of fixed capital, see equation 2. That means, no return to capital (opportunity cost of capital) as regards these assets was considered. In other words, the role of non-financial assets used in non-market production was not fully recognized, which is creating a conceptual inconsistency compared to market producers (for details see e.g. Harrison, 2004). To remove this inconsistency, it was discussed whether to replace consumption of fixed capital with capital services which are approximately equal to consumption of fixed capital plus return to capital. Regarding the general government sector, this treatment would imply an increase in government non-market production and consequently in government consumption. However, the cost of capital services for non-market producers was in the end included neither in the final version of the 2008 SNA nor in the ESA 2010. It was in particular due to expected problems with practical implementation and resistance of many European countries.

Last but not least, the institutional coverage of the general government sector will be reviewed to be consistent with some new or more detailed guidelines provided by the 2008 SNA and the ESA 2010. It is a crucial issue because any inclusion or exclusion of an institutional unit in/from the general government sector has an impact on government production and consumption as well as on government expenditure. Moreover, the ESA 2010 (similarly to the 2008 SNA) will finally provide a detailed discussion about the notion of a control by the government units of non-profit institutions and public corporations. Government control plays an important role in deciding whether a non-market institutional unit should be classified in the general government sector or not and thus more explicit guidelines for control may lead to reclassifications of institutional units in/out of the general government sector.

CONCLUSION

The concept of government final consumption expenditure in national accounts is an accounting convention which is not easily interpretable. The SNA manuals (both 1993 and 2008 versions) provide rather general guidance, while the ESA 1995 (since 2000) and the forthcoming ESA 2010 are more specific and define government final consumption expenditure on the basis of elementary transactions.

Government final consumption expenditure includes two basic elements. First, there is expenditure related to production of government non-market goods and services provided completely free (and derived residually). Such output cannot be practically shown as intermediate consumption or final consumption of other sectors. Valuation of non-market output is done indirectly i.e. by convention as a sum of production costs (in particular of wages and salaries, intermediate consumption and consumption of fixed capital), while any partial payments for non-market output are deducted. The second part of government final consumption expenditure is represented by goods and services purchased by the government units from market producers which are provided to households sector as social transfers in kind.

Derivation of government individual and collective consumption expenditure breakdowns is not described in detail in the national accounts manuals. It is a relatively complex statistical exercise, involving cross-classifications of all transactions, which are included in government final consumption expenditure, by functions of government (COFOG 1999) and represents, inter alia, an important element for compilation of actual consumption expenditure of the general government and households sector.

Concepts such as government final consumption expenditure (P.3), government total expenditure (TE) or government current expenditure have to be strictly distinguished as they are different in their scope, coverage of transactions as well as in respect of inclusion or exclusion of imputed flows.

Once the conventions used and elementary components (and their content) making up government final consumption are well understood, then the methodological revisions already carried out e.g. FISIM allocation or inclusions of new fixed assets in the calculation of consumption of fixed capital; or revisions planned in the context of the ESA 2010 implementation like for instance reclassification of some military expenditure or research and development, cease to be surprising for data users and their impact on the value of government output and consequently on the value of government final consumption expenditure become comprehensible.

REFERENCES

CZECH STATISTICAL OFFICE. *Government Expenditure by Function (Table 1100)* [online]. Prague: Czech Statistical Office. [cit. 31.12.2012]. <http://www.czso.cz/eng/redakce.nsf/i/government_expenditure_by_function_cofog_table>.

CZECH STATISTICAL OFFICE. *Gross National Income Inventory 2002* [online]. Prague: Czech Statistical office, 2006. <http://apl.czso.cz/nufile/GNI_CZ_en.pdf>.

CZECH STATISTICAL OFFICE. *Main Aggregates of the General Government Sector (Table 0200)* [online]. Prague: Czech Statistical Office. [cit. 31.10.2012]. <http://www.czso.cz/eng/redakce.nsf/i/main_aggregates_of_the_general_government_sector_table_0200_tab>.

EUROSTAT. *ESA 2010 Manual, Part I and Part II.* Draft 20 December 2010 (internal document).

EUROSTAT. *European System of Accounts: ESA 1995.* Luxembourg: Office for Official Publications of the European Communities, 1996. ISBN 92-827-7954-8.

EUROSTAT, IMF, OECD, UN, WB. *System of National Accounts 1993.* Brussels/Luxembourg, New York, Paris, Washington, D.C., 1993. ISBN 92-1-161352-3.

EUROSTAT, IMF, OECD, UN, WB. *System of National Accounts 2008.* New York, 2009. ISBN 978-92-1-161522-7.

HARRISON, A. *Measuring the Contribution of Non-financial Assets to Non-market Production* [online]. Paris: OECD, 2004. <http://unstats.un.org/unsd/nationalaccount/AEG/papers/m2assets.pdf>.

HRONOVÁ, S., FISCHER, J., HINDLS, R., SIXTA, J. *Národní účetnictví – nástroj popisu globální ekonomiky* (National Accounts – A Tool for Describing of the Global Economy), 1st ed. Prague: C. H. Beck, 2009. ISBN 978-80-7400-153-6.

LEQUILLER, F., BLADES, D. *Understanding National Accounts.* Paris: OECD, 2006. ISBN 92-64-02566-9.

ONDRUŠ, V., HELLER, J. *Historická ročenka národních účtů 1990–2010* (Historical Yearbook of National Accounts 1990–2010) [online]. Prague: Czech Statistical Office, 2012. <http://czso.cz/csu/2012edicniplan.nsf/publ/5013-12-n_2012>.

PŮLPÁNOVÁ, L. Trends in Selected General Government Expenditure by Function of EU Member States. *Statistics in Focus,* Luxembourg: Office for Official Publications of the European Communities, 2004, No. 43. ISSN 1024-4298.

UN. *Classification of Expenditure According to Purpose.* Statistical papers, Series M, No. 84, New York: United Nations, 2000. ISBN 92-1-161420-1.

UN. *Classification of the Functions of Government.* Statistical papers, Series M, No. 70, New York: United Nations, 1980.

VALENTOVÁ PŮLPÁNOVÁ, L. Co nabízí statistika vládních financí (Government Finance Statistics – What Does it Offer). *Statistika,* 2010, Vol. 90, No. 5, pp. 365–385. ISSN 0322-788x.

VALENTOVÁ PŮLPÁNOVÁ, L. *International Standards for Statistics on the Government Sector.* PhD dissertation, Prague: University of Economics, 2012.

VANOLI, A. *A History of National Accounting.* Amsterdam: IOS Press, 2005. ISBN 1-58603-469-3.

ZBRANEK, J., FISCHER, J. Dopad kapitalizace výdajů na výzkum a vývoj na makroekonomické agregáty (Impact of Capitalization of the Research and Development Expenses on the Macroeconomic Aggregates). *Statistika*, 2010, Vol. 90, No. 1, pp. 28–46. ISSN 0322-788x.

Wages of Czech Employees at the Beginning of the 3rd Millennium and the Impact of Economic Crisis on Wage and Income Development According to the Educational Attainment

Diana Bílková[1] | *University of Economics, Prague, Czech Republic*

Abstract

The paper deals with the development of wage distribution by the educational attainment in the Czech Republic in the years 2003–2010, examining forty wage distributions as the object of research and the gross monthly wage in CZK as the research variable. It analyses the development of the wage distribution in time and the gross monthly wage in relation to the level of educational attainment. It also pursues the development of a minimum wage in the monitored period. The author gives special attention to the lowest guaranteed wage levels classified according to wage classes and work capability assessment, comparing the minimum wage to that of subsistence. The forecasts of future wage distribution are an integral component of the research, the financial standing of Czech households being evaluated in an international context within the European Union.

Keywords

Wage distribution, stages of education, characteristics of wage location and differentiation, development of wage, forecasts of wage distribution, impact of economic crisis on wages

JEL code

J31, G01, H24, E24, D31, O15

INTRODUCTION

In the Czech Republic, the development of employees' wages in the last two decades made us pay greater attention to their level and differentiation. Since the transition from command to market economy, the

[1] Faculty of Informatics and Statistics, Department of Statistics and Probability, University of Economics, Nám. W. Churchilla 4, 130 67 Prague 3, Czech Republic. E-mail: bilkova@vse.cz, phone: (+420)224095484.

wage structure has changed, the level and differentiation increasing considerably. Groups of people with very high wages have increased in number and continue to grow markedly. When pursuing the development of wage differentiation, it has turned out that it is not enough to focus only on the evaluation of the current situation, estimating the future development on the basis of average wage classified according to various socio-economic, demographic and time-spatial aspects. It has proved useful to move from the level and differentiation characteristics to the entire frequency distribution. Estimates of the wage distribution development allow us to combine the wage differentiation of employees with socio-political aspects. It is not usually sufficient to estimate the level development of employees' wages, the compared numbers of workers with low, medium and high wages have to be estimated as well. The statistical analysis of employees' wages should form the basis for decisions in the state budget and social policy-making process. The direct relationship between the wages of employees and their purchasing power justifies monitoring of wage levels and their structure as well as the research of their distribution when tracking sales opportunities for products of both long- and short-term consumption. The distribution of wages should be, therefore, taken into account by entrepreneurs when they do market research. An estimate of the wage distribution supported by data indicating differentiation can determine the total amount of wages. The knowledge of the wage distribution of employees can be also used on other occasions, e.g. when setting the level of tax burden, etc.

Recently, many authors have dealt with the analysis of development and with modeling of wage and income distribution in the statistical literature, for example Bartošová and Bína (2007), Bílková (1995), Bílková (2012), Marek (2011), Malá (2011), Pacáková and Sipková (2007), Parker (1997) and more.

1 DATABASE

The article is divided into two parts. In the first part, the research variable is the gross monthly (nominal) wage in CZK monitored in the period between 2003 and 2010. This variable was studied in relation to the employees' educational attainment broken down into five levels of education: primary and incomplete, secondary without GCSE, secondary with GCSE, higher professional and undergraduate (first stage of tertiary) and graduate (second stage of tertiary) education. The necessary data were taken from the official website of the Czech Statistical Office. They are the data on sample sizes (see Table 1) and interval frequency distributions with extreme open intervals presented by the CSO website table "Percentages of employees in the bands of gross monthly wages by education". All calculations related to wages were based on the interval frequency distribution (incl. characteristics published by the Czech Statistical Office, calculated from the respective data) in order to ensure the comparability of the results obtained. The outcome accuracy can be compared from this perspective.

Table 1 Sample sizes of the wage distribution divided by the educational attainment

Stages of education	Year							
	2003	2004	2005	2006	2007	2008	2009	2010
Primary and incomplete	95 112	119 480	125 972	129 027	135 399	137 190	120 254	116 383
Secondary without GCSE	377 347	470 688	523 744	553 522	587 081	591 669	57 780	555 266
Secondary with GCSE	408 562	560 237	575 668	621 306	629 447	644 576	625 631	627 073
Higher professional and undergraduate	15 749	29 144	40 055	42 856	47 967	54 439	57 747	64 684
Tertiary (2nd stage)	122 164	224 947	250 088	267 661	273 604	283 937	290 094	299 423

Source: www.czso.cz

The Czech Statistical Office draws the information on gross monthly wage growth from two sources – business reports and structural statistics. The former provide reliable data on wages in the national economy that can be classified by different criteria such as sectors and group sizes, not enabling, however, a more detailed classification. Structural statistics, on the other hand, provide the most detailed information on wages of individual employees, using various ways of sorting, particularly in terms of employment.

The second part of the paper focuses on the comparison of Czech households' financial position with that of the EU member states households, the net annual household income per consumption unit (equalised income) in EURO being the research variable, i.e. the nominal income again. We used this variable for international comparisons within the European Union because of a uniform methodology of the EU-SILC statistical survey (Statistics on Income and Living Conditions) being employed across the EU. The monitored period is 2005–2010, as the data on the median income for almost all EU member states have already been available (except for Bulgaria and Romania). The variable was studied in relation to the educational attainment of the head of household. In two-parent (husband-and-wife) families, the head of household is always a man regardless of the economic activity. In single-parent families (one parent with children) and non-family households, whose members are related neither by marriage nor partnership or parent-and-child relationship, the first criterion for determining who is the head of household is the economic activity, the second one being the individual incomes of household members. The latter criterion also applies for more complex types of households. Small sample sizes where the head of household is female are observable, a man being the most common head of household. The conversion of income per consumption unit is used as it reflects the situation of households better than that of income per person. The following units can be used for the conversion purposes:

- a consumer unit defined by an OECD scale with the following coefficients: first adult in the household = 1, a person older than 13 years (other adults) = 0.7, another 13-year-old or younger child = 0.5;
- a consumer unit defined by an EU scale (a modified OECD scale) with the following coefficients: first adult in the household = 1, a person older than 13 years (other adults) = 0.5, another 13-year-old or younger child = 0.3.

In this research, the consumer unit defined by the EU scale was applied. The values of the median (middle income) by the educational attainment were obtained from an official Eurostat website, median income values having been used in an international comparison within the European Union. Information on sample sizes is, therefore, not required for the income distribution. We know from experience, however, that these sample sizes are much smaller (thousands at maximum) than those of the wage distribution. (The three stages of education – based Eurostat terminology – are: pre-primary, primary and lower secondary education; upper- and post-secondary [non-tertiary] education; first and second stage of tertiary education.)

Microsoft Excel spreadsheet and Statgraphics and SAS statistical programs were used for data processing. The Internet data were tested from two or three independent sources. Because the nominal wage and nominal income are researched, Table 2 gives some idea of the development of the average annual inflation in the period.

Table 2 Average annual inflation rate in the years 2003–2010 (in %)

	Year						
	2004	2005	2006	2007	2008	2009	2010
Inflation rate	2.8	1.9	2.5	2.8	6.3	1.0	1.5

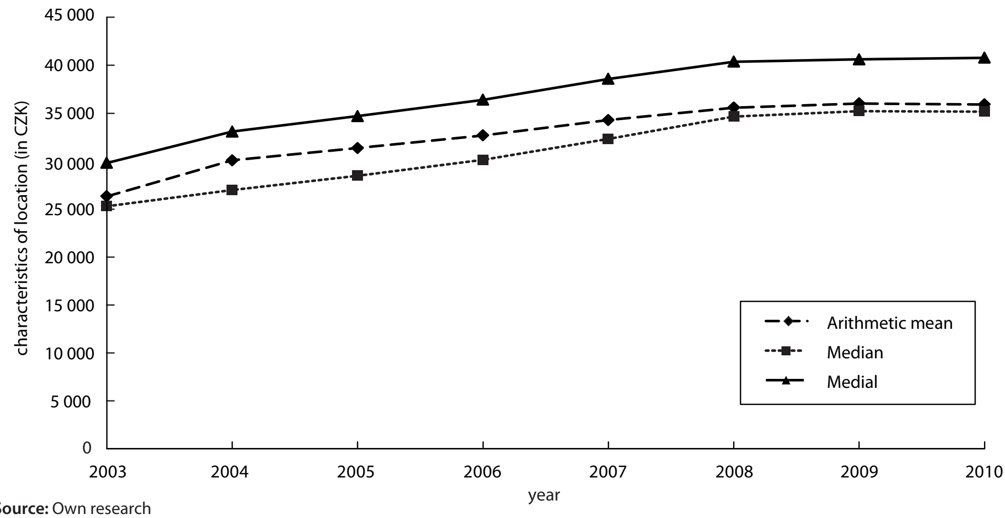
Source: www.czso.cz

2 DEVELOPMENT OF SAMPLE CHARACTERISTICS OF WAGE DISTRIBUTION

The construction of descriptive characteristics is explained in Triola (2003), or Bílková and Malá (2012). Sample characteristics of the location, variability and shape of the wage distribution were calculated in the research period.

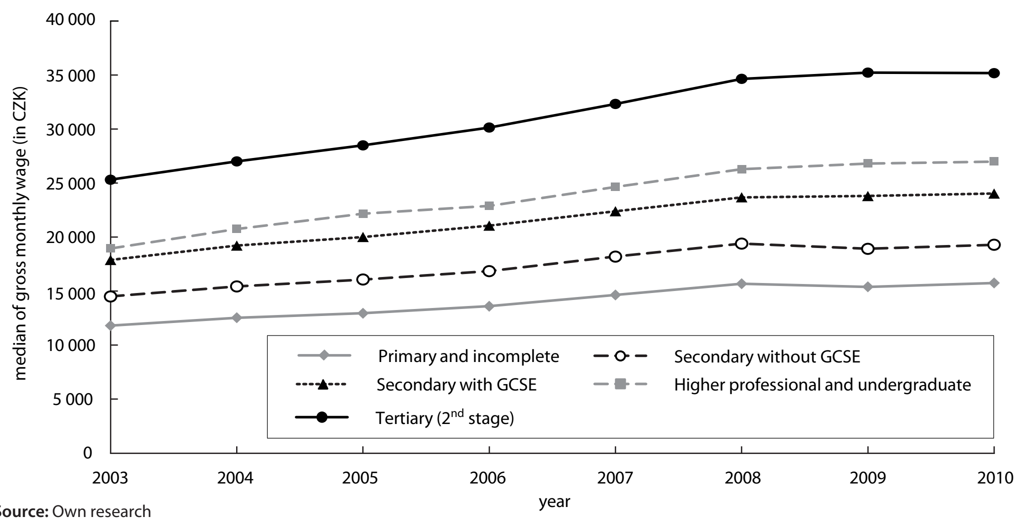
The arithmetic mean, median (middle wage) and medial represent the location characteristics. (The medial is a remarkable location characteristic; households with the wage lower or equal to the medial receive a half of the total wage in the sample, those with the wage higher or equal to the medial receiving the other half.) Figure 1 presents the development of the three location characteristics for tertiary education during the research period.

Figure 1 Development of characteristics of location of gross monthly wage (in CZK) in the years 2003–2010 for tertiary (2nd stage) education



Source: Own research

Figure 2 Development of median of gross monthly wage (in CZK) in the years 2003–2010 by the educational attainment



Source: Own research

It shows that for all researched wage distributions, the relation is valid. This relationship is typical of a positively skewed frequency distribution, the wage distribution being characterized exactly by positive skewness. The median is more often used as a wage location characteristic since the absolute majority of employees do not reach an average wage. The medial is a less frequent characteristic of the wage distribution level. Figure 2 presents the development of the median of the wage distribution according to the level of education completed.

It gives an overview of the impact of educational attainment on the level of wages. Well-marked differences in the level of wages by the educational attainment are apparent. It can be concluded that the wage level rises with an increasing level of education. It is not, however, a linear rise. The largest difference between the last two levels of education, i.e. between higher professional or undergraduate and (the second stage of) tertiary education, is significant. Tertiary-educated employees are paid by far the highest salaries, their wage levels being markedly different from other groups. In 2010, the middle wage of employees with tertiary education was more than CZK 8 000 higher than that of workers who received higher professional education or bachelor's degree, and almost 2.25 times higher than that of workers with primary or incomplete education. It is also evident from Figure 2 that during the financial crisis which began in autumn 2008, the growth of wages in the Czech Republic practically stopped in all categories of employees researched in this study. Table 3 presents the growth coefficients and average annual growth coefficients of the arithmetic mean and median of the gross monthly wage in the period 2003–2010 in the Czech Republic according to the educational attainment. In terms of both the arithmetic mean and median, we can see a much smaller average annual growth rate of wages in the period 2008–2010 than in 2003–2008. In economic recession, only a slight increase in wages of employees with different levels of education has been recorded. (Even tertiary graduates' level of wages decreased between the years 2009 and 2010, the wages of employees with primary or incomplete education and secondary education without GCSE having gone down between 2008 and 2009.) We observe the highest average annual growth rate for the entire monitored period in the category of higher professional and undergraduate education (the average wage increasing by an average of 5.3% and the middle wage by an average of 5.2% per year) and the lowest average annual growth rate in the category of primary and incomplete education (the average wage increasing by an average of 3.7% and the middle wage by an average of 4.2% per year, respectively). On the other hand, we do not see striking differences between various categories of educational attainment in the average annual growth rate. Table 4 presents the average and middle wage forecasts for 2011 and 2012 in relation to the educational attainment. These forecasts are based on the past development of the wage distribution during the years 2003–2010 (see Chapter 5).

Table 3 Growth coefficients and average annual growth coefficients of the arithmetic mean and median of gross monthly wage in the period 2003–2010 in the Czech Republic according to the educational attainment

Year	Stages of education completed									
	Primary and incomplete		Secondary without GCSE		Secondary with GCSE		Higher professional and undergraduate education		Tertiary (2nd stage)	
	Arithmet. mean	Median	Arithmet. mean	Median	Arithmet. mean	Median	Arithmet. mean	Median	Arithmet. mean	Median
2003	–	–	–	–	–	–	–	–	–	–
2004	1.009	1.062	1.044	1.064	1.082	1.074	1.121	1.095	1.142	1.067
2005	1.053	1.033	1.048	1.042	1.045	1.041	1.060	1.068	1.043	1.055
2006	1.086	1.050	1.062	1.048	1.052	1.052	1.045	1.032	1.042	1.058
2007	1.030	1.077	1.068	1.080	1.060	1.063	1.058	1.077	1.049	1.072
2008	1.077	1.071	1.070	1.066	1.061	1.058	1.064	1.066	1.038	1.072
2009	0.979	0.982	0.972	0.975	1.002	1.005	1.018	1.020	1.012	1.017
2010	1.027	1.023	1.020	1.020	1.006	1.010	1.006	1.007	0.997	0.999
Ø 2003–2008	1.051	1.058	1.058	1.060	1.060	1.058	1.069	1.068	1.062	1.065
Ø 2008–2010	1.003	1.002	0.996	0.997	1.004	1.007	1.012	1.013	1.005	1.008
Ø 2003–2010	1.037	1.042	1.040	1.042	1.044	1.043	1.053	1.052	1.045	1.048

Source: Own research

Table 4 Forecasts of the arithmetic mean (in CZK) and median (in CZK) for 2011 and 2012 based on the development in previous years

Stages of education	Arithmetic mean		Median	
	Year 2011	Year 2012	Year 2011	Year 2012
Primary and incomplete education	16 530	16 763	15 945	16 194
Secondary education without GCSE	20 367	20 473	19 113	19 163
Secondary education with GCSE	26 388	26 486	23 843	24 064
Higher professional and undergraduate education	29 759	29 849	26 673	26 746
Tertiary education (2nd stage)	35 708	35 014	33 434	33 384

Source: Own research

Sample characteristics of absolute and relative variability (both the standard deviation and the coefficient of variation) were calculated. From an interpretation perspective, the standard deviation indicates how particular gross monthly wage values deviate on average from their arithmetic mean. The standard deviation is constructed as a quadratic average of these deviations. The coefficient of variation is the ratio of standard deviation to the arithmetic mean, indicating (and usually expressed – when multiplied by a hundred – as) a percentage of standard deviation to the arithmetic mean. The characteristic of absolute variability – standard deviation – increased during the years 2003–2008, i.e. from the beginning of the research period until the beginning of the global economic crisis, in all given categories of educational attainment, with the exception of tertiary education. In the category of tertiary education, the standard deviation of wages rose sharply between 2003 and 2004 and then, having declined gradually till 2009, it increased slightly again between 2009 and 2010. As the characteristic of absolute variability changes over time, the data cannot be considered homoscedastic within the meaning of the same variability of distributions. The characteristic of relative variability – the coefficient of variation – also increased substantially between 2003 and 2004 for all given categories of educational attainment. In the following years, the coefficient of variation rather fluctuated, showing a slightly decreasing trend for all given categories of educational attainment with the exception of secondary education without GCSE. We can also observe from the shape characteristics of the distribution that all researched wage distributions are positively skewed, which is typical just for the wage distribution.

3 DEPENDENCE OF THE WAGE ON THE LEVEL OF EDUCATIONAL ATTAINMENT

Table 5 provides an overview of the wage differentiation in terms of intragroup and intergroup variability. We can see from this table that in the process of decomposition of total variability into intragroup and intergroup components, intragroup variability clearly dominates over intergroup variability (the source of the wage dependence on the educational attainment). Total variability represents the variability of wages of individual employees around the total average wage calculated together for all categories of educational attainment. Intragroup variability, on the other hand, is the variability of wages of individual employees around the average wage in a respective category of educational attainment, intergroup variability being the variability of average wages in various categories of education attainment around the total average wage calculated together for all categories of educational attainment. The sum of intragroup and intergroup variability yields total variability; i.e. the sum of average variance and the variance of averages is equal to total variance. As already mentioned above, the source of dependence of the wage on the level of educational attainment is the variability of average wages in various categories of educational attainment around the total average wage for all employees altogether. This means that the more intergroup variability contributes to total variability, i.e. the less intragroup variability contributes to total variability (the sum of intra and inter-group variability yielding total variability), the stronger the wage dependence on the level of educational attainment and vice versa. Thus, we can see from the decomposition of total variability into two individual components in Table 5 that the dependence of the wage on the level of educational attainment is not too strong in all monitored years.

Table 5 Total average (in CZK), variance components – intragroup and intergroup variance (both in CZK^2), total variance (in CZK^2), total standard deviation (in CZK) and the total coefficient of variation (in %)

Year	Total average	Average variance (intragroup)	Variance of averages (intergroup)	Total variance	Total standard deviation	Total variation coefficient
2003	17 938	41 563 482 73.71%	14 826 227 26.29%	56 389 708 100%	7 509	41.86
2004	19 943	71 110 787 72.33%	27 197 442 27.67%	98 308 230 100%	9 915	49.72
2005	20 884	73 917 878 71.19%	29 913 665 28.81%	103 831 543 100%	10 190	48.79
2006	22 052	78 945 914 71.98%	30 725 907 28.02%	109 671 820 100%	10 472	47.49
2007	23 221	86 807 711 71.89%	33 943 680 28.11%	120 751 391 100%	10 989	47.32
2008	24 694	91 773 158 73.05%	33 862 539 26.95%	125 635 697 100%	11 209	45.39
2009	27 101	99 768 934 72.51%	37 821 881 27.49%	137 590 815 100%	11 730	43.28
2010	25 130	92 616 356 71.69%	36 569 695 28.31%	129 186 051 100%	11 366	45.23

Source: Own research

Table 6 Hypothesis test about the independence of the gross monthly wage on the level of educational attainment

Year	Value of test criterion F	Critical value	Ratio of determination (in %)	P-value
2003	90 866	2.37193	26.29	0.00000
2004	134 292	2.37193	27.67	0.00000
2005	153 328	2.37193	28.81	0.00000
2006	157 079	2.37193	28.02	0.00000
2007	163 593	2.37193	28.11	0.00000
2008	157 906	2.37193	26.95	0.00000
2009	109 132	2.37193	27.49	0.00000
2010	164 142	2.37193	28.31	0.00000

Source: Own research

We can also conclude from Table 5 that the total standard deviation of wages (for all categories of educational attainment together) increased gradually from 2003 to 2009. A slight decline was recorded between 2009 and 2010. The characteristic of absolute variability of all employees' wages changes in time again. The total coefficient of variation representing the characteristics of relative variability increased markedly between 2003 and 2004, decreasing gradually until 2009. A slight increase was recorded between 2009 and 2010. We can still look at the development of the total average wage for all categories of employees altogether in Table 5. The average wage grew between 2003 and 2009, essentially in a linear way. Then it fell markedly between 2009 and 2010 probably due to the economic recession.

Table 6 is directly linked to Table 5 giving an overview of the statistical dependence of gross monthly wage on the educational attainment. Having applied a test analysis of variance known as ANOVA (one-factor), the above mentioned dependence was verified for each year of the period (see Roberts and Russo (1999), or Turner and Thayer (2001)).

In the test of ANOVA: H_0: Gross monthly wage does not depend on the level of educational attainment; H_1: Gross monthly wage depends on the level of educational attainment. Critical value is $F_{0.95}(k - 1; n - k)$ – i.e. 95 percent quantile of F-distribution with $\nu_1 = k - 1$ and $\nu_2 = n - k$ degrees of freedom, where k is the number of levels of educational attainment, which were considered ($k = 5$), n being the sample size, see Table 1. P-value is $P(F \geq F_{vyp})$ – i.e. probability that the random variable F having the F-distribution with $\nu_1 = k - 1$ and $\nu_2 = n - k$ degrees of freedom takes value at least equal to the calculated value of a test criterion.

The gross monthly wage dependence upon the educational attainment was demonstrated for virtually any commonly used significance level ($\alpha = 0.05$) with regard to large sample sizes typical for the research of the wage distribution. The critical value for a given number of five decimal places remains consistent in all years of the research period, probably due to large sample sizes used. The same is also valid for the so called P-value, which is the smallest significance level at which we can still reject the tested (null) hypothesis.

We can see from Table 6 that the values of test criterion F amply exceed the critical value in all cases. This is because such large sample sizes that are used in the case of wage distributions equate to a very high power of the test. Thus the test leads unambiguously to the rejection of the tested hypothesis, assuming the independence of wages on the level of educational attainment. The same conclusion has to be drawn from the comparison of P-value and the significance level. We can see from Table 6 that the significance level $\alpha = 0.05$ clearly exceeds the corresponding P-value in all cases. Let us add that the significance level α presents the probability of error of the first type, i.e. the probability that we reject the tested hypothesis (hypothesis of independence), although it is valid. It is evident from Table 6 that the tested hypothesis is rejected, using any significance level in this case ($\alpha = 0.10$ and even $\alpha = 0.01$). A one-way analysis of the variance test (known as ANOVA) clearly leads to the rejection of the tested hypothesis about the independence of the wage on the educational attainment. We can, therefore, conclude that the dependence of wages on the level of educational attainment is proved with 5% (as well as 1%) risk of error. Or, the dependence of the wage on the level of educational attainment is statistically significant at a 5% (as well as 1%) significance level. The ratio of determination then gives the intensity of dependence, i.e. the share of intergroup and total variability. It can take its value from the interval

The closer to one is the value of ratio of determination, the stronger the dependence and vice versa. The determination ratio is presented in percentage terms (when multiplied by a hundred), taking values from the interval The dependence of the wage on the level of educational attainment has been proved. From Table 6 we can see, however, that it is a considerably weak intensity dependence. The values of the ratio determination range from 26.29% to 28.81%.

4 MINIMUM WAGE

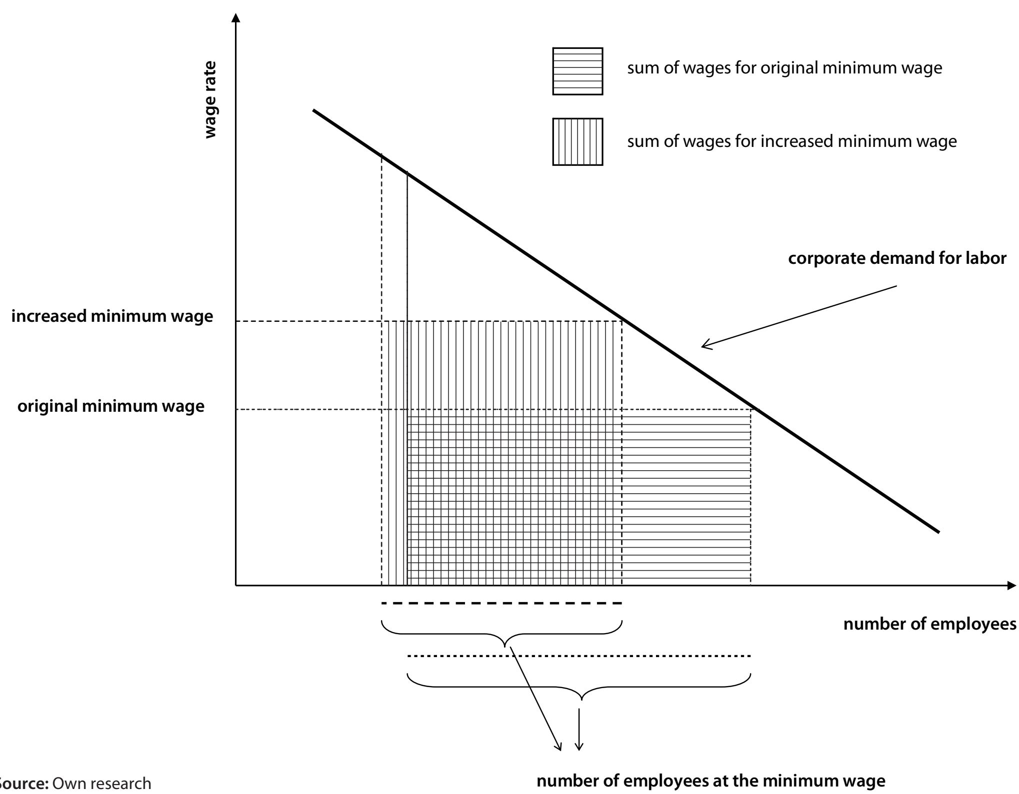
In statistical calculations, the first percentile is conventionally used as a characteristic of the minimum wage, the 99th percentile being then used as a characteristic of the maximum wage. The first decile is used to define low wages (those less or equal to the first decile), the 9th decile being then used for the definition of high wages (those at least equal to the ninth decile). The legislation, however, is different, the minimum wage being set by law.

The wage distribution is strongly influenced by the minimum wage. Workers' wages would presumably decline if the minimum wage was reduced or even abolished. The changes are naturally reflected in characteristics of the location, variability and shape of the wage distribution.

Fixing the minimum wage is a special case of price regulation. If the established minimum wage was lower than all market wages, the arrangement would have no effect. It is unlikely anyway. The minimum wage is fixed at a higher level than some market-set wages. This would affect those workers whose wages would otherwise be below the minimum wage. Their employers belong apparently to another affected group. If workers receive wages as a marginal product of labor before the implementation of minimum wage legislation, the introduction of the minimum wage may lead to reduction in their employers' profits. Under otherwise identical circumstances, the employer can increase the profit by making these workers redundant. The firm does not have to dismiss all the workers whose wages were initially below the minimum wage. It would be sufficient if such a number of workers were dismissed so that the marginal product of labor could increase to the minimum wage at least.

Finally, the growth of a relative price of goods results in the firm not having to reduce the number of workers to the point where their marginal product would correspond to the minimum wage at original prices. The introduction of the minimum wage leads to some redundancies of workers in a particular sector. This, however, results in an increase of the real value of wages in given sectors at the expense of real wages in other sectors. Table 7 presents the development of general rate of unemployment (in %), the number of job seekers registered and the number of vacancies in the years 2003–2010. Figure 3 presents the effect of minimum wage increasing to the number of workers employed.

Figure 3 Effect of minimum wage increasing to the number of workers employed



Source: Own research

Table 7 Development of general rate of unemployment (in %), the number of job seekers registered and the number of vacancies in the years 2003–2010

Year	2003	2004	2005	2006	2007	2008	2009	2010
General rate of unemployment	7.8	8.3	7.9	7.1	5.3	4.4	6.7	7.3
Number of job seekers registered	542 420	541 675	510 416	448 545	354 878	352 250	539 136	561 551
Number of vacancies	40 188	51 203	52 164	93 425	141 066	91 189	30 927	30 803

Source: www.mpsv.cz, www.czso.cz

Real wages of workers who receive the minimum (or nearly minimum) wage would probably decrease if it was reduced or completely abolished. Firms would hire new workers with a lower marginal product of labor and the price of goods would also decline. As a result, the conditions of current workers would deteriorate. Trade unions usually stand for this group of low-income workers, opposing minimum wage cuts. Employers and enterprise owners, on the other hand, are against (raising) the minimum wage as it lowers their profits. Political parties differ in their approach to the implementation and existence of the minimum wage, depending on which side of the political spectrum they represent.

