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### 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 published quarterly in English only.

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### Contact us

Journal of Statistika | Czech Statistical Office | Na padesátém 81 | 100 82 Prague 10 | Czech Republic  
e-mail: [statistika.journal@czso.cz](mailto:statistika.journal@czso.cz) | web: [www.czso.cz/statistika\\_journal](http://www.czso.cz/statistika_journal)

# Impact of the Economic Crisis on the Institutional Sectors of the Czech Economy

Drahomíra Dubská<sup>1</sup> | *Czech Statistical Office, Prague, Czech Republic*

## Abstract

The article analyzes institutional sectors of the Czech economy since 2000 with respect to the year 2009 when impacts of economic crisis were felt. It is an empirical analysis based on data of the national accounts. The sense was to show the different influence of this crisis on the sector of nonfinancial corporations, sector of financial institutions, government sector and household sector. Initially, the economic crisis hit significantly mainly nonfinancial corporations in sphere of their performance but with little impact on profitability. Sector of financial institutions found in deficit itself in 2009 due to adverse development of interest balance and huge outflow of dividends, as well. The result in the household sector was reinforced by changes in redistribution processes both received benefits and paid payments. Received wages and salaries in household sector stagnated. Government sector was hit very significantly by crisis when its deficit doubled in 2009. From a broader perspective the global financial and economic crisis brought for statistics and analyses also a need to watch not only total figures for economy but also an emphasis on the detailed view on the institutional sectors. This article is an attempt to contribute to this newly arisen and emphasized need.

## Keywords

*Economic crisis, institutional sectors, nonfinancial corporations, financial institutions, government sector, households*

## JEL code

*E01, E02, E21*

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## INTRODUCTION

The system of national accounts (CZSO, 2002) enables to take a look on economy from point of view not only traditional macroeconomic quantities (Spěváček, 2000) as gross domestic product (GDP), gross fixed capital formation, employment, etc. Besides segmentation of economy into branches or sectors in concept rather “evolutionary” (e.g. primary, secondary, tertiary or quaternary sectors) it is possible to look economy also according the groups of institutions.<sup>2</sup> This way distinguishes the total

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<sup>1</sup> Na padesátém 81, 100 82 Prague 10, Czech Republic. E-mail: drahomira.dubaska@czso.cz, phone: (+420) 274 054 041.

<sup>2</sup> CZSO. *Sector Accounts* (database) [online]. Prague: Czech Statistical Office.

<[http://apl.czso.cz/pll/rocnka/rocnkavyber.sek\\_en](http://apl.czso.cz/pll/rocnka/rocnkavyber.sek_en)>.

CZSO. *Sector Accounts Time Series* (database) [online]. Prague: Czech Statistical Office.

<[http://apl.czso.cz/pll/rocnka/rocnkavyber.casrady\\_sek\\_en](http://apl.czso.cz/pll/rocnka/rocnkavyber.casrady_sek_en)>.

economy in nonfinancial corporations, financial corporations, government sector, households, and non-profit institutions serving households (the weight and role of the latter is up to now smaller in comparison with other sectors and therefore it is not analysed in this article). These mentioned institutional sectors can be further segmented for example according predominated character of ownership (e.g. public nonfinancial corporations, national private nonfinancial institutions, foreign controlled nonfinancial corporations) or according character of activity (e.g. the central bank, other monetary financial institutions, other financial intermediaries, financial auxiliaries, insurance corporations and pension funds). The government institutions exist on so-called central level or local level, households' sector has a part regarding inhabitants and a part of self-employed persons. Naturally, each of sectors has its particularities.

The method of analysis is a pick of comparable indicators in each of sector on one hand and also — due to specifics of particular sectors — it was necessary to use other indicators taking into consideration the particularities of sectors, as well for finding out the changes during crisis. In case of nonfinancial corporations the special attention is devoted to performing characteristics, in case of financial corporation's it is rather an indicator taking into consideration a strong influence of cost interests and yield interests. For calculating of the impact of the crisis on government sector its deficit is crucial. The households are described according the most important parameters for handling with money and also the changes which the economic fall caused for this sector in 2009. Therefore the gross disposable income and financial and tangible accumulation in households sector was used for it.

The final comparison of sectors comments their surpluses or deficits as a final result of their activity and compares them with the size of these surpluses of deficits during preceding years.

Calculations and used data sources are based on data published at the end of February 2011.

## 1 GLOBAL AND EUROPEAN CONTEXTS OF CRISIS

Global financial and economic crisis meant the significant reduction of the global economic activity.<sup>3</sup> Global GDP decreased by 2.6 % in real terms after increase by 1.7 % in 2009. However the developed countries suffered deeper recession when real GDP in euro area dropped by 4.1 %, in Japan even by 6.3 % and US economy declined by 2.6 %. The emerging and developing countries of so-called BRIC group (Brazil, Russia, India, and China) showed only moderate loss of growth rate in case of China and India. On the contrary, Russian economy fell in rapidly and Brazilian economy stagnated in fact.

Due to shrinking of demand the reduction of global economic activity was connected with the contraction of international trade, as well. Its turnover according World Trade Organization dropped by more than fifth (–22.7 %) after enhancement by 15.6 % in 2008. Intra turnover in the EU27 came down by 23.4 % after upgrowth by 9.0 % in 2008. European labour market with 7.1 % rate unemployment in 2008 further deteriorated to 9.0 % people without jobs.

The Czech real GDP slumped only negligibly less (–4.1 %) y-o-y compared to the EU27 (–4.3 %) in 2009 (Dubská, 2010). But previous growth rates in the Czech Republic were more than twice faster against the EU27. It resulted to the strong real convergence to the average EU economic level. But as the structure of expenditure side of GDP in 2009 the fall of investment (gross fixed capital formation) was deeper in the Czech Republic compared to the EU27 average. However, the final consumption expenditure increased above all due to expenditures by general government. On the contrary, in the EU27 total expenditure decreased (by households more markedly). Also in the Czech Republic final consumption expenditure by households reduced when more than 1.7 % jobs got lost on the labour

<sup>3</sup> More detailed analysis of the impacts of the global financial and economic crises on the Czech economy is made in Dubská (2010).

market (even  $-5.9\%$  in manufacturing). Foreign investment inflow fell on one half of 2008 level. Exchange rate weakened both against EUR and USD (more significantly), Interest rates on the interbank deposits market declined in 2009.

## **2 DEVELOPMENT IN THE INSTITUTIONAL SECTORS OF THE CZECH ECONOMY**

The sector of nonfinancial corporations felt impacts of the imported crisis due to slumps of the demand from abroad (Dubská, 2011). In certain sense the “reciprocal” development in the sector of government institutions and sector of the households (due to redistribution process) revealed in 2009 through unprecedented level of deficit in government sector. It was caused not only by the size of budget expenditures but the economic decline brought also significant decrease in tax incomes. Overall the relatively small impact of crisis on households in 2009 can be attributed just to the redistribution process. Nevertheless, the distinctive cuts in government expenditures in 2010 and its further reduction in 2011 protracted and highlighted the negative effects of crisis so that just 2011 can be considered as real crisis’ year in the Czech households.

### **2.1 Nonfinancial corporations**

#### **2.1.1 Changes in performance of sector**

The hit of crisis was heavier in the sector of nonfinancial corporations compared to the “rest” of the Czech economy. Although in 2008 the growth rate of the output (production) in the nonfinancial corporations was identical as in total the Czech economy ( $+4.8\%$  y-o-y), in 2009 the output in this sector fell by more than  $11\%$ . It was more compared to its decline in the total economy ( $-9.2\%$ ).