Interaction between the minimum wage and social benefits is important. When deciding on the supply of labor for a given minimum-wage, workers have to compare the minimum wage with the amount of unemployment (or other social) benefits they would receive if they did not work. An increase of the minimum wage would make the difference between the wages and benefits bigger. That would lead to a new (higher) minimum wage of some previously unemployed people and a decline in the unemployment rate due to the minimum wage increase. This, however, does not explain why new jobs should be created. If no new jobs are created, some voluntarily unemployed people would just become involuntarily unemployed.

There are some measures taken in order to prevent wage increases, wage control being one of them. It is an extreme economic-political arrangement made only exceptionally by the governments in market economies.

The minimum wage is the lowest permissible level of remuneration an employer must pay to employees for their work. Its basic legal provision can be found in the Labor Code. The minimum wage applying to all employees or people hired on the basis of a work contract. Table 8 indicates the development of a minimum gross monthly wage in the years 2003–2010. It is evident from the table that the minimum wage has not changed since 2007, having stayed at CZK 8 000.

Table 8 Minimum gross monthly wage (in CZK) for a forty-hour working week [1) from 1 January 2006 to 30 June 2006, 2) from 1 July 2006 to 31 December 2006]

Year	2003	2004	2005	2006	2007	2008	2009	2010
Minimum wage	6 200	6 700	7 185	7 570 [1)] 7 955 [2)]	8 000	8 000	8 000	8 000

Source: www.mpsv.cz

The minimum wage concept is associated with some common misinterpretations. It seems obvious that the remuneration cannot be lower than CZK 8 000 per month (or CZK 48.10 per hour), i.e. the amount provided by government. However, a lot of people are unaware of the fact that most employees receive much higher minimum. This is the guaranteed wage, i.e. minimum tariffs for different groups of workers. The minimum wage, in fact, forms a real basis valid for the least skilled workers. Higher rates – the so called guaranteed wage levels – are crucial for most employees. There are higher levels of minimum wages for specific occupations. The guaranteed wage has eight levels set by the Government Regulation No. 567/2006 Sb. They are known as the previous "minimum wage tariffs" or "wage groups". Different levels are distinguished by the complexity, responsibility and strenuousness of work from the least-skilled and worst-remunerated work (the first group) to the most-qualified and best-paid (the eight group), see Table 9. The table provides an overview of minimum levels of the guaranteed wage for the given weekly working time of 40 hours graded according to the complexity, responsibility and strenuousness of work done, valid in 2012. The minimum amount set for the lowest group equals the minimum wage, other groups receiving a higher amount.

Table 9 Current minimum levels of guaranteed wage for the given weekly working time of 40 hours graded according to the complexity, responsibility and strenuousness of work performed – classified into eight income brackets (in CZK)

	Group work	Hourly wage	Monthly wage
1	Work in the first and second grade	48.10	8 000
2	Work in the third and fourth grade	53.10	8 900
3	Work in the fifth and sixth grade	58.60	9 800
4	Work in the seventh and eighth grade	64.70	10 800
5	Work in the ninth and tenth grade	71.50	12 000
6	Work in the eleventh and twelfth grade	78.90	13 200
7	Work in the thirteenth and fourteenth grade	87.10	14 600
8	Work in the fifteenth and sixteenth grade	96.20	16 100

Source: http://business.center.cz

In practice, remuneration may not be lower than the wage guaranteed for particular jobs by the government. This applies not only to people in employment, but also to employment agreements or contracts for work; no matter whether it is a contract for a fixed or indefinite period. It is not relevant either whether it is just a second job or an extra income. The entitlement to the minimum wage arises independently in such a case. All levels of the minimum (guaranteed) wage apply to all private entrepreneurs, the system of sixteen wage tariffs being applicable to a non-business sphere as well.

Table 10 Current gross minimum wage rates for workers with limited work ability

Percentage of the basic amount of gross monthly minimum wage	Limited work ability reasons
90% that is 7 200 CZK monthly, i.e. 43.30 CZK hourly	the first employment of a person aged from 18 to 21, namely a period of six months from the start of the employment
80% that is 6 400 CZK monthly, i.e. 38.50 CZK hourly	a young employee
75% that is 6 000 CZK monthly, i.e. 36.10 CZK hourly	an employee who receives a partial disability pension
50% that is 4 000 CZK monthly, i.e. 24.10 CZK hourly	an employee who receives a full disability pension, or a young employee who is totally disabled and is not entitled to a full disability pension

Source: http://business.center.cz

Table 10 presents current gross minimum wage rates for those with limited work ability in 2012. A monthly rate of the minimum (guaranteed) wage allows for a weekly working time of 40 hours. If an employee negotiates shorter working hours, the minimum wage is reduced in proportion to his/her real hours of work. If this is the first employment of a person aged from 18 to 21, the corresponding minimum is reduced to 90 per cent, see Table 10. The reduction, however, is valid only in the first six months after the conclusion of the first employment contract. Juvenile employees who are under eighteen years of age are entitled to only 80 per cent of the corresponding minimum. The minimum is reduced for people receiving partial or full disability pension to 75 and 50 per cent respectively.

If in a particular calendar month the wage is lower than the minimum, the employer has to pay it up to the given minimum regardless of whether the employee him/herself has caused a poorer performance. It should be pointed out that various premiums (for overtime, holidays, weekends, night work, etc.) and wage compensations (including travel expenses and remuneration for operating emergency cases) are not included in the mentioned monthly amount.

Various social benefits are related to the minimum wage. The subsistence wage is a socially recognized amount of money covering basic personal needs. The subsistence level fulfills a crucial role in measuring material poverty and as a socio-protective value. A basic subsistence does not include the necessary housing costs that are covered by housing allowances. Jointly assessed persons are: parents and dependent minors (children under 15); a husband and wife or registered partners; parents and children (both minors and adolescents) if they share an apartment with parents and are not raised by other people; other persons sharing an apartment (if they do not supply evidence of neither living nor covering costs of living together permanently). Table 11 shows the subsistence monthly wages valid in the Czech Republic in 2011 and 2012.

Table 11 Current subsistence amounts valid in the Czech Republic (in CZK) per month

Type of household in terms of its members		From 1 January 2007 to 31 December 2011	From 1 January 2012
For individuals		3 126	3 410
For the first adult in the household		2 880	3 140
For the second and other adults in the household		2 600	2 830
For a dependent child aged up to:	6 years	1 600	1 740
	15 years	1 960	2 140
	26 years	2 250	2 450

Source: http://portal.mpsv.cz

5 FORECASTS OF WAGE DISTRIBUTIRON

Table 12 presents the forecasts of wage distribution according to the stages of education completed for 2011 and 2012. It shows the percentages of employees in the bands of gross monthly wages (in CZK) calculated on the basis of the development of wage distribution between 2003 and 2010, including the period of the global economic crisis since autumn 2008.

The process of these calculations is not presented here in detail. The three-parametric lognormal probability distribution has been used here as a theoretical distribution, see Bartošová (2006), and Kleiber and Kotz (2003). It is one of the most widely used probability distributions in wage and income modeling. A lesser-known method, the L-moments method, is employed to estimate parameters of this theoretical distribution, see Hosking (1990) and Kyselý and Picek (2007). The advantages of this method of parameter estimation in terms of its accuracy are indisputable. L-moments are linear functions of data, thus being more resistant to the influence of sampling variability. They are more robust than conventional moments, being resistant to the existence of outliers in data and enabling better conclusions on basic probability distribution (even in the case of small samples). L-moments sometimes bring even more efficient parameter estimations of parametric probability distributions than the estimates made by a maximum likelihood method. It has been proved in practice that L-moments are less prone to the bias of estimation compared to conventional moments, an approximation by asymptotic normal distribution being more accurate in final samples.

Table 12 Forecasts of wage distributions for 2011 and 2012 according to the educational attainment – proportions of employees (in %) in the bands of gross monthly wage (in CZK)

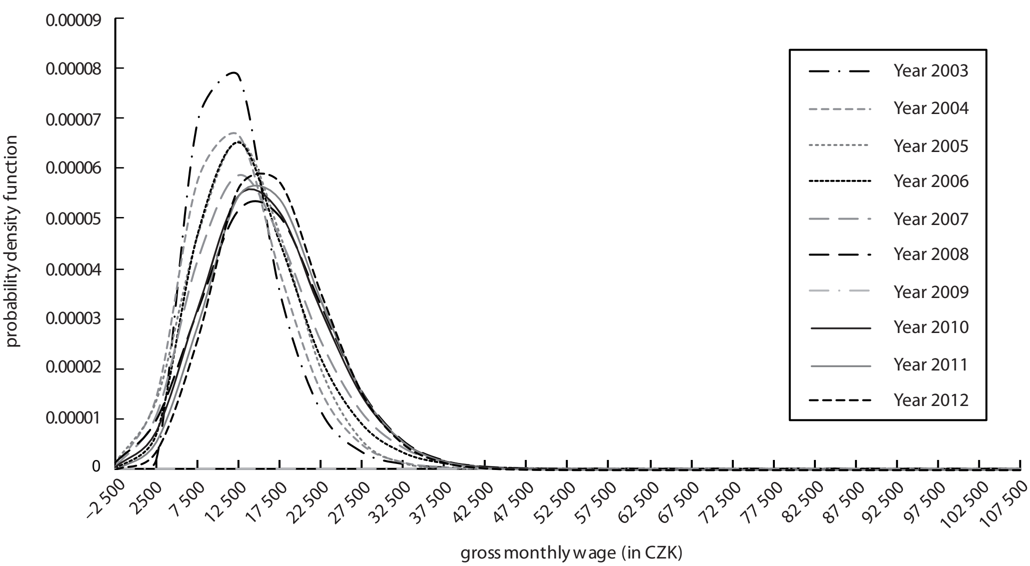
		Stages of education									
		Primary and incomplete education		Secondary education without GCSE		Secondary education with GCSE		Higher professional and undergraduate education		Tertiary (2nd stage) education	
Interval	Year	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
0 –	5 000	3.42	2.35	0.38	0.23	0.00	0.00	0.00	0.00	0.00	0.00
5 001 –	10 000	14.44	13.14	6.94	6.32	0.00	0.00	0.00	0.00	0.00	0.06
10 001 –	15 000	26.68	27.26	20.93	21.04	6.25	5.11	0.45	0.44	0.13	1.14
15 001 –	20 000	26.53	28.02	26.19	26.65	24.01	23.49	15.68	15.49	3.65	5.67
20 001 –	25 000	16.96	17.64	20.62	20.79	24.93	25.73	26.07	25.95	13.12	12.79
25 001 –	30 000	7.87	7.84	12.56	1.54	17.60	18.31	20.81	20.82	19.56	17.80
30 001 –	35 000	2.89	2.71	6.59	6.57	10.93	11.28	13.71	13.77	19.22	18.23
35 001 –	40 000	0.89	0.78	3.18	3.17	6.51	6.61	8.56	8.62	15.20	15.24
40 001 –	45 000	0.24	0.20	1.45	1.47	3.84	3.83	5.29	5.34	10.68	11.10
45 001 –	50 000	0.06	0.05	0.65	0.66	2.28	2.23	3.29	3.33	7.01	7.35
50 001 –	55 000	0.02	0.01	0.28	0.30	1.37	1.31	2.08	2.10	4.42	4.55
55 001 –	60 000	0.00	0.00	0.12	0.13	0.83	0.78	1.33	1.35	2.73	2.68
60 001 –	65 000	0.00	0.00	0.05	0.06	0.51	0.48	0.87	0.88	1.67	1.53
65 001 –	70 000	0.00	0.00	0.04	0.04	0.32	0.29	0.57	0.58	1.01	0.85
70 001 –	75 000	0.00	0.00	0.02	0.02	0.21	0.18	0.39	0.39	0.62	0.47
75 001 –	80 000	0.00	0.00	0.00	0.01	0.13	0.12	0.26	0.27	0.37	0.25
80 001 –	85 000	0.00	0.00	0.00	0.00	0.09	0.08	0.18	0.19	0.23	0.14
85 001 –	90 000	0.00	0.00	0.00	0.00	0.06	0.05	0.13	0.13	0.14	0.07
90 001 –	95 000	0.00	0.00	0.00	0.00	0.04	0.04	0.09	0.09	0.09	0.04
95 001 –	100 000	0.00	0.00	0.00	0.00	0.03	0.03	0.06	0.07	0.05	0.02
100 001 –	105 000	0.00	0.00	0.00	0.00	0.02	0.02	0.05	0.05	0.04	0.01
105 001 –	110 000	0.00	0.00	0.00	0.00	0.02	0.02	0.03	0.04	0.03	0.01
110 001 –	115 000	0.00	0.00	0.00	0.00	0.01	0.01	0.03	0.03	0.01	0.00
115 001 –	120 000	0.00	0.00	0.00	0.00	0.01	0.00	0.02	0.02	0.01	0.00
120 001 –	125 000	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.01	0.00
125 001 –	130 000	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00
130 001 –	135 000	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00
135 001 –	∞	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total (in %)		100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Source: Own research

The first three sample L-moments were calculated from sample data, see Hosking, (1990). The method of L-moments was used to estimate the parameters of theoretical lognormal distribution. The values of Gini's coefficient were calculated having used these estimated parameters of lognormal distribution. The sum of all absolute deviations of the observed and theoretical frequencies of all intervals was used when evaluating the accuracy of the parameter estimation methods (moment, quantile, maximum likelihood and L-moments methods). The method of L-moments provides the most accurate results (other methods' outcomes are not listed here). The values of a well-known chi-square criterion were also calculated for each wage distribution. The problem is that for large samples, which are common in case of wage distributions, the power of the test is too high (for a given significance level), uncovering even the smallest differences between the observed and theoretical distribution. The test leads in almost every case to the rejection of the hypothesis about the tested distribution. From a practical point of view, however, negligible differences are not important, an approximate correspondence of the model with realities being sufficient. In these cases, we just "borrow" the model distribution. The chi-square criterion is applied only for indicative purposes, the most important aspect being the logical analysis and experience.

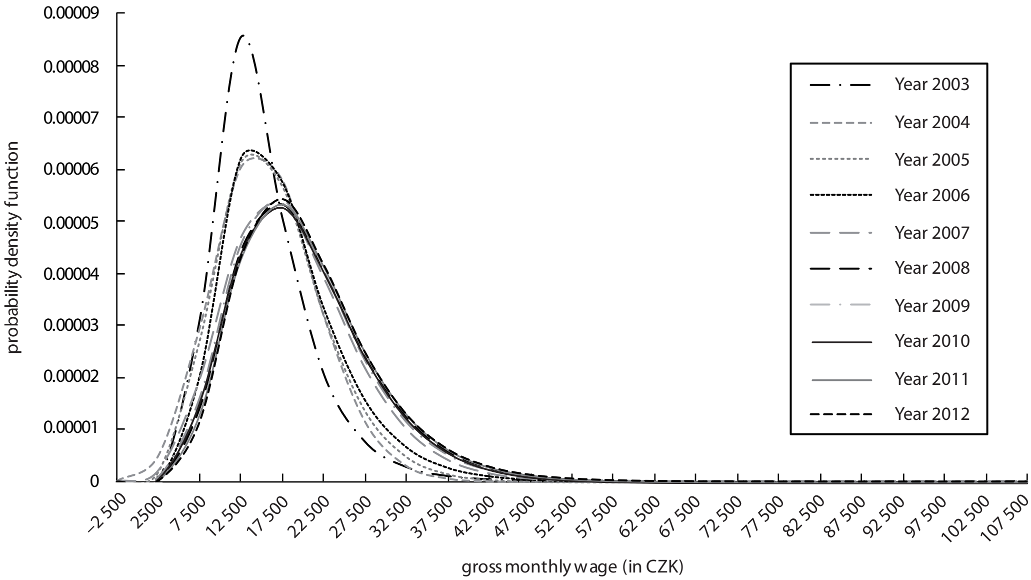
A trend analysis of the development of the first three sample L-moments in the period of 2003–2010 has been performed, see Brockwell and Davis (2002) and Cowpertwait and Metcalfe (2009). Having been based on the trend analysis, the forecasts of the first three sample L-moments development for the years 2011 and 2012 were calculated. Having been based on the forecasts of the first three sample L-moments with the use of the L-moments method, the values of parameters of three-parametric lognormal distribution for 2011 and 2012 were constructed. The values of Gini\s coefficient were computed from the above parameter values for 2011 and 2012. Figures 4–8 present the development of model probability density functions of three-parametric lognormal distribution in the years 2003–2010, including the predictions for 2011 and 2012 by the educational attainment. These figures suggest that the development of probability density functions in the years 2011 and 2012 follows continuously the development in the years 2003–2010. The obtained predictions of wage distribution appear to be very accurate from this point of view, too.

Figure 4 Probability density function including the predictions by the educational attainment – Primary and incomplete



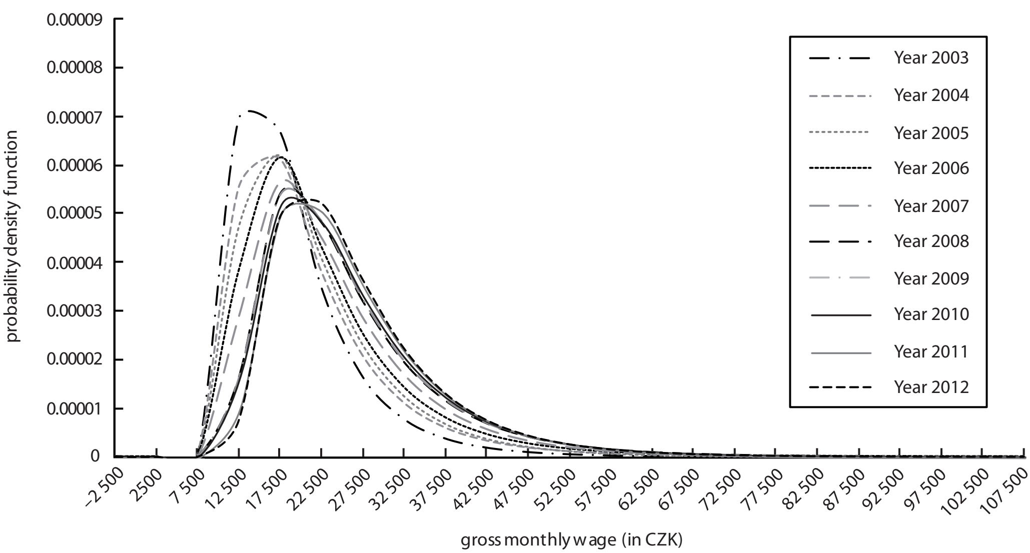
Source: Own research

Figure 5 Probability density function including the predictions by the educational attainment – Secondary without GCSE



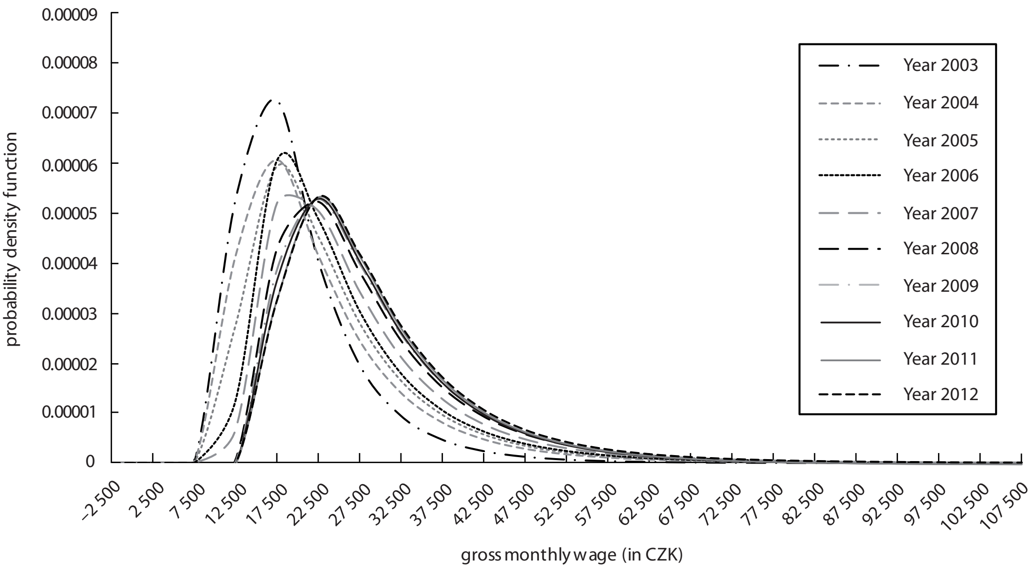
Source: Own research

Figure 6 Probability density function including the predictions by the educational attainment – Secondary with GCSE



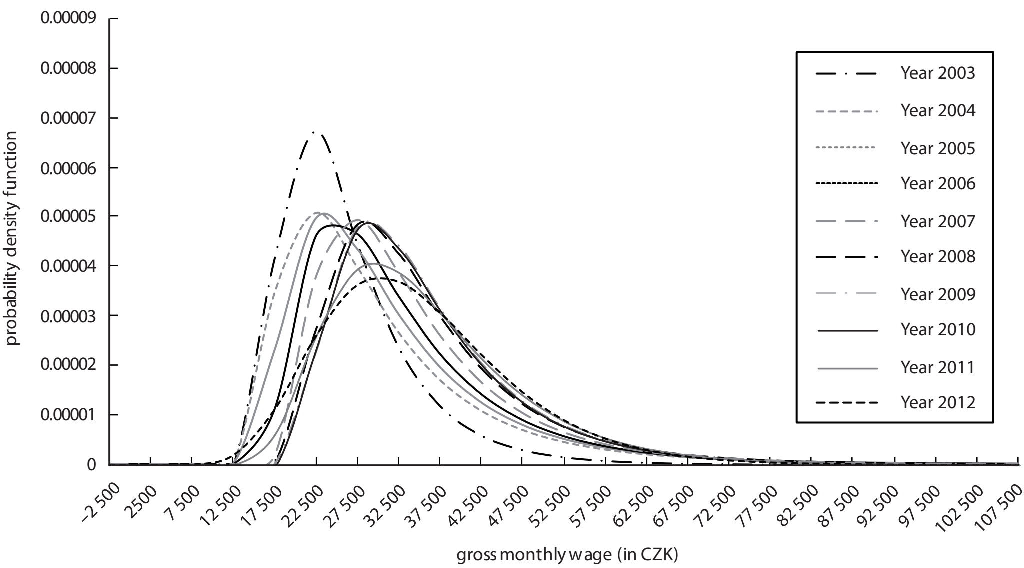
Source: Own research

Figure 7 Probability density function including the predictions by the educational attainment – Higher professional and undergraduate



Source: Own research

Figure 8 Probability density function including the predictions by the educational attainment – Tertiary (2nd stage)



Source: Own research

The forecasts of wage distribution according to level of educational attainment for 2011 and 2012 (in Table 12) were constructed from the probability density functions of three-parametric lognormal distribution calculated for 2011 and 2012.

The values of the arithmetic mean and median in 2011 and 2012 by the stages of education in Table 4 were also calculated from the model three-parametric lognormal curves computed for 2011 and 2012. Of course, we could have created a direct projection of an arithmetic mean and median development for 2011 and 2012 based on the development of these characteristics in the period 2003–2010. The advantage of the procedure used in this research lies in the fact that the predictions of any characteristics of wage distribution, having a theoretical basis in one distribution, can be calculated from those of wage distribution in Table 12. It is not, therefore, a separate research of the development of individual characteristics of wage distribution. Table 13 provides an overview of the differences between the arithmetic mean and median, including the forecasts. We can see from this table that these differences were likely to be greater in 2011 and 2012 compared to previous years. This means that the increasing skewness in the wage distribution can be expected. The average wage is receding from the middle wage, which remains at a lower level. A higher proportion of employees does not reach the growing average wage (with the exception of those with tertiary education); this trend being probably fuelled by the growth of extreme wages (the middle wage not being affected). It should be noted that both the periods of economic recession and previous economic growth are taken into consideration in this research; it cannot be expected, however, that the global economic crisis will last forever. It is necessary, therefore, to allow for some improvements in the area of wages and incomes in the future.

Table 13 Differences between the arithmetic mean and median (in CZK)

Year	Primary and incomplete education	Secondary education without GCSE	Secondary education with GCSE	Higher professional and undergraduate education	Tertiary (2nd stage) education
2003	697	638	1 298	1 443	1 032
2004	82	377	1 541	2 121	3 081
2005	338	491	1 680	2 089	2 877
2006	836	738	1 749	2 463	2 548
2007	219	582	1 781	2 163	1 973
2008	318	701	1 960	2 251	946
2009	265	618	1 890	2 231	794
2010	341	633	1 819	2 236	749
2011	585	1 254	2 545	3 086	2 274
2012	569	1 310	2 422	3 103	1 630

Source: Own research

6 INTERNATIONAL COMPARISON WITHIN THE EUROPEAN UNION

The income is the variable strongly correlating with that of wage. The variable of income is thus used to compare the development of financial position of households in the Czech Republic with those in other EU countries. It is consistent with a uniform methodology employed in all EU countries when carrying out surveys and personal income calculations. The research variable is net annual household income per consumption unit in EURO (not per capita; the differences consisting in calculations applied – the methodology of the EU conversion having been employed in the research). The conversion to a consumer unit is used here as it is likely to reflect the situation of households better than the conversion per capita as a result of quantity savings.

Figure 9 represents the current states of the European Union. The original "European Twelve" (comprising Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Luxemburg, the Netherlands, Portugal, Spain and the United Kingdom) enlarged by three countries (Austria, Finland and Sweden) in 1995; the development of income distribution in the Czech Republic being compared with that of the "European Fifteen". Further EU enlargements brought in Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia in 2004 and Bulgaria and Romania in 2007; Croatia, Iceland, Macedonia and Turkey being the current EU candidates.

Figure 9 Current European Union member states

Source: http://en.wikipedia.org

Table 14 presents the development of the median of net annual income per consumption unit (nominal income) in the EU states in the years 2005–2010. The year 2005 was chosen as a starting point of the income time series as the first sample SILC survey was carried out in the Czech Republic then. The twelve new EU member states having acceded since 2000 (mostly post-communist states of the former Soviet block) are marked in dark.

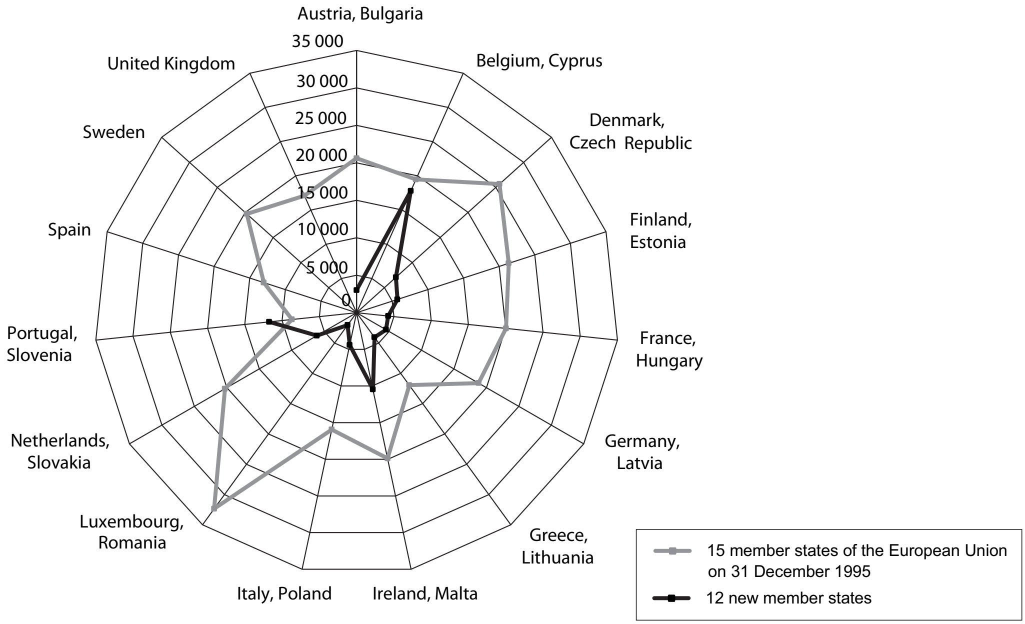
Figure 10 represents the median of net annual household income per consumption unit in 2010 for all current EU countries, the fifteen original members (having joined the EU by 31 December 1995) and twelve new member states. Their low net annual income, in comparison with the fifteen original member states, is clearly evident from the above mentioned figure. It can be calculated from Table 14 that the 2005 median net annual income in new EU member states accounted for about 19.45% of that of the fifteen original members, this share developing to around 21.28%, 19.64%, 22.38%, 26.36% and 23.61% in 2006, 2007, 2008, 2009 and 2010, respectively. Eurostat data on new EU members, however, have been available only since 2005 (with the exception of Bulgaria and Romania).

Table 14 The median of net annual household income per consumption unit (in EURO) in 2005–2010

EU Country	Year					
	2005	2006	2007	2008	2009	2010
European Union (all 27 countries)	13 613	13 617	13 885	14 598	14 626	14 748
European Union (15 countries) Member states on 31 December 1995	15 396	15 527	16 530	17 281	17 292	17 516
European Union (12 countries) New member states	2 994	3 304	3 246	3 868	4 558	4 135
Austria	18 001	17 854	18 156	19 011	19 886	20 618
Belgium	16 581	17 213	17 566	17 985	19 313	19 464
Bulgaria	–	1 384	1 481	2 171	2 828	3 016
Cyprus	13 157	14 536	16 014	16 765	17 432	17 780
Czech Republic	4 233	4 802	5 423	6 068	7 295	7 058
Denmark	22 124	22 663	23 341	24 161	25 029	25 668
Estonia	2 980	3 639	4 448	5 547	6 209	5 727
Finland	17 496	18 345	18 703	19 794	20 962	21 349
France	15 946	16 209	16 441	18 984	19 760	20 046
Germany	16 393	15 663	17 697	18 309	18 586	18 797
Greece	9 417	9 850	10 000	10 800	11 496	11 963
Hungary	3 447	3 849	3 936	4 400	4 739	4 241
Ireland	18 798	19 757	22 065	22 995	22 445	19 882
Italy	14 352	14 524	15 011	15 639	15 637	15 937
Latvia	2 204	2 534	3 242	4 832	5 474	4 537
Lithuania	2 058	2 534	3 276	4 169	4 815	4 059
Luxembourg	28 396	29 480	29 892	30 917	31 764	32 333
Malta	8 578	9 039	9 302	10 054	10 654	10 458
Netherlands	17 000	17 263	18 244	19 522	20 156	20 292
Poland	2 533	3 111	3 502	4 155	5 097	4 405
Portugal	7 195	7 311	7 532	8 143	8 282	8 678
Romania	–	–	1 658	1 953	2 162	2 037
Slovakia	2 830	3 313	3 880	4 792	5 671	6 117
Slovenia	8 797	9 317	9 907	10 893	11 864	11 736
Spain	10 600	11 480	11 939	12 950	13 300	13 030
Sweden	17 498	17 991	18 845	20 573	21 248	19 709
United Kingdom	18 540	19 495	21 143	18 923	16 262	17 106

Source: http://epp.eurostat.ec.europa.eu

Figure 10 Median of the net annual household income per consumption unit in 2010 (in Euro) – Total set



Source: Own research

It is obvious that the population (nominal) incomes in new EU member states are still almost five times lower than those in the "European Fifteen" countries, the three exceptions among the newly accepted countries being Cyprus Malta and Slovenia whose median net annual income is markedly higher, as indicated in Figure 10. Taking into account only an income factor of the living standard in 2010, it can be deduced from Table 14 and Figure 10 that the best-paid population is in Luxembourg, followed by Denmark, Finland, Austria, the Netherlands and France. (In 2010, the order was slightly different: Luxembourg, Denmark, Ireland [despite notorious financial problems], Sweden, Finland, and the Netherlands.)

Let us not forget, however, that this only refers to the nominal income. Financial problems of Greece, Ireland, Spain and Portugal are widely debated today. From Table 14 and Figure 10 we can conclude that the population of Portugal, Greece and Spain is the least affluent of the original fifteen EU states. The net annual household income per consumption unit decreased both in Ireland (sharply) and in Spain (slightly) between 2009 and 2010. As for the new EU members, Cyprus, Slovenia, Malta and the Czech Republic were the income leaders in 2009 and 2010. It is worth noting that the Czech Republic has the second highest net annual household income per consumption unit in the post-communist countries (after Slovenia). The inhabitants of Romania, Bulgaria, Lithuania, Hungary and Poland earned the lowest incomes across the European Union in 2010. In 2009, this order was almost the same – Romania, Bulgaria, Hungary, Lithuania and Poland. On the other hand, as it is indicated in Table 15, twelve new EU members show a higher average annual growth rate of median net annual income (an average growth of 6.67% per annum) than the original fifteen member states (2.61%) between 2005 and 2010. Considering just the period 2005-2009, however, twelve new EU members show a markedly higher average annual growth rate of median net annual income (average growth of 18.32% per annum), while the original fifteen member states show roughly the same average growth rate of median net annual income (average annual growth of 2.83%). Currently, we can register a strong decrease in the average growth rate of net annual household income in the twelve new EU member states.

Table 15 Average annual growth coefficient of the net annual income median in European Union 2005–2010

Countries	European Union (27 countries)	European Union (15 countries) Member states on 31 December 1995	European Union (12 countries) New member states
Average growth rate	1.016145	1.026137	1.066706

Source: Own research

A decline in the median of net annual income reflected by the average growth coefficient in the years 2005–2010 is only the case of the United Kingdom (an average decrease of 1.60% per annum), the net annual income median for all the other countries indicating average growth experienced each year. Within the monitored period of years 2005–2010, we can distinguish a period of economic growth between 2005 and 2008 (before the global economic crisis) and that of global economic recession during the years 2008–2010. It can be seen from Table 16 that the average annual growth rate of the median of net annual household income per consumption unit indicates the growth in income in the period 2005–2008 for all EU member states. This does not apply for the economic crisis in the years 2008–2010.

Table 16 Average annual growth coefficient of the net annual income median in 2005–2010

European Union (15 countries) Member states on 31 December 1995				European Union (12 countries) New member states			
Country	Period			Country	Period		
	2005–10	2005–08	2008–10		2005–10	2005–08	2008–10
Austria	1.0275	1.0184	1.0414	Bulgaria	1.2150 (2006–10)	1.2525 (2006–08)	1.1787
Belgium	1.0326	1.0275	1.0403	Cyprus	1.0621	1.0841	1.0298
Denmark	1.0302	1.0298	1.0307	Czech Republic	1.1077	1.1275	1.0785
Finland	1.0406	1.0420	1.0385	Estonia	1.1396	1.2301	1.0161
France	1.0468	1.0599	1.0276	Hungary	1.0423	1.0848	**0.9818**
Germany	1.0277	1.0375	1.0132	Latvia	1.1553	1.2991	**0.9690**
Greece	1.0490	1.0467	1.0525	Lithuania	1.1455	1.2653	**0.9867**
Ireland	1.0113	1.0695	**0.9299**	Malta	1.0404	1.0543	1.0199
Italy	1.0212	1.0290	1.0095	Poland	1.1170	1.1794	1.0296
Luxembourg	1.0263	1.0288	1.0226	Romania	1.0710 (2007–10)	1.1779 (2007–08)	1.0213
Netherlands	1.0360	1.0472	1.0195	Slovakia	1.1667	1.1919	1.1298
Portugal	1.0382	1.0421	1.0323	Slovenia	1.0593	1.0738	1.0380
Spain	1.0421	1.0690	1.0031				
Sweden	1.0241	1.0554	**0.9788**				
United Kingdom	0.9840	1.0068	**0.9508**				

Source: Own research

The median of net annual income – reflected by the average annual growth coefficient of the original fifteen EU member states in the years 2008–2010 – was in decline in the case of Ireland (an average decrease of 7.01% per annum, presumably due to its notorious financial problems), Sweden (an average decrease of 2.12% per annum) and the United Kingdom (4.92% per annum), as indicated in Table 16 in black. Among the new twelve EU member states, decline in the median of net annual income was recorded in the case of Hungary (an average decrease of 1.82% per annum), Latvia (3.10% per annum) and Lithuania (1.33%), again indicated in black in Table 16. The decline was apparently caused by the global economic crisis. If we look at Table 16, we can see that the average annual growth rate of the median of net annual household income per consumption unit decreased in the period 2008–2010 compared to that of 2005–2008 for all the EU member states except for Austria, Belgium, Denmark and Greece, where the average annual growth rate increased, as marked by light gray shade of color.

Out of the twelve new EU member states, only Cyprus and Malta (indicated in dark gray in Tables 16 and 18) are not among the former Soviet bloc countries. Bulgaria, Slovakia, Latvia, Lithuania and Estonia demonstrate the faster growth of median net annual income in the given period (13.96–21.50% per annum on average). The Czech Republic is the seventh fastest growing country in this respect. We can see in Table 16 that in total, the median of net annual household income per consumption unit grew faster in the post-communist countries than in other current EU member states. It can be concluded that a very low income level in certain countries is not necessarily accompanied by an extremely low rate of income growth, while the countries with higher levels of income show a lower rate of income growth. A considerable difference in the level of net annual household income per consumption unit by the educational attainment for the whole research period in individual member states of the European Union is shown in Table 17 and Figures 11–16.

Table 17 The median of net annual household income per consumption unit (in EURO) in 2005–2010 according to the educational attainment

EU Country	Stages of education	Year					
		2005	2006	2007	2008	2009	2010
European Union (all 27 countries)	Primary	11 887	12 087	11 901	12 608	12 692	12 705
	Secondary	14 190	14 342	14 221	14 675	14 750	14 740
	Tertiary	19 873	20 108	20 474	21 287	21 690	21 492
European Union (15 countries) Member states on 31 December 1995	Primary	12 825	13 077	13 441	14 210	14 223	14 144
	Secondary	17 026	17 286	17 991	18 572	18 561	18 766
	Tertiary	21 421	22 102	22 817	23 626	23 824	23 974
European Union (12 countries) New member states	Primary	2 409	2 454	2 140	2 588	2 937	2 652
	Secondary	3 038	3 422	3 401	4 053	4 749	4 242
	Tertiary	4 700	5 208	5 447	6 343	7 399	6 595
Austria	Primary	15 819	15 428	15 611	15 878	16 634	17 596
	Secondary	19 129	19 086	19 383	20 495	21 276	21 948
	Tertiary	22 636	22 671	22 969	24 127	25 684	26 522
Belgium	Primary	14 600	15 147	15 444	15 633	16 675	16 310
	Secondary	17 264	17 862	18 211	18 870	20 167	20 397
	Tertiary	21 969	22 701	23 303	24 129	25 445	26 143
Bulgaria	Primary	–	999	979	1 557	2 072	2 032
	Secondary	–	1 569	1 706	2 620	3 233	3 338
	Tertiary	–	2 090	2 272	3 360	4 445	4 705

Source: http://epp.eurostat.ec.europa.eu

Table 17 The median of net annual household income per consumption unit (in EURO) in 2005–2010 according to the educational attainment — Continuation

EU Country	Stages of education	Year					
		2005	2006	2007	2008	2009	2010
Cyprus	Primary	11 643	12 677	13 870	14 439	14 764	15 026
	Secondary	13 905	15 082	16 689	17 087	17 752	18 125
	Tertiary	19 212	20 499	22 073	23 205	23 577	24 319
Czech Republic	Primary	3 618	4 090	4 540	5 129	6 201	6 040
	Secondary	4 559	5 127	5 854	6 438	7 802	7 490
	Tertiary	6 246	7 030	7 860	8 673	10 258	10 168
Denmark	Primary	21 118	21 723	22 171	23 264	23 266	24 290
	Secondary	23,616	24 314	25 175	25 663	26 360	27 307
	Tertiary	27 433	27 969	29 439	29 350	30 883	31 996
Estonia	Primary	2 467	3 049	3 812	4 808	5 290	4 834
	Secondary	3 136	3 874	4 714	5 752	6 340	5 680
	Tertiary	4 386	5 100	6 185	7 743	8 775	8 360
Finland	Primary	16 751	17 361	17 508	18 753	19 693	19 719
	Secondary	17 445	18 320	18 770	20 004	21 262	21 261
	Tertiary	22 871	23 459	24 537	25 944	27 287	27 691
France	Primary	14 200	14 687	14 655	17 235	17 613	17 509
	Secondary	16 611	16 632	16 771	19 218	19 930	20 171
	Tertiary	21 290	21 715	21 399	24 342	25 282	25 444
Germany	Primary	15 369	14 984	15 236	15 960	15 745	15 298
	Secondary	17 293	17 370	18 059	18 639	18 952	19 228
	Tertiary	21 147	21 599	22 623	23 514	24 660	24 823
Greece	Primary	8 202	8 480	8 690	9 278	9 706	9 923
	Secondary	10 212	10 478	10 804	11 500	11 800	12 167
	Tertiary	15 029	16 094	16 500	17 120	17 600	18 289
Hungary	Primary	2 915	2 979	3 224	3 540	3 820	3 346
	Secondary	3 587	4 075	4 076	4 506	4 853	4 345
	Tertiary	5 260	6 077	5 833	6 252	6 849	6 092
Ireland	Primary	16 463	17 272	18 506	19 132	18 680	17 188
	Secondary	20 756	22 276	24 240	24 157	23 769	20 797
	Tertiary	27 778	29 596	34 150	34 057	32 122	27 930
Italy	Primary	13 283	13 248	13 548	14 120	14 063	14 391
	Secondary	16 566	16 669	17 340	17 959	17 999	18 083
	Tertiary	22 566	22 990	23 753	23 360	23 867	23 705
Latvia	Primary	1 768	1 825	2 585	3 903	4 261	3 368
	Secondary	2 335	2 698	3 559	5 152	5 811	4 604
	Tertiary	3 603	4 266	5 270	7 825	8 665	7 508

Source: http://epp.eurostat.ec.europa.eu

Table 17 The median of net annual household income per consumption unit (in EURO) in 2005–2010 according to the educational attainment Continuation

EU Country	Stages of education	Year					
		2005	2006	2007	2008	2009	2010
Lithuania	Primary	1 622	1 936	2 568	3 204	3 547	2 972
	Secondary	2 052	2 563	3 340	4 212	4 876	3 887
	Tertiary	3 709	4 198	5 307	6 363	7 656	6 472
Luxembourg	Primary	23 758	24 027	24 302	25 177	25 567	26 036
	Secondary	30 215	30 897	31 057	31 674	32 765	34 092
	Tertiary	41 198	41 746	44 225	44 614	46 422	48 066
Malta	Primary	8 599	8 918	9 098	9 887	10 119	9 866
	Secondary	11 234	11 482	11 450	12 697	13 578	12 599
	Tertiary	14 659	15 323	14 701	15 922	17 047	16 916
Netherlands	Primary	15 870	16 259	16 891	17 767	18 259	18 270
	Secondary	17 769	17 943	18 849	19 974	20 671	20 742
	Tertiary	21 986	22 883	24 027	25 274	26 031	25 949
Poland	Primary	1 863	2 310	2 659	3 211	3 938	3 296
	Secondary	2 526	3 065	3 459	4 151	5 070	4 372
	Tertiary	4 392	5 420	5 899	6 730	8 158	6 974
Portugal	Primary	7 016	7 046	7 292	7 822	7 930	8 158
	Secondary	10 046	10 043	10 698	10 343	10 451	10 765
	Tertiary	18 059	17 733	18 229	17 060	17 277	16 657
Romania	Primary	–	–	1 150	1 424	1 555	1 456
	Secondary	–	–	1 889	2 245	2 462	2 283
	Tertiary	–	–	3 784	4 405	4 440	4 135
Slovakia	Primary	2 474	2 845	3 268	4 073	4 645	4 960
	Secondary	2 982	3 455	4 177	5 021	5 858	6 374
	Tertiary	3 706	4 318	5 163	6 304	7 709	8 375
Slovenia	Primary	7 581	8 074	8 548	9 379	10 372	9 776
	Secondary	9 305	9 820	10 119	11 070	12 123	11 817
	Tertiary	14 051	14 314	14 616	15 615	16 486	16 547
Spain	Primary	9 741	10 480	11 045	11 731	11 900	11 424
	Secondary	12 213	12 893	13 411	14 343	14 709	14 402
	Tertiary	15 996	16 867	17 291	18 801	19 610	19 060
Sweden	Primary	18 189	18 139	19 241	20 670	20 399	19 153
	Secondary	18 384	18 831	19 944	21 528	22 172	20 478
	Tertiary	21 006	21 193	22 378	24 835	25 344	22 991
United Kingdom	Primary	15 086	15 880	16 951	14 467	13 411	13 794
	Secondary	20 375	21 161	22 873	19 845	16 840	17 801
	Tertiary	25 686	29 047	30 903	26 815	23 354	24 025

Source: http://epp.eurostat.ec.europa.eu

Table 18 Average annual growth coeffcent of the net annual income median in 2005–2010 according to the educational attainment

European Union (15 countries) Member states on 31 December 1995				European Union (12 countries) New member states			
Country	Stages of education			Country	Stages of education		
	Prim.	Sec.	Tert.		Prim.	Sec.	Tert.
Austria	1.0215	1.0279	1.0322	Bulgaria	1.1942 (2006–10)	1.2077 (2006–10)	1.2249 (2006–10)
Belgium	1.0224	1.0339	1.0354	Cyprus	1.0523	1.0544	1.0483
Denmark	1.0284	1.0295	1.0313	Czech Republic	1.1079	1.1044	1.1024
Finland	1.0332	1.0404	1.0390	Estonia	1.1440	1.1261	1.1377
France	1.0428	1.0396	1.0363	Hungary	1.0280	1.0391	1.0298
Germany	**0.9991**	1.0214	1.0326	Latvia	1.1376	1.1454	1.1582
Greece	1.0388	1.0357	1.0400	Lithuania	1.1288	1.1363	1.1178
Ireland	1.0087	1.0004	1.0011	Malta	1.0279	1.0232	1.0291
Italy	1.0162	1.0177	1.0099	Poland	1.1209	1.1160	1.0969
Luxembourg	1.0185	1.0244	1.0313	Romania	1.0818 (2007–10)	1.0652 (2007–10)	1.0300 (2007–10)
Netherlands	1.0286	1.0314	1.0337	Slovakia	1.1493	1.1641	1.1771
Portugal	1.0306	1.0139	**0.9840**	Slovenia	1.0522	1.0490	1.0332
Spain	1.0324	1.0335	1.0357				
Sweden	1.0104	1.0218	1.0182				
United Kingdom	**0.9823**	**0.9734**	**0.9867**				

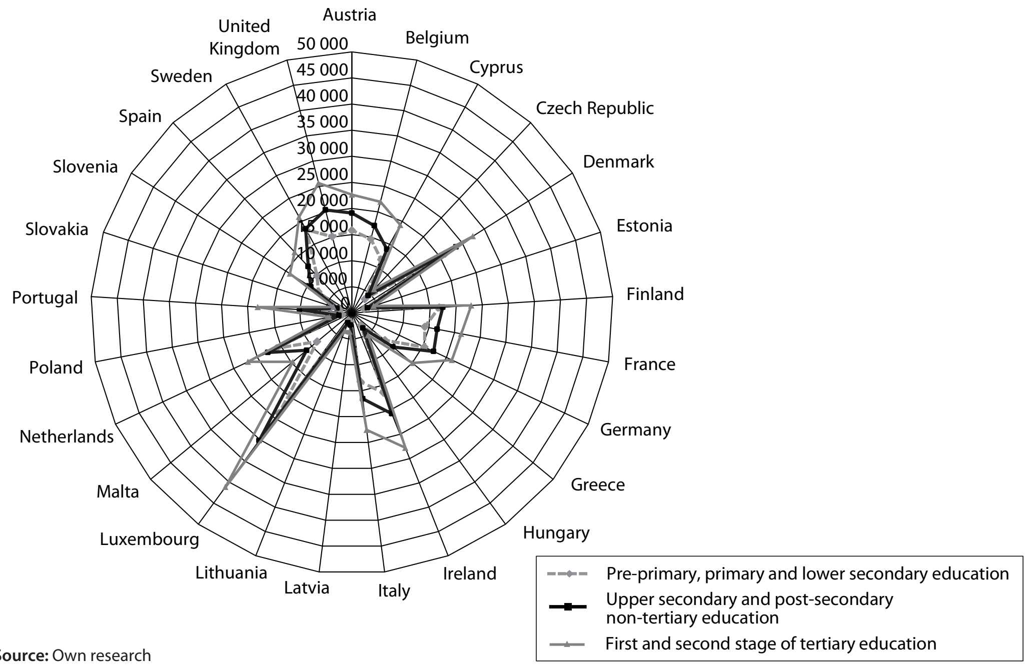
Source: Own research

Regarding all EU member states, we can notice – as expected – that both the level of education completed and that of income is higher. Table 18 allows for a comparison of an average annual growth rate of the median of net annual household income per consumption unit of all EU member states by educational attainment. The three stages of education are:

- Pre-primary, primary and lower secondary education;
- Upper secondary and post-secondary (non-tertiary) education;
- First and second stage of tertiary education.

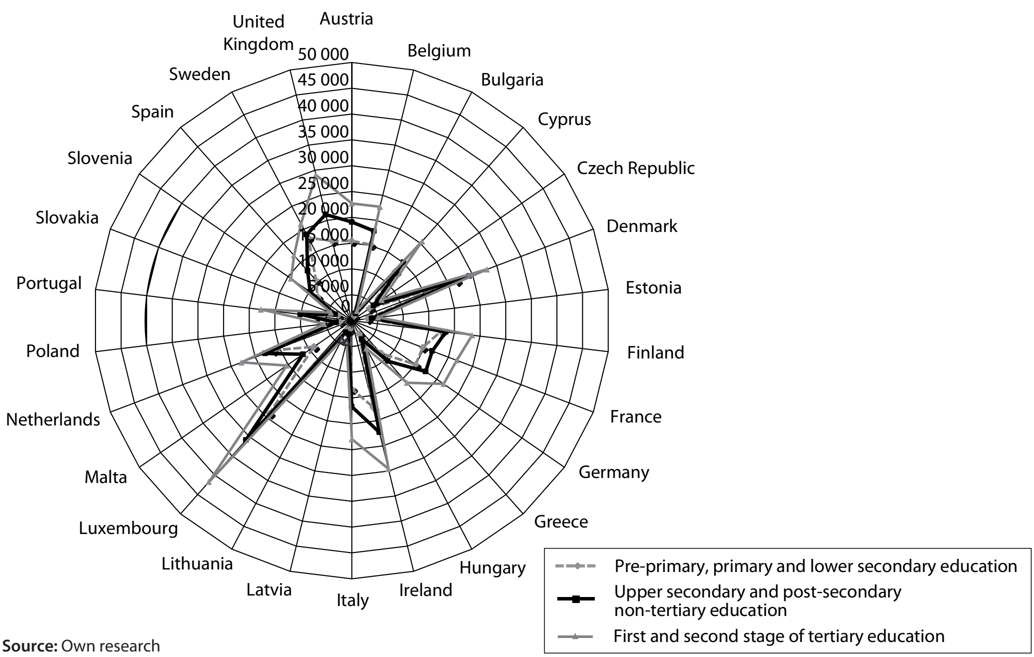
The division of households into categories is made according to the stages of education completed by the head of household (mal in overwhelming majority).

Figure 11 Median of the net annual household income per consumption unit in 2005 (in Euro) – According to the educational attainment



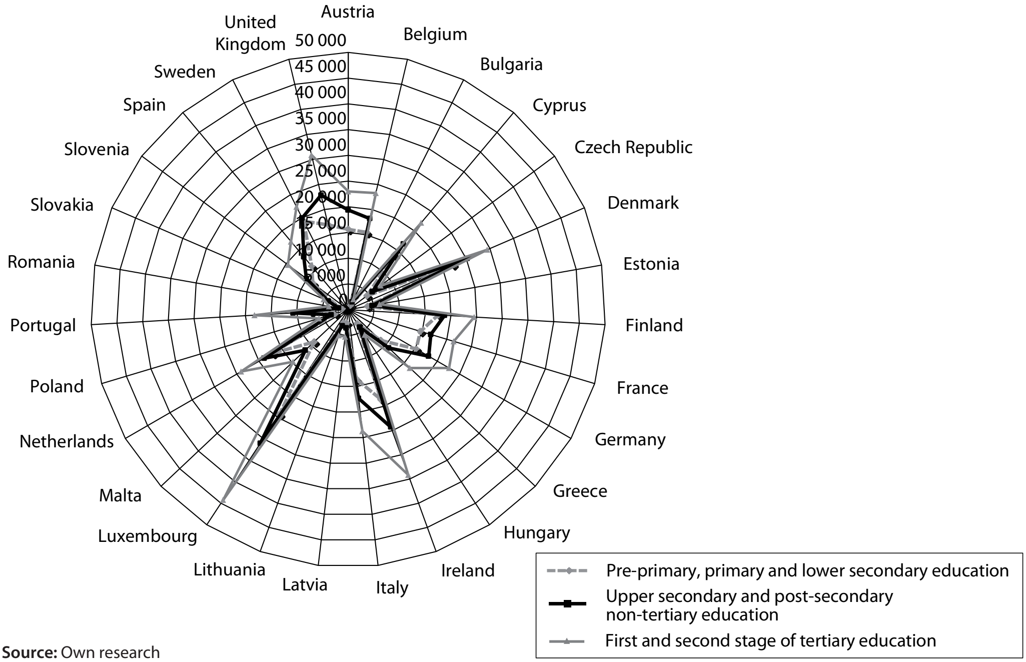
Source: Own research

Figure 12 Median of the net annual household income per consumption unit in 2006 (in Euro) – According to the educational attainment



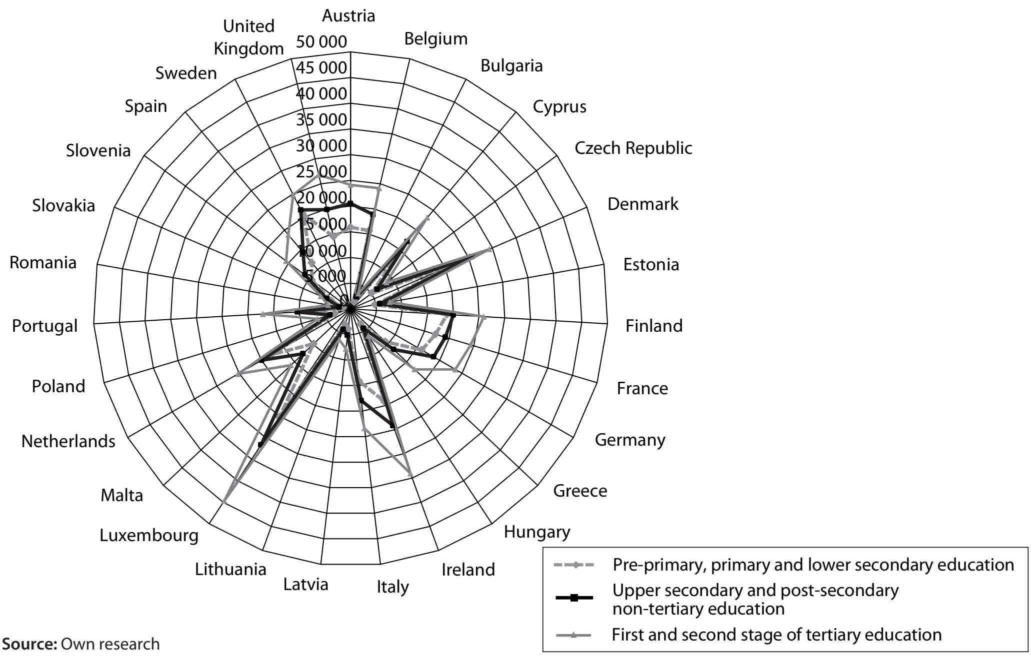
Source: Own research

Figure 13 Median of the net annual household income per consumption unit in 2007 (in Euro) – According to the educational attainment



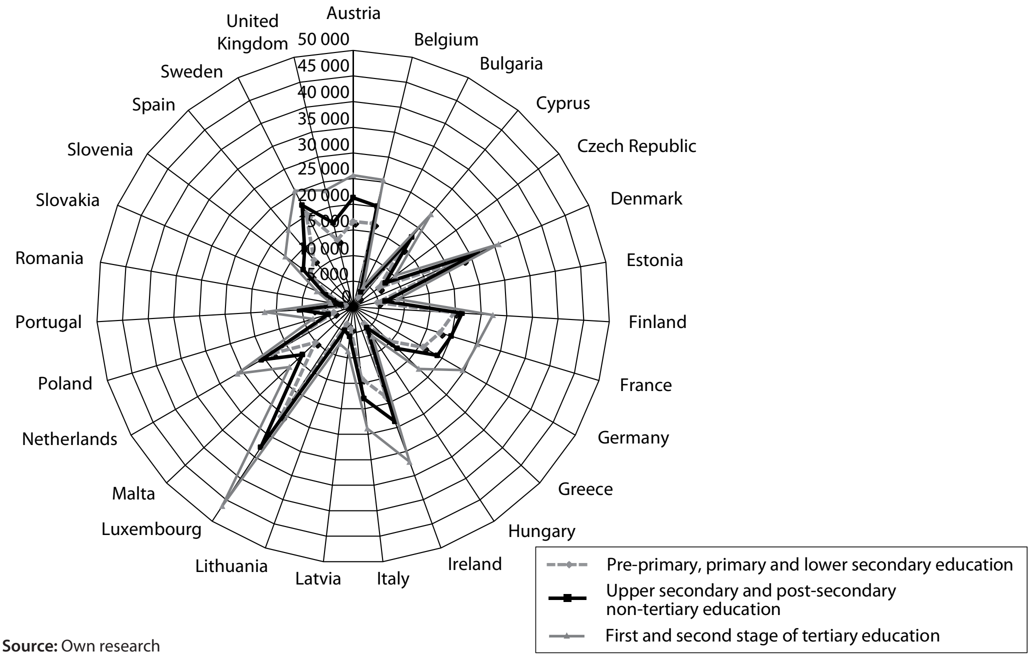
Source: Own research

Figure 14 Median of the net annual household income per consumption unit in 2008 (in Euro) – According to the educational attainment



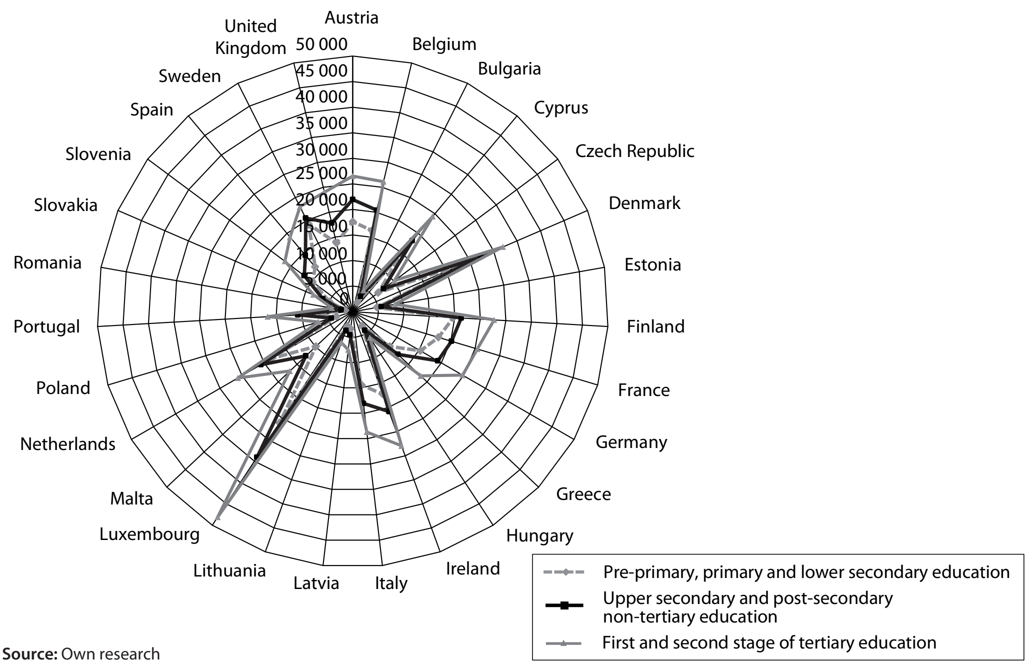
Source: Own research

Figure 15 Median of the net annual household income per consumption unit in 2009 (in Euro) – According to the educational attainment



Source: Own research

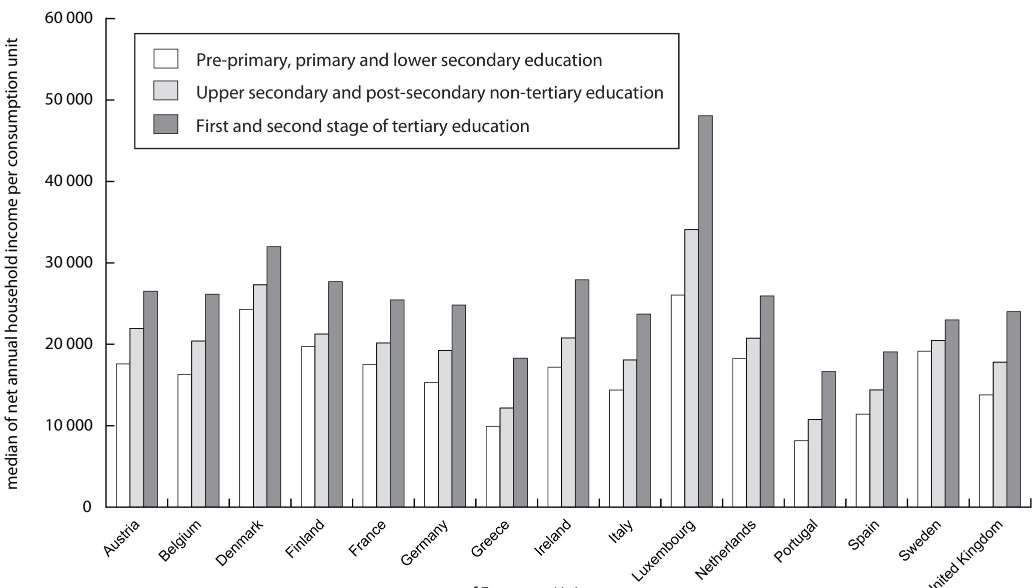
Figure 16 Median of the net annual household income per consumption unit in 2010 (in Euro) – According to the educational attainment



Source: Own research

In the period between 2005 and 2010, we can see the growth of net annual household income per consumption unit in all three differentiated categories of educational attainment for all European Union member states apart from Germany, Portugal and the United Kingdom, which corresponds with the data in Table 18. In case of Germany during the years 2005–2010, the median net annual household income per consumption unit fell by an average of 0.09% annually for households whose head has finished pre-school (i.e. pre-primary) or lower secondary education. As for Portugal in the years 2005–2010, the median net annual household income declined by an average of 1.60% per annum for households whose head has finished the first or second stage of tertiary education. Regarding the United Kingdom in the given period, the median net annual household income per consumption unit decreased for all differentiated categories of the stages of education completed. An average 1.77% decline per year was recorded for households whose head has finished pre-school or lower secondary education, an average 2.66% decline for those whose head has upper secondary or post-secondary (non-tertiary) education and an average 1.33% decline for households whose head has the first or second stage of tertiary education. As far as the Czech Republic is concerned, the growth rate of median income was balanced for all three categories of educational attainment. During the years 2005–2010, the median of net annual household income per consumption unit increased by an average of 10.79% per annum for households whose head has pre-school or lower secondary education, an average 10.44% increase being recorded for those whose head has upper secondary or post-secondary (non-tertiary) education and an average 10.24% increase for households whose head has the first or second stage of tertiary education. Bulgaria has the highest growth rate of all the EU countries. During the years 2005–2010, median net annual income increased by 19.42% per year on average for households whose head has pre-school or lower secondary education, by 20.77% on average for those whose head has upper secondary or post-secondary (non-tertiary) education and by 22.49% on average for households whose head has the first or second stage of tertiary education. The fastest growth of incomes was experienced in tertiary education in Bulgaria.

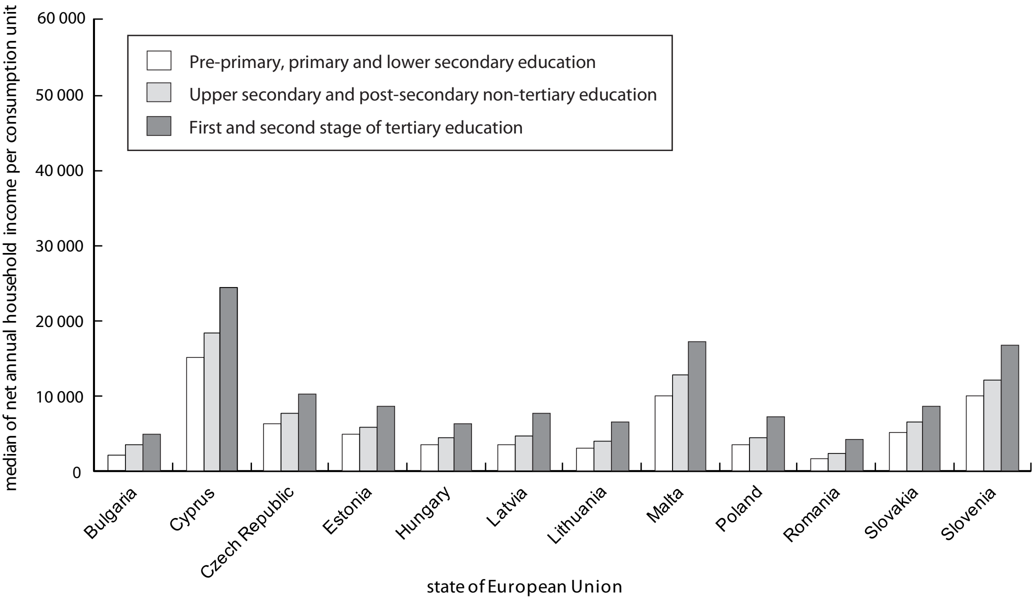
Figure 17 Median of the net annual household income per consumption unit according to the educational attainment in 2010–15 member states of the European Union on 31 December 1995



Source: Own research

Figures 17 and 18 allow a very illustrative comparison of income levels by the educational attainment between the fifteen original and twelve new EU member states in 2010. High income of Luxembourg is noticeable compared to the original fifteen EU countries. Among the twelve new EU member states, incomes in Cyprus, Malta (none of them being a former Soviet bloc country) and Slovenia clearly exceed those in other countries, the other nine states having markedly lower incomes.

Figure 18 Median of the net annual household income per consumption unit according to the educational attainment in 2010–12 new EU member states



Source: Own research

CONCLUSION

The paper starts with a development analysis of descriptive characteristics of wage distribution over the last years, monitoring particularly the changes of wage distribution in the context of economic recession at the end of the research period. We can conclude that wage growth has virtually stopped. Wage distributions are classified by the level of educational attainment. Differences between particular wage levels were assessed on the basis of given stages of education. The arithmetic mean, median and medial were applied. Since most employees do not reach an average wage, the median was employed as a fundamental characteristic of the level of wage and income distribution. The research results show a clear impact of educational attainment on wage, this dependence being proved by test at any significance level. Both the wage range and distribution are strongly influenced by the amount of the minimum wage. Workers' wages would presumably decline if the minimum wage was reduced or even abolished. The changes are naturally reflected in characteristics of the location, variability and shape of wage distribution. It is noteworthy that the number of extremely well-paid people was increasing gradually over the whole research period 2003–2010. The level of wage distribution was rising until 2008, wage growth having almost stopped in the year when economic recession began. Also having increased until the onset of the financial crisis, wage differentiation started to decline later. The dual dimension of wage differentiation by the educational attainment – both within and between the groups – had to be taken into account, the latter dimension being already indicated by differences in wage growth rates. It is expected that the deceleration in the growth rate of nominal and real wage level may cause structural changes in household budgets, leading to cuts in money spent on food, clothes and other durable and nondurable goods while energy, housing and transport costs may rise due to relative price changes.

The research results prove that despite a much faster growth of nominal incomes, the new EU member states do not even begin to compare with the income level of the original fifteen EU countries. Weak income differentiation was a distinctive feature of former communist regimes, having manifested itself in wage discrepancy between skilled and less-skilled work and undifferentiated staffing and position appointment policies. Since the transition to market economy, income differentiation has been deepening significantly. A group of people with very high incomes has been growing gradually. The Czech Republic's standing among the new EU member states in terms of income is not bad at all. The country boasts of the fourth highest income level, the growth rate of the income median being approximately in the middle of the ranking list. The population of neighbouring Slovakia has a slightly lower income than that of the Czech Republic. This is mainly due to the division of former Czechoslovakia. Having lost its industrial capacity and resources located in the more advanced western part of the common state, the Slovak Republic adapted to a significant reduction in the wage level as well as a deeper exchange rate depreciation. Various countries suffered different effects of the financial crisis, some of them (e.g. the United Kingdom) having gone into an income level decline, others (e.g. Ireland) having virtually stopped their income level increase.

References

BARTOŠOVÁ, J. Logarithmic-Normal Model of Income Distribution in the Czech Republic. *Austrian Journal of Statistics,* 2006, Vol. 35, No. 23, pp. 215–222.

BARTOŠOVÁ, J., BÍNA, V. Mixture Models of Household Income Distribution in the Czech Republic. Paper presented at the *6th International Conference APLIMAT (Part I),* 6–9 February 2007, Bratislava, pp. 307–316.

BÍLKOVÁ, D. Recent Development of the Wage and Income Distribution in the Czech Republic. *Prague Economic Papers,* 2012, Vol. 21, No. 2, pp. 233–250.

BÍLKOVÁ, D. Vývoj příjmových rozdělení v letech 1956–1992 a jejich předpovědi pro roky 1995 a 1997 (Development of Income Distribution in the Years 1956–1992 and their Forecasts for 1995 and 1997). *Politická ekonomie,* 1995, Vol. 43, No. 4, pp. 510–531.

BÍLKOVÁ, D., MALÁ, I. Application of the L-Moment Method when Modelling the Income Distribution in the Czech Republic. *Austrian Journal of Statistics,* 2012, Vol. 41, No. 2, pp. 125–132.

BROCKWELL, P. J., DAVIS, R. A. *Introduction to Time Series and Forecasting*. 2nd ed. New York: Springer, 2002, 434 p.

COWPERTWAIT, P. S. P., METCALFE, A. V. *Introductory Time Series with R.* New York: Springer, 2009, 254 p.

HOSKING, J. R. M. L-moments: Analysis and Estimation of Distributions Using Linear Combinations of Order Statistics. *Journal of the Royal Statistical Society (Series B),* 1990, Vol. 52, No. 1, pp. 105–124.