The massive decline of the market output was seen especially in comparison with previous average growth. In 2009 the decrease of market output in the Czech economy was nominally even higher than its nominal increment on boom in 2007. Between 2005 and 2007 the market output in total economy grew yearly in average growth by CZK 571 bn. It was possible due to massive foreign demand which was generated by the favourable economic development in the countries of the main trade partners. Apart from the Czech foreign trade strengthened also due to cancelled trade barriers as a further factor supporting growth of the Czech market output.

In 2007 which was the last year untouched by recession the size of output according national accounts increased by the historically highest y-o-y increment, i.e. CZK +915 bn. In 2008 this increment diminished on only one half (CZK +439 bn) following the fall by CZK 891 bn in 2009.

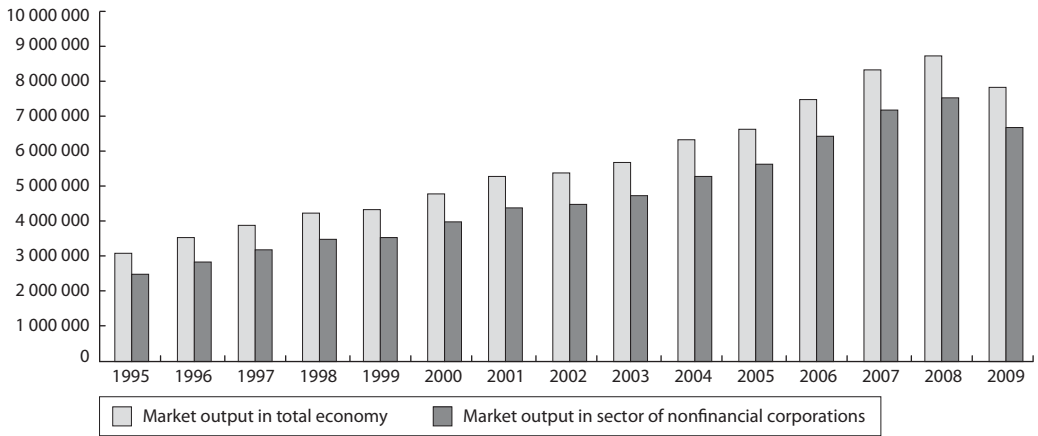
Logically, due to the weight of the nonfinancial corporations in the Czech economy, output (78 %), market output (86 %) and intermediate consumption (85 %), also the impact on this sector was analogical in the development of growths and declines of total economy.

The shares of nonfinancial corporations on the total decreased in all mentioned indicators in 2009 y-o-y. In 2008 difficulties appeared in the second half of year but proportions of the nonfinancial corporations on volume output, market output and intermediate consumption grew or stagnated, y-o-y.

Only in case of gross value added the share of nonfinancial sector declined in 2008 yet. It can be explained by fact that the financial sector was not hit by crisis in that time. In financial institutions the gross value added grew sufficiently also in the second half of 2008 when nonfinancial corporations (especially in industrial branches) slowed down yet (the industry fell since October and since November even of two digits).

Consequently the nonfinancial institutions’ fall of output amounted CZK 840 bn ( $-11.2\%$ , the total economy  $-10.2\%$ ). There were no previous nominal positive change of market output in size comparable to this extreme drop in 2009 namely even in years of big boom of the Czech economy during 2005–2007.

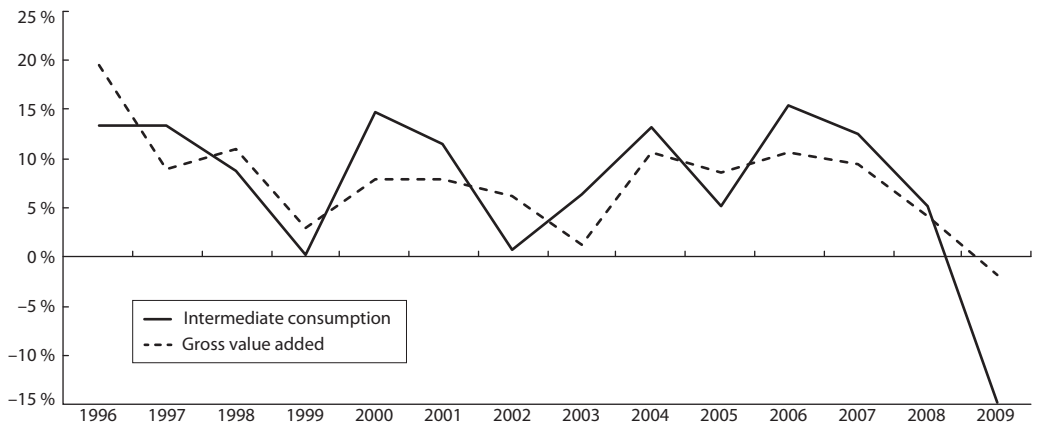
**Figure 1** Market output in sector of nonfinancial corporations and in total economy (in million CZK)



Source: Czech Statistical Office

In the sphere of intermediate consumption the decline during crisis in 2009 was substantial (-14.8 % against -13 % in total economy) compared to gross value added (-1.9 % against -1,7 % in total economy). The reason is that the companies reacted on the much declined demand through the emptying of the warehouses. In addition to that they did not refill the stock in time of uncertainty.

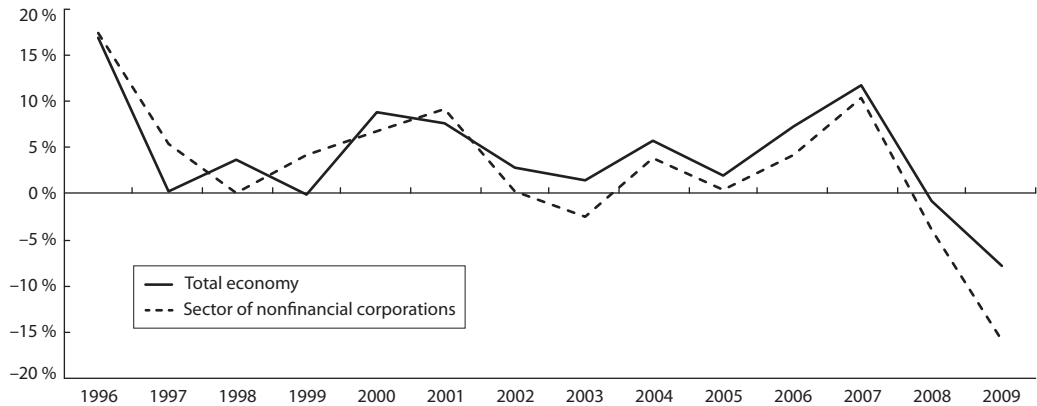
**Figure 2** Nonfinancial corporations — intermediate consumption and gross value added (year-on-year changes in %)



Source: Czech Statistical Office, own calculation

The impact of crisis was hardest on the gross fixed capital formation. Investment of the nonfinancial sector fell by 16 % y-o-y in 2009 (-7.8 % in total economy). This development is not surprising but households and also government sector were able to increase investment. It led to the diminished share of nonfinancial corporations from previous very strong proportion on investment in the Czech economy. In 2009 this proportion decreased by 5 percentage points to roughly one half (51.4 %).