KLEIBER, C., KOTZ, S. *Statistical Size Distributions in Economics and Actuarial Sciences*. New Jersey: Wiley-Interscience, 2003, 332 p.

KYSELÝ, J., PICEK, J. Regional Growth Curves and Improved Design Value Estimates of Extreme Precipitation Events in the Czech Republic. *Climate Research,* 2007, Vol. 33, pp. 243–255.

MALÁ, I. The Use of Finite Mixtures of Lognormal Distributions in the Modeling of Incomes in the Czech Republic. *Research Journal of Economics, Business and ICT,* 2011, Vol. 4, No. 1, pp. 41–46.

MAREK, L. Wage Development in the Czech Republic for the past 16 Years. Paper presented at AIESA – *Budovanie společnosti založenej na vedomostiach,* 10–11 November 2011, Bratislava, pp. 1–7.

PACÁKOVÁ, V., SIPKOVÁ, L. Generalized Lambda Distributions of Household's Incomes. *E+M Ekonomie a Management,* 2007, Vol. 10, No. 1, pp. 98–107.

PARKER, S. C. The Distribution of Self-Employment Income in the United Kingdom, 1976–1991. *The Economic Journal,* 1997, Vol. 107, pp. 455–466.

ROBERTS, M. J., RUSSO, R. *A Student's Guide to Analysis of Variance.* New York: Routledge, 1999.

TRIOLA, M. F. *Elementary Statistics.* 9th ed. Boston: Addison Wesley, 2003.

TURNER, J. R., THAYER, J. F. *Introduction to Analysis of Variance: Design, Aanalysis & Interpretation*. Thousand Oaks: Sage Publications, 2001.

The Czech Wage Distribution and the Minimum Wage Impacts: an Empirical Analysis[1]

Martin Matějka[2] | *TREXIMA, spol. s r.o., Zlín; University of Economics, Prague, Czech Republic*
Kateřina Duspivová[3] | *TREXIMA, spol. s r.o., Zlín; University of Economics, Prague, Czech Republic*

Abstract

A well-fitting wage distribution is a crucial precondition for economic modeling of the labour market processes. In the first part, this paper provides the evidence that – as for wages in the Czech Republic – the most often used log-normal distribution failed and the best-fitting one is the Dagum distribution. Then we investigate the role of wage distribution in the process of the economic modeling. By way of an example of the minimum wage impacts on the Czech labour market, we examine the response of Meyer and Wise's (1983) model to the Dagum and log-normal distributions. The results suggest that the wage distribution has important implications for the effects of the minimum wage on the shape of the lower tail of the measured wage distribution and is thus an important feature for interpreting the effects of minimum wages.

Keywords	***JEL code***
Wage distribution, wage, minimum wage, employment	*J31, E24*

INTRODUCTION

During economic crises, we usually notice a higher demand for economic models which analyse and describe the economic situation and are able to identify the point of the economic cycle that the economy is approaching. Regardless their assumptions, the economic models represent always a simplified relationship among relevant variables. As for individual models, a set of appropriate and reliable variables is needed. The most often inputs are variables directly measured (e.g. an average wage), but in some cases we need – roughly said – hypothetical variables, i.e. those which cannot be measured under current conditions.

As for labour market models, one can encounter problems concerning lack of information needed although there are many results from labour market surveys available in the Czech Republic. The most likely disadvantage concerning labour market indicators is the fact that each of the key aspects of the labour market (i.e. employment as well as remuneration) has been so far surveyed and evaluated sepa-

[1] Paper made with the financial support of the TA CR (Project No. TD010171 The Impact of the Minimum Wage on the Socioeconomic Development in the Czech Republic).
[2] TREXIMA, spol. s r.o., tr. T. Bati 299, 764 21 Zlín-Louky; University of Economics, Nam. W. Churchilla 4, 130 67 Prague, Czech Republic. Corresponding author: e-mail: matejka.vse@gmail.com.
[3] TREXIMA, spol. s r.o., tr. T. Bati 299, 764 21 Zlín-Louky; University of Economics, Nam. W. Churchilla 4, 130 67 Prague, Czech Republic. Corresponding author: e-mail: duspivova@trexima.cz.

rately (Duspivová, Spáčil, 2011). Another problem, one can encounter quantifying individual effects on the labour market, are insufficiently comprehensive and accurate inputs that implied distorted conclusions. To this end, we pay our attention to the wage distribution in the Czech Republic, because no doubt a well-fitting wage distribution is a crucial precondition for an economic modeling of the labour market processes. As far as wages are concerned, we suppose that – in the Czech Republic usually used – the log-normal distribution is not the best-fitting one and this distribution is used because of its convenient theoretical qualities. Thanks to advanced technologies, there is no need to use simpler methods neither for the modeling nor as a teaching tool anymore.

The main aim of this paper is to find the best-fitting wage distribution in the wage sphere in the Czech Republic with respect to its further use in the process of economic modeling. As for wage distributions, we will fit generally known income and wages distributions (lognormal, Dagum, Singh-Maddala, etc.) to the microdata from the Average Earnings Information System (the Structure of Earnings Survey family) using the maximum-likelihood estimation to estimate the parameters of individual models. To illustrate the role of the wage distribution in economic models, we will focus on the results of the Meyer & Wise's (1983a, 1983b) model which is used to estimate the impact of the minimum wage on employment and wages comparing market wage rates that individuals would receive in the absence of the minimum wage (i.e. the above mentioned hypothetical variable) with an actual wage distribution. Meyer & Wise's model was chosen because of two reasons – on the one hand the empirical as well as hypothetical distributions are considered, on the other hand the quantification of the minimum wage effects is not in the forefront of the public interest in the Czech Republic, although the minimum wage is an important state intervention on the labour market.

The structure of the paper is as follows: section 1 describes the dataset and methods used, section 2 presents the main empirical results concerning wage distributions in the Czech Republic and in section 3 there are presented important implications of different wage distributions used in the Meyer & Wise's (1983a, 1983b) model. The last section concludes the paper.

1 METHODOLOGY

In this part, we will briefly introduce the data (namely the Average Earnings Information System) and the methodology that will be used. Methodological issues, we will deal with, will concern the sample for our analysis, the estimation of wage distributions and the model proposed by Meyer & Wise (1983a, 1983b).

Data Sources

As far as wages are concerned, there are two different data sources available, namely surveys concerning Labour Statistics conducted by the Czech Statistical Office (CZSO) and the *Average Earnings Information System (ISPV)* conducted by the MoLSA. Within the Labour Statistics of the CZSO, there are surveyed the number of employees and sum of earnings in the enterprise, so an average gross monthly wage can be calculated. On the contrary, the ISPV gathered data on individual employees in the enterprise, so – in addition to the average wage – the wage distribution is known (Malenovský, Duspivová, 2012). Considering the aims of this paper, the only one possible data source is the ISPV.

The ISPV is a quarterly employer survey carried out by a private agency (TREXIMA, spol. s r.o.) on behalf of the Ministry of Labour and Social Affairs (MoLSA) since 1992. The ISPV is based on the stratified random sampling which has been fully in accordance with the European Structure of Earnings Survey (SES) guidelines since 2006.

Since 2011, the ISPV population has been extended by the employees of economic subjects previously not surveyed, above all by employees of economic subjects with less than 10 employees (for more detailed information see Malenovský, Duspivová, 2012). The sample in the wage sphere contained c. 4 900 economic subjects with total employment about 1.5 million workers in 2011 (ISPV, 2012). In addition to the improvements made in the ISPV survey in 2011, the 2011 data are the latest available ones, so all the figures presented in the next parts will be the *measures concerning the year 2011*.

Estimations of individual wage distributions and Meyer & Wise's model will represent only the *wage sphere*[4] *in the Czech Republic*. The salary sphere[5] will not be considered because there is a minimum of employees remunerated at the minimum wage, so the further use of the wage distribution in the Meyer & Wise's model does not make sense.

Wage Distribution

As for wage distributions, we will consider the following seven most frequently used distributions in wage statistics: the Dagum, Singh-Maddala, log-logistic, log-normal (2 and 3 parameter), Gamma and Weibull distribution. A brief description of each distribution (including its probability density function) will be in the following section concerning fitted wage distributions, for more detailed information on individual distributions see e.g. Kleiber, Kotz (2003) or Yee, Wild (1996).

In our case, a random variable is defined as the nominal average gross monthly wage in the wage sector in the Czech Republic in 2011.

The distributions mentioned above are fitted to our data using an iterative procedure of the maximum likelihood estimation method in statistical software R (version 2.14.2). The only exception is the estimation of parameters of the 3-parameter log-normal distribution, where the parameters were estimated in MS Excel according to Cohen & Whitten (1980) for the following reason: the probability density function includes the logarithm of the difference between an observed wage and the parameter lambda, see (4). Because of very low wages in the sample, a calculation of the probability density function is impossible. Cohen & Whitten (1980) provide an iterative process algorithm, which allows to include the information on the lowest wages in the initial values of the estimated parameters.

The maximum likelihood estimates and the related fits are evaluated by the Akaike information criterion (AIC) according to Yee and Wild (1996) (1).

$$AIC = -ln(L) + 2p, \tag{1}$$

where *ln(L)* is the logarithm of the likelihood and p is the number of estimated parameters in the maximum likelihood estimation method.

Minimum Wage Effects (Meyer & Wise's model)

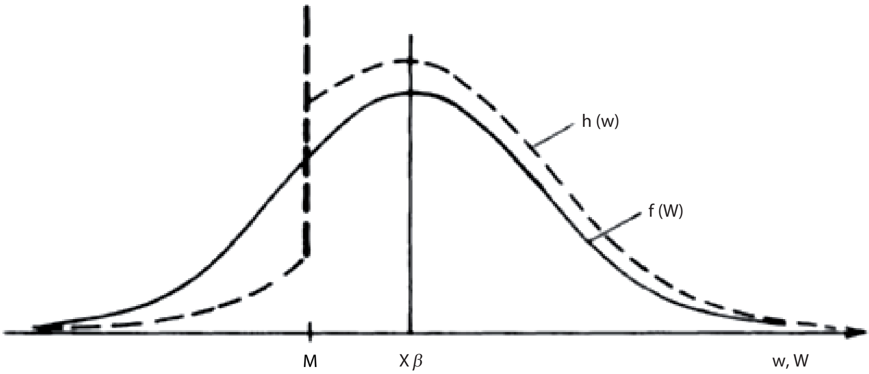
To illustrate the role of wage distribution estimations in some models, we use the Meyer & Wise's (1983a, 1983b) model. As was mentioned above, Meyer & Wise's model is used to estimate the impact of the minimum wage on employment and wages comparing market wage rates that individuals would receive in the absence of the minimum wage with an actual wage distribution. The basic idea of this model is shown in Figure 1.

In the Figure 1, there are two density functions – f(W) and h(W). The density function *f(W)* represents the *distribution of wages* in a given population *in the absence of the minimum wage* (the solid line in the Figure 1). *After introducing the minimum wage* at level M, we switch to the density function *h(W)*,

[4] The wage sphere includes economic subjects who provide remuneration in the form of wages pursuant to Section 109 (2) of Act No. 262/2006 Coll., the Labour Code, as amended. For more detailed information see Malenovský, Duspivová (2012).

[5] Economic subjects belonging to the salary sphere provide remuneration in the form of salaries pursuant to Section 109 (3) of Act No. 262/2006 Coll., the Labour Code, as amended. For more detailed information see Malenovský, Duspivová (2012).

Figure 1 Basic principles of the Meyer & Wise's model



Source: Meyer, Wise (1983a)

that is distorted compared to f(W) due to several effects caused as a consequence of the minimum wage introduction. Suppose the whole economy, some employees continue to be paid below the minimum, because they are employed in a non-covered sector (i.e. sector not covered by the minimum wage law) or their employers do not comply with the law. The spike represents employees whose wage rose up to the minimum because of compliance with the law. Most of the employees with wages above the minimum are unaffected but we can see a spillover effect[6] (i.e. shift to the right). There may be other effects caused by the minimum wage in the economy, too, but an in-depth analysis of this issue is not a subject matter of this paper. Minimum wage effects are analysed in more detail e.g. in Stigler (1946), Mankiw (1998) or Dolado et al (1996).

As for the Czech Republic, the distribution of wages in a given population (to be more specific in the wage sphere) in the existence of the minimum wage is well-known. To be able to quantify the effects of the minimum wage using the Meyer & Wise's model, we need to know the distribution of wages in the absence of the minimum wage. The minimum wage legislation has been in force since the early 1990's, so the only option how to get the density function f(W) is to estimate hypothetical density function. In accord with Meyer & Wise (1983), we suppose that employees paid above the minimum are unaffected by the minimum, so we use the likelihood function for estimating the distribution of wages from a sample of employees where the wages are *truncated at 8 800 CZK*. Contrary to Dickens et al (1994), the ideal level of truncation is hardly to estimate in the Czech Republic, because an in-depth analysis of quantile differences is biased due to the process of the transformation of the Czech economy (Milanovic, 1998). The level of 8 800 CZK represents those employees who are definitely not paid at the minimum on neither monthly nor hourly basis.

2 WAGE DISTRIBUTION

A theoretical wage distribution is essential for probabilistic considerations. There are many applications of wage distributions and detailed information can be obtained from the modelling of the entire distribution of wages, which is the main purpose of this paper also.

A frequent assumption is that the wage distribution is described by the log-normal distribution. We are aware of its strengths concerning above all academic purposes (where exponential transformation of a normally distributed random variable results subsequently in the log-normal distribution), but we

[6] Roughly said, a spillover effect balances the differences in productivity of individual employees.

are aware of its weaknesses lying in simplifying assumptions, too. Contrary to Marek (2010) and others, we question an assumption of the usefulness of the log-normal distribution and will answer the question which wage distribution is the most appropriate one as far as the Czech data are concerned.

As was mentioned above, close attention will be given to seven most frequently used distributions in wage statistics: the Dagum, Singh-Maddala, log-logistic, log-normal (2 and 3 parameter), Gamma and Weibull distribution.

2.1 Dagum distribution

In the 1970s, C. Dagum proposed several variants of a new model for the size distribution of personal income. Dagum (1977) motivates his model from the empirical observation and his approach was further developed in a series of papers on generating systems for income in 1980's and 1990's (for more detailed information see Kleiber, 2007).

In this paper, we apply the three parametric version of the Dagum distribution with the following probability density function defined for all positive values of y (2):

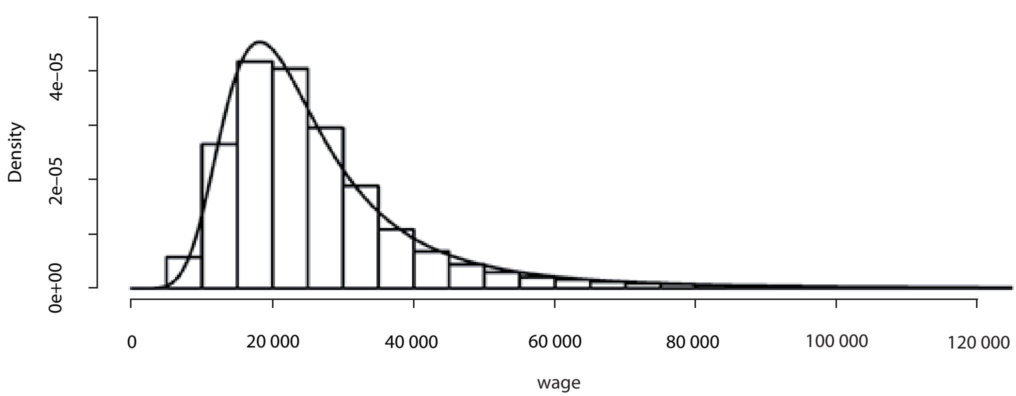
$$f(y) = apy^{ap-1} / \left[b^{ap} \left\{ 1 + (y/b)^{a} \right\}^{p+1} \right], \qquad (2)$$

where $a, b, p, y > 0$. Parameters a and p determine a shape of the distribution and b is a scale parameter.

Kleiber & Kotz (2003) point out that the maximum likelihood estimates are very sensitive to outlier observations. Nevertheless, the sample size of the ISPV meets required numerical estimate conditions (the recommended sample size should be at least 7 000 observations, but the size from 2 000 up to 3 000 provides unbiased estimators of parameters a and p.) Thus, this recommendation is irrelevant due to the size of our sample.

Figure 2 shows the observed wages (the histogram) and probability density function of the Dagum distribution (the solid line). Parameters obtained by maximum likelihood estimation are $a = 2.9300$, $b = 15\,974.43$, $p = 2.3043$.

Figure 2 The probability density function of the Dagum distribution and the histogram of observed wages



Source: ISPV, own calculations

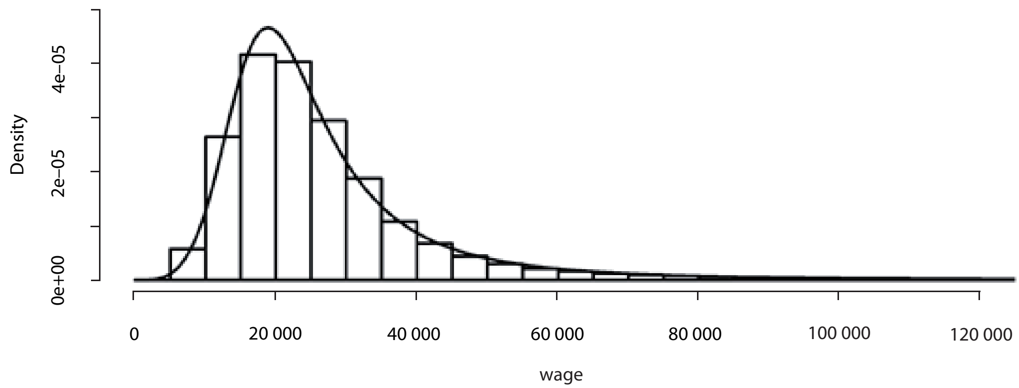
2.2 Singh-Maddala distribution

Similar to the Dagum distribution, the Singh-Maddala distribution (Singh, Maddala, 1976, and following papers) comes from a generalization of the Beta distribution of the second order (more information see in Kleiber, Kotz, 2003). The Singh-Maddala distribution (often known as the generalized log-logistic distribution) is very widely used in the modeling of the household income particularly in the USA. Probability density function for this distribution has the form of (3).

$$f(y) = aqy^{a-1} / \left[b^{aq} \{1 + (y/b)^a\}^{1+q} \right], \tag{3}$$

where *a, b, q, y* > 0. Parameters *a* and *b* determine the shape of the distribution and *q* is the scale parameter.

Figure 3 The probability density function of the Singh-Maddala distribution and the histogram of observed wages



Source: ISPV, own calculations

In the Figure 3, you can see the observed wages (the histogram) and the probability density function of the Singh-Maddala distribution (the solid line). Parameters estimated by maximum likelihood method are $a = 4.6021$, $b = 18\,940.34$, $q = 0.5725$.

2.3 Log-logistic distribution

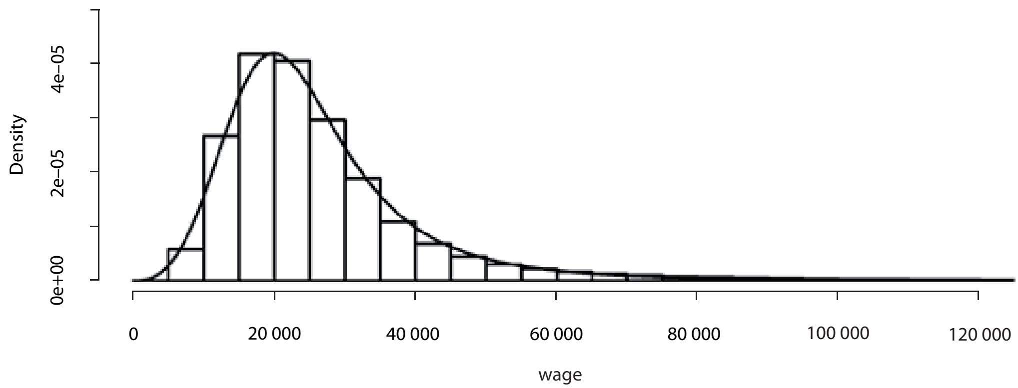
The Log-logistic distribution (in the economic theory also known as the Fisk distribution) is a simplification of the Sing-Maddala distribution (where the parameter q = 1), or of the Dagum distribution (where the parameter p = 1). It is mostly used in survival analyses as a model for rapidly rising events which afterwards fall more slowly (for example the mortality of people diagnosed with cancer). The relevant probability density function has the form of (4).

$$f(y) = ay^{a-1} / \left[b^{a} \{1 + (y/b)^a\}^{2} \right], \tag{4}$$

where *a, b, y* > 0. The parameter a determines the shape of the distribution and the parameter *b* specifies the scale of the distribution.

The Figure 4 shows the observed wages (the histogram) and the probability density function of the log-logistic distribution (the solid line). Parameters obtained by maximum likelihood estimation are $a = 3.6103$ and $b = 23\,283.94$.

Figure 4 The probability density function of the log-logistic distribution and the histogram of observed wages



Source: ISPV, own calculations

2.4 3-parameter log-normal distribution

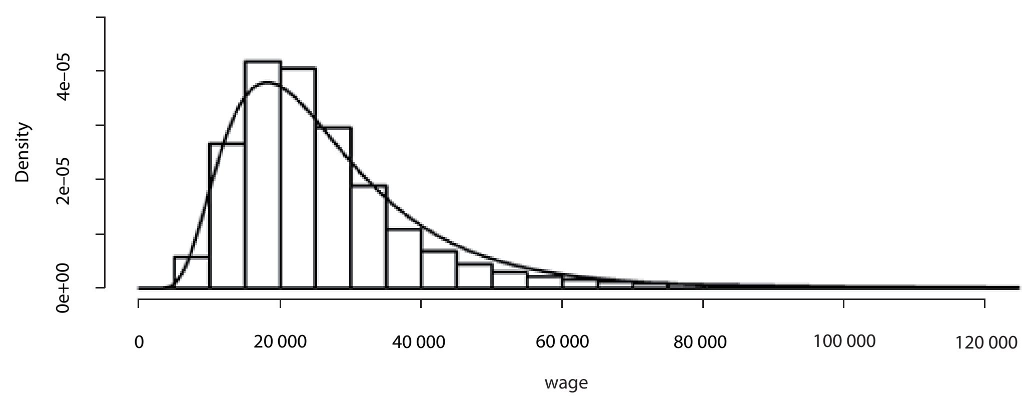
As was mentioned above, the log-normal distribution is often used above all for its convenient theoretical qualities. This distribution is used for example in economics, financial applications, hydrology and other scientific areas. The probability density function of the 3-parameter log-normal distribution is calculated according to the formula (5).

$$f(y) = \frac{1}{(y-\lambda)\sigma\sqrt{2\pi}} \exp\left\{-\frac{[\ln(y-\lambda-\mu]^2}{2\sigma^2}\right\}, \quad (5)$$

where $0 \le \lambda \le y$, $-\infty < \mu < \infty$, $\sigma > 0$ are parameters of the probability density function, specifically μ is the expectation value, σ is the standard deviation and λ is the shift parameter. Density function (5) is defined for $y > 0$.

The Figure 5 shows the observed wages (the histogram) and the probability density function of the 3-parameter log-normal distribution (the solid line). Parameters obtained by the maximum likelihood estimation are $\mu = 10.0331$, $\sigma = 0.5326$, $\lambda = 1\,004.13$.

Figure 5 The probability density function of the 3-parameter log-normal distribution and the histogram of observed wages



Source: ISPV, own calculations

2.5 2-parameter log-normal distribution

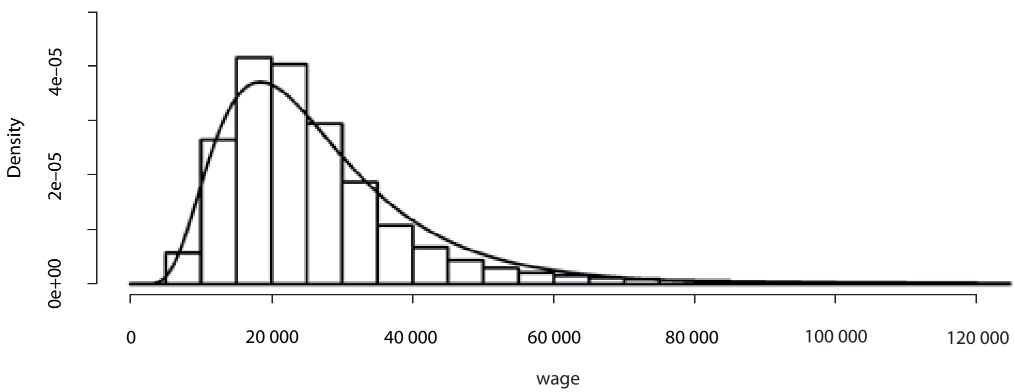
The 2-parameter log-normal distribution is used more frequently than its 3-parameter extension. It is obvious that – if the shift parameter of the 3-parameter log-normal distribution (λ) equals zero – the probability density function of the 2-parameter log-normal distribution is given by the formula (6).

$$f(y) = \frac{1}{y\sigma\sqrt{2\pi}} \exp\left\{ -\frac{[\ln(y-\mu]^2}{2\sigma^2} \right\}, \qquad (6)$$

where $-\infty < \mu < \infty$, $\sigma > 0$, are parameters of the density function, μ is the expected value and σ is the standard deviation. The density function is defined for values of $y > 0$.

The Figure 6 shows the observed wages (the histogram) and the probability density function of the 2-parameter log-normal distribution (the solid line). Parameters obtained by the maximum likelihood estimation are $\mu = 10.0818$, $\sigma = 0.5106$.

Figure 6 The probability density function of the 2-parameter log-normal distribution and the histogram of observed wages



Source: ISPV, own calculations

2.6 2-parameter Gamma distribution

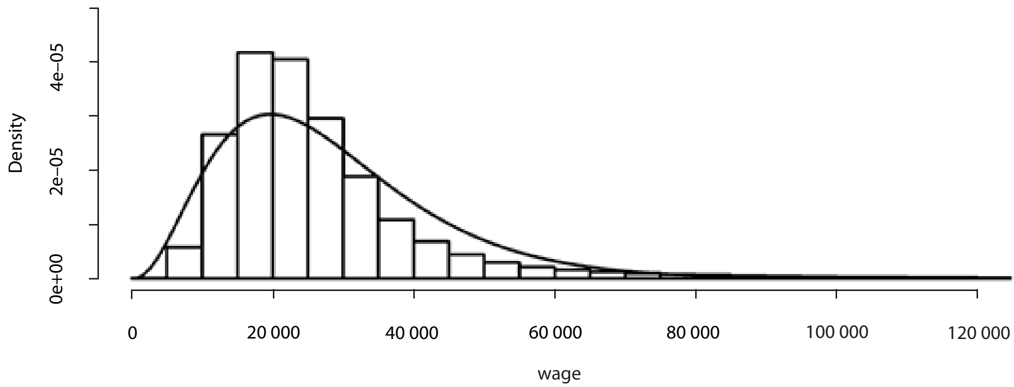
The Gamma distribution has expanded parameterization according to the purpose of its modeling. As for the probability density function, there are many modifications available. In this paper we use the following form (7).

$$f(y) = \exp(-\beta y) \times y^{\alpha-1} \frac{\beta^{\alpha}}{\Gamma(\alpha)}, \qquad (7)$$

where the parameter α determines the shape of the distribution and β is the parameter determining the scale (also known as the inverse scale parameter, because it is calculated as an inversion of the original scale parameter in the basic definition of the distribution) and Γ is the gamma function.

Figure 7 shows the observed wages (the histogram) and the probability density function of the 2-parameter Gamma distribution (the solid line). Parameters obtained by the maximum likelihood estimation are $\alpha = 0.00012197$, $\beta = 3.4015398$.

Figure 7 The probability density function of the 2-parameter Gamma distribution and the histogram of observed wages



Source: ISPV, own calculations

2.7 Weibull distribution

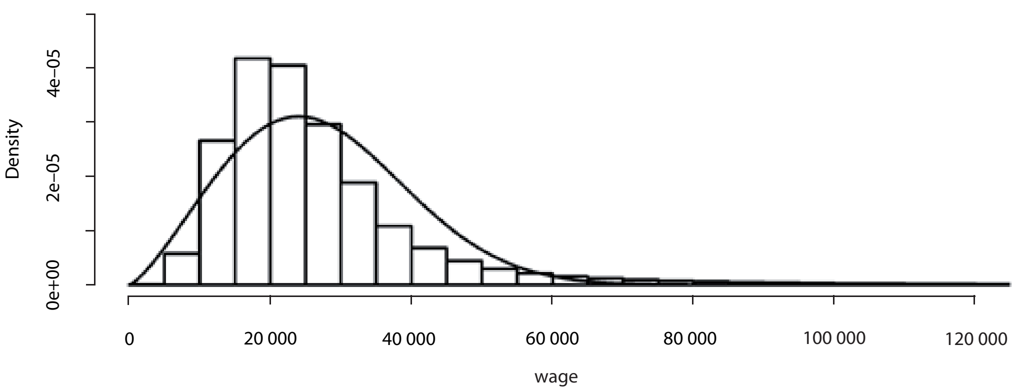
The Weibull distribution (Weibull, 1951) is often used in the reliability theory for the random variable, which represents a lifetime (especially of a technical equipment). Another use of this distribution is particularly in situations where the log-normal distribution does not meet the research requirements. The probability density function of the Weibull distribution is defined by the formula (8).

$$f(y) = ay^{a-1}\exp\left[-(y/b)^{a}\right]/(b^{a}), \tag{8}$$

where $y > 0$, $a > 0$ is the parameter, which determines the shape of the distribution, $b > 0$ is the scale parameter.

The Figure 8 shows the observed wages (the histogram) and the probability density function of the 2-parameter Weibull distribution (the solid line). Parameters obtained by the maximum likelihood estimation are $a = 2.3172$, $b = 30\ 660$.

Figure 8 The probability density function of the Weibull distribution and the histogram of observed wages



Source: ISPV, own calculations

2.8 Results

The Figure 9 compares the results mentioned above and shows the fitting of all selected theoretical distributions to observed wages. Observed wages are represented by histograms and the probabilistic distributions are illustrated by the probability density functions (solid lines). Individual graphs are sorted by the best fit according to the AIC (1).

The fit between theoretical and empirical wage distributions is more clearly shown in the Table 1, which contains estimated parameters, the logarithm of the likelihood and values of the AIC (1).

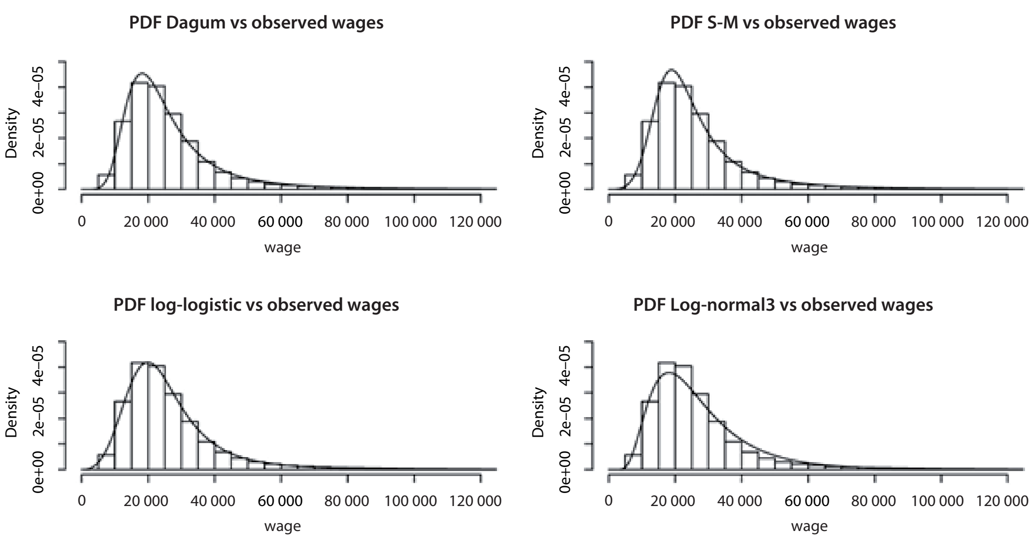
Table 1 Fits between empirical and theoretical wage distributions

Distribution	Parameter estimates			log-likelihood	AIC
Dagum	$a = 2.930$	$b = 15\,974.43$	$p = 2.3042$	–16 448 865	32 897 736
Singh-Maddala	$a = 4.602$	$b = 18\,940.34$	$q = 0.5725$	–16 450 507	32 901 020
Log-logistic	$a = 3.610$	$b = 23\,283.94$		–16 472 863	32 945 730
3-param. log-normal	$\mu = 10.033$	$\sigma = 0.5326$	$\lambda = 1\,004.13$	–16 473 337	32 946 680
2-param. log-normal	$\mu = 10.081$	$\sigma = 0.5106$		–16 512 126	33 024 256
2-parameter Gamma	$\alpha = 0.000121$	$\beta = 3.4015$		–16 677 991	33 355 986
Weibull	$a = 2.3172$	$b = 30\,660$		–16 865 534	33 731 072

Source: ISPV, own calculations

It is obvious, that the best fitting wage distribution is the Dagum distribution and the log-normal distribution does not by far suit the data well.

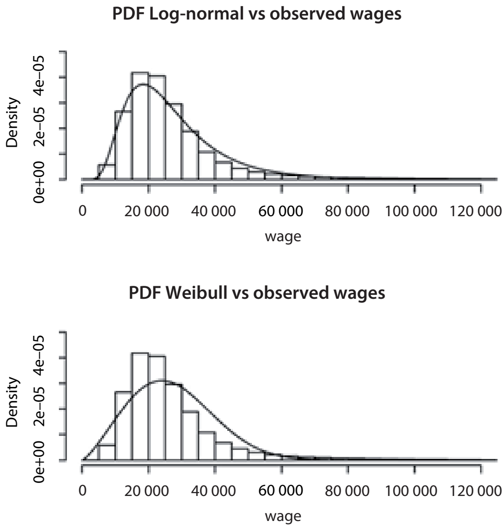
Figure 9 Probability density functions of common wage distributions



Source: ISPV, own calculations

Figure 9 Probability density functions of common wage distributions

Continued

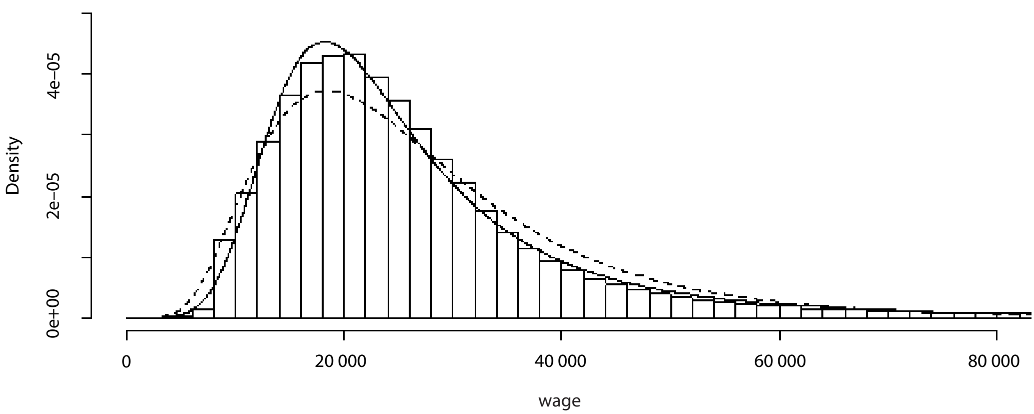


Source: ISPV, own calculations

3 WAGE DISTRIBUTION AND MINIMUM WAGE EFFECTS MODELING

To illustrate the role of the wage distribution in economic models, we will focus on the results of the Meyer & Wise's (1983a, 1983b) model which presents the method how to estimate the effect of the minimum wage on wages and employment using data based only on the observed distribution of wages. As for wage distributions, there is no doubt about using the Dagum distribution which seems to be the best-fitting one. By way of illustration, we will quantify the Meyer & Wise's model using not only the Dagum distribution, but also the 2-parameter log-normal distribution which is on one hand often used but on the other hand is not the well-fitting one as far as wages are concerned (see Table 1 and Figure 10).

Figure 10 The probability density function of the Dagum (the solid line) and 2-parameter log-normal (the dashed line) distributions and the histogram of observed wages

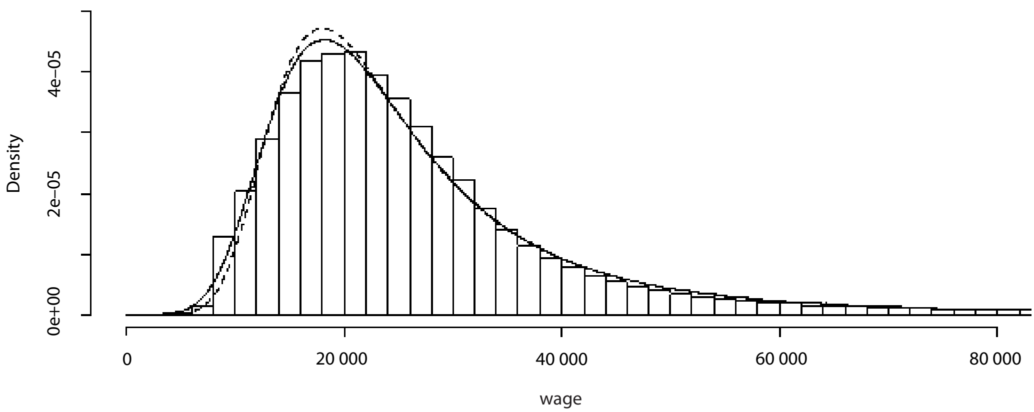


Source: ISPV, own calculations

As was mentioned above, the Meyer & Wise's model compares the distribution of market wage rates that individuals would receive in the absence of the minimum and the observed distribution with the minimum. As for observed wages, the distribution in the wage sphere is well-known (see the section 2) but it is very difficult to find the theoretical distribution in the absence of the minimum. In practice, truncated distributions are used to substitute the missing distribution.

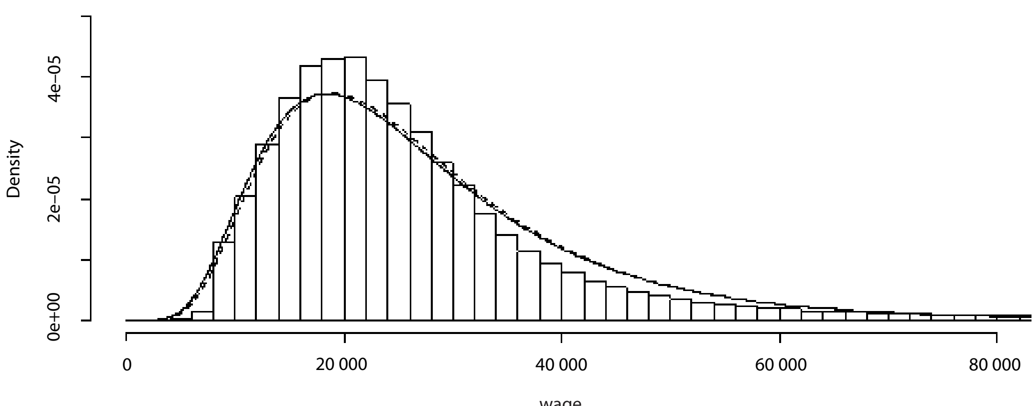
In Figures 11 and 12, there are shown the Dagum and 2-parameter log-normal distributions (solid lines) with the corresponding distributions truncated from the left at 8 800 CZK (dashed lines). Truncated distributions make use only of a part of the sample because objects with lower wages are excluded. In accord with the theory, a higher mean is typical of truncated distributions from the left (see the Table 2). As for the higher mean of the truncated distribution, it is important that individual means do not differ at too high levels because difference is „only" a half of the intervals used to quantify differences between the situations with and without minimum wage (the range of intervals equals to CZK 1 000).

Figure 11 The probability density function of the Dagum (the solid line) and Dagum distribution truncated from the left at 8 800 CZK (the dashed line) and the histogram of observed wages



Source: ISPV, own calculations

Figure 12 The probability density function of the 2-parameter log-normal (the solid line) and 2-parameter log-normal distribution truncated from the left at 8 800 CZK (the dashed line) and the histogram of observed wages



Source: ISPV, own calculations

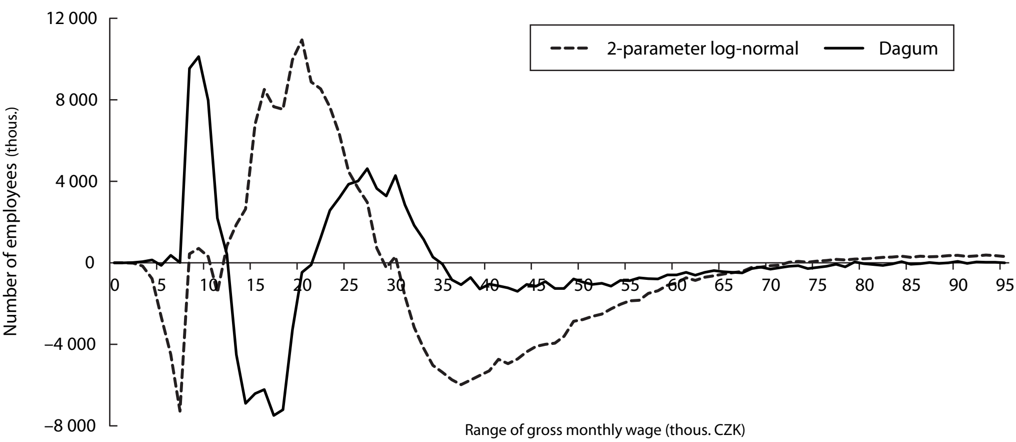
Table 2 Statistical characteristics of the Dagum and 2-parameter log-normal distributions and the Dagum and 2-parameter log-normal distributions truncated from the left at 8 800 CZK

Distribution	n	E(X)	Median	Variance
Dagum	1 524 860	27 663	22 836	450 201 178
Dagum truncated	1 507 392	28 060	22 876	511 571 849
2-parameter log-normal	1 524 860	27 233	23 904	220 908 895
2-parameter log-normal truncated	1 507 392	27 426	24 211	213 096 556

Source: ISPV, own calculations

If we compare the distribution of market wage rates that individuals would receive in the absence of the minimum (the distribution truncated from the left extrapolated up to the lower tail) and the observed distribution, the difference represents the effect of minimum wage on wages and employment in the wage sphere. Differences between observed values and truncated Dagum (or log-normal) distribution are shown in the Figure 13. The interpretation of results is obvious – the areas above the x axis represent the employment gains owing to the minimum wage (i.e. in the existence of the minimum wage, there are more employees remunerated at the wage ranging in the given interval), the areas under the axis represent employment losses (i.e. in the existence of the minimum wage, there are less employees remunerated at the wage ranging in the given interval).

Figure 13 Results of the Meyer & Wise's model using Dagum and 2-parameter log-normal distributions



Source: ISPV, own calculations

The diametrically opposite results showed in the Figure 13 for the Dagum and 2-parameter log-normal distribution imply that the distribution really matters. The only conclusion, we can draw for both distributions, is that the minimum wage distorts the wage distribution. The shift in an actual distribution differs between the Dagum and the 2-parameter log-normal distribution. As for the 2-parameter log-normal distribution, the spill-over effect is clearly evident even for highest wages (see employment losses in the intervals surrounding the 9th decile, roughly said 40 000 CZK) and what is more, there is no spike at the minimum representing the lowest wage workers clustering to the minimum wage after its introduction.

These findings contradict both the minimum wage theory and empirical studies carried out in other countries. On the contrary, conclusions drawn from the Dagum distribution are in accordance with the economic theory as well as empirical studies, i.e. there is a spike at the minimum and the spill-over effect corresponds to the best knowledge as far as the minimum wage is concerned.

CONCLUSION

In this paper we present empirical work on the wage distribution in the Czech Republic and its further use in an economic model concerning the labour market consequences of the minimum wage.

Contrary to other authors, we assume that the log-normal distribution is not the best-fitting one as far as wages in the Czech Republic are concerned. We fit common income and wages distributions to the microdata from the Average Earnings Information System using the maximum-likelihood estimation to estimate the parameters of individual models. In our case, a random variable is defined as the nominal average gross monthly wage in the wage sphere in the Czech Republic in 2011. In accord with our assumption, the log-normal distribution does not by far suit the data well and the best- fitting distribution is the Dagum distribution.

To achieve the second aim, i.e. to illustrate the role of the wage distribution in economic models, we quantify the Meyer & Wise's (1983a, 1983b) model that estimates the employment consequences of minimum wages. According to the model, we compare the distribution of wages that individuals would receive in the absence of the minimum wage (i.e. an estimate based on the distribution truncated from the left and subsequently extrapolated up to the lower tail) and the observed distribution, so the difference represents the effect of the minimum wage on wages and employment in the wage sphere. By way of illustration, we quantify the Meyer & Wise's model using not only the Dagum distribution, but also the 2parameter log-normal distribution which is not the well-fitting one as far as wages are concerned.

In view of the fact, that more work concerning above all truncation points is needed to identify how robust are the results of the Meyer & Wise's model in the Czech Republic, we focus on conclusions resulting from alternative measures of wage distributions. The only conclusion, we can draw for both distributions, is that the minimum wage distorts the wage distribution. The shift in an actual distribution differs between the Dagum and the 2-parameter log-normal distribution. As for the 2-parameter log-normal distribution, there is no spike at the minimum wage representing the lowest wage workers clustering to the minimum wage which contradicts both the minimum wage theory and empirical studies carried out in other countries. On the contrary, conclusions drawn from the Dagum distribution are in accordance with the economic theory as well as empirical studies. In other words, we found the evidence that the distribution really matters.

Last but not least our analysis illustrates the fact that well-specified models are required to evaluate the impact of state interventions on social-economic development. Improperly used models result in distorted conclusions and if we think of the worst consequences, it might be misused in favour of preferred solution alternatives.

References

COHEN, A. C., WHITTEN, B. J. Estimation in the Three-Parameter Lognormal Distribution. *Journal of the American Statistical Association,* 1980, Vol. 75, No. 370, pp. 399–404.

DAGUM, C. Un nouveau modèle de répartition du revenu privé: spécification et estimation. *Économie Appliquée,* 1977, Vol. 30, No. 3, pp. 413–437. Reprinted in: CHOTIKAPANISCH, D. eds. *Modeling Income Distributions and Lorenz Curves.* New York: Springer Verlag, 2008, pp. 3–25.

DICKENS, R., MACHIN, S., MANNING, A. Estimating the Effect of Minimum Wages on Employment from the Distribution of Wages: A Critical Review. *Centre for Economic Performance LSE CEP Discussion Paper,* No. 203 (August 1994).

DOLADO, J., KRAMARZ, F., MACHIN, S., MANNING, A., MARGOLIS, D., TEULINGS, C. The Economic Impact of Minimum Wages in Europe. *Economic Policy,* 1996, Vol. 23, pp. 317–372.

DUSPIVOVÁ, K., SPÁČIL, P. The Czech Labour Market and the Current Economic Crisis: What Can the Linked Employer-Employee Data Tell Us? *Statistika*, 2011, 48, 4 (December), pp. 22–34.

ISPV. *Informační systém o průměrném výdělku: 2011, IV. čtvrtletí, Mzdová sféra* (Information System on Average Earnings: 2011, IV. Quarter, Wage Sphere). Prague: Ministry of Labour and Social Affairs, 2012.

KLEIBER, C. A Guide to the Dagum Distributions. *The Center of Business and Economics, University of Basel (WWZ) Working Paper* No. 23/07, 2007.

KLEIBER, C., KOTZ, S. *Statistical Size Distributions in Economics and Actuarial Sciences.* New Jersey: John Wiley & Sons Inc., 2003.

MALENOVSKÝ, L., DUSPIVOVÁ, K. Harmonisation of the Average Earnings Information System (MoLSA) with the Wage Statistics (CZSO). *Statistika: Statistics and Economy Journal,* 2012. Vol. 49, No. 2, pp. 76–89.

MANKIW, N. G. *Principles of Economics.* Fort Worth, TX [US]: Dryden Press, 1998.

MAREK, L. Analýza vývoje mezd v ČR v letech 1995–2008 (Analysis of the Wages in the Czech Republic in 1995–2008). *Politická ekonomie,* 2010, Vol. 58, No. 2, pp. 186–206.

MEYER, R. H., WISE, D. A. Discontinuous Distributions and Missing Persons: The Minimum Wage and Unemployed Youth. *Econometrica,* 1983a, Vol. 51, No. 6 (Nov.), pp. 1677–1698.

MEYER, R. H., WISE, D. A. The Effects of the Minimum Wage on the Employment and Earnings of Youth. *Journal of Labor Economics,* 1983b, Vol. 1, No. 1 (Jan.), pp. 66–100.

MILANOVIC, B. *Income, Inequality, and Poverty During the Transition from Planned to Market Economy.* Washington, D.C.: The World Bank. 1998.

SINGH, S. K., MADDALA, G. S. A Function for Size Distribution of Incomes. *Econometrica,* 1976, Vol. 44, No. 5 (Sep.), pp. 963–970.

STIGLER, G. J. The Economics of Minimum Wage Legislation. *The American Economic Review,* 1946, Vol. 36, No. 3 (Jun.), pp. 358–365.

THOMAS, W. Y., WILD, C. J. Vector Generalized Additive Models. *Journal of Royal Statistical Society,* 1996, Series B, Vol. 58, No. 3, pp. 481–493.

WEIBULL, W. A Statistical Distribution Function of Wide Applicability. *Journal of Applied Mechanics,* 1951, Vol. 18, No. 3, pp. 293–297.

Measuring the Efficiency of Public Road Transport Companies in the Slovak Republic Using DEA and SFA

Pavol Kráľ[1] | *Matej Bel University, Banská Bystrica, Slovakia*
Viera Roháčová[2] | *Matej Bel University, Banská Bystrica, Slovakia*

Abstract

The paper measures and compares the efficiency of companies providing public road transport in the Slovak Republic. For this purpose two rather complementary methods, namely data envelopment analysis (DEA) and stochastic frontier analysis (SFA), are used. An input-oriented slack based model under variable returns to scale is applied as a DEA efficiency measure. The validity of DEA results is confirmed by the stability analysis consisting of re-calculation of DEA under different combinations of inputs and outputs. Identified efficient decision making unites are ranked using super-efficiency. A SFA model is based on the well-known Cobb-Douglas function type, assuming normally distributed errors and half-normally distributed inefficiencies. In order to overcome the multicolinearity problem principal component analysis is applied. Finally, we identify transport companies efficient with respect to both methods.

Keywords	***JEL code***
Data envelopment analysis, stochastic frontier analysis, efficiency measurement, public road transport	*L91, C67, C44*

INTRODUCTION

Transport is one of the key factors in the development of any modern society and in itself it is not a goal but a means of economic development and a prerequisite for achieving social and regional cohesion (Kitnerová, 2008, p. 18). The transport sector (H branch of the Statistical classification of economic activities SK NACE Rev. 2) is one of the largest spheres of economy and because of its importance and role in the national economy it is an equal partner of agriculture or information and communication sector (see Figure 1). In the Slovak Republic, for example, transport (land, air, water and pipeline transport) contributed 1.591 billion € to Slovak's Gross Domestic Product (GDP) in 2010, representing around 2.57 per

[1] Matej Bel University, Faculty of Economics, Department of Quantitative Methods and Information Systems, Tajovského 10, 975 90 Banská Bystrica, Slovakia. Corresponding author: e-mail: pavol.kral@umb.sk, phone: (+421)484466614.

[2] Matej Bel University, Faculty of Economics, Department of Quantitative Methods and Information Systems, Tajovského 10, 975 90 Banská Bystrica, Slovakia. Corresponding author: e-mail: viera.rohacova@umb.sk, phone: (+421)484466617.

cent of the Slovak economy. According to SLOVSTAT database (Statistical Office of the SR, 2012), the average number of employed persons was 140 420 in the third quarter of 2012, representing around 6.42 per cent of the total average number of employed persons.

The functioning of the transport market is influenced by national economic and social policy. In this sense transport companies are understood not only as part of the economy, but also as part of the infrastructure. Proportions of market principles and government interventions are one of the traits that characterize the transport market. These macroeconomic and microeconomic aspects are the main driver of many discussions aimed at achieving efficiency of the transport sector.

The scientific community works with a number of quantitative approaches to measure the efficiency of the transformation process. These can be classified into two groups. Group of parametric methods is characterized by the stochastic nature represented by including at least one random component, i.e. stochastic frontier analysis (SFA), thick frontier analysis (TFA), distribution free approach (DFA), etc. The second group of non-parametric methods is characterized by the deterministic nature and thus they do not effectively eliminate the negative influence of random errors, errors in measurement or imperfect data to measure efficiency, i.e. data envelopment analysis (DEA) and free disposal hull (FDH). Two methods DEA and SFA are linked with both strengths and weaknesses. The solution of DEA model does not generate any error estimation and creates no space for classical hypothesis testing of the statistical significance of the results. In addition, any deviation from the production possibility frontier (PPF) is considered as inefficiency, i.e. there is no possibility of random shocks as well as measurement errors. SFA, on the other hand, takes into account that the deviation from the PPF is not necessarily a manifestation of production unit inefficiency. It can be caused by some noise in the data, or unspecified error (Kočišová, 2008, p. 379) or as a result of accident (luck) or measurement errors (Vincová, 2005, p. 24). Unfortunately, it requires strict parametric functional form and distributional assumptions. At the present state of the art of the two approaches should primarily be viewed as complements rather than substitutes (Kooreman, 1994, p. 345).

1 LITERATURE REVIEW

The literature related to the efficiency measurement of transport sector has developed rapidly over the last few years. The main impetus was the need to eliminate of inefficiency in transport performance in terms of society-wide interest, as well as growing competition between transport companies. Given the relatively specific group of inputs used and outputs achieved in the transport sector, the need arose to apply the approaches allowing the inclusion of variables expressed not always in a financial nature.

In earlier research the non-parametric method DEA and parametric method SFA were used separately. In recent years, the issue of measuring transport efficiency by DEA is elaborated, i.e. in Barnum et al. (2007), Sampaio et al. (2008), Agarwal (2009), Kliestik (2009) and Ozbek et al. (2009). Barnum et al. (2007) applied DEA in measuring the efficiency of public transport in Chicago. The authors simultaneously examined the effects of external environmental factors on the efficiency of decision making units (DMUs). Sampaio et al. (2008) analyzed technical efficiency of 19 transport systems of Europe and Brazil by means of the radial output-oriented BCC model of Banker, Charnes and Cooper (1984) (hence the acronym BCC) and Agarwal (2009) examined the differences in technical efficiency and scale efficiency of 29 state transport undertakings in India. Kliestik (2009) applied input and output-oriented CCR model of Charnes, Cooper and Rhodes (1978) (hence the acronym CCR) to evaluate the efficiency of 15 transport companies in the Slovak Republic. Using Malmquist index Kliestik evaluated the efficiency change in two successive periods. Ozbek et al. (2009) primarily focused on the DEA methodology and utilized CCR model to compare the efficiency of state transportation departments in the maintenance of highways.

Farsi et al. (2006) and Holmgren (2012) are dealing with the quantification of the efficiency of transport using SFA. Farsi et al. (2006) quantified cost and scale efficiencies of Switzerland's regulated rural bus companies operating in regional networks using 4 alternative SFA models. The final dataset involved 985 observations including 94 operators over a 12-year period from 1986 to 1997. Holmgren (2012) evaluated the efficiency of public transport operations undertaken in 26 Swedish counties by the public transport authorities, in the period 1986–2009, taking into account substantial differences in operating conditions between countries.

Additionally, both DEA and SFA methods have been applied simultaneously in transport sector, e.g. Lan and Lin (2003), Michaelides et al. (2009), Margari et al. (2007). Lan and Lin (2003) adopted these methods to estimate productive efficiency of 74 railway systems in 1999. Lan and Lin (2003) used CCR and BCC DEA models and the SFA with translog production function for the half-normal and truncated-normal distributions. Michaelides et al. (2009) performed an independent comparison of DEA and SFA results in measuring technical efficiency in International Air Transport. Using a panel set of the world's 24 largest network airlines, for the period 1991–2000, Michaelides et al. (2009) concluded that SFA results are comparable to those from DEA. Margari et al. (2007) used a special three-stage DEA-SFA approach using panel of 42 Italian public transit companies for the period 1993–1999. Authors decomposed DEA inefficiency measures into three components: exogenous effects, pure managerial inefficiency and statistical noise.

2 METHODS

In measuring the efficiency of the 20 transportation companies[3] of the Slovak Republic via DEA in 2010 it is necessary to select appropriate set of inputs and outputs. One of the established aspects of selection variables is to fulfil an initial condition regarding the number of inputs and outputs in relation to the number of DMUs. In this context, Ozbek et al. (2009) postulate the following rule for the minimal number of DMUs (n):

$$n \geq 2ms, \tag{1}$$

where m is the number of inputs and s is the number of outputs.

Table 1 presents 8 possible combinations of 5 inputs and 2 outputs, which relatively precise characterize operations of the transport companies. It is clear that the total number of inputs and outputs fulfils the condition (1).

In order to choose an appropriate DEA model one has to specify the orientation of the model, form of identified technical efficiency and the assumption of returns to scale. Concerning the purpose of the analysis it is appropriate to consider the quantification of input-oriented Pareto-Koopmans technical efficiency under assumption of the variable returns to scale. Input orientation is due to the nature of variables considered, i.e. within the frame of increasing efficiency a potential reduction in the level of inputs relative to a given level of outputs is considered. The score of Pareto-Koopmans technical efficiency can be quantified by non-radial DEA models and assumption of the variable returns to scale takes into account the different scale of transport operations. All these arguments are satisfied by using input-oriented Slack Based Model under variable returns to scale assumption – hereafter SBM-I-V model (Tone, 2001).

[3] Totally 14 companies of the Slovak Bus Transport (SBT), i. e. SBT Banská Bystrica Inc., SBT Dunajská Streda Inc., SBT Humenné Inc., SBT Lučenec Inc., SBT Michalovce Inc., SBT Nové Zámky Inc., SBT Poprad Inc., SBT Prešov Inc., SBT Trenčín Inc., SBT Trnava Inc., SBT Žilina Inc., SBT Liorbus Inc., Veolia Transport Nitra Inc. and Slovak Lines Inc. and 6 City Transport Companies (CTC), i. e. CTC Bratislava Inc., CTC Banská Bystrica Inc., CTC Košice Inc., CTC Prešov Inc., CTC Žilina s.r.o. and CTC Považská Bystrica Inc.

Let $\mathbf{X} \in R_+^{m \times n}$ represents a matrix of m inputs of n DMUs and $\mathbf{Y} \in R_+^{s \times n}$ represents a matrix of s outputs of n DMUs. Any DMU o, $o \in \{1, \ldots, n\}$ transforms m inputs $\mathbf{x}_o \in R_+^m$ into s outputs $\mathbf{y}_o \in R_+^s$. Consider a vector of potential disproportional slacks of inputs – *excesses* $\mathbf{s}_o \in R_+^m$ that shift up DMU o to the production possibility frontier. Then a potential input inefficiency of DMU o can be expressed as average percentage slacks of inputs $\frac{1}{m}\sum_{i=1}^{i=m}\frac{s_{io}}{x_{io}}$. The optimization task of SBM-I-V model is then formulated as:

$$\min_{\mathbf{s}_o,\boldsymbol{\lambda}} \; \rho = 1 - \frac{1}{m}\sum_{i=1}^{i=m}\frac{s_{io}}{x_{io}} \quad \text{subjekt to} \quad \begin{aligned} &\mathbf{s}_o = \mathbf{x}_o - \mathbf{X}\boldsymbol{\lambda} \geq \mathbf{0}, \\ &\mathbf{Y}\boldsymbol{\lambda} - \mathbf{y}_o \geq \mathbf{0}, \\ &\boldsymbol{\lambda} \geq \mathbf{0}, \\ &\mathbf{e}'\boldsymbol{\lambda} = 1, \end{aligned} \tag{2}$$

where $\boldsymbol{\lambda} \in R^n$ is a vector of weights, $\mathbf{e} \in R^n$ is a corresponding unit vector, $\mathbf{s}_o \in R_+^m$ is a vector of potential disproportional input slacks and ρ is a score of efficiency taking values from the interval (0, 1). As an optimal solution of the model (2) is ($\mathbf{s}_o^*$, $\boldsymbol{\lambda}^*$), the DMU o ($\mathbf{x}_o$, $\mathbf{y}_o$) is considered efficient if $\rho = 1$, i.e., $\mathbf{s}_o^* = \mathbf{0}$.

In order to solve the problem of many DMUs efficiency being 1, we can use a slack-based measure of super efficiency ρ^* to estimate DMUs efficiency (Tone, 2002). Super-efficiency model discriminates between these efficient DMUs. The corresponding super SBM-I-V model is the following:

$$\min_{\bar{x},\bar{y},\lambda} \; \rho^* = \frac{1}{m}\sum_{i=1}^{i=m}\frac{\bar{x}_i}{x_{io}} \quad \text{subjekt to} \quad \begin{aligned} &\bar{\mathbf{x}} \geq \sum_{j=1,\neq o}^{n} \lambda_j \mathbf{x}_j, \\ &\bar{\mathbf{y}} \leq \sum_{j=1,\neq o}^{n} \lambda_j \mathbf{y}_j, \\ &\sum_{j=1,\neq o}^{n} \lambda_j = 1, \\ &\boldsymbol{\lambda} \geq \mathbf{0}, \bar{\mathbf{x}} \geq \mathbf{x}_o, \bar{\mathbf{y}} = \mathbf{y}_o. \end{aligned} \tag{3}$$

SFA is a parametric method of measuring the relative efficiency of production units based on the cost and production functions. We assume that these functions have a specific functional form with unknown parameters. In the presented study we restrict ourselves to the well-known Cobb-Douglas function type:

$$y = \beta_0 x_1^{\beta_1} x_2^{\beta_2} \cdots x_m^{\beta_m}, \tag{4}$$

where y is an output, $x_1, x_2, \ldots, x_m$ are inputs and $\beta_o \in R_+$, $\beta_1, \beta_2, \ldots, \beta_m \in R$ are unknown production technology parameters.

The underlying assumption of SFA is that the deviations from the production frontier are results of both inefficiency and noise. Assuming an additive specification we use the following base model (Bogetoft, 2011):

$$y^k = f\left(x^k; \beta\right) + v^k - u^k, \; k = 1, \ldots, n \tag{5}$$

where $f(x^k; \beta)$ is the logarithm of Cobb-Douglas function type (4), $v^k \sim N(0, \sigma^2_v)$ is the random error, $u^k \sim N_+(0, \sigma^2_u)$ is the possible inefficiency (N_+ denotes a half-normal probability distribution) and v^k, u^k are independent. The model can be reparametrized using $\sigma^2 = \sigma_u^2 + \sigma_v^2$, $\lambda = \sqrt{\frac{\sigma_u^2}{\sigma_v^2}}$ (Kumbhakar, 2003). As $\lambda \rightarrow 0$ either $\sigma^2_v \rightarrow \infty$ or $\sigma^2_u \rightarrow \infty$, i.e. the random error dominates the inefficiency and we have the ordinary regression. As $\lambda \rightarrow \infty$ either $\sigma^2_v \rightarrow 0$ or $\sigma^2_u \rightarrow \infty$, i.e. the inefficiency dominates the random error. The parameters λ and σ are estimated along with the parameters β using the maximum likelihood method (Kumbhakar, 2003).

The DMU-specific technical efficiency *TE* is then given by (Bogetoft, 2011):

$$TE^k = 1 - \frac{\hat{u}}{f\left(x^k, \hat{\beta}\right)}, k = 1, \ldots, n. \quad (6)$$

SFA provides us with significance test for parameters of stochastic frontier function coefficients. They are analogous to the tests used in multiple linear regression. More details can be found in (Bogetoft, 2011).

3 RESULTS

The data set consists of a cross-sectional data extracted from Annual Reports 2010 provided by fourteen companies of the Slovak Bus Transport (SBT) and six city transport companies (CTC). Three SBT companies were omitted because they did not provide data. The available variables were split into inputs (the average number of employees (IN1), total kilometres driven (IN2), total number of vehicles (IN3), tangible fixed assets (IN4), operation costs (IN5)) and outputs (total number of passengers (OUT1) and total sales (OUT2)).

One of the main claims for the selection of variables is a relatively high between-group correlation, i.e. all outputs should be directly generated by inputs. For the purpose to quantify the intensity of dependence between the set of inputs and the set of outputs the canonical correlation analysis was applied. The stated criterion speaks in favor of the first combination of inputs and outputs, i.e. 1st possible combination in Table 1. The correlation matrix of all considered variables is displayed in Table 2. Listed correlation coefficients indicate the problem with multicollinearity in the case of inputs. It can negatively influence the results of SFA. Also the assumed outputs are highly correlated. Therefore we applied principal component analysis (PCA) and replaced the original inputs in SFA by the first two principal components representing 96.8% of variance and the original outputs by the first principal component representing 96.5% of variance.

Applying model (2) we obtained results listed in Table 3. It is easy to identify the high number of technically efficient companies (twelve). Moreover, three companies are relatively close to the production frontier and there is small difference in technical efficiency among inefficient companies with low technical efficiency. DEA results are generally quite sensitive to the selection of the DMUs and the selection of inputs and outputs. Ozbek et al. (2009) emphasize the need of a sensitivity analysis in the form of re-calculating the DEA model with omitted variables or some DMUs. In this case, the DEA sensitivity analysis was performed as re-calculating of the SBM-I-V model (2) for different combinations of inputs and outputs according to Table 1. To compare difference between the efficiency scores, Pearson's and Spearman's rank correlation coefficients were used. The relatively high values of correlation coefficients can be a sign that two approaches generate very similar values of efficiency scores. As Table 4 shows, it can be concluded that the DEA results were not highly influenced by the selection of inputs and outputs.[4] Then applying model (3) we ranked efficient DMUs (column ρ^* in Table 3).

Applying (5) and (6) we obtained results listed in Table 3 (column TE) and Table 6 (part a). According to them approximately 98% ($100 \times \frac{\lambda^2}{1+\lambda^2}$) of the total error variance is due to inefficiency. However, λ and the parameter corresponding to the second component of inputs are not statistically significant (p-value = 0.268, p-value = 0.1, respectively). It was probably caused by the small number of DMUs. If we omit the second principal component of inputs (Table 6, part b), λ remains insignificant (p-value = 0.209). Moreover, the resulting efficiencies are very similar (column TE* in Table 3). There is only one interesting difference, namely CTC Bratislava and CTC Košice exchanged their positions

[4] Only the 2nd combination of inputs and outputs provided the relatively different results. In almost all cases, relatively-low values of correlation coefficients were reported.

(TE = 0.915, TE* = 0.723 for CTC Bratislava, TE = 0.707, TE* = 0.966 for CTC Košice). Because DEA methods and SFA were applied to different data sets (principal components versus original variables), results are not directly comparable. Applying SBM-I-V model to principal components we got results listed in Table 3, column ρ' (for two inputs and one output) and column ρ" (for one input and one output). For two inputs and one output two DMUs are efficient (CTC Kosice and CTC Bratislava). Moreover, almost all other DMUs have efficiencies between 0.5 and 0.7. For one input and one output, one DMU is efficient (CTC Bratislava) and all other DMUs have efficiencies between 0.16 and 0.244. If we omit CTC Bratislava, we can get results similar to SFA model with one input and one output.

Using boxplots and multidimensional scaling we can identify CTC Bratislava and CTC Košice as outliers. Omitting these companies and applying model (2) we can get very similar set of efficient DMUs. The previously efficient DMUs remain efficient and SBT Trenčín transforms to an efficient DMU.

CONCLUSION

The presented paper is the initial stage of our research devoted to efficiency of public transport companies in Slovakia. The set of twelve efficient companies resulting from the slack based input-oriented DEA model with variable returns to scale was further ranked using super slack based input-oriented DEA model. Moreover, obtained results were compared to SFA model based on the well-known Cobb-Douglas type of production function. Due to highly correlated inputs and outputs we used simple SFA models with one output and two inputs based on principal components or one output and two inputs, respectively. The presented SFA models are not statistically significant but are in general coherent with results obtained applying DEA methods to the same data set. Models can be negatively affected by the insufficient number of decision making units and by the presence of outliers in our data set. According to our analysis the set of efficient DMUs includes all city transport companies. A thorough analysis of identified efficient companies (separately for CTCs), as well as a comparative application of alternative DEA and SFA models will be the object of our future research.

References

AGARWAL, S. *Measuring the Efficiency of Public Transport Sector in India: An Application of Data Envelopment Analysis* [online]. Philadelphia, USA, July, 2009. [cit. 5.1.2012]. <http://astro.temple.edu/~banker/dea2009/paper/Agarwal.pdf>.

AIGNER, D., LOVELL, C. A. K., SCHMIDT, P. Formulation and Estimation of Stochastic Frontier Production Function Models. *Journal of Econometrics*, 1977, 6, pp. 21–37.

BANKER, R. D., CHARNES, A., COOPER, W. W. Some Models for Estimating Technical Scale Inefficiencies in Data Envelopment Analysis. *Management Science*, 1984, 30 (9), pp. 1078–1092.

BARNUM, D. T., MCNEIL, S., HART, J. Comparing the Efficiency of Public Transportation Subunits Using Data Envelopment Analysis. *Journal of Public Transportation*, 2007, 10 (2), pp. 1–16.

BOGETOFT, P., OTTO, L. *Benchmarking with DEA, SFA and R*. Heidelberg: Springer, 2011.

BOGETOFT, P., OTTO, L. *Benchmarking with DEA and SFA*. R package version 0.23, 2013.

CHARNES, A., COOPER, W. W., RHODES, E. Measuring the Efficiency of Decision Making Units. *European Journal of Operational Research,* 1978, 2 (6), pp. 429–444.

DEBREU, G. The Coefficient of Resource Utilization. *Econometrica*, 1951, 19 (3), pp. 273–292.

FARRELL, M. J. The Measurement of Productive Efficiency. *Journal of the Royal Statistical Society. Series A (General)*, 1957, 120 (III), pp. 253–281.

FARSI, M., FILIPPINI, M., KUENZLE, M. Cost Efficiency in Regional Bus Companies: An Application of Alternative Stochastic Frontier Models. *Journal of Transport Economics and Policy,* 2006, 40 (1), pp. 95–118.

HOLMGREN, J. The Efficiency of Public Transport Operations – An Evaluation Using Stochastic Frontier Analysis [online]. *Research in Transportation Economics*, 2012. [cit. 19.6.2012]. <http://dx.doi.org/10.1016/j.retrec.2012.05.023>.