**Figure 3** Gross fixed capital formation in nonfinancial corporations and total economy (year-on-year changes in %)



Source: Czech Statistical Office, own calculation

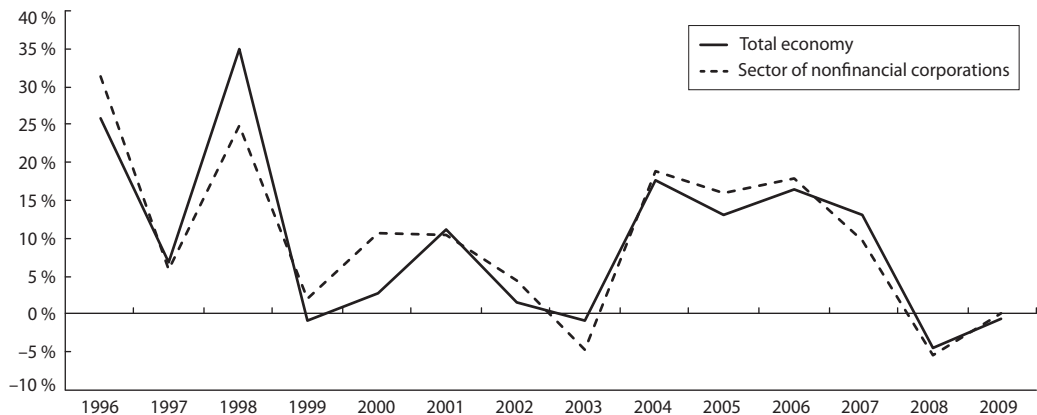
**2.1.2 Changes in income parameters**

The development during economic crisis in the Czech economy influenced the income side of sector of nonfinancial corporations. Not only in the sphere of compensation of employees and only wages but also in the sphere of profits and their distribution, i.e. in net operating surplus and in the structure of property income.

While in total economy the compensations of employees decreased in 2009 by 1.6 % y-o-y, in non-financial corporations by 3.6 %. The fall was all the more because in 2008 this indicator had increased by 9.5 % in the sector (also in total economy the growth was significant, +7.7 %, but not as dynamic as in nonfinancial corporations).

In 2009 wages and salaries had the similar development as compensations of employees. But the difference both in dynamics and in comparison between total economy and nonfinancial corporations was even much more significant. In the nonfinancial sector the corporations paid their employees by

**Figure 4** Net operating surplus in sector of nonfinancial corporations and in total economy (year-on-year changes in %)



Source: Czech Statistical Office, own calculation

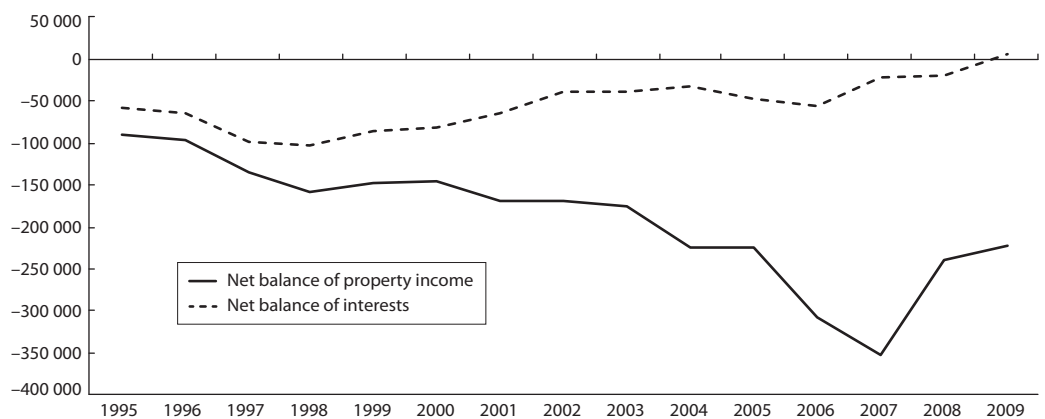


2.0 % less in comparison with 2008. On the contrary, in that time the wages rose by 10.6 % because the tendencies of the first half 2008 outweighed with huge pressures on the labour market. According Jobcentres in the first quarter 2008 the offer in total economy achieved 151 thousand of vacancies in the Czech Republic.

Net operating surplus in nonfinancial corporations as an indicator of their profits stagnated in 2009 on the level of previous year (in 2008 net operating surplus in this sector decreased by 5.4 %). It was a signal of the exit of crisis in the sector of nonfinancial corporations. During 2005–2007 the increments of this key parameter of the financial situation in mentioned sector increased +17.5 % yearly on average and in total economy by 14.2 % yearly. The nonfinancial corporations had the possibility to create a “pillow” of the profits and to strengthen the capital in their balance sheets for the risk period.

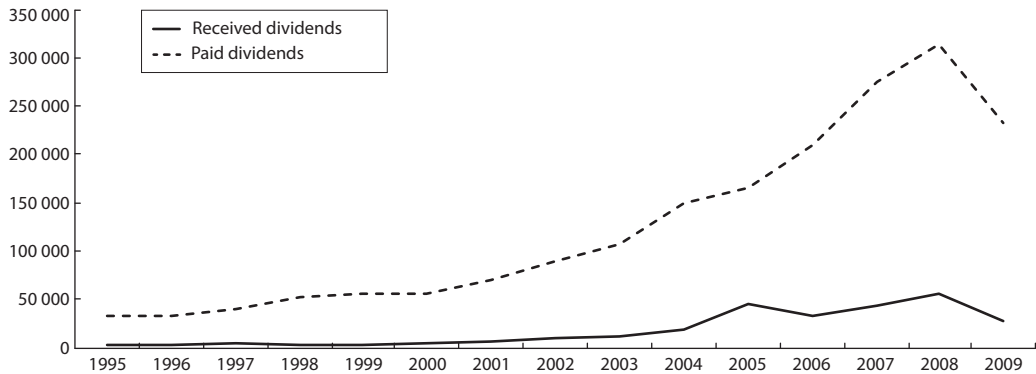
The negative net property income in the sector of nonfinancial corporations diminished in 2008 and 2009. The negative balance used to be logical because the nonfinancial sector pays higher interests of its loans usually in comparison with the interests of its deposits (the nonfinancial sector is due to its character lent largely). In 2009 the interest balance in property income was first positive when received volume of interests from deposits was higher than the paid interests of the loans. The opposite development noticed in 2009 is possible to explain by the lower lending of this sector during crisis resulting from by the caution of the commercial banks on one hand and a lower need of the operating finances in this sector during a crisis.

**Figure 5** Net balance of property income and net balance of interests in nonfinancial corporations (in million CZK)



Source: Czech Statistical Office

Paid dividends dominate the side of use of property income in the sector of nonfinancial corporations. The volume of these payments was lower by CZK 82 bn year-on-year in 2009 and their net balance was improved by CZK 53 bn. The dominance of the paid dividend on side of the use in property income is the specificity of the Czech economy due to the very significant share of the companies under the foreign control. Their owners download CZK 257 bn in 2008 in net balance of dividends which was historically the highest level. Maybe the fears connected with the situation in global financial markets influenced “mother companies” to act by this way and to use the profits generated in their Czech acquisitions at home. In 2009 net balance of dividends reduced to CZK 204 bn. One of the reasons had been the diminished net operating surplus (up to deficit) which did not enable to draw the volume of dividends as previous year. The proportion between paid and received dividends in the sector of nonfinancial corporations is shown in the Figure 6.

**Figure 6** Paid and received dividends in the sector of nonfinancial corporations (in million CZK)

Source: Czech Statistical Office

However, totally the change in net property income did not lead to the worsening in total income situation of the nonfinancial corporations.