KITNEROVÁ, J. Možnosť poistenia ako spôsob zníženia rizík v cestnej nákladnej doprave (Insurance Option as a Way of Reducing the Risk of the Road Freight Transport). *Doprava a spoje – elektronický časopis,* 2008, 1, pp. 19–30.

KLIEŠTIK, T. Kvantifikácia efektivity činností dopravných podnikov pomocou data envelopment analysis (The Quantification of the Efficiency of Transport Enterprises Using the Data Envelopment Analysis). *E+M Ekonomie a Management,* 2009, 1, pp. 133–145.

KOČIŠOVÁ, K. Efektívnosť bankového sektora: Stochastic frontier approach (Efficiency of the Banking Sector: Stochastic Frontier Approach). *Proceedings of Conference National and Regional Economy VII.* Faculty of Economics of Technical University of Košice, Herľany, 2008. ISBN 978-80-553-0084-9.

KOOPMANS, T. An Analysis of Production as an Efficient Combination of Activities. *Proceedings of the Conference. Activity Analysis of Production and Allocation.* John Wiley, New York, 1951, pp. 33–97.

KOOREMAN, P. Data Envelopment Analysis and Parametric Frontier Estimation: Complementary Tools. *Journal of Health Economics,* 1994, 13, pp. 345–346.

KUMBHAKAR, S. C, KNOX LOVELL, C. A. *Stochastic Frontier Analysis.* Cambridge: Cambridge University Press, 2003.

LAN, L. W., LIN, E. T. J. Measurement of Railways Productive Efficiency with Data Envelopment Analysis and Stochastic Frontier Analysis. *Journal of the Chinese Institute of Transportation,* 2003, 15, pp. 49–78.

MARGARI, B. B., ERBETTA, F., PETRAGLIA, C., PIACENZA, M. Regulatory and Environmental Effects on Public Transit Efficiency: A Mixed DEA-SFA Approach. *Journal of Regulatory Economics,* 2007, 32 (2), pp. 131–151.

MEEUSEN, W., VAN DEN BROECK, J. Efficiency Estimation from Cobb-Douglas Production Functions with Composed Error. *International Economic Review,* 1977, 18, pp. 435–444.

MICHAELIDES, P. G., BELEGRI-ROBOLI, A., KARLAFTIS, M., MARINOS, T. International Air Transportation Carriers: Evidence from SFA and DEA Technical Efficiency Results (1991–2000). *European Journal of Transport and Infrastructure Research,* 2009, 9 (4), pp. 347–362.

OZBEK, M. E., GARZA, J. M., TRIANTIS, K. Data Envelopment Analysis as a Decision-Making Tool for Transportation Professionals. *Journal of Transportation Engineering,* 2009, 135 (11), pp. 822–831.

R CORE TEAM. *A Language and Environment for Statistical Computing.* R Foundation for Statistical Computing, Vienna, Austria, 2012.

SAMPAIO, B. R., NETO, O. L., SAMPAIO, Y. Efficiency Analysis of Public Transport Systems: Lessons for Institutional Planning. *Transportation Research Part A: Policy and Practice,* 2008, 42 (3), pp. 445–454.

STATISTICAL OFFICE OF THE SR. *SLOVSTAT Database*, 2012. [cit. 28.12.2012]. <http://www.statistics.sk/pls/elisw/vbd>.

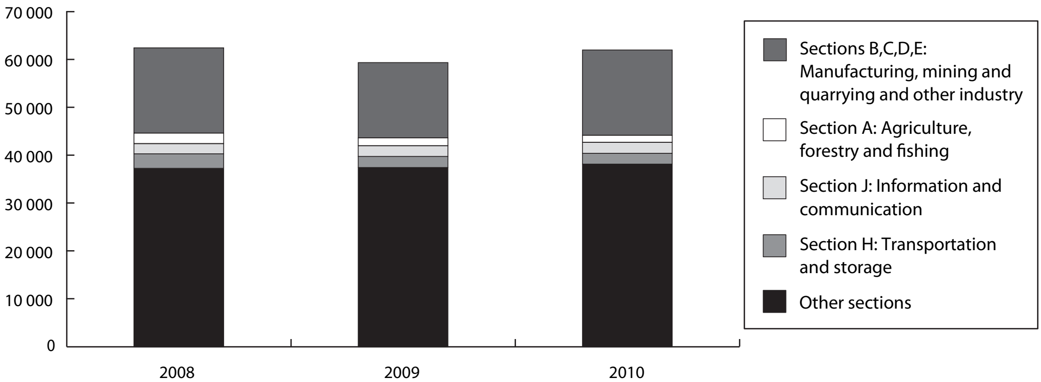
TONE, K. A Slacks-based Measure of Efficiency in Data Envelopment Analysis. *European Journal of Operational Research,* 2001, 130, pp. 498–509.

TONE, K. A Slacks-based Measure of Super-efficiency in Data Envelopment Analysis. *European Journal of Operational Research,* 2002, 143, pp. 32–41.

VINCOVÁ, K. Využitie modelov DEA na hodnotenie efektívnosti (The Use of the DEA Models for Evaluation of the Effectiveness). *Biatec,* 2005, 13 (8), pp. 24–28.

ANNEX – TABLES AND FIGURES

Figure 1 GDP (in mil. EUR at constant prices: chain-linked volumes with reference year 2005) by branches of statistical classification of economic activities SK NACE Rev.2



Source: Statistical Office of the Slovak Republic

Table 1 The possible combinations of inputs and outputs

Variables	Notation	Unit of measure	Possible combinations							
			1.	2.	3.	4.	5.	6.	7.	8.
Inputs considered										
Average number of employees	IN_1	Number	•	•	•	•	•	•	•	
Total kilometres driven	IN_2	Km	•	•	•	•	•	•		•
Total number of vehicles	IN_3	Number	•	•	•	•	•		•	•
Tangible fixed assets	IN_4	€	•	•	•	•		•	•	•
Operation costs	IN_5	€	•	•	•		•	•	•	•
Outputs considered										
Total number of passengers	OUT_1	Thousand	•	•		•	•	•	•	•
Total sales	OUT_2	€	•		•	•	•	•	•	•
First canonical correlation			**0.995**	0.987	0.992	0.990	0.994	0.997	0.992	0.995

Source: Own construction, annual reports 2010 of the transport companies

Table 2 The correlation matrix of the variables considered

	IN_1	IN_2	IN_3	IN_4	IN_5	OUT_1	OUT_2
IN_1	1	0,8984	0,7704	0,9434	0,9673	0,9691	0.9297
IN_2	0.8984	1	0.8268	0.9148	0.9537	0.8871	0.9815
IN_3	0.7704	0.8268	1	0.7162	0.7934	0.7976	0.8425
IN_4	0.9434	0.9148	0.7162	1	0.9521	0.9444	0.9295
IN_5	0.9673	0.9537	0.7934	0.9521	1	0.9670	0.9770
OUT_1	0.9691	0.8871	0.7976	0.9444	0.9670	1	0.9305
OUT_2	0.9297	0.9815	0.8425	0.9295	0.9770	0.9305	1

Source: Own construction, R (R Core Team, 2012)

Table 3 SFA efficiency scores and DEA efficiency scores with perceptual excesses

DMU	TE	TE*	ρ	ρ*	ρ′	ρ″	Excesses (in %)				
							IN_1	IN_2	IN_3	IN_4	IN_5
CTC Ban. Bystrica	0.769	0.718	1	1.064	0.566	0.166	0	0	0	0	0
CTC Bratislava	0.915	0.723	1	1	1	1	0	0	0	0	0
CTC Košice	0.707	0.966	1	1.176	1	0.244	0	0	0	0	0
CTC Pov. Bystrica	0.768	0.695	1	1.893	0.554	0.163	0	0	0	0	0
CTC Prešov	0.974	0.894	1	1.627	0.600	0.175	0	0	0	0	0
CTC Žilina	0.869	0.794	1	1.080	0.579	0.172	0	0	0	0	0
SBT Ban. Bystrica	0.736	0.673	1	1.153	0.561	0.165	0	0	0	0	0
SBT Dun. Streda	0.964	0.933	1	1.278	0.638	0.183	0	0	0	0	0
SBT Prešov	0.907	0.882	1	1.002	0.644	0.189	0	0	0	0	0
SBT Žilina	0.964	0.935	1	1.063	0.694	0.208	0	0	0	0	0
Slovak Lines	0.949	0.886	1	1.019	0.636	0.193	0	0	0	0	0
Veolia Tran. Nitra	0.986	0.962	1	1.303	0.701	0.205	0	0	0	0	0
SBT Humenné	0.811	0.814	0.999		0.645	0.186	0.01	0.02	0.01	0	0.01
SBT Trenčín	0.958	0.933	0.803		0.7188	0.219	15.34	21.04	19.23	42.81	0
SBT Nové Zámky	0.848	0.881	0.772		0.689	0.198	28.81	13.45	20.56	38.56	12.60
SBT Trnava	0.925	0.921	0.722		0.678	0.198	37.38	8.49	25.69	61.85	5.38
SBT Liorbus	0.934	0.899	0.710		0.642	0.189	54.51	10.05	16.40	55.10	9.19
SBT Michalovce	0.921	0.903	0.694		0.654	0.191	41.32	24.33	20.47	44.20	22.64
SBT Poprad	0.835	0.815	0.642		0.621	0.180	34.04	37.65	35.78	54.33	17.36
SBT Lučenec	0.883	0.863	0.618		0.647	0.191	44.18	43.08	26.00	62.21	15.49

Source: Own construction, DEA Solver Pro, R (package Benchmarking (Bogetoft, 2013))

Table 4 The stability results of DEA

Possible combinations		1.	2.	3.	4.	5.	6.	7.	8.
1.	Pearson correlation coefficient	x	0.552	0.811	0.953	0.683	0.937	0.901	0.995
	Spearman rank correlation coefficient		0.553	0.824	0.934	0.779	0.928	0.883	0.960
2.	Pearson correlation coefficient	0.552	x	0.242	0.630	0.475	0.640	0.550	0.550
	Spearman rank correlation coefficient	0.553		0.251	0.650	0.440	0.6581	0.428	0.463
3.	Pearson correlation coefficient	0.811	0.242	x	0.744	0.672	0.730	0.690	0.808
	Spearman rank correlation coefficient	0.824	0.251		0.728	0.761	0.744	0.736	0.823
4.	Pearson correlation coefficient	0.953	0.630	0.744	x	0.616	0.882	0.846	0.954
	Spearman rank correlation coefficient	0.934	0.650	0.728		0.694	0.852	0.830	0.906
5.	Pearson correlation coefficient	0.683	0.475	0.672	0.616	x	0.612	0.573	0.682
	Spearman rank correlation coefficient	0.779	0.440	0.761	0.694		0.694	0.577	0.657
6.	Pearson correlation coefficient	0.937	0.640	0.730	0.882	0.612	x	0.833	0.929
	Spearman rank correlation coefficient	0.928	0.660	0.744	0.852	0.694		0.822	0.902
7.	Pearson correlation coefficient	0.901	0.550	0.690	0.846	0.573	0.833	x	0.890
	Spearman rank correlation coefficient	0.883	0.428	0.736	0.830	0.577	0.822		0.924
8.	Pearson correlation coefficient	0.995	0.550	0.808	0.954	0.682	0.929	0.890	x
	Spearman rank correlation coefficient	0.960	0.463	0.823	0.906	0.657	0.902	0.924	

Source: Own construction, R (R Core Team, 2012)

Table 5 Loadings of principal components for inputs and outputs

	Comp.1	Comp.2	Comp.3	Comp.4	Comp.5
IN_1	–0.456	0.237	–0.612	0.344	0.493
IN_2	–0.457		0.767	0.223	0.39
IN_3	–0.405	–0.870	–0.191	–0.197	
IN_4	–0.451	0.394		–0.800	
IN_5	–0.465	0.176		0.391	–0.775
OUT_1	0.707	–0.707			
OUT_2	0.707	0.707			

Source: Own construction, R (R Core Team, 2012)

Table 6 SFA model based on principal components – a) 2 inputs, b) 1 input

2 inputs	**Parameters**	**Std.err**	**t-value**	**Pr(>|t|)**
(Intercept)	3.904	0.324	12.036	0.0
xComp.1	–0.739	0.081	–9.098	0.0
xComp.2	–0.701	0.182	–3.864	0.1
lambda	6.396	5.571	1.148	0.268
sigma2	0.028			
sigma2v	0.001			
sigma2u	0.027			
log likelihood	19.003			
1 input	**Parameters**	**Std.err**	**t-value**	**Pr(>|t|)**
(Intercept)	3.072	0.345	8.907	0.0
xComp.1	–0.776	0.141	–5.482	0.0
lambda	2.996	2.293	1.306	0.209
sigma2	0.048			
sigma2v	0.005			
sigma2u	0.043			
log likelihood	11.365			

Source: Own construction, R (package Benchmarking (Bogetoft, 2013))

“Beyond GDP” Indicators in the Czech Republic

Tomáš Hák[1] | *Charles University Environment Center, Prague, Czech Republic*
Svatava Janoušková[2] | *Charles University Environment Center, Prague, Czech Republic*

Abstract

This paper contributes to the ongoing debate on the “Beyond GDP” issues addressed in the Czech Republic and the two member organizations: Organisation for Economic Co-Operation and Development and the European Union. Traditional indicators such as e.g. Gross Domestic Product (GDP) and the Human Development Index (HDI) have been the main determinants used to measure the progress of nations. However, neither GDP nor the HDI reflex the state of the natural environment and both focus on the short-term aspects, with no indication of whether current wellbeing can be sustained. We have applied a simple categorization framework that revealed types of indicator-related initiatives run by the respective bodies. The framework is based on the purpose of the alternative “Beyond GDP” indicators to replace, adjust or complement GDP. Yet the Czech politicians and experts have hardly used this term, the analysis has shown quite extensive activities in that field.

Keywords

Sustainable development, wellbeing, EUROSTAT, OECD, “Beyond GDP” initiatives, alternative indicators

JEL code

Z

INTRODUCTION

The geobiosphere´s capacity to support human needs has been seriously threatened (Millennium Ecosystem Assessment, 2005; Rockström, 2009). The Happy Planet Index 2012 report confirms that humankind is still not living on a happy planet and the British Prime Minister J. Cameron has recently stated that “it’s time we admitted that there’s more to life than money, and it’s time we focused not just on GDP but on GWB – general well-being”. The Happy Planet Report 2012 shows that no country is able to combine success across the three goals of high life expectancy, high experienced well-being and living within environmental limits. The Index, meant to be used as a “new measure of human progress”, measures the extent to which countries deliver long, happy, sustainable lives for their population. For the second time, Costa Rica tops the Happy Planet Index. Norway, on the 29th place out of 151 countries, is the highest ranking for Western European nation (NEF, 2012).

Traditional (i.e.used for official purposes and for a long time) indicators such as Gross Domestic Product (GDP) and the Human Development Index (HDI) have been the main determinants used to measure the progress of nations (UNEP, 2012). However, neither GDP nor the HDI reflex the state of

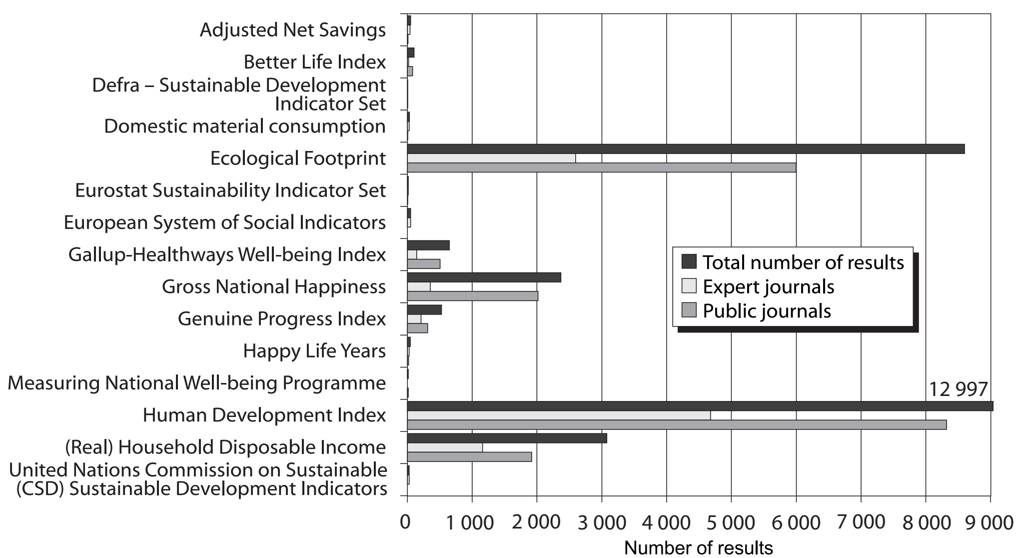
1 Charles University Environment Center, José Martího 2/407, 162 00 Prague, Czech Republic. Corresponding author: e-mail: tomas.hak@czp.cuni.cz, phone: (+420)220199475, fax: (+420)220199462.
2 Charles University Environment Center, José Martího 2/407, 162 00 Prague, Czech Republic. E-mail: svatava.janouskova@czp.cuni.cz, phone: (+420)220199468, fax: (+420)220199462.

the natural environment and both focus on the short-term aspects, with no indication of whether current well-being can be sustained. For decades, decision makers have lacked the information needed for good governance. By concentrating efforts on increasing the supply of scientific information, scientists may not be producing information considered relevant or useful by decision makers, and may simply be producing too much information of the wrong kind. On the other hand, actual and potential users may have specific information needs that remain unmet.

GDP is presented every quarter, stock markets daily. For environmental and some social issues, data is often two years old. (There are some exceptions, such as e.g. real time online data for air pollution; however, these data are useful for other purposes as regulation than for a strategic long term planning). There is need for timelier data to assist people in making decisions. Spatial differentiation of data can help make "dry" statistics accessible, relevant and engaging.

Besides timeliness and a proper scale there are other important criteria for good indicators: Statistical rigor (credibility), status and significance (relevance) and public participation (legitimacy) among the most important once. The call for action comes not just from policy makers and experts, but also from the public and media. A survey conducted in the context of the Beyond GDP Conference in 2007 clearly showed that people want measures of progress that go beyond GDP: three-quarters of the population surveyed (in ten countries including Australia, Brazil, Canada, France, Germany and Russia) wanted governments to „look beyond economics and include health, social and environmental statistics in measuring national progress". In a subsequent survey, almost 12 000 people across industrialized and developing countries were interviewed: The findings show that Germans (84 percent of whom want governments to also focus on health, social and environmental data to measure progress) are the most dissatisfied with GDP, followed by Brazilians (83 percent), Italians (79 percent) and Canadians (76 percent) (GlobeScan, 2011).

Figure 1 Media coverage of selected Beyond GDP indicators / indicies (ProQuest, 1995–2012)



Source: Hák, Janoušková, Abdallah, Seaford and Mahony (2012)

The above findings are supported by a basic media analysis of English-written papers (including papers having at least abstracts in English) from the whole world that shows the increasing number of articles dealing with some non-traditional indicators e.g. Ecological Footprint or Gross National Happiness over time (Hák, Janoušková, Abdallah, Seaford and Mahony, 2012). An overview of the media analysis results may be seen at Figure 1. As there is double sided effect between media and the public (the media present attractive information for the people while people expect and search for such information), it may be assumed that the public interest in alternative indicators increases. It seems that the "Beyond GDP" concept might be useful for presentation of these indicators which would not necessarily implicate the need to bring and present newly developed indicators but to use the existing ones and focus on finding an effective way for better presentation within the "Beyond GDP" concept.

This paper contributes to a debate on the "Beyond GDP" issues addressed in the Czech Republic and the two member organizations: Organisation for Economic Co-Operation and Development (OECD) and the European Union (EU). Introduction introduces the readers to the problem – lack of measurement tools to assess the real progress of nations. Chapter 1 opens the issue of measuring progress and provides basic historical perspective for that. Chapter 2 then discusses the current debates about shift from sustainability to wellbeing. Chapter 3 brings definitions and key characteristics of the "Beyond GDP" indicators while Chapter 4 introduces main initiatives of the European Commission, OECD and the Czech Government in the area. Chapter 5 briefly reminds membership of the Czech Republic in OECD and EU with the notion of reporting obligations. Chapter 6 presents the categorization framework and finally, the last chapter draws conclusions and implies further steps in the Czech Republic. The article ultimately points out to the fact that there has been several "Beyond GDP" indicator initiatives in the Czech Republic despite that term has not been promoted or consistently used. These activities have been of a various character (official reports, informal efforts, local initiatives) and timing (e.g. a regular indicator-based evaluation of Local Agenda 21 systematically building and applying the methodology and the whole measurement concept) and ad hoc papers or one-time events.

1 MEASURING PROGRESS

For almost ten years, focusing on people's well-being and societal progress, the OECD has been looking not only at the functioning of the economic system but also at the diverse experiences and living conditions of people and households. Measuring well-being and progress remains a key priority for the OECD through research, regional conferences and the OECD World Fora on "Statistics, Knowledge and Policy" (The Fora have been organized regularly since 2004 – in Palermo, Istanbul, Busan and New Delhi). They gather decision makers, policy actors, statisticians, academics and NGOs to discuss how best to measure and foster the progress of societies. The authors´ department actively participated in that process (Moldan et al., 2004). The last, 4th Forum „Measuring Well-Being for Development and Policy Making" in 2012 was built around a program demonstrating how the OECD will contribute to a more resilient and balanced world economy in the future. This is an ongoing challenge – shortly after the birth of the OECD, in 1962, US economist Simon Kuznets (Nobel Economics prizewinner 1971) wrote that distinctions must be kept in mind between quantity and quality of growth, between costs and returns, and between the short and long run (Kuznets, 1962). After 30 years (since about 2000) experts have been looking at what a "better life" measure would include. The OECD´s "Measuring Progress of Societies" project has been fostering the development of key economic, social and environmental indicators to measure well-being of societies.

In 2007, a high-level conference "Beyond GDP" was organized by the European Commission (with European Parliament, Club of Rome, OECD and WWF) in Brussels. The objectives of the Conference were to clarify which indicators and indices are most appropriate to measure progress, and how these can best be integrated into the decision-making process and taken up by public debate. Over 650 delegates from more than 50 countries debated how to improve the measurement of progress, true wealth and the well-being of nations. The Conference reacted on common criticism that even though we live in an era of unprecedented data quality and quantity, in some key areas the issue of data quality and timeliness is not yet adequately addressed. For example, we need to improve our understanding of how people actually spend their time (including their involvement in non-market activities) and how these activities contribute to overall welfare. The subjective nature of progress and well-being was also posed as a challenge to developing effective indicators and statistics; the discussion showed that aspirations and needs have unique national and local circumstances. Spurred on by success of the 2007 Conference, the European Commission released the Communication "GDP and beyond: Measuring progress in a changing world" (EC, 2009). The Communication outlines an EU roadmap with five key actions to improve existing indicators of progress in ways that meet citizens' concerns and make the most of new technical and political developments. The five key actions support the Commission's aims to develop indicators relevant to the challenges of today — ones that provide an improved basis for public discussion and policy-making. The five key actions are the following:

- Complementing GDP with highly aggregated environmental and social indicators;
- Near real-time information for decision-making;
- More accurate reporting on distribution and inequalities;
- Developing a European Sustainable Development Scoreboard;
- Extending National Accounts to environmental and social issues.

Besides these highly visible initiatives there are plenty of research as well as testing and implementation efforts to assess quality of life, well-being and sustainable development of all scales (from local to global). Overviews of these activities are published e.g. by Bossel (1999), Booysen (2002) and UNDP (2008).

2 GDP AND BEYOND – A NEW PARADIGM?

Since the 80´s of the last century, the term "sustainable development" has been used (first in the IUCN´s 1980 World Conservation Strategy). In 1987 "Our Common Future" gave direction to comprehensive global solutions (WCED, 1987). In Chapter 2 it says: "Sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains two key concepts: the concept of 'needs' and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs."[3] This definition was extended by the Earth Summit in 1992 (UN, 1992) and the formalization was completed by the World Summit on Sustainable Development in 2002 (UN, 2002) with the notion of the three pillars – social, environmental, economic – as symbolized by the summit motto "People, Planet, Prosperity". Finally, at the UN Conference on Sustainable Development (Rio+20) in June 2012 heads of states renewed their commitment to sustainable development and to ensure the promotion of an economically, socially and environmentally sustainable future for our planet and for present and future generations. Rio Declaration (UN, 2012) specifically affirms that progress towards the achievement of the goals needs to be assessed and accompanied by targets and indicators while taking into account different national circumstances, capacities and levels of development.

Sustainability is a concept based on a holistic view of the world. It therefore requires multidimensional indicators expressing links between human and natural environment. Despite the debate on the misuse of GDP as an indicator of well-being is almost as old as GDP itself, the OECD´s and EC´s "measuring progress" initiatives have recently intensified to show that the commonly used statistics may not be capturing some phenomena, which have an increasing impact on the well-being of citizens. A relevant question is hence the following: What are the current practices of governments to build on the existing knowledge and consensus on alternative measures of well-being?

Despite a growing stock of literature about well-being and existing both broad and narrow definitions of well-being (Saltelli, Jesinghaus and Munda, 2007), there are serious difficulties with operationalization of the concept. A problem of broad definitions of well-being – in relation to available statistical informa-

[3] Brundtland Report, <http://www.un-documents.net/wced-ocf.htm>.

tion – is that broad definitions would provide little guidance on the selection of relevant indicators, since almost all indicators collected by statistical offices and international agencies are – must be – of some relevance to the well-being of citizens. At the same time narrow definitions of well-being tend to lack key characteristics of concern to policy. An open problem for a well-being research agenda is then how to set up a framework which is both theoretically defensible and operationally useful.

A starting point might be to connect well-being research with the sustainability agenda. One shared non-controversial result of the sustainability literature is that sustainability is a multidimensional concept, which should at least include economic, social, environmental (and institutional) dimensions. The usual business of statisticians is to measure what happens or what has happened in the more or less remote past. In other words, we most often get the information on the current state of the world. However, when it comes to sustainability, the question turns to producing numbers about the future, which is not yet observed by nature (Stiglitz, 2009). Thus, it is conceptually useful to distinguish between an assessment of current well-being and an assessment of sustainability, whether this can last over time. Current well-being has to do with both economic resources, such as income, and non-economic aspects of peoples' life (what they do and what they can do, how they feel, and the natural environment they live in). Whether these levels of well-being can be sustained over time depends on whether stocks of capital that matter for our lives (natural, physical, human, social) are passed on to future generations.

It seems that the growing interest and demand for measuring well-being may be just rhetorical phenomenon or an effort to give a new momentum to the sustainability agenda. There is no real shift – in terms of new methodological approaches, data requirements etc. – from sustainability assessment to well-being assessment. In fact, due to a short political cycle politicians are more concerned with the current wellbeing of people. The demand for "Beyond GDP" indicators demonstrates an observable increased interest in alternative indicators providing decision makers (at all levels) with valuable information for decision-making processes. Politicians call for an index (one number or perhaps a small set of indicators) having similar communication power as GDP but conveying different information.

3 "BEYOND GDP" INDICATORS

What are such indicators? The term 'Beyond GDP' (or "GDP and beyond" as recently promoted by the EC) suggests both dominance of GDP (as a measure of quality of life) in the public debate and the need to go beyond that measure. Analytically speaking, the term "Beyond GDP" implies that "Beyond GDP" indicators provide the information that GDP does not. Of course, there are thousands of indicators which capture information not present in GDP – the key feature must be that "Beyond GDP" indicators somewhat capture information that people using GDP should know, i.e. that "Beyond GDP" indicators should somehow be used in at least some contexts where GDP is used. Therefore to understand what a "Beyond GDP" indicator is, one needs to know how GDP is perceived to be used. In the FP7 project BRAINPOol (Hák, Janoušková, Abdallah, Seaford and Mahony, 2012), the "Beyond GDP" indicators/indicator sets have been defined as those that have been proposed as being necessary and vital for the measurement of societal progress, in a broad sense, other than those indicators, such as GDP itself, that are already playing this role.

A broad variety of indicators are presently in use. These indicators often reflect trends in the state of the social and physical environment. One of the most important functions of these indicators is to monitor the progress made in fulfilling policy goals. As such, indicators have become indispensable to decision-makers and other stakeholders. However, it is becoming more and more difficult for policy-makers to grasp the relevance and meaning of the existing indicators, especially given the number and diversity of indicators presently in use. Furthermore, new indices as well as indicator sets are still to be expected. Therefore, some typology or system is needed. In this paper, we look more closely at how the indicators are linked to the "Beyond GDP" theory and practice.

The Beyond GDP initiatives have proposed indicators to alter or complement GDP and other key economic indicators. EC distinguishes development of new measures of societal progress from attempts to enlarge GDP (Goosens et al., 2007). The former starts from GDP (or other figures from the System of National Accounts) but adjusts for some of its shortcomings to deliver more comprehensive overview of a country's wealth or well-being. Examples may be Adjusted Net Savings, Environmentally Sustainable National Income, Genuine Progress Indicator, Index of Sustainable Economic Welfare, and Sustainable National Income. Other categorization proposed Costanza et al. (2009): He speaks on (i) indexes that correct GDP (e.g. ISEW, GPI, and GreenGDP); (ii) indexes that do not use GDP (e.g. EF, subjective WB, GNH) and (iii) indexes that include GDP (e.g. HDI, HPI). All these initiatives stem from the realization that GDP is a measure of economic quantity, not economic quality or welfare.

A similar, comprehensive and comprehensible typology with regards to links between these alternatives and GDP was introduced by the European Parliament (Goosens et al., 2007). It came with the following grouping of the "Beyond GDP" indicators:

1. The category adjusting GDP includes those approaches where traditional economic performance measures like GDP or national saving rates have been adjusted by monetized environmental and social factors.
2. The category replacing GDP on the other hand contains indicators that try to assess well-being more directly than GDP, e.g. by assessing average satisfaction (like the Happy Planet Index) or the achievement of basic human functions (like the Human Development Index).
3. The category supplementing GDP consists of approaches, which have been designed to supplement GDP. Here GDP is not adjusted or replaced by constructing new indices but complemented with additional environmental and/or social information.

We consider useful elaborating on this concept further and creating two sub-categories within the last category:

- Indicators supplementing GDP based on a national accounts system. Recent revisions of the System of National Accounts (SNA) attempted to widen the scope of the conventional national accounts to incorporate data and indicators relating to environmental and social factors.
- Indicators supplementing GDP setting social and environmental information in relation to GDP.

The former group of indicators is based on accounting principles using the data from accounts (e.g. system of integrated environmental and economic accounts – SEEA) while the latter allows more flexible approach: dashboards of sustainability indicators, subjective indicators based on perception of life satisfaction etc. would fit into this group.

Further we will use this lucid categorization framework to look more closely at the "Beyond GDP" indicators activities of EUROSTAT, OECD and the Czech Government.

4 "BEYOND GDP" – INITIATIVES OF THE EU (EUROPEAN COMMISSION) AND OECD

Any indicators that might be called "Beyond GDP" indicators (in terms of the above mentioned classification) were subjects of our analysis. We surveyed various attempts seeking to enlarge GDP by incorporating a variety of indicator factors which are not included in the conventional measure. Also, we explored indicators supplementing GDP by extending the national accounts system in areas as materials, water, land, ecosystem services etc. Last but not least, we also included new or alternative indicators identified in various sustainability indicator sets.

4.1 European Commission – Eurostat and Environment Directorate General

In August 2009, the EC adopted a Communication "GDP and Beyond: Measuring progress in a changing world", which outlines a number of actions to improve and complement current growth measurements. The Communication concludes that it is important to complement the current GDP in order to answer political challenges of the 21st century and to steer the EU policies towards green growth and a low-carbon, resource-efficient and inclusive society (EC, 2009).

Besides EUROSTAT, also the Environment Directorate-General has been active in the "Beyond GDP" initiative. It has sought to develop an environmental index and a sustainable development scoreboard (EC, 2012). The index aims to complement other macro-indicators - such as GDP or unemployment - by providing information on the level of 'pressure' exerted on the environment by activities taking place in the EU. The scoreboard aims to inform citizens and politicians about major trends in progress towards sustainable development. The Communication argues that environmental and social outcomes need to be measured and assessed separately from economic output, as the link between economic growth and well-being is not always automatic. The key issue is to improve timeliness of social and environmental statistics to the level of key economic indicators. The sustainable development scoreboard aims to inform citizens and politicians in a concise way about major trends in the progress towards sustainable development. It will contain issues related to sustainable development that are not yet sufficiently covered by official statistics, e.g. on biodiversity or eco-innovation. Therefore, the inclusion of data from non-official sources will be one important feature of this scoreboard. The Commission also adopted a proposal for a Regulation on Integrated Environmental Economic Accounting in 2010. The emphasis will be put on accounting of natural resources, including eco-system services and indicators on resource efficiency of the economy. The full elaboration of wealth or asset accounts could contribute to an adequate basis for this endeavor.

Figure 2 Evaluation of progress towards sustainable development by the EU headline indicators (EU-27, from 2000)

SDI theme	Headline indicator	EU-27 evaluation of change
Socioeconomic development	Real GDP per capita	
Sustainable consumption and production	Resource productivity	
Social inclusion	Risk of poverty or social exclusion (*)	
Demographic changes	Employment rate of older workers	
Public health	Life epectancy and healthy life years (**)	
Climate change and energy	Greenhouse gas emissions	
	Consumption of renewables (***)	
Sustainable transport	Energy consumption of transport relative to GDP	
Natural resources	Abundance of common birds (****)	
	Conservation of fish stocks	
Global partnership	Official Development Assistance	
Good governance	*[No headline indicator]*	:

(*) From 2005
(**) From 2002
(***) From 2006
(****) EU aggregate based on 19 Member States

Source: Eurostat (2012)

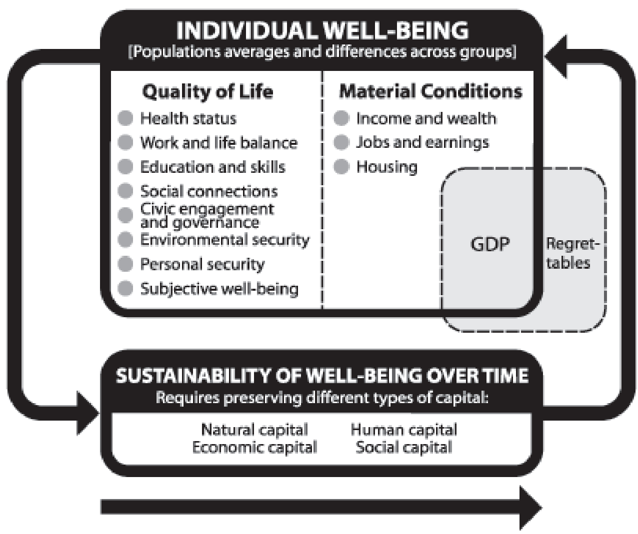
Eurostat reports on progress towards the objectives of the EU Sustainable Development Strategy every two years, drawing on the set of sustainable development indicators (Eurostat, 2011). This Report does not aim to give an absolute assessment of whether the EU is sustainable, as there is no political or scientific consensus on what this state of sustainability would be, or on the optimal (critical, minimal etc.) levels for many of the indicators presented here. Therefore, it aims rather at an assessment of progress towards the objectives and targets of the EU SDS, Eurostat admits that the focus is on sustainable development rather than sustainability: Sustainability is understood as a property of a system maintained in a particular state through time. Unlike the concept of sustainable development refers to a process involving change or development. The strategy aims to "achieve continuous improvement of quality of life" and the focus is therefore on sustaining the process of improving human well-being. Rather than seeking a stable equilibrium, sustainable development is a dynamic concept, recognizing that changes are inherent to human societies. Eleven headline indicators give an overall picture of achieving progress towards sustainable development in the EU (Figure 2).

4.2 OECD´s activities

For almost ten years, focusing on people's well-being and societal progress, the OECD has been looking not only at the functioning of the economic system but also at the diverse experience and living conditions of people and households. The measuring well-being and sustainable development needs new (improved) statistics aimed at complementing standard economic statistics and developing indicators having a more direct impact on people's life. This work has been grouped under two conceptual pillars: Individual well-being (Quality of life and Material conditions) and Sustainability of well-being over time (Figure 3).

Measuring people's material conditions (i.e. their command over commodities) requires looking not only at their income but also at their assets and consumption expenditures, and at how these economic resources are distributed among different people and population groups. It also requires focusing on the economic resources of households rather than on measures pertaining to the economic system as a whole (e.g. GDP per capita). Economic resources, while important, are not all that matters for people's well-being. Health, human contacts, education, environmental quality, civic engagement, governance, security and leisure time are all fundamental to people´s quality of life, as are people's subjective experiences of life, i.e. their feelings and evaluations. Measuring quality of life requires looking at all of these elements at the same time: economic and non-economic, subjective and objective as well as at disparities across population groups. Sustainability (measuring of well-being over time) is assessed by looking at the set of key economic, environmental, social and human assets transmitted from current to future generations, and how these assets are affected by today's actions, policies and behavior. To be able to do so, the OECD is developing metrics that better capture all types of capital (e.g. environmental capital by indicators to monitor the stock of natural

Figure 3 OECD framework for measuring wellbeing and progress



Source: OECD (2012)

resources) and has started work on valuing those natural resources that are recognized in the national accounts, in particular land and subsoil assets. This work feeds into the development of Green Growth Indicators and will contribute to the implementation of the new System of Integrated Environmental and Economic Accounts (SEEA).

In terms of compound indicators, a 10-year work to identify the best way to measure the progress of societies is manifested in the OECD Better Life Initiative (OECD, 2012). Drawing upon the recommendations of the Stiglitz Commission, the OECD has identified eleven dimensions as being essential to well-being (community, education, environment, civic engagement, health, housing, income, jobs, life satisfaction, safety, work-life balance). These dimensions are explored and analyzed in detail in an attempt at an international level to present the well-justified set of comparable well-being indicators. At the same time, the OECD has created the "Your Better Life Index" – an interactive tool that allows everybody to see how countries perform (The Index allows putting different weights on each of the topics, and thus to decide what contributes most to well-being).

5 THE CZECH REPUBLIC – A MEMBER OF RICH CLUBS

The Czech Republic signed the Convention founding the Organisation for Economic Co-Operation and Development on 21 December 1995, thereby pledged its full dedication to achieving the Organization's fundamental aims. Through its country surveys and comparable statistical and economic data, the OECD provides its member countries with tools to analyze and monitor their economic, social and environmental policies. Countries can draw on the OECD's reservoir of expertise, including peer reviews.

The Czech Republic formally entered the European Union along with nine other countries on 1 May 2004, in what is the biggest enlargement staged so far by the EU. The Czech Republic was the second of the ten new member states that joined the EU to hold the presidency in 2009. The priorities of the Czech presidency were 'the three Es', economy, energy and external relations.

The membership in these two prestigious organizations brings a lot of benefits as well as obligations. Both organizations among others serve as comprehensive and reliable sources of comparable statistical and other type of data and information. They monitor trends, collect data, analyze and forecast economic, social and environmental development. The reporting tasks of the member states are clearly visible from organizational structures of both organizations: OECD family of organizations includes, in addition, special bodies as the International Energy Agency (IEA), the Nuclear Energy Agency (NEA), and the International Transport Forum (ITF). Similarly, the EU has specialized agencies to meet its responsibilities – European Commission's departments (known as Directorates-General) and services as e.g. Joint Research Center or Eurostat, agencies as the European Environment Agency and others.

The problem for both organizations´ member states may be that data collection and monitoring systems are not identical, neither is there harmony in approaches and concepts regarding quality of life (well-being) and sustainable development. Furthermore, methodologies for Beyond GDP indicators are in progress, particularly in social domain due the intricacy of the monitored phenomena (Noll, 2002). However, changes and inconsistencies in data collection and indicators methodologies are inherent to measurement efforts in all domains. The Czech Republic like many other members have faced dilemma between complying with international reporting requirements and building reliable data and information system enabling long term reporting based on an agreed set of the most relevant indicators. So what is the situation in the Czech Republic with regard to the Beyond GDP indicators?

5.1 The Czech Government´s monitoring progress

The Beyond GDP term has not been widely known and used in daily practice in the Czech Republic (see e.g. Vopravil, 2009; Dubska, 2010; Dubská and Drápal, 2010). There may be more reasons for that: reluctance to novelties, the EU "diktat", language barrier, unclear concept, different priorities, etc. Despite many various obstacles, we have identified several initiatives that may be put into the above categorization framework. The next text presents examples of the national "Beyond GDP" initiatives:

Sustainable development indicators

In 2010, the Czech Government passed Resolution on Sustainable Development Strategy of the Czech Republic. It lays out the strategic vision of sustainable development, which relies upon five priority axes: Society, people and health; Economy and innovation; Regional development; Landscape, ecosystems and biodiversity; and Stable and secure society.

National Council on Sustainable Development (NCSD) along with Charles University have compiled goals and designated indicators for each of the priorities through which the fulfillment of the Strategy can be monitored. Progress Reports containing assessments of the state of and trends in sustainable development in the Czech Republic have been published biannually since 2004. Several indicators may be classified as alternative or belonging to the Beyond GDP indicators family, e.g.: Household material and carbon footprint; Energy intensity of GDP; Material consumption; Ecological footprint, Land and ecosystems changes; and Corruption perception index (National Council on Sustainable Development, 2012).

Green Growth report

Another initiative employing the Beyond GDP indicators is the "Green Growth in the Czech Republic" – an analysis made by the Czech Statistical Office. Its mission subsists in acquisition of data and consequent production of statistical information on social, economic, demographic, and environmental development of the state. The interest is primarily motivated by the need to assess the environmental state as well as to define and describe multiple social-demographic-environmental-economic interrelations strongly influencing economic activity, employment, foreign trade, price level, etc. The Office analyzed five themes relevant for green growth assessment and calculated 27 indicators. Some of them are new indicators looking beyond GDP, e.g. Genuine savings (Adjusted net savings); Production-based greenhouse gas productivity; Consumption-based greenhouse gas emissions; Energy productivity; Material productivity; Water use productivity; Forest growing stock volume; Green jobs; and Green patents (Havranek and Sidorov, 2011).

Healthy Cities

In 1994, eleven active cities formed an association called Healthy Cities of the Czech Republic (HCCZ). Since 1998, HCCZ member cities, towns and regions have proceeded according to a HCCZ Methodology, co-operating with a wide range of HCCZ's expert partners, particularly Charles University, Prague. Recently, there are around 100 Healthy cities, municipalities and regions in the Czech Republic, with the regional influence on 2 233 municipalities (37% country´s population). HCCZ is presently the only association of Czech municipalities whose statutes stipulate to consistently work towards sustainable development, health and the quality of life in cities, municipalities and regions of the Czech Republic.

Contrary to many national programs the HCCZ strongly involved the citizens into the strategic planning and decision making processes in the cities. This participatory approach towards public policy making fosters the shift from government to governance. The HCCZ developed a methodology (and published methodological guidelines) for sustainability assessment at the level of municipalities and regions in 2011. The methodology establishes sustainable development categories (derived from the Aalborg Commitments) and relevant indicators as assessment tools. The cities started using the methodology in 2012 (Smutný et al., 2012).

The Public Opinion Research Centre

The Public Opinion Research Centre (Centrum pro výzkum veřejného mínění - CVVM) was established in 2001 by transferring the Public Opinion Research Institute (Institut pro výzkum veřejného mínění) from the Czech Statistical Office. CVVM conducted ten investigations within the "Our Society 2002" survey and has been involved in the Eurobarometer surveys conducted by the European Commission. CVVM presents its work to the public as press releases on a regular basis and, several times a year, it organizes press conferences on current social and political issues. CVVM has come up with a number of new results that may contribute to "Beyond GDP" discussion in the Czech Republic, for example: information on satisfaction with the situation of public life (quality of goods and services, culture, environment, personal safety, education, health, position of the CR in EU, governance corruption, economic crime and law, unemployment, political situation, state of public finance). The surveys represent the subjective well-being category in frame of Beyond GDP surveys. Another data reveal people´s willingness to protect the environment (a survey on Opinion on environmentally friendly behavior) etc. Thus CVVM´s qualitative indicators provide important information appropriately complementing mostly quantitative indicators of many governmental agencies.

DGINS Conference and ESSC Meeting

98th DGINS Conference and 14th ESSC Meeting titled "Meeting new needs on statistics for green economy" and "Coordination of statistics and geospatial information" was held in Prague, 24–26 September 2012. Over the past years National Statistical Institutes (DGINS) have become a valuable platform for discussing issues of the statistical program, methods and processes. Several years ago, DGINS Conference (Sofia, 2010) focused on the topic of measuring progress, well-being and sustainable development. Despite the main aim of the Prague event was to measure green economy, the task was understood as a part of the broader Beyond GDP process.

DGINS Conference is the most important forum in the European Union for discussions about the future of the European Statistical System (ESS). Besides Presidents of the National Statistical Offices and the European Commission experts presence of the United Nations and the Organisation for Economic Co-operation and Development representatives demonstrated the will and need for coordination in developing and using relevant statistics and indicators.

6 CATEGORIZATION OF THE SELECTED INDICATOR SYSTEMS

All the above initiatives – including the Czech ones – have clear "Beyond GDP" attributes and some even conceptual foundations. Several indicators are linked to the sustainable development concept, others to the quality of life or wellbeing concept. The frameworks distinguish domains of used indicators – social, economic and environmental, types of indicators – sets, aggregates and indices, types of the assessment approach – objective, subjective and certainly the level of impact. Now, there is a challenge how to categorize the described initiatives according to the "Beyond GDP" concept which might be more attractive for the public and media and amend so traditional categorization frameworks. We think that the EC approach to "Beyond GDP" initiative classification fully meets the needs for straightforward arrangement of indicators allowing uncomplicated analyses. The table below shows application of the categorization framework to the selected organizations and their indicators.

As manifested by the above table, there are several initiatives underway to develop or use new indicators, which can be employed as measures of societal well-being, as well as measures of economic, environmental and social sustainability. It seems that what is missing at the moment is better theoretical foundations of the whole theme. Many terms have got new definitions often rooted in disciplines of the proponents of the changes. Well-being is once understood as economic prosperity of the nation or country (welfare), another time it means life satisfaction (happiness) or subjective perception of physical conditions (health).

Politicians (elected decision makers), policy makers (official, administrators at all levels) as well as experts have to communicate and understand each other in a very poorly arranged terrain: There has been neither agreed terminology nor exists a consensus on categorization or typology of the indicators. Thus, one indicator can be called economic or environmental (resource productivity), composite or index (human development index), replacing or complementing GDP (ecological footprint) etc. This chaos is boosted by an international setting where the entire debate has been taking place: Both key players in the area – OECD and EU – are prominent clubs of countries speaking 28 different languages. Translation and the newspeak of both organizations may make the whole agenda difficult to comprehend sometimes. And finally, some words may bear specific connotation as e.g. frequently used word "alternative": It may stand for "different" (neutral, probably intended meaning of the phrase alternative indicators, but also "unusual", "replacing" or even "marginal".

Table 1 Beyond GDP initiatives in OECD, European Commission and the Czech Republic

	Indicators adjusting GDP	Indicators replacing GDP	Indicators supplementing GDP (based on a national accounts system)	Indicators supplementing GDP (setting social and environmental information in relation to GDP)
OECD			Contributions to SEEA (resource accounting etc.), energy accounting	Sustainability indicators (capital approach), green growth indicators, decoupling indicators , Better Life Index; etc.
EU (Eurostat, DGs, EEA[1])			Contributions to SEEA (resource accounting etc.), land and ecosystem accounting	European Sustainable Development Scoreboard, indicators, decoupling indicators, agri-environmental indicators; etc.
Czech Government (NCSD, CZSO)	Genuine Savings (used in the context of Green Growth analyses)		Resource productivity indicators, land use accounts, ecosystem services accounts	Sustainability indicators, green growth indicators, ecological footprint, decoupling indicators; etc.

[1] The European Environmental Agency is an agency of the European Union.
Source: Own construction

Besides language-based problem due to translation, e.g. a missing apt Czech term for "beyond GDP", there comes a certain difficulty with adoption of the whole concept. Our experience – corresponding with findings of the POINT project (Gudmundsson, 2008) – shows that decision makers, policy makers as well as the public are confused by emerging concepts complementing with re-established indicators and measurement tools.

We may assume that due to the above difficulties the Stiglitz report or other international "Beyond GDP" initiatives have never strongly resonated in the Czech settings – in politics, academic spheres, media or at the public. Nevertheless, the reporting activities of the OECD, EU and the Czech institutions show another picture. All kinds of alternative indicators have been used to some extent in official publications: some were just tested or used for a single purpose while others have been regularly published.

CONCLUSIONS AND POTENTIAL FURTHER ACTIONS

The review of literature as well as our experience show that it is not easy to develop such indicators that are clear and appealing as GDP but more inclusive of environmental and social aspects of progress. Although problems with GDP and its misinterpretation have been well known for a long time there survive significant obstacles to develop and use better indicators of progress. These obstacles involve data issues (reliability), timeliness and methodology – to mention the most important. Besides these mostly technical issues, there is another, probably the most important barrier – people´s system of values. In other words, we measure what we think is important. Indicators should reflect the societal change after the changes really happen, i.e. when people change their choices, values and goals. The observation has shown a reverse process: while the economic performance is what moves the world round, the "Beyond GDP" initiatives wish to report on other, sometimes hardly measurable aspects of progress.

The "Beyond GDP" concept has opened various opportunities (adjusting, replacing or complementing the GDP indicator). In our opinion it would be very difficult – if possible at all – to replace the GDP indicator nowadays. Although its methodology is complicated and people do not fully understand which variables come to the calculation, the everyday presentation of GDP in the media (in different contexts) teaches them to perceive the number as important information for their lives. People usually have a simple association – if GDP is rising, my quality of life will be better; if GDP is falling, hard times will come. This interpretation is not absolutely correct and it does not stand universally (during 1950–1970 increase in mean welfare stagnated or even reversed into a negative trend in most western countries despite a steady GDP growth (Van den Bergh, 2009), but it provides quick navigation in difficult economic settings.

This article could not solve many problematic issues that are not only of methodological or data character. Human values, fetish of the economic growth, short-sightedness of policy cycles and other important issues must be publicly debated and a broad consensus must be built about them. This article is rather a contribution opening a needed debate that is still in its infancy in the Czech Republic (other reading e.g. Křovák and Ritschelová, 2008). We recommend switching to better/alternative indicators of progress by using the existing indicators and developing new ones in new ("Beyond GDP") contexts without ambitions to develop a perfect indicator – that includes all social, economic and environmental aspects – that could replace GDP. It is not effective to organize scientific conferences for that idol indicator, convincing there the already convinced and arguing about details while the whole concept of alternative indicators needs more precise shape. It seems that feasible (workable and relatively fast) way to show people also other than economic aspects of their life could likely be complementing the GDP with other indicators. "Beyond GDP" concept might be than very appropriate promotion of various already existing social and environmental indicators. However, it will imply a great shift in people´s thinking and not only re-naming current indicators. It will require development of the "Beyond GDP" – or rather the "GDP and beyond" – concept (manifesting the rhetorical shift from replacing to complementing GDP) hand in hand with the whole system of indicators complementing the GDP information. Such system could serve as real description of the quality of life in the Czech Republic. At times of economic crises – when GDP is stagnating or rising slow – people will learn to appreciate other positive aspects of their lives as a good quality of the natural environment, effective educational system or accessible healthcare.

It is encouraging to see that there is an adequate capacity and expertise internationally as well as in the Czech Republic to cooperate effectively and contribute to work in this area.

ACKNOWLEDGMENTS
This work has been supported by a collaborative project BRAINPOol funded by the European Commission under the FP7 Programme (Contract No. 283024) and by Program "Environmental Research" (PRVOUK) funded by Charles University.

References

BERGH, Van den, J. C. J. M. The GDP Paradox. *Journal of Economy Psychology,* 2009, 30, pp. 117–135.

BOOYSEN, F. An Overview and Evaluation of Composite Indices of Development. *Social Indicators Research*, August 2002, Volume 59, Issue 2, 2002, pp. 115–151.

BOSSEL, H. *Indicators for Sustainable Development*: *Theory, Method, Applications.* A Report to the Balaton Group. International Institute for Sustainable Development, 1999.

COSTANZA, R. Beyond GDP: The Need for New Measures of Progress. *The Pardee Papers*, No. 4, January 2009, Boston University.

DUBSKÁ, D. *The New Paradigm – Why is it Important to Measure the Progress of Societies?* „Measuring the Well-being and the Progress of Society" Conference. November 2010, Radenci, Slovenia.

DUBSKÁ, D., DRÁPAL, S. Měření pokroku, vytváření vizí, zlepšování života (Measuring the Progress, Creating the Visions, Improving the Life). *Statistika,* 2/2010, pp. 179–183.

EUROPEAN COMMISSION. *European Commission Goes Beyond GDP* [online]. EC, 2012. [cit. 20.10.2012]. <http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/European_Commission_goes_beyond_GDP>.

EUROPEAN COMMISSION. *GDP and Beyond: Measuring Progress in a Changing World.* COM final 433/2009. EC, 2009.

EUROSTAT. *Sustainable Development in the European Union — 2011 Monitoring Report of the EU Sustainable Development Strategy.* Luxembourg: Publications Office of the European Union, 2011.

GLOBESCAN. *Continued Public Support for Going Beyond GDP: Global Poll* [online]. GLOBESCAN, 2011. [cit. 21.3.2013]. <http://www.globescan.com/commentary-and-analysis/press-releases/press-releases-2011/94-press-releases-2011/152-continued-public-support-for-going-beyond-gdp.html>.

GOOSENS, Y., MÄKIPÄÄ, A., SCHEPELMANN, P., Van de SAND, I., KUHNDTAND, P., HERRNODORF, M. *Alternative Progress Indicators to GDP as a Means towards Sustainable Development*. European Parliament, Policy Department study. IP/A/ENVI/ST/2007-10, Brussels: European Parliament, 2007.

HÁK, T., JANOUŠKOVÁ, S., ABDALLAH, S., SEAFORD, CH., MAHONY, S. *Review Report on Beyond GDP Indicators: Categorisation, Intensions and Impacts.* Final Version of BRAINPOoL deliverable 1.1, a collaborative project funded by the European Commission under the FP7 Programme (Contract No. 283024) [online]. BRAINPOoL, 2012. [cit. 20.10.2012]. <http://www.czp.cuni.cz/czp/images/stories/Projekty/BRAINPOoL_Review_report_Beyond-GDP_indicators.pdf>.

HAVRÁNEK, M., SIDOROV, E., eds. *Green Growth in the Czech Republic. Selected Indicators.* Prague: Czech Statistical Office, 2011.

KŘOVÁK, J., RITSCHELOVÁ, I. Za (rámec) HDP: měření pokroku, skutečného bohatství a blahobytu národů (Behind the GDP (Framework): Measuring of the Progress, True Wealth and Welfare of the Nations). *Statistika*, 3/2008, 274–277.

KUZNETS, S. How To Judge Quality. *The New Republic.* October 20, 1962.

MILLENNIUM ECOSYSTEM ASSESSMENT. *Ecosystems and Human Well-being: Synthesis.* Washington, DC: Island Press, 2005.

MOLDAN, B., HÁK, T., KOVANDA, J., HAVRÁNEK, M., KUŠKOVÁ, P. Composite Indicators of Environmental Sustainability. *Statistics, Knowledge and Policy: Key Indicators to Inform Decision Making.* Proceedings from the international conference OECD World Forum on Key Indicators, 10–13 November 2004, Palermo, pp. 154–163.

NATIONAL COUNCIL ON SUSTANABLE DEVELOPMENT. *Monitoring Report on the Strategic Framework for Sustainable Development in the Czech Republic*. NCSD and Ministry of Environment, 2012.

NEW ECONOMICS FOUNDATIONS. *The Happy Planet Index: 2012 A Global Index of Sustainable Well-being.* London: NEF, 2012.

NOLL, H. H. Social Indicators and Quality of Life Research; Background, Achievements and Current Trends. In GENOV, N., eds. *Advances in Socio-logical Knowledge over Half a Century,* Paris: ISSC, 2002.

OECD. *Your Better Life Index* [online]. Paris: OECD, 2012. <http://www.oecdbetterlifeindex.org>.

ROCKSTRÖM, J. et al. Planetary Boundaries: Exploring the Safe Operating Space for Humanity. *Ecology and Society*, 2009, 14(2), art. 32.

SALTELLI, A., JESINGHAUS, J., MUNDA, G. *Well Being Stories* [online]. Contribution to the Experts Workshop at the Beyond GDP Conference, EU Parliament, Brussels, 19–20 November 2007. [cit. 21.3.2013]. <http://www.beyond-gdp.eu/download/beyond-gdp_wb_stories.pdf>.

SMUTNÝ, M., ŠVEC, P., MUSIL, M., BOUŠKOVÁ, J., PETROVÁ, M. eds. *Metodika hodnocení kategorie „A" Místní agendy 21* (Evaluation Methodology of the Category "A" of the MA21) [online]. 2012. [cit. 21.3.2013]. <http://dataplan.info/img_upload/f96fc5d7def29509aeffc6784e61f65b/metodika_a_ma21_final_verze1.1_duben-2012.pdf>.

STIGLITZ, J., SEN, A., FITOUSSI, J. P. *Report by the Commission on the Measurement of Economic Performance and Social Progress*. 2009.

UNDP. *A Survey of Composite Indices Measuring Country Performance: 2008 Update*. UNDP/ODS Working Paper. New York: Office of Development Studies, 2008.

UNEP. *Inclusive Wealth Report 2012.* UNEP, UNU-IHDP, Cambridge University Press, 2012

UNITED NATIONS. *Earth Summit Agenda 21. The United Nations Programme of Action from Rio.* New York: United Nations Department of Public Information, 1992.

UNITED NATIONS. *Realizing the Future We Want for All.* Report to the Secretary-General. New York: UN System Task Team on the Post-2015 UN Development Agenda, 2012.

UNITED NATIONS. *Report of the World Summit on Sustainable Development.* Johannesburg, South Africa, 26 August–4 September 2002. New York: United Nations, 2002.

VOPRAVIL, J. Global Projekt „Measuring the Progres of Societies". *Statistika,* 3/2009, pp. 275–279.

WORLD COMMISSION ON ENVIRONMENT AND DEVELOPMENT. *Our Common Future.* World Commission on Environment and Development, Oxford: Oxford University Press, 1987.

Climate Change and European Official Statistics

Cesare Costantino[1] | *ISTAT, Rome, Italy*
Angelica Tudini[2] | *ISTAT, Rome, Italy*

Abstract

According to an approach widely shared in the European Statistical System (ESS), "climate change related statistics" (CCRS) are environmental, social and economic high quality statistics and indicators suitable for monitoring changes related to climate change. The component "State" of the *Driving forces, Pressures, State, Impacts, Responses* model (DPSIR) is not covered by the CCRS currently produced within the ESS. The latter is responsible for providing a substantial amount of basic data that serve as inputs for the GHG emissions inventory. As core priorities for the future, it is envisaged to produce early estimates of CO_2 emissions based on monthly energy statistics and to investigate the "consumer perspective" of global climate change. Recommendations on how to improve CCRS in the ESS are expected from the UNECE Task Force on climate change related statistics.

Keywords	***JEL code***
Sustainable development, GHG emissions, climate change, air emissions accounts, emission inventory, driving forces	*Z19*

INTRODUCTION

Despite the controversial discussions that have characterized the debate on climate change for quite a long period, it is widely recognized that alterations caused by human activities to the natural environment are at the origin of this phenomenon to a large extent. Now the issue is definitely on top of global concerns in the political agenda on sustainability, and not only from an environmental viewpoint. While the United Nations Framework Convention on Climate Change (UNFCC) encourages a significant reduction of greenhouse gas emissions and the Kyoto Protocol sets binding targets for these emissions, the outcome document of the Rio+20 United Nations Conference on Sustainable Development reaffirms that "climate change is one of the greatest challenges of our time" (United Nations, 2012).

This is very clear to statisticians. As it is maintained in a paper presented in 2008 at the Oslo *Conference on Climate Change and Official Statistics*, the Intergovernmental Panel on Climate Change (IPCC) "has been incredibly successful in organizing the collective effort of many of the world's top scientists. It has been also incredibly successful in its advocacy role. It has had a fundamental role in convincing global and national policy makers that climate change is an issue that has to be addressed"; as the author

[1] ISTAT, via Depretis 74/B, Rome, Italy. Corresponding author: e-mail: cecostan@istat.it, phone: (+39)0646733140.
[2] ISTAT, via Depretis 74/B, Rome, Italy.

argues, "that battle has largely been won" and "its major challenge now is to provide the best possible evidence base to support policy makers" (Trewin, D. 2008).[3]

The Oslo Conference reflects the official statistical community's awareness of the importance of climate change in a statistical perspective, as well as the feeling that there is a need to better identify the role that the same community has to play in this field.[4]

Starting from the consideration that official statistics are used to identify and track changes in a changing world, it has been suggested that statisticians would have to look at climate change as "simply another type of driving force that produces change that needs to be identifiable" (Radermacher, W.[5] et al, 2009).

Currently, an approach widely shared in the European Statistical System (ESS) is to look at statistics for climate change as "climate change related statistics" (CCRS), i.e. statistics and indicators for monitoring changes related to climate change. Accordingly, the term CCRS refers to environmental, social and economic statistics measuring the drivers, impacts and costs of climate change; it is not meant to cover data measuring climate and weather directly, for example data on temperature and precipitation (UNECE, 2013). Also, CCRS are not necessarily thought as a new system of climate change statistics.

As a matter of fact, CCRS do not feature as such in the Classification of Statistical Activities (CSA), which describes the wide set of information supplied by National Statistical Offices (UNECE, 2009). Indeed, CSA includes a breakdown into detailed subject areas for long-established subject matters such as social and economic statistics, which is not the case, instead, with "environment". The latter is shown as one comprehensive category with no further breakdown, which mirrors the relatively more recent engagement of NSIs in the environmental field and also the significant role played by actors other than statistical ones such as ministries and governmental agencies. In no case CCRS are identifiable as such within CSA, neither within statistical activities dealing with the natural environment nor within those dealing with social and economic aspects.

In line with the above, the Framework for the Development of Environment Statistics (United Nations Statistics Division, 2013), which the UN Statistical Commission endorsed at its 44th Session in 2013, considers "Climate Change" among four main cross-cutting environmental issues – the others being "Water", "Energy" and "Agriculture and the Environment" – and describes "Statistics on Climate Change" as an application of the FDES itself (United Nations, 2013).

CCRS have become more and more the focus of users' demand over time. In particular, high interest in CCRS has been expressed within most significant initiatives on well-being and sustainability: the EU Commission's initiative "GDP and beyond", calling, among other things, for statistics on climate change with a view to complement Gross Domestic Product (Commission of the European Communities, 2009); the Commission on the Measurement of Economic Performance and Social Progress, calling for a well-chosen set of physical indicators to describe the environmental aspect of sustainability including the climate change (Stiglitz, J. E. et al, 2009); the co-operative project Sponsorship Group on "Measuring Progress, Well-being and Sustainable Development", co-chaired by Eurostat and INSEE, calling for the development of indicators related to climate change as one of the first priorities for future work (ESSC, 2012).

But it is at the UNECE that the most recent initiative concerning CCRS has been pursued: in November 2011 the Bureau of the Conference of European Statisticians set up the "Task Force on climate

---

[3] The Oslo Conference was convened by the United Nations Statistics Division (UNSD), in collaboration with Eurostat, the World Bank and Statistics Norway. At the time of the conference, Dennis Trewin was former Chief Executive Officer of the Australian Bureau of Statistics and a member of the Australian State of the Environment Committee.

[4] See also the *Conference on Climate Change, Development and Official Statistics in the Asia-Pacific Region*, organized jointly by the Korea National Statistical Office (KNSO) and UNSD in the same year in Seul: <http://unstats.un.org/unsd/climate_change/Korea/default.htm>.

[5] Walter Radermacher currently is, and was when he argued about climate change and the role of statisticians at the 57th Session of the ISI, Eurostat's Director General.

change related statistics". The ongoing work of the latter, particularly relevant for the ESS, is focused on climate change in a very systematic way and is aimed at better understanding the role of official statistics in this field, with a view to come up with recommendations that will be of great interest for the European National Statistical Institutes (NSIs) (UNECE, 2013).

1 EUROPEAN OFFICIAL STATISTICS AND EUROSTAT'S ACTION CONCERNING CLIMATE CHANGE

1.1 The institutional arrangement of European official statistics

Similarly to the case of other areas of official statistics, the role of the ESS in the area of CCRS depends heavily on the institutional arrangement characterising the work carried out by statistical authorities within the EU.

According to the European Statistics Regulation (Official Journal of the European Union, 2009), Eurostat works in partnership with the national authorities responsible for the development, production and dissemination of European statistics in each Member State and in each European Economic Area (EEA) as well as European Free Trade Association (EFTA) country. These are NSIs, but also other authorities, and the ESS is the partnership between Eurostat and these national authorities; it functions as a network. Eurostat has a leading role in harmonization of statistics in close cooperation with the national statistical authorities. Member States collect data and compile statistics for national and EU purposes. The ESS work concentrates mainly on EU policy areas and, with the extension of EU policies, harmonization has been extended to nearly all statistical fields.

By sharing a common ESS definition of quality in statistics, Eurostat and the statistical authorities of the EU Member States have committed themselves to take an encompassing approach towards high quality statistics. This includes the implementation of the European Statistics Code of Practice (ESCP), which targets both processes in the statistical production and outputs of this production, i.e. the European official statistics, as well as institutional and organisational factors. The ESCP includes fifteen key principles for the production and dissemination of European official statistics and the institutional environment under which national and Community statistical authorities operate. Out of these fifteen principles, seven refer to the institutional environment: professional independence, mandate for data collection, adequacy of resources, quality commitment, statistical confidentiality, impartiality and objectivity, sound methodology; in addition to that, three principles refer to statistical processes: appropriate statistical procedures, non-excessive burden on respondents, cost effectiveness; finally, five principles refer to statistical outputs: relevance, accuracy and reliability, timeliness and punctuality, coherence and comparability, accessibility and clarity.[6]

The above highlights that in the ESS CCRS are intended to be high quality statistics and indicators as far as climate change is concerned. They are to meet requirements typical of official statistics such as, in particular, those set out in the ESCP.

CCRS provided within the ESS represent a clear case of application of the vision outlined in the 2009 Communication from the Commission to the European Parliament and the Council on "The production method of EU statistics: a vision for the next decade" – COM(2009) 404 (Commission of the European Communities, 2009) – in which the Communication puts an emphasis on combining the information produced in different areas to develop cross-cutting datasets suitable to satisfy different specific user needs. In the light of this vision, the ESS has one major comparative advantage in the area of climate change, in the same way as for other cross-cutting areas: i.e. access to large and diverse micro-level data and the

[6] These principles largely transpose the fundamental principles of official statistics adopted by the United Nations and, in general, the existing international rules. A set of indicators of good practice for each of the fifteen principles provides a reference for reviewing the implementation of the Code.

possibility of combining various types of information at the micro-level, thereby increasing the consistency of the figures produced and their quality.

1.2 Significant steps made by Eurostat in relation to Climate Change

In recent years Eurostat has made a number of significant steps with a view to best satisfy user needs related to climate change. Major achievements include the following: the introduction in the organisational chart of the "Environmental accounts and climate change" unit (E.2); the setting up of an internal reflection group on climate change-related statistics; the development of a legal base for environmental accounting; the setting up of the Sponsorship Group on "Measuring Progress, Well-being and Sustainable Development", in collaboration with the French NSI (INSEE); the active participation in the UNECE Task Force on climate change related statistics; the production and publication of the statistical guide "Using official statistics to calculate greenhouse gas emissions: A statistical guide" (2010 edition). Main achievements are further explained below.

As concerns the legal base for environmental accounting, following a preparatory work carried out within the ESS, in July 2011 the European Parliament and the Council adopted the Regulation (EC) No 691/2011 on European environmental economic accounts (Official Journal of the European Union, 2011). This includes, in particular, a module for air emissions accounts (Annex I to the Regulation), which, among other things, covers greenhouse gas emissions and is directly connected, therefore, to climate change issues.

In November 2011 the European Statistical System Committee (ESSC) adopted the final report of the Sponsorship Group on "Measuring Progress, Well-being and Sustainable Development". The report (ESSC, 2011) translates the recommendations from the Stiglitz-Sen-Fitoussi Commission and the directions given by the European Commission's Communication "GDP and beyond" into a plan for concrete actions to be put in place within the ESS, among which actions related to environmental sustainability – one of the priority areas – are covered. Climate change is specifically considered in the section dealing with environmental sustainability, where climate change is explicitly referred to as follows: "First priority will be given to the following areas: ... Further develop indicators related to climate change, also by using data derived from accounts: the module on Air emission accounts, covering greenhouse gas emissions, is already part of the first set of modules included in the EU Regulation on environmental economic accounts. Besides indicators derived on the basis of Air emission accounts, further indicators relevant to climate change mitigation and adaptation need to be developed in collaboration with other stakeholders … Regularly produce environmentally-extended Supply and Use Input/Output Tables (SUIOT) to investigate the "consumer perspective" of global climate change or air pollution … The following indicators could be further developed or result from the first priority areas listed above: … Expenditure related to climate change adaptation …". A further statement included in the report, also relevant in relation to climate change issues, is as follows: "c. Improve timeliness of climate-related indicators by developing early estimates of CO2 emissions based on monthly energy statistics: The methodology for using monthly energy statistics to produce early estimates of CO2 emissions from energy is in an advanced stage of development by Eurostat. …. In addition, Eurostat is looking into developing "now-casting" techniques which could later be tested by EU Member States to be applied also at national level. With high political importance, such early estimates are also a priority".

An important step made by Eurostat in terms of providing statistical guidance is represented by the above mentioned publication "Using official statistics to calculate greenhouse gas emissions: A statistical guide". Following the United Nations Climate Change Conference held in Copenhagen in 2009, Kyoto Protocol countries had committed to reduce emissions; the planned reductions were to be monitored by means of detailed emissions inventories, to which official statistics collected by NSIs were an essential input. With the above publication Eurostat has presented a selection of official European statistics with relevance for the calculation of greenhouse gas emissions. Topics covered include land use and agriculture, energy, business (industry and services), transport and waste. As a follow up to this publication, a map of data availability was created in the Eurostat portal with the purpose to lead users towards the relevant basic information related to emissions and other relevant aspects of climate change (Eurostat, 2013).