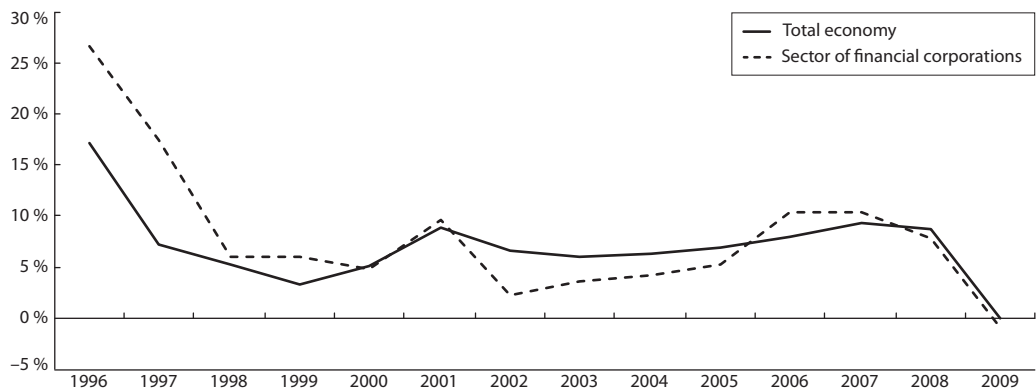
## 2.2 Financial corporations

The sector of financial institutions in the Czech Republic was not hit significantly by crisis as a whole. The balance sheets of the banks were relatively healthy without toxic assets, i.e. without sophisticated instruments of the derivative character and huge share of bonds of the countries which were endangered by default.

High profitability of the banks in the Czech Republic resulting from the strengthening retail trades with the highest margins which even further increased during the crisis. Constantly growing share of the fees in the structure of total yields against interest yield also contributed to the stability of the yields and strengthened profitability in times of the lower interest rates.

In 2009 net operating surplus in financial institutions grew significantly (+11.9 %) after its factual stagnation in 2008 (-0.4 %). It was the highest result during time series since 1995.

As the second part of the income characteristics of GDP, the volume of the compensations of employees in sector of financial institutions even increased slightly in 2009 (+0.4 %). But only wages, in comparison

**Figure 7** Wages and salaries in total economy and sector of financial corporations (year-on-year changes in %)

Source: Czech Statistical Office, own calculation

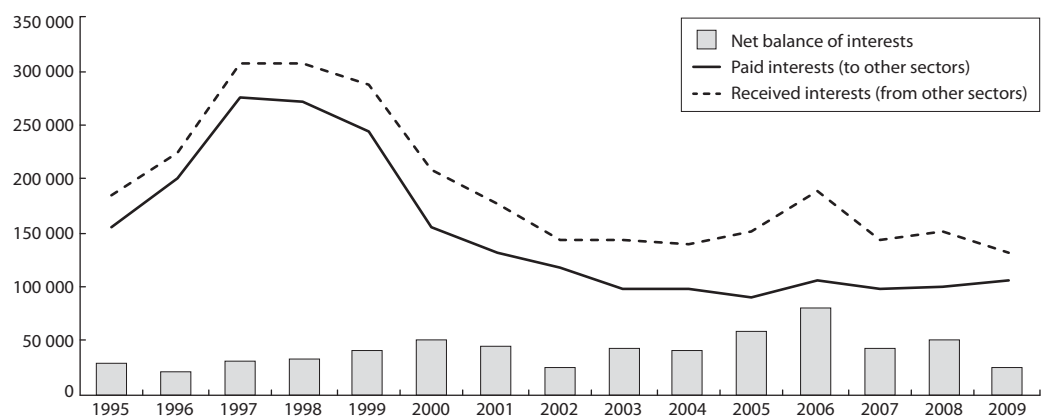
with the development of compensation of employees, showed the reduction (-0.9 %). The average wage was twice higher in sector of financial institutions compared to its level of total economy.

Segment of other financial intermediaries suffered from the weak results of the trades of leasing companies and in 2009<sup>4</sup> also the instalment sale companies showed the same development. It above all influenced net operating surplus towards its stagnation in 2008 because the segment of other monetary financial institutions — which commercial banks belong to — showed constantly the increments of net operating surplus since 2001 without wobble in 2008.

But there is a better measurement of the profit in the sector of financial corporations than net operating surplus. It is so-called business profit indicator which the statistics of national accounts do not publish usually but it is available. This indicator is preferable especially due to its capability to show the net yields resulting from interests. Just this net interest income is main factor of profitability in financial corporations.

Net business profit as a truer picture of the financial results in this sector significantly decreased in 2009 (-40.4 %). It was caused by a huge reduction of balance of interests when the paid interest increased and on the contrary the received interest (from the provided loans) diminished. The reason was the development in economy during the crisis.

**Figure 8** Interests in sector of financial corporations (in million CZK)



Source: Czech Statistical Office

Therefore, the financial corporations got on received interests by CZK 20.8 bn less in 2009 compared to 2008. The volume of the received interests was market lower due to state of the provided loans began to decrease. Namely the banks accessed to their clients from point of view a cautious weighing of the risk. But also the need of the operating funding showed a lower as a logical usual symptom of crisis.

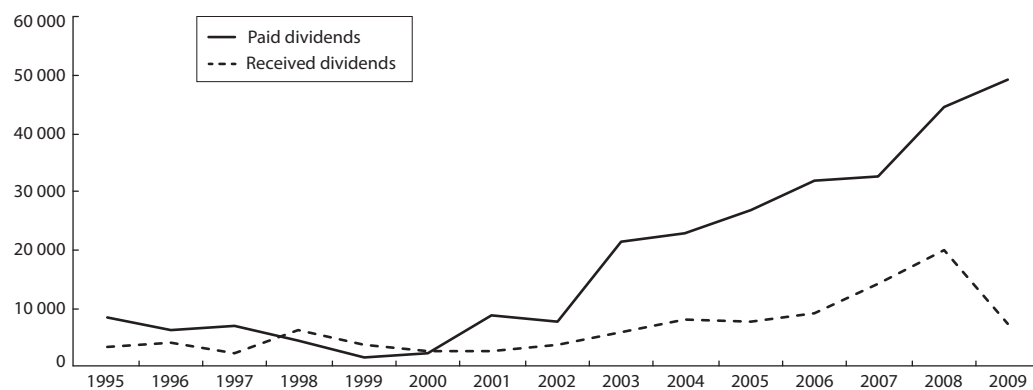
On the contrary, the financial corporations paid on interests by CZK 5.7 bn more year-to-year in 2009. As a result of the all mentioned movements the net balance of the interests in this sector shrank to CZK 25.5 bn which was the lowest level since 1996.

Next unfavourable factor influencing negatively business profit in financial corporations was the development of dividends. The foreign owners reacted responded to global financial crisis in 2008 yet and they pumped away a significantly higher share of profits achieved on the financial market of the Czech Republic. Compared to 2007, the outflow of profits in the sector of financial corporations in the form of

<sup>4</sup> Data from time series of the annual national accounts were not available in time of the processing of this analysis.

dividends increased by more than CZK 12 bn (from CZK 32.6 bn to CZK 44.7 bn). This extreme relative movement had only parallel during 1996–2009 — year 2003 but it followed after year 2002 when no money did not pass toward the foreign owners (thus it was the accumulation of two years practically).

**Figure 9** Paid and received dividends in sector of financial corporations (in million CZK)



Source: Czech Statistical Office

In 2009 the outflow of the profits in the financial sector further continued if not so sharply as in 2008. It achieved historical level CZK 49.4 bn with y-o-y increment by CZK 4.7 bn.

If the volume of dividends in the financial corporations paid to foreign owners significantly grew in 2008 and 2009 but the volume of the dividends received by this sector did not. Received dividends fell by two thirds and they were only CZK 7.5 bn which was roughly the same level as in 2005 (CZK 7.6 bn). In 2008 on the contrary the financial sector received on dividends almost CZK 20 bn, i.e. the absolutely greatest amount since 1995.

This sharp opening of scissors between paid and received money as dividends was together with reduction of net balance of interests the second reason of the marked decrease of business profit in the sector of financial corporations of the Czech Republic during crisis year 2009. The volume of this business profit achieved only CZ 69.7 bn against historical CZK 117 bn in 2008.

### 2.3. General government sector

The crisis in 2009 doubled the deficit of the general government sector how in nominal conditions so in ratio to GDP in current prices. It was the worst impact of the crisis of all institutional sectors of the Czech economy.

According notification of the government deficit and debt in 2009 the net borrowing rose to 5.8 % of nominal GDP from 2.7 % in 2009. While during the strong growth of the economy the Czech Republic was able to keep the general government deficit under level of convergence criterion but six-percent growth rates were not able to generate surpluses of government sector. During 2006–2008 the deficits were 2.6 %, 0.7 % and 2.7 % of nominal GDP.

In 2009 the general government sector found itself in deficit of CZK 209 bn which was the highest level since 1995 (just in 1995 the deficit was the second deepest when did CZK 197 bn). The deficit of central government represented CZK 176.6 bn in 2009, i.e. 84.4 % of the total deficit of government sector (only in 1995 it was higher, CZK 224 bn).

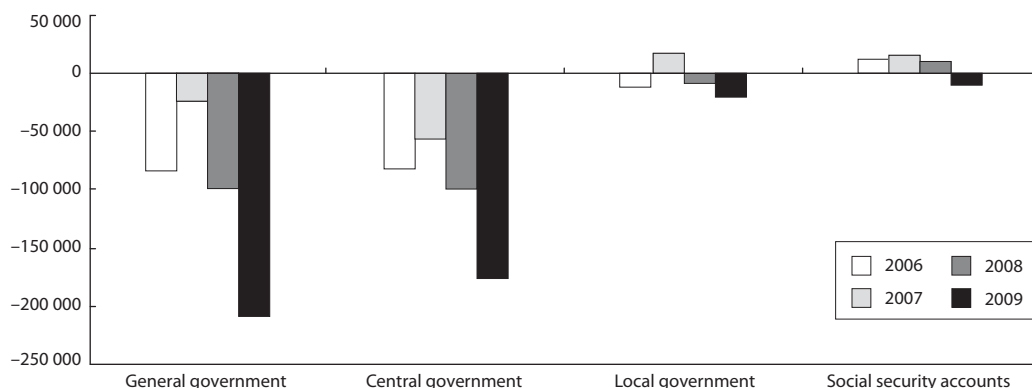
Nevertheless, the deficit of general government sector rose faster than deficit of the central government. Namely the deficits of the other segments of the government sector grew significantly in 2009 although they are lower a lot in comparison with the central government. Against 2008 (CZK –98.9 bn)

the general government sector deficit was double in 2009 and in previous year (CZK -23.2 bn) it was quadruple y-o-y. But they were not the same dramatic increments in the case of the central government deficits (in 2009 its deficits deepened by 78 %).

The crisis year 2009 brought also the significant negative jump in the deficit of the local government and the segment of social security on the worst historical level. Nevertheless, these deficits remained substantially lower compared to central government deficits. The local government deepened its deficit by 140.0 % to CZK 21.8 bn in 2009 when in 2008 the expenditure was greater than revenues by CZK 9.2 bn. In 2007 this segment reported surplus (CZK 16.8 bn) yet.

After four years a deficit in the social security accounts appeared, as well. Its range was very large (CZK -10.6 bn) if we consider that the previous years with deficits (2001–2005) had showed a lot of narrower negative differences between revenues and expenditures (hundreds of millions usually). Before the largest deficit was reported in 2002 (CZK -4.2 bn).

**Figure 10** Sector of general government and its structure — deficits / surpluses (in million CZK)



Source: Czech Statistical Office

Paradoxically, the compensations of employees in general government sector rose also in 2008 and 2009. The salaries in this sector increased by CZK 12.7 bn (+6.0 %) in 2009. It was even more than in 2008 (CZK +8.3 bn, i.e. +5 %). This increment of salaries exceeded nominally annual average increases of period 2004–2008 (CZK +9.9 bn) and also the average annual additions in peak year of boom in economy (CZK +11.8 bn yearly during 2005–2007). Wages and salaries in the total economy stagnated in 2009 compared to 2008.

One of the most important changes which appeared in 2009 and which influenced the deficit in general government sector was the change in money inflows and outflows reflecting the redistribution processes. It associated with the household sector especially with the sides of resources and use of the gross disposable income of households.

### 2.4. Households

The decade 2000–2009 can be divided into three periods in terms of handling money in the Czech households:<sup>5</sup> (1) period 2000–2004 with the featureless growth or stagnation of the main parameters,

<sup>5</sup> Aggregates of the household sector bring information both from the entrepreneurs-actual persons and from behavior of the consumers (Duspivová, 2009).

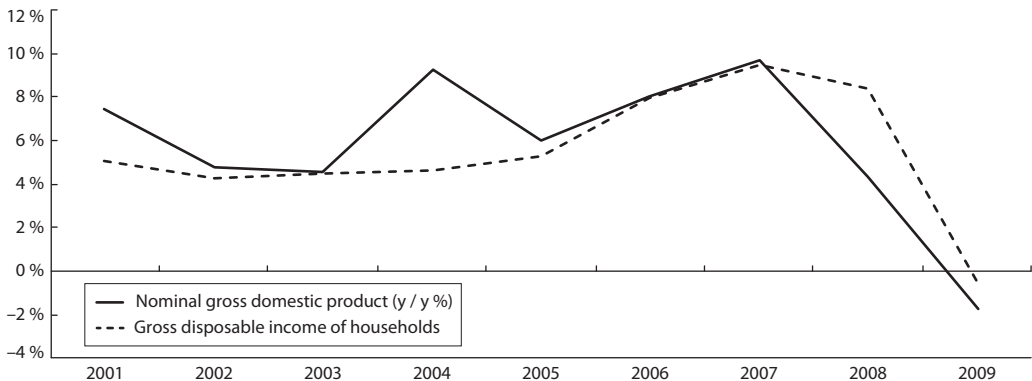
(2) period 2005–2008 benefiting from the strong boom of the Czech economy and (3) 2009 as a year of crisis.

Period 2000–2008 and especially its second half brought the growth of the Czech households. Development of its tangible accommodation and financial accommodation, as well enabled that its increment of capital gains doubled due to savings and capital transfers in 2008 against 2000. An ability of the households to finance others sectors of economy failed in two years of decade only. It was the strongest in 2008 with the surplus of almost CZK 39 bn. This sector maintained its ability to finance others sector also in 2009 but the surplus as a net lending to others sectors dwindled to half compared to 2008. While capital gain in the sector of household annually rather fluctuated, since 2005 its growing trend was already apparent clearly. So the Czech households benefited from the strongest boom of the Czech economy in modern history of the country (and simultaneously, it was significant resource of the high economic growth in many respects).

Compared to the growth of the Czech economy the gross disposable income of household sector grew smoothly since 2002. But also it modestly lost its position measured by the share on nominal GDP. It can be concluded that the others sectors strengthened their incomes which was logical especially in case of nonfinancial corporations and their good financial health during strong boom. But in 2008 the share of gross disposable income of household sector on nominal GDP grew again year on year because nominal GDP had been losing the pace significantly.

In 2009 households' gross disposable income decreased year on year but it was milder compared to nominal GDP.

**Figure 11** Nominal GDP and gross disposable income of households (year-on-year changes in %)



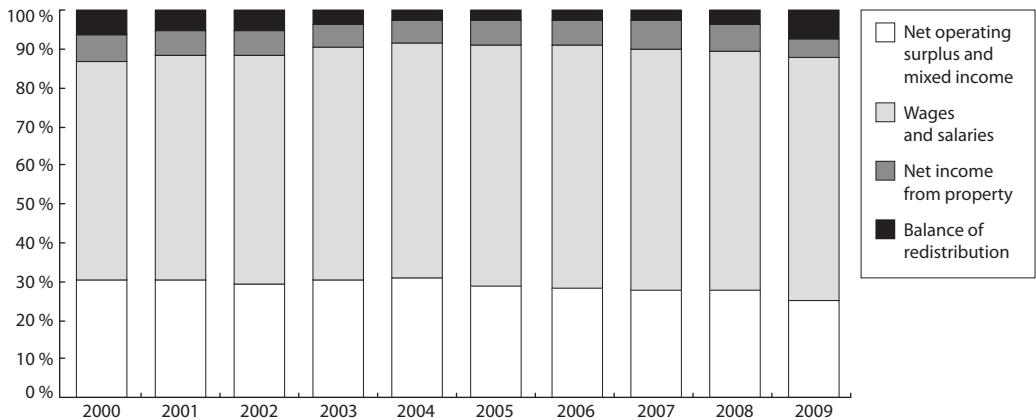
Source: Czech Statistical Office

The Czech households were affected ambivalently in the year of crisis — their net worth grew year on year though in lower growth against 2008. The range of this increase was comparable with 2007: capital transfers did not dropped significantly but gross saving of the Czech households diminished relatively markedly. But the side of resources of gross disposable income of household sector showed substantial changes in its structure.

In 2009 the Czech households disposed of less money compared to 2008 (CZK –5.9 bn). Their gross disposable income decreased by 0.3 % year on year when during 2005–2008 it was rising annually on average by CZK 128 bn (+7.8 %). In year of crisis especially income from property dropped significantly (–15.4 %) with the decreasing in 2008 (–8.1 %). Also their income from business (as a net operating surplus and mixed income) diminished by 8.8 % in 2009 against 2008. Balance of redistri-

bution<sup>6</sup> rose significantly not only due to strengthening of the expenditures from the public resources which used to be logical during crisis but also due to legislative changes (mainly introduction of the flat tax).<sup>7</sup> The volume of the wages and salaries recorded factual stagnation (−0.3 %).

**Figure 12** Shares of components of households' gross disposable income on its total volume (in %)



Source: Czech Statistical Office, own calculation

Wages and salaries dominate in the structure of the primary income of the Czech households. During 2000–2008 they were rising by 7.3 % annually on average. It was roughly the same pace as the average growth of the second significant resource of income in household sector which is received income from redistribution (+7.4 %) especially social benefits. Both of resources were developing from point of view of household more favourably than their gross disposable income in total (+6.0 %). However, compared to it also gross capital formation grew faster (+6.4 %). Especially the gross fixed capital formation increased very strong (in 2006 and 2007 by one fifth year on year on average). It was connected with acquisition of the owner occupied housing which culminated in mentioned two years. It was also hurried by high increments of the real wage, attractive conditions of the interest rates on lending for home purchase and in general positive future expectations based on ongoing phase of the business cycle.

On the contrary, in 2009 the wages and salaries slightly reduced (by 0.3 %, i.e. CZK 1 244.185 bn). This factual stagnation seems to be surprising at the relatively large fall of the Czech economy. But it can be explained by the structure of changes on the labour market. It means not only by layoffs mainly of the low-income employees but also lower numbers of the employees which were sick in 2009 compared to 2008. Both of these reasons caused that impact of crisis on the reported level of the wages and salaries in the Czech households was not so adverse on average.

Profits in the household sector (Duspivová, 2009) expressed as the sector's net operating surplus and mixed income decreased more significantly compared to wages and salaries. Profits in the sector of non-financial corporations only stagnated in 2009 and the decrease appeared there in 2008 yet. But the seg-

<sup>6</sup> In logic of the gross disposable income of households the "resource" is understood from their point of view, i.e. as a receiving social benefits. On the contrary, the side of "use" means in this context also (from point of view of households) the payment to the system, for example any paid tax.

<sup>7</sup> The contributions of employers are not involved to the balance of redistribution. All results mentioned in this chapter regard only the relationship between the household sector and government sector.

ment of entrepreneurs as a part of the household sector was in “the black figures” in 2008 yet (+7.5 %). In 2009 the fall appeared (−8.8 % year on year). The reason was probably the character of business activities in the household sector responsive slower on the cyclical fluctuation. The second reason may be some specificity of employment especially in construction industry in the Czech Republic (considerable preferences of employment for Trade Certificates, so-called “svarc-system”).

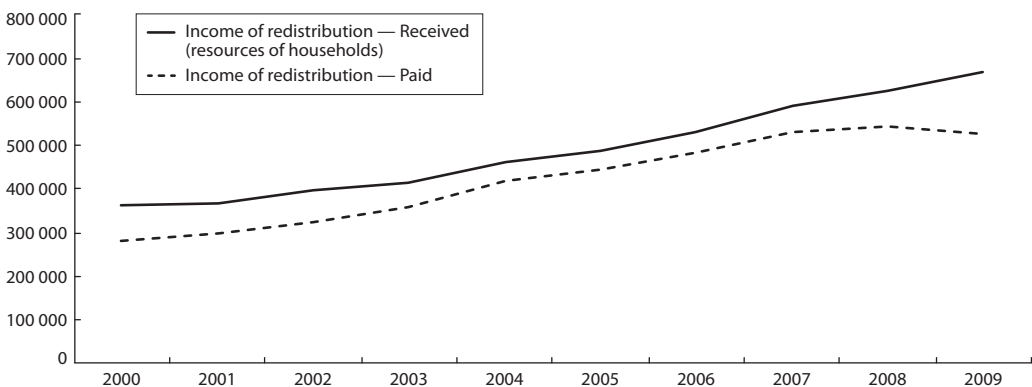
Despite of the perceptible reduction in profits of this sector the Czech households suffered much more due to a fall in the net income from property. It was lower by CZK 18.2 bn. The strong reduction of the income from property (by CZK 29.6 bn) was caused mainly lower received interests. But the fall of the net income from property was moderate by lower expenditure on property (by more than CZK 11 bn). The reason was also significant decrease in interests paid by households.

Just the changes in interest balance influenced decisively the net income from property of the Czech households during crisis. The lower volume of interests from banks was caused by the historically lowest basic interest rates in economy and their projections to the trade policy of commercial banks. The second reason is that households’ deposits were moving from the term deposit accounts to demand deposit accounts. Logically, it influenced the volume of the received interest in household sector.

On the side of the paid interest probably played a role the fact that the new loans were not so high compared to previous period. People mainly paid their current loans which had provided from the banks and other financial intermediaries. Increased tendency of the Czech households to debt was also motivated — along with desire for their own housing — by exceptionally low level of the interest rates. The most of loans for housing was provided just during the period of very low interest rates and this type of loans for households did almost three quarters of the total indebtedness of the Czech households. In 2005 and 2006 the interest rates of loans for housing decreased to 4.34 % or 4.66 % respectively. But the largest annual volume of housing loans were provided in 2007 (CZK 139.4 bn) of which only mortgage loans CZK 95.3 bn when the interest rates go higher in this year (5.67 %). It means that the Czech households need to have own housing was very strong in spite of the growth of the price of money. In 2009 during crisis the increment of housing loans was only half (CZK 70.7 bn) compared to 2007 and thereafter in 2010 the Czech households borrowed for housing only CZK 43.9 bn. This situation reflected the state of the budgets of the households which have suffered due to restrictions in public sector and not so good situation on Czech labour market.

Balance of redistribution recorded a significant strengthening of the side of resources and, on the contrary, substantial reduction on the side of use.

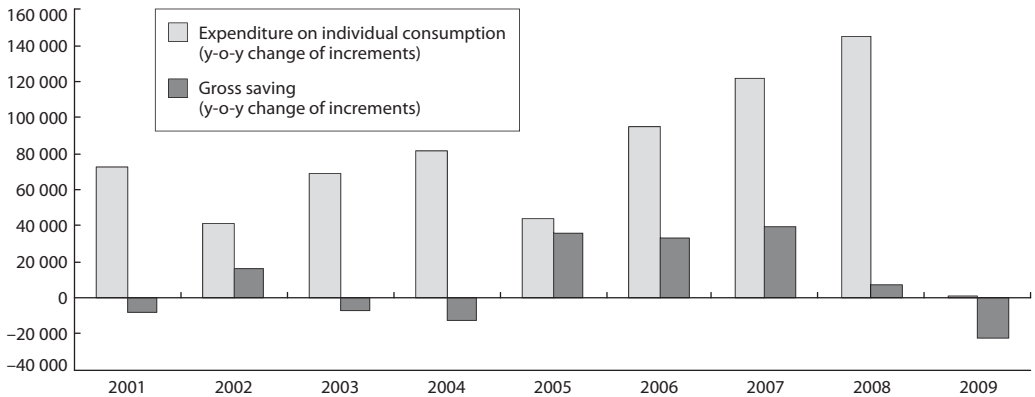
**Figure 13** Resources and use of the income of redistribution in household sector (received and paid, in million CZK)



Source: Czech Statistical Office



**Figure 14** Household final consumption expenditure and gross saving (increments y-o-y, in million CZK)



Source: Czech Statistical Office

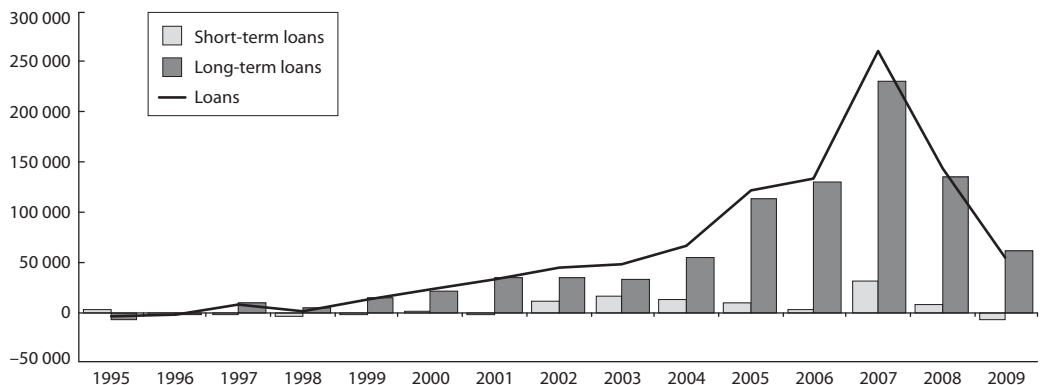
Household final consumption expenditure stopped in 2009 on the level of 2008 when surprisingly grew year on year in the historically highest annual increment. The impact of crisis on consumption was relatively low with the year on year decrease since the third quarter 2009.

Besides stagnation of the households' consumption also the increment of their gross saving was lower year on year. The decrease of the savings rate was observed in 2008 yet. During 2000–2009 the Czech households were able to save more than one tenth of their gross disposable income. In 2009 they gave aside only substantial less.

Lower savings influenced the accumulation of Czech households. But in 2009 the recovery of the tangible accumulation was seen after its decrease in 2009. This recovery was approximately same as the dynamics of the gross fixed capital formation in 2004 and 2005. On the contrary, the strong impact of economic crisis on the household sector was seen in the sphere of the financial accumulation and it was connected with the shift to the higher liquidity of deposits.

In 2009 the significant growth of net equity of households in life insurance reserves was caused by administrative chase (a reclassification in banc-assurance in one of the big financial institution when

**Figure 15** Year-on-year change of state of total loans provided to households (in million CZK)



Source: Czech Statistical Office, Czech National Bank

term deposits were reported as capital life insurance). Exactly the opposite trend showed net equity of households in pension funds reserves. In 2009 it decreased by CZK 10.3 bn, i.e.  $-42.0\%$ . The people saved there less compared to 2008 when a moderate reduction was observed yet. But during previous monitored period (2000–2007) the constant growth of increments was seen year on year.

Households' indebtedness was hit by crisis not so dramatically as the lending in sector of non-financial corporation. In spite of it the increment of the total loans provided to households diminished to 2004 level. This development was different structurally. Although state of short term loans decreased year on year in 2009, the long term loans continued in growth.

### 3. COMPARISON OF THE IMPACTS OF CRISIS ON THE INSTITUTIONAL SECTORS

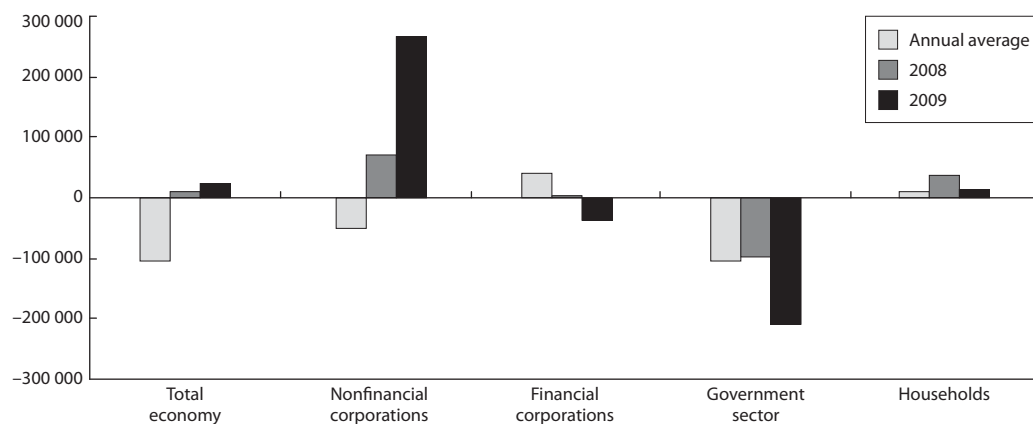
In the first phase of crisis mainly the sector of nonfinancial corporations was influenced negatively. The huge fall of the foreign demand led to the lost of the pace of the value of the market output, intermediate consumption and gross added value. In 2008 this parameters only lost pace but in 2009 a reduction was seen. Firing of the employees resulted to the fall of the wages and salaries. So in the performance, the nonfinancial corporations suffered more than other sectors. Just the strong fall in performance changed an existing proportion of this sector in net lending / borrowing. While since the beginning of the time series — and finally, in logic of things — the sector of nonfinancial corporations demanded a financing from other sectors, in 2009 it was conversely. This sector created huge surplus. It was due to lower loan financing, lost of the activity in investment and significant smaller need of the operational funding.

The surplus in sector of nonfinancial corporations was higher than the deficit of the government sector in 2009.

The sector of financial institutions generated a historically first deficit in 2009. Net borrowing represented CZK 35 bn. These institutions were hit by substantial deterioration of the balance of interests (CZK  $-25.5$  bn) and also higher dividend payments (CZK 50 bn in 2009 when the significant outflow of repatriated profits was seen in 2008 due to uncertainty induced by global financial crisis). In this sector especially the segment of the other financial intermediaries failed as leasing companies but also the companies of hire purchase suffer a huge fall of income. Their net worth decreased.

The household sector was hit by crisis up in the second half of 2009 when gross disposable income diminished. But their wages and salaries only stagnated in that year. The biggest fall showed the net income

**Figure 16** Comparison of net lending/borrowing (surpluses or deficits) of the institutional sectors and total economy (2008, 2009 and annual average 2000–2007, in million CZK)



Source: Czech Statistical Office

from property. Interesting development was recorded on the side of resources in balance of distribution. Due to new legislation more money remained in household sector. The higher social transfers (unemployment benefits and others social benefits for people without job) were the second strengthening supply for the households' budgets. So the crisis hit the Czech households came later and it was tempered by stagnation of the wages and salaries in economy and bigger balance of redistribution.

The hardest impact of crisis felt the government sector of the Czech Republic. Its deficit was twice higher in 2009 compared to 2008 and achieved CZK 209 bn. It was the historical record. The public sector could not count on the sufficient revenues of the central government due to weak tax collection on one hand and, on the other hand, emerging needs of additional expenditure resulting in a crisis.

Fortunately, the Czech government sector was not forced to carry bank bailout as some countries in Europe or especially in US. Also providing of liquidity was not necessary to support interbank market (except a very short period).

In total the Czech economy generated surpluses in 2008 and 2009 (net lending). Its internal resources sufficed to finance the strong subdued economic activity. Refilling from the external resources was not necessary in those years as in all period 1995–2007.

## CONCLUSION

The institutional sectors of the Czech economy were influenced by crisis in a different extent, both in the size of damage and the time period when the impact was observed.

The non financial corporations were afflicted the soonest and this affect was heavier compared with the rest of the Czech economy. The output of total economy — which fall in 2009 was nominally larger than its biggest increment from the climax (peak) in 2007 — had declined in comparison with 2008 by 9.2 % but nonfinancial corporations' output had dropped by 11.2 % y-o-y. Gross added value in the sector of nonfinancial corporations was lower as well. Their gross fixed capital formation decreased by 16.0 %, it means more than in total economy and likewise the downswing in wages was worse compared to total economy.

Net operating surplus in nonfinancial corporations sector which expressed their profits decreased in 2008 yet and stagnated in 2009. Although the substantial reduction of the provided loans was assigned to the weaker willingness of the banks to give credits, it was only one of truth. Actually, non-financial corporations did not need the credits in the same magnitude as during period before, mainly the working funding. In addition — in spite of the anaesthesia of investment activity and lower need of the credits during the crisis — a surplus appeared in the sector of nonfinancial corporations. It was historically for the first time and this surplus was even larger than the deficit of sector of government institutions in 2009.

The healthy and capital strong sector of financial institutions in the Czech Republic was not afflicted so much by crisis as the same institutions on European or global level. They did not need to be reactivated or made stronger through the capital injections from the shareholders. In spite of it this sector felt effects of the crisis. In 2009 the wages descended year-on-year (–0.9 %) compared to their significant growth in 2008. Nevertheless, an average wage in the sector of financial institutions remained more than twice higher in comparison with its level in total economy in crisis.

Although the profits of financial institutions (as their net operating surplus) increased in 2009 year-on-year next by 12 %, a more important indicator taking into consideration the specifics of this sector, so-called entrepreneurial profit influenced by the balance of paid and received interests and increasing in trend since 2003, dropped by 40.0 % year-on-year in 2009. The reason was also the lower interest yield due to weak giving credits to corporations and households, as well. Especially the segment of other financial intermediaries did not was not found in the good condition (leasing companies, companies of instalment payment, factoring companies).

A very strong outflow of dividends to the mother companies which own the financial institutions in the Czech Republic was larger than their positive result of profits on operating level in 2009. It was just reason for rather surprising deficit of total sector in this year.

The government sector was hit very significantly by crisis. In 2009 its deficit was twice higher against 2008 and it amounted to CZK 209 bn. The cyclical effect became evident which was enhanced by exposed legislation since 2008 (income tax, social insurance). The changed legislation cut revenues of the state budget by almost CZK 30 bn. Logically, the expenditure side of state budget spread during crisis and it was paid roughly CZK 45 bn more against 2008 from the budget. Nevertheless, after period of decreasing growth pace in wages in government sector during 2006–2008 their increase appeared in 2009 (+5.8 % y-o-y).

The main feature of the significant worsening of the Czech government sector deficit was its complexity. Apart from the traditional deficit of state finance which went deeper also the deficit of local governments spread. The segment of social funds (health insurance companies) dropped into deficit, as well. The total deficit of the government sector in ratio to nominal GDP was twice as big (5.8 %) against 2008 (2.7 %). In spite of it the worsening was not so much expressive as in EU27 where this ratio was 6.8 % while only 2.3 % in 2008.

However, very unfavourable balance in the government sector in 2009 had a positive impact on households due to income from redistribution. But in spite of this fact their gross disposal income as a complex indicator of the treatment of money was weakened mildly in the year of crisis. The reason was only an imperceptible growth of wages and salaries y-o-y (+0.3 % to CZK 1 235 bn) as main source of the gross disposable income of households and decline of net operating profit of self-employed persons (–8.8 %), as well. Also sharp downswing in net income from property (by one quarter, i.e. CZK 32 bn) caused together a slight decline of gross disposal income in household sector y-o-y.

Household final consumption expenditure stagnated and their gross savings decreased by 11 %. Tangible accumulation as an increment of investment for tangible fixed assets rose in 2009 paradoxically when it had decreased in 2008 yet. People invested to the dwellings also in crisis year. But it was financial accumulation which noticed the sharp negative change — the increase of the households' deposits (with exception of so called non-fixed term deposits) was only one third of the rise in 2008.

On the whole, the Czech households were able to make their wealth by CZK 121 bn in crisis year 2009 as a result of the changes in savings and capital transfers. It was in narrower measure in comparison with 2008 or 2007 (CZK +137 bn). The ability of this sector to finance the deficits of the other sectors of economy (which was observed for almost all the period 1995–2009 except 2001 and 2004) remained preserved.

The Czech economy as a whole, i.e. in summary of all institutional sectors, generated surpluses in 2008 and 2009. However, according to the running recession it was not necessary to use external resources of financing for funding of its performance as yearly during 1995–2007.

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# The Czech Labour Market and the Current Economic Crisis: What Can the Linked Employer-Employee Data Tell Us?

Kateřina Duspivov<sup>1</sup> | *University of Economics, Prague, Czech Republic*

Pavel Spcil<sup>2</sup> | *TREXIMA, spol. s r.o., Zln, Czech Republic*

## Abstract

Current economic crisis has hit the Czech economy in a less severe way compared with other economies, but there have been affected employees who have lost their jobs as well as those who have remained employed but their wages have been reduced. The main aim of this paper is to discuss the possibility of wider use of linked employer-employee microdata from the Average