2 EXISTING CLIMATE CHANGE RELATED STATISTICS IN THE ESS

2.1 Climate change related statistics available within the ESS

In the wide range of statistics regularly produced within the ESS there are many that potentially contribute to provide a comprehensive picture of phenomena which in one way or another are related to climate change. Table 1 offers a tentative overview of current situation in this respect.

The first column in Table 1 lists the main sets of data at issue; these sets are associated with the broad categories of phenomena shown in the next column, which are considered to be of particular importance in relation to climate change. The central column lists phenomena that are relevant from the viewpoint of the interaction between climate change and the socio-economic system and to which, therefore, the statistics listed in the first column are connected; one example is the existence of the economic system itself, with production and consumption activities or its dynamics such as the internationalization of the economy, which constitute driving forces at the origin of certain alterations of the natural environment which in turn cause changes in climate patterns. For purposes of presentation and to help better understanding of the different sets of data listed in the first column, the latter are also labelled (in the third column) in terms of categories of the Driving forces–Pressure–State–Impacts–Response model (DPSIR).

Table 1 Supply of climate change related statistics in the ESS

Main CC related statistics in the ESS	Main CC related phenomena	DPSIR
GDP Industries' production Construction Agriculture Manufacturing Transport Energy	production	D
Gross inland energy consumption Number of cars, km driven Energy consumed for heating houses Food consumption	consumption	D
Trade data Tourism data Data on international transportation (land, rail, water, air)	internationalization of the economy	D
Basic data for GHG Emissions Inventories Energy Agriculture Forestry Waste Trade Air emission Accounts GHG emissions by economic activity Sector statistics Transport (e.g. emissions from vehicles) Agriculture (agri-environmental indicators)	emission of pollutants	P

Legend: ESS stands for European Statistical System; CC for climate change; DPSIR for driving forces, pressures, state, impacts, responses; GDP for Gross Domestic Product; D for driving forces; GHG for greenhouse gas; P for pressures; R for responses; GVA for Gross Value Added.
Source: Own construction

Table 1 Supply of climate change related statistics in the ESS Continued

Main CC related statistics in the ESS	Main CC related phenomena	DPSIR
Environmental Protection Expenditure Environmental Taxes (by industry) Environmental Subsidies Price changes (e.g. of energy price)	market instruments	R
	switch to renewable energy	R
	recycling	R
Agricultural production and crop statistics (yield, areas harvested, etc.) Fisheries statistics (catch, aquaculture production) Forestry statistics (area, land change, forest damage, trade in wood) Water statistics (abstraction, wastewater treatment) Health statistics (causes of death including by vector-borne disease) Economic statistics (e.g. GDP, GVA per region, etc.) Population and migration statistics	vulnerability	I

Legend: ESS stands for European Statistical System; CC for climate change; DPSIR for driving forces, pressures, state, impacts, responses; GDP for Gross Domestic Product; D for driving forces; GHG for greenhouse gas; P for pressures; R for responses; GVA for Gross Value Added.
Source: Own construction

As shown by Table 1, the statistics produced within the ESS typically do not cover the component "State" of the DPSIR, which mainly refers e.g. to information on concentration of greenhouse gases in the atmosphere, on air temperature, on sea temperature, i.e. to data mostly produced outside the ESS. Also, Table 1 highlights how phenomena like the switch to a more sustainable use of energy sources, as well as recycling, are not yet regularly covered within the ESS.

Eurostat makes use of figures that are part of CCRS in particular for compiling indicators for "Climate change and energy" in the context of Eurostat's Sustainable Development Indicators (SDI) – the indicator system established to monitor the EU Sustainable development strategy.

2.2 The ESS' and Eurostat's role in climate change measurement

Currently, the ESS is responsible for providing a substantial amount of basic data that serve as inputs for the GHG emissions inventory. In a sense, these are complementary data. A central role in the calculation of emission inventories could even be envisaged for Eurostat, and actually at the national level such a role is played in some cases, e.g. by the Finnish NSI. Any innovation of this kind would require evaluation in close liaison with the IPCC, while the main stakeholders at the EU level would be DGs CLIMA and ENV and the European Environment Agency. In addition to that, the ESS – and Eurostat in particular – provides information that adds value to already existing data, as in the case of emissions figures calculated according to a consumption-perspective.

As for the future, the Sponsorship Group on "Measuring Progress, Well-being and Sustainable Development" has identified priorities for the ESS in relation to climate change; the core priorities are as follows: to produce early estimates of CO2 emissions based on monthly energy statistics, thus improving timeliness of indicators; to produce on a regular basis environmentally-extended Supply and Use Input/Output Tables (ee-SUIOT) to investigate the "consumer perspective" of global climate change in order to develop carbon footprint indicators.

Specific challenges can be envisaged for Eurostat, ranging from possible contributions to the development of guidelines for the calculation of emission factors in some specific domains, such as e.g. agriculture, to the provision of geographically referenced data.

A clear demand has been expressed by the EU Commission with reference to both mitigation and adaptation aspects. As for mitigation of climate change, the Commission's demand is along two lines: the production of data on air emissions and the production of data on environmental protection expenditure. In the first case the idea is to introduce in the calculation of air emissions the consumption-perspective as an approach complementary to the production-perspective. As far as adaptation is concerned, the Commission calls for the production of statistical information mainly based on expenditures data; this is still under discussion, however, since the topic is quite difficult in terms of measurement and data production.

Within the European Statistical Programme 2013–2017, reference is made explicitly to climate change when defining statistical outputs in terms of indicators, accounts and primary/secondary statistics to be used for monitoring the implementation of the Europe 2020 strategy.

The dissemination of data and analyses through "Statistics in focus" highlights as well the role played by Eurostat in the area of climate change. Two recent publications seem to be of particular interest in this respect: "Driving forces behind EU-27 greenhouse gas emissions over the decade 1999–2008" (EUROSTAT, 2011a) and "CO2 emissions induced by EU's final use of products are estimated to be 9 tonnes per capita" (EUROSTAT, 2011b). The first publication is a clear demonstration of the role played by the ESS in the process of producing information crucial for the Kyoto protocol's needs: official statistics collected by the ESS are used to estimate greenhouse gas emissions which are then reported in emissions inventories; thus, while the inventory data is collected by the European Environment Agency, Eurostat's statistics provide a solid basis for analysis of the underlying driving forces behind emissions. The second publication presents modelling-estimations based on environmentally extended input-output tables which have been compiled for the very first time for the aggregated EU. Another significant Eurostat publication is the statistical article "Sustainable development - Climate change and energy" (EUROSTAT, 2011c) in "Statistics Explained", which provides an overview of statistical data on sustainable development in the areas of climate change and energy.

3 POSSIBLE IMPROVEMENTS IN CLIMATE CHANGE RELATED STATISTICS WITHIN THE ESS AND BEYOND

Hints on possible future developments for CCRS in the direction of enhancing the role of NSIs come from the Meeting on Climate Change Related Statistics for Producers and Users, organized in Geneva on 19–20 November 2012 by the UNECE Task Force on climate change related statistics. The Meeting identified, on the one hand, possible specific data improvements to better meet users' demand, and, on the other hand, more general improvements concerning the role of NSis within the overall "infrastructure" of CCRS production.

On the basis of the outcome of the session "User needs and data gaps", the following items can be identified as concerns improvements in the production of CCRS to better meet users' demand:

- detailed geo-referenced data and spatial statistics,
- statistics on green growth and sustainable development,
- environmental subsidies and taxes,
- employment and turnover in green sectors,
- higher level of detail for existing statistics both with regard to economic sectors and geographic breakdown,
- investments in adaptation measures,
- climate-related morbidity and mortality,
- resilience of people, economic systems and ecosystems, population dependent on subsistence farming and access to reliable water supply,
- indicators that include causality assumptions, such as mortality due to heat waves,
- improved quality and availability of data underpinning GHG emission estimates.

As concerns more general improvements, a number of interesting points can be derived from the main conclusions of the panel discussion and the open discussion of the Meeting.

An important issue is how can national statistical offices better organize themselves to contribute to the emission inventory compilation process. With regard to this, the main conclusions of the Meeting are as reported hereafter.

NSIs should be part of the national system of greenhouse gas emission inventories in all countries, and this should be established through official agreements. NSIs' involvement can be beneficial since their existing role in the collection of economic, social and environmental statistics would reduce the need for additional data collection, help to improve data quality and enable linking of emissions with particular sectors of the economy. NSIs usually enjoy high public trust as professionally independent producers of statistics. Countries that are just building up the inventory system should involve the NSI from the beginning to avoid creating burdensome and overlapping data reporting systems.

NSIs should be proactive in reaching out and improving communication with emission inventory compilers. Well-functioning communication channels are a key to bridging the gap between statisticians and the emission inventory system. NSIs and inventory compilers should meet to discuss how the emission inventory system works and how the National Statistical System can contribute. Information on what data are needed would help NSIs to better organize their work related to climate issues and would optimize the data for the purposes of emission inventories.

NSIs should review the existing reporting systems for CCRS and emission inventories to identify any duplicated processes and to move towards multipurpose data systems serving various user needs. The existing data pool of NSIs is not used to its full potential for climate change analysis. Parallel and sometimes duplicate reporting exists, for example energy data reported both in energy statistics and emission inventories. This leads to unnecessarily high costs of data collection and additional burden for respondents. Production of emission inventories and other CCRS would benefit from coordination with the NSI.

NSIs should be active in improving coherence of emission inventories and official statistics where possible. New areas for using common tools, terminology and definitions can be identified in cooperation with the emission inventory compilers. For example, NSIs should be more aware of how the activity data are used in the inventories to be able to take into account the related data needs.

NSIs should actively follow up on the meetings of the Conferences of the Parties (COP) to be able to prepare for forthcoming data requirements. Whereas a more active role of NSIs would enhance the quality of emission inventories in several countries, the delicate negotiation process of the Kyoto protocol needs to be respected. NSIs should, therefore, rely on existing frameworks and existing data rather than on building something new or parallel to the emission inventories. NSIs can add value to the process by assessing data availability and feasibility of requirements related to the Kyoto protocol, and by preparing themselves for new data requirements, for example regarding the flexibility mechanisms.

Based on the outcome of the Meeting, a number of recommendations for the future could be formulated by the UNECE Task Force on climate change related statistics, that the Conference of European Statisticians and the ESS could consider with a view to improve CCRS. Such recommendations can be derived starting from the following:

- NSIs should start improving their contribution to climate change analysis based on their core competencies, for example, in provision of data for research and other producers of CCRS, linking climate information with other statistical data and harmonizing methods, concepts and classifications, etc. Taking on new tasks involves respect for the traditional role of NSIs: they do not usually compile forecasts or make judgements about cause-effect relations. The improvements should be implemented in steps: by first organising the existing data, secondly improving the quality and usefulness of data and exploring needs for new statistics after that (such as data on resilience, risks and vulnerabilities to climate change). In the longer term, a set of regularly produced CCRS should be developed to be part of official statistics.

- NSIs should have a role in disseminating climate information to make it more accessible and easy to use, even when the information is not produced by the NSI. Scientific climate information is often complex and difficult to communicate and understand. Communicating statistics is the core business of statistical offices. NSIs should create a dissemination platform or a portal for CCRS to bring together at least the regularly produced CCRS. Through the portal NSIs could disseminate their existing statistics with relevance to climate change and provide access to CCRS produced by other organizations and research.
- The key for improving CCRS is to improve communication at all levels and to establish a clear institutional setting for producing CCRS. Closer collaboration within a country, between countries and among international organizations could bring the work forward. The dialogue between users and producers of climate information should continue. Nationally improving communication between emission inventory compilers and the NSI is particularly important. International organizations, for their part, should work closer together to harmonize data requirements and collection. In some cases, national legislation related to CCRS needs to be reviewed with the aim to clarify division of work, support cooperation between agencies and ensure access to the required data.
- The need to change existing frameworks of official statistics to serve climate change data needs has to be examined. For instance, CCRS may require changes in the System of National Accounts in some future revision, so as to strengthen the links between emission trading systems (the carbon market) and national accounts.
- New solutions are needed in NSSs for dealing with confidentiality issues to ensure a better response to climate data needs. Climate change analysis can benefit from detailed, often geo-referenced, data and the possibility to combine data.
- The organizational structure of NSIs may require modernizing to support production of CCRS that cuts across the statistical system. Traditionally, the organizational structure of NSIs is set up to produce different economic and social statistics, rather than multi-domain statistics such as CCRS and other environmental statistics. Modernizing statistical production may also release resources that can be used to meet new user needs related to climate change.
- A new kind of expertise will be required from statisticians producing CCRS. Traditionally, statisticians have been professional data managers specialised in narrow societal issues. CCRS require the understanding of natural science and knowledge that cuts across many societal issues.
- The international statistical community and NSIs should invest in building capacity and knowledge required for CCRS in all countries. The need for reliable, comprehensive and objective CCRS is increasing, but countries have different levels of capacity for reporting climate change information: some provide emission inventory data and others do not. NSIs have extensive experience in effective statistical capacity building that should be gradually enlarged to include climate issues.

CONCLUSION

The Rio+20 Conference on Sustainable Development has reaffirmed that climate change is one of the greatest challenges of our time.

In line with the outcome of the Conference, the ESS' commitment to best contribute to the knowledge base needed for this challenge has been increasing in recent years, as proven by the inclusion of climate change-related statistics in the European Statistical Programme 2013–2017. The CCRS produced within the ESS are typically meant to include environmental, social and economic high quality statistics measuring the drivers, impacts and costs of climate change. The fact that they typically do not cover the component "State" of the DPSIR is quite natural. As a matter of fact, information on e.g. concentration of greenhouse gases in the atmosphere is mostly produced outside the ESS. Indeed for such data it is not easy, for the time being, to follow the same approach towards high quality statistics as e.g. for data on driving forces.

Particularly important in a long-term perspective is that climate change has been indicated by the Sponsorship Group on "Measuring Progress, Well-being and Sustainable Development" as one of the first priorities for future work. This is in line with the "GDP and beyond" initiative of the EU Commission and at the same time it reflects recommendations from the Commission on the Measurement of Economic Performance and Social Progress, calling for them to be made operative.

According to specific priorities identified in relation to climate change by the Sponsorship Group on "Measuring Progress, Well-being and Sustainable Development", the ESS is supposed to develop in due time early estimates of CO2 emissions as well as environmentally-extended Supply Use Input/Output Tables aimed at investigating global climate change in a "consumer perspective". As environmental accounts qualify as statistical tools particularly suitable for this kind of analysis, they will possibly play an increasing and central role in the future in relation to climate change issues.

The overall role that official statistics can play in general in the field of climate change will be better understood based on the final report of the UNECE "Task Force on climate change related statistics". The recommendations expected from the UNECE task force will be of specific interest for the ESS.

Given also more and more binding budget constraints all over the EU, possible duplicated processes in the production of data related to climate change would have to be identified, with a view to move towards multipurpose data systems serving various user needs. To that end, NSIs would be best candidates to review the existing reporting systems for CCRS and emission inventories.

Furthermore, coherence of emission inventories and official statistics would have to be improved to the extent possible. NSIs should be active in promoting this, in particular by identifying, in cooperation with the emission inventory compilers, areas for using common concepts, definitions and classifications, as well as statistical tools.

REFERENCES

COMMISSION OF THE EUROPEAN COMMUNITIES. *Communication from the Commission to the Council and the European Parliament GDP and Beyond Measuring Progress in a Changing world* [online]. Bruxelles: EC, 2009. [cit. 16.3.2013]. <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2009:0404:FIN:EN:PDF>.

ESSC. *Sponsorship Group on Measuring Progress, Well-being and Sustainable Development: Final Report Adopted by the European Statistical System Committee* [online]. Luxembourg: ESSC, 2011. [cit. 16.3.2013]. <http://epp.eurostat.ec.europa.eu/portal/page/portal/pgp_ess/0_DOCS/estat/SpG_progress_wellbeing_report_after_ESSC_adoption_22Nov1.pdf>.

EUROSTAT. *Climate Change* [online]. Luxembourg: Eurostat, 2013. [cit. 16.3.2013]. <http://epp.eurostat.ec.europa.eu/portal/page/portal/climate_change/overview>.

EUROSTAT. *Driving Forces Behind EU-27 Greenhouse Gas Emissions over the Decade 1999–2008* [online]. Luxembourg: Eurostat, 2011a. [cit. 14.4.2013]. <http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-SF-11-010/EN/KS-SF-11-010-EN.PDF>.

EUROSTAT. *CO_2 Emissions Induced by EU's Final Use of Products are Estimated to be 9 tonnes per Capita* [online]. Luxembourg: Eurostat, 2011b. [cit. 14.4.2013]. <http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-SF-11-022/EN/KS-SF-11-022-EN.PDF>.

EUROSTAT. *Sustainable Development – Climate Change and Energy* [online]. Luxembourg: Eurostat, 2011c. [cit. 14.4.2013]. <http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Sustainable_development_-_Climate_change_and_energy>.

OFFICIAL JOURNAL OF THE EUROPEAN UNION. *Regulation (EC) No 223/2009*.

OFFICIAL JOURNAL OF THE EUROPEAN UNION. *Regulation (EC) No 691/2011*.

RADERMACHER, W. et al. *Role of Statisticians in Research and Action on Climate Change.* Powerpoint Presentation at the 57th Session of the International Statistical Institute, 16–22 August 2009, Durban, South Africa, 2009.

STIGLITZ, J. E. et al. *Report by the Commission on the Measurement of Economic Performance and Social Progress,* Paris, 2009.

TREWIN, D. *Can the Official Statistical Community Provide Greater Support to the IPPC?* [online]. Conference on Climate Change and Official Statistics, 14–16 April 2008, Oslo, Norway, 2008. [cit. 16.3.2013]. <http://unstats.un.org/unsd/climate_change/>.

UNECE. *Classification of Statistical Activities* (CSA REV. 1 – October 2009) [online]. Geneva: UNECE, 2009. [cit. 16.3.2013]. <http://www1.unece.org/stat/platform/download/attachments/58492889/Classification+of+statistical+activities.pdf>.

UNECE. *Task Force on Climate Change Related Statistics* [online]. Geneva: UNECE, 2013. [cit. 16.3.2013]. <http://www.unece.org/statistics/about-us/statstos/task-force-on-climate-change-related-statistics.html>.

UNITED NATIONS. *The Future We Want 2012* [online]. New York: UN, 2012. [cit. 16.3.2013]. <http://www.uncsd2012.org/content/documents/727The%20Future%20We%20Want%2019%20June%201230pm.pdf>.

UNITED NATIONS STATISTICS DIVISION. *FDES* [online]. New York: UN, 2013. [cit. 16.3.2013]. <http://unstats.un.org/unsd/environment/fdes.htm>.

The Revised Framework for the Development of Environment Statistics

Iva Ritschelová[1] | *Czech Statistical Office, Prague, Czech Republic*
Egor Sidorov[2] | *Czech Statistical Office, Prague, Czech Republic*

Abstract

Interest among decision-makers in high quality and complex environment statistics, suitable for developing their policies has been growing during the last few decades. Different countries have diverse experience of establishing their own national system of environment statistics. In order to motivate countries to build national environment statistics and consequently support international activities in the field the UN has introduced the Framework for the development of environment statistics (FDES) in 1984. Since that time institutional conditions, production and consumption patterns, environmental state, as well as environmental science itself has changed significantly. This was the reason for the recent updating of the FDES. The paper presents the outcome of the revision process, providing short introduction of institutional context, the proposed structure as well as the key features of the newly developed framework.

Keywords

Environment statistics, development, FDES, UN, framework

JEL code

Q01

INTRODUCTION

The need for information is constantly increasing. Users are becoming more demanding and users' needs are increasingly diverse. Geography of these needs rapidly expands in concern with the development of the different countries of the World. The nature of statistics – in general – is changing, as they are being used more and more for evidence-based policy-making.

The development of environment statistics in particular goes hand in hand with the development of environmental management and technology. Without appropriate environment information systems it would have been impossible to define and describe the environmental-economic and social interrelations that are highly influencing economic activities, investments, employment, foreign trade, price levels, etc., in other words – all those factors that determine the welfare of nations. This was undoubtedly the reason for the ever increasing interest among decision-makers in high quality and complex environment statistics, suitable for developing their policies.

[1] Chairperson of the Expert Group on the Revision of the FDES. Czech Statistical Office, Na padesátém 81, 100 82 Prague 10, Czech Republic. Corresponding author: e-mail: predsedkyne@czso.cz
[2] Czech Statistical Office, Na padesátém 81, 100 82 Prague 10, Czech Republic.

1 FDES EVOLUTION

Not all countries of the World have comparable experience of establishing their own national system of environment statistics. One of the reasons is the fact that the process of creating a high quality environment statistics system is highly resource and time consuming. Furthermore it requires a great deal of synergy and coordination of environmental research with the creation of an appropriate institutional framework, up-to-date statistics collection and production techniques, and last but not least, financial resources.

The financial aspects of statistics production are currently becoming even more critical due to the current state of the World impacted by the financial crisis and consequent economic issues. Environmental issues, and therefore environment statistics, may seem to have a lower priority compared to "all-absorbing" economic problems. Under these conditions it is more important than ever to realize that a healthy environment is one of the core factors influencing, or better-to-say enabling our well-being. Economic welfare is only a part of it if we think of it in the global environmental context. And we should also be conscious about this.

Nations of the World should under no circumstances give up activities aimed at keeping our natural environment intact for both current and future generations. Environment statistics may be one of the powerful tools to persuade the policy makers to develop policies that would respect these principles.

As it was mentioned, we are all aware that different countries have diverse experience and possibilities concerning both financial and research capacities. For the common good any valuable experience in the field of environment statistics development should be actively disseminated. The role of international organizations and agencies in this respect is indisputable.

One of the important milestones was the introduction of the common Framework for the Development of Environment Statistics (FDES) by the UN back in 1984. The main goal of FDES development was to motivate and support countries to build their own environment statistics which would be a part of the world wide environment statistics system. Another expected effect was making environmental data comparable, and therefore usable for designing policies on a global scale, since only at this level specific environmental issues could be treated efficiently.

After three decades it can be seen that a really a significant improvement in the field of environment statistics was reached. Since 1984 the FDES has served a number of countries as a good tool for establishing and developing their environment statistics that in its turn supported development, realization and consequent assessment of environmental policies. Due to overall progress of society both in terms of the institutional conditions, as well as in the field of environmental science, much has changed since the initial introduction of the FDES.

That is why at its 41st Session in 2010 the United Nations Statistical Commission decided to set up a work program for FDES revision. Recommendations stated that the revision process should:

- Provide supporting methodological guidance and best practices;
- Engage a variety of stakeholders and Stress institutional coordination and cooperation;
- Ensure links to the System of Environmental-Economic Accounting (SEEA), the Driving force – Pressure – State – Impact – Response (DPSIR) framework, the MDGs indicator framework, and other relevant frameworks.

The Expert Group for this task consisted of 20 experts representing all regions, in both developing and developed countries, as well as international organizations and specialized agencies. One should also mention that the group was chaired by the Czech Republic.

The revision process was based on analyzing and reviewing of the existing state-of-the-art indicator frameworks. According to UN (2013) during this process more than 2 500 environmental indicators from around 50 existing frameworks were analyzed by the UN SD professionals. This knowledge was applied for the revised FDES development.

2 REVISED FDES STRUCTURE

The structure of the framework is represented by the six components, i.e. broader domains according to which the statistics is categorized and organized. Those include (FDES, 2013):

1. Environmental conditions and quality;
2. Environmental resources and their use;
3. Residuals;
4. Extreme events and disasters;
5. Human settlements and environmental health;
6. Environmental protection, management and engagement.

One should also mention, that component "environmental conditions and quality" is considered to be at centre of the FDES. The rest of components are closely related to it being in close interactions between each other. The structure respects the coverage of biophysical aspects of the environment on the one hand and human-society processes that either directly influence, or are influenced by, the state and quality of the environment on the other hand.

Above mentioned components of the framework are further broken down into the more specific subcomponents according to types and sources of the relevant environment data. The final decomposition level of the framework is represented by the respective indicators.

Due to the resource scarcity and different environmental issues nature in different parts of the World the framework represents a flexible approach to environmental statistics development. The set of statistics is designed with enough flexibility to be adapted to individual countries' needs listing the most important environment statistics that is in its turn is classified according to priority and importance. Prioritization is presented by the progression of the three tiers (FDES, 2013):

1. Tier 1 is the Core Set of Environment Statistics which are of high priority and relevance to most countries and have a sound methodological foundation. This set of indicators represents a broad consensus of opinion, high relevancy and sound methodological base accompanying the included statistics.
2. Tier 2 includes environment statistics that are of priority and relevance to most countries but need more investment in time, resources or methodological development.
3. Tier 3 includes environment statistics which are either of less priority or require significant methodological development.

As one can see, countries facing e.g. resource constraints can flexibly choose the set and structure of statistics to develop according to their priorities and also plan the development process in short-, medium- as well as long-term. The Core Set was tested in 25 countries, and both the revised FDES and the Core Set were subjected to a Global Consultation process, that showed that this approach is suitable for both developing and developed counties with each of them showing different level and structure of national environment statistics.

CONCLUSIONS

The updated Framework is a complex, coherent and flexible tool that is currently missing at the international level. It is truly multi-purpose; referring to the widest range of user needs set up within a sound logical framework. It is compatible with other existing frameworks and classifications. It provides valuable reference to the existing knowledge and enables further synergic development of environmental statistics programs, accounting, and policy making. Finally it is flexible enough to fit the conditions of any given country of the World at any stage of the environment statistics development, setting up clear priorities with a full respect to existing resource scarcity.

We are witnessing an important milestone in the history of environmental management in general and environment statistics in particular. The 44th session of the United Nations Statistical Commission endorsed the revised FDES together with the plan to put the FDES to work. The special Standing Expert Group for further methodological development in this field was also established.

Three decades of the FDES existence became history and, a new era of its existence has begun. One can expect that this step would greatly contribute to the overall development of environment statistics, as well as to its development in individual countries. We all have to keep in mind that the natural world can do without humanity, but humanity cannot do without the natural world.

References

UN. *Framework for the Development of Environment Statistics.* New York: United Nations Statistics Division, 1984.

UN. *Framework for the Development of Environment Statistics (FDES) 2013. Final Draft.* New York: United Nations Statistics Division, 2013.

Recent Publications and Events

New Publications of the Czech Statistical Office

Česká republika v mezinárodním srovnání (Czech Republic in International Comparison). Prague: CZSO, 2013.

Malé a střední firmy v ekonomice ČR v letech 2003–2010 (Small and Medium-Sized Companies in the Czech Economy in 2003–2010). Prague: CZSO, 2013.

The Czech Economy Development in 2012. Prague: CZSO, 2013.

Other Selected Publications

BEATON, R., MASER, C. *Economics and Ecology. United for a Sustainable World.* London, New York: Taylor & Francis Group, 2012.

ECB. *Financial Integration in Europe.* Frankfurt am Main: European Central Bank, 2013.

FAO. *Statistical Yearbook 2012. Europe and Central Asia Food and Agriculture.* Budapest: FAO of the UN, 2012.

HENDL, J. *Přehled statistických metod* (Overview of Statistical Methods). Prague: Portal, 2012.

Řešení eurokrize: federalizace nebo rozpad eurozóny? (Solution of the Euro Crisis: Federalization or Breakup of the Eurozone?). Brno: NEWTON College, a.s., 2012.

UN. *Forests and Economic Development: A Driver for the Green Economy in the ECE Region.* New York and Geneva: United Nations, 2013.

UNIDO. *International Yearbook of Industrial Statistics 2013.* Vienna: UNIDO, 2013.

Conferences

The ***29th European Meeting of Statisticians*** will be held ***in Budapest, Hungary***, during ***20–25 July 2013***. More information: *http://ems2013.eu/site/index.php*.

The ***59th World Statistics Congress*** (WSC) will take place during ***25–30 August 2013 in Hong Kong, China***. The Scientific Programme of the 59th WSC is developed with an aim to reach out to practitioners in the statistical community and to share and exchange the latest insights in their work. The ISI World Statistics Congress, formerly known as ISI Sessions, takes place once every two years in a different country and is organised with the host country's central bureau of statistics. More information available at: *http://www.isi2013.hk/en/index.php*.

The ***16th International Scientific Conference AMSE 2013*** (Applications of Mathematics and Statistics in Economy) will be held ***from 28 August to 1 September 2013 in Gerlachov, Slovakia.*** The aim of the conference is to acquaint the participants of the conference with the latest mathematical and statistical methods that can be used in solving theoretical and practical economic problems. AMSE 2013 is organized by the University of Economics, Prague, Czech Republic (Faculty of Informatics and Statistics, Department of Statistics and Probability), Matej Bel University, Banská Bystrica, Slovakia (Faculty of Economics, Department of Quantitative Methods and Information Technology) and the Wroclaw University of Economics, Wroclaw, Poland (Department of Statistics). More information available at: *www.amse.umb.sk.*

The ***7th International Days of Statistics and Economic*** will take place during ***19–21 September 2013 at the University of Economics, Prague, Czech Republic***. The aim of the conference is to present and discuss current problems of statistics, demography, economics, and management and their mutual interconnection. The Conference is organized by the University of Economics, Prague (Department of Statistics and Probability and the Department of Microeconomics), the University of Economics with seat in Košice (Faculty of Business Economics) and the ESC Rennes International School of Business. It is organized at the occasion of the 60th anniversary of the University of Economics, Prague. More information available at: *http://msed.vse.cz*.

Papers
We publish articles focused at theoretical and applied statistics, mathematical and statistical methods, conception of official (state) statistics, statistical education, applied economics and econometrics, 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:
The *Analyses* section publishes high quality, complex, and advanced analyses based on the official statistics data focused on economic, environmental, and social spheres. Papers shall have up to 12,000 words or up to twenty (20) 1.5-spaced pages.

The *Methodology* section gives space for the discussion on potential approaches to the statistical description of social, economic, and environmental phenomena, development of indicators, estimation issues, etc. Papers shall have up to 12,000 words or up to twenty (20) 1.5-spaced pages.

The *Book Review* section brings reviews of recent books in the field of the official statistics. Reviews shall have up to 600 words or one (1) 1.5-spaced page.

In the *Information* section we publish informative (descriptive) texts. The maximum range of information is 6 000 words or up to 10 1.5-spaced pages.

Language
The submission language is English only. Authors are expected to refer to a native language speaker in case they are not sure of language quality of their papers.

Recommended Paper Structure
Title (e.g. On Laconic and Informative Titles) — Authors and Contacts — Abstract (max. 160 words) — Keywords (max. 6 words / phrases) — JEL classification code — Introduction — … — Conclusion — Annex — Acknowledgments — References — Tables and Figures

Authors and Contacts
Rudolf Novak*, Institution Name, Street, City, Country
Jonathan Davis, Institution Name, Street, City, Country
* Corresponding author: e-mail: rudolf.novak@domain-name.cz, phone: (+420) 111 222 333

Main Text Format
Times 12 (main text), 1.5 spacing between lines. Page numbers in the lower right-hand corner. *Italics* can be used in the text if necessary. *Do not* use **bold** or underline in the text. Paper parts numbering: 1, 1.1, 1.2, etc.

Headings
1 FIRST-LEVEL HEADING (Times New Roman 12, bold)
1.1 Second-level heading (Times New Roman 12, bold)
1.1.1 Third-level heading (Times New Roman 12, bold italic)

Footnotes
Footnotes should be used sparingly. Do not use endnotes. Do not use footnotes for citing references (except headings).

References in the Text
Place reference in the text enclosing authors' names and the year of the reference, e.g. "White (2009) points out that…", "… recent literature (Atkinson et Black, 2010a, 2010b, 2011, Chase et al., 2011, pp. 12–14) conclude…". Note the use of alphabetical order. Include page numbers if appropriate.

List of References
Arrange list of references alphabetically. Use the following reference styles: [for a book] HICKS, J. *Value and Capital: An inquiry into some fundamental principles of economic theory.* Oxford: Clarendon Press, 1939. [for chapter in an edited book] DASGUPTA, P. et al. Intergenerational Equity, Social Discount Rates and Global Warming. In PORTNEY, P., WEYANT, J., eds. *Discounting and Intergenerational Equity.* Washington, D.C.: Resources for the Future, 1999. [for a journal] HRONOVÁ, S., HINDLS, R., ČABLA, A. Conjunctural Evolution of the Czech Economy. *Statistika, Economy and Statistics Journal,* 2011, 3 (September), pp. 4–17. [for an online source] CZECH COAL. *Annual Report and Financial Statement 2007* [online]. Prague: Czech Coal, 2008. [cit. 20.9.2008]. <http://www.czechcoal.cz/cs/ur/zprava/ur2007cz.pdf>.

Tables
Provide each table on a separate page. Indicate position of the table by placing in the text "insert Table 1 about here". Number tables in the order of appearance Table 1, Table 2, etc. Each table should be titled (e.g. Table 1 Self-explanatory title). Refer to tables using their numbers (e.g. see Table 1, Table A1 in the Annex). Try to break one large table into several smaller tables, whenever possible. Separate thousands with a *space* (e.g. 1 528 000) and decimal points with a *dot* (e.g. 1.0). Specify the data source below the tables.

Figures
Figure is any graphical object other than table. Attach each figure as a separate file. Indicate position of the figure by placing in the text "insert Figure 1 about here". Number figures in the order of appearance Figure 1, Figure 2, etc. Each figure should be titled (e.g. Figure 1 Self-explanatory title). Refer to figures using their numbers (e.g. see Figure 1, Figure A1 in the Annex).

Figures should be accompanied by the *.xls, *.xlsx table with the source data. Please provide cartograms in the vector format. Other graphic objects should be provided in *.tif, *.jpg, *.eps formats. Do not supply low-resolution files optimized for the screen use. Specify the source below the figures.

Formulas
Formulas should be prepared in formula editor in the same text format (Times 12) as the main text.

Paper Submission
Please email your papers in *.doc, *.docx or *.pdf formats to statistika.journal@czso.cz. All papers are subject to double-blind peer review procedure. You will be informed by our managing editor about all necessary details and terms.

Contacts
Journal of Statistika | Czech Statistical Office
Na padesátém 81 | 100 82 Prague 10 | Czech Republic
e-mail: statistika.journal@czso.cz
web: www.czso.cz/statistika_journal

Managing Editor: Jiří Novotný
phone: (+420) 274 054 299
fax: (+420) 274 052 133
e-mail: statistika.journal@czso.cz
web: www.czso.cz/statistika_journal
address: Czech Statistical Office | Na padesátém 81 | 100 82 Prague 10 | Czech Republic

Subscription price (4 issues yearly)
CZK 372 (incl. postage) for the Czech Republic,
EUR 110 or USD 165 (incl. postage) for other countries.
Printed copies can be bought at the Publications Shop of the Czech Statistical Office (CZK 66 per copy).
address: Na padesátém 81 | 100 82 Prague 10 | Czech Republic

Subscriptions and orders
MYRIS TRADE, s. r. o.
P. O. BOX 2 | 142 01 Prague 4 | Czech Republic
phone: (+420) 234 035 200,
fax: (+420) 234 035 207
e-mail: myris@myris.cz

Design: Toman Design
Layout: Ondřej Pazdera
Typesetting: Josef Neckář
Print: Czech Statistical Office

93rd year of the series of professional economy and statistics journals of the State Statistical Service in the Czech Republic: **Statistika** (since 1964), **Statistika a kontrola** (1962 – 1963), **Statistický obzor** (1931 – 1961), **Československý statistický věstník** (1920 – 1930).

Published by the Czech Statistical Office
ISSN 1804-8765 (Online)
ISSN 0322-788X (Print)
Reg. MK CR E 4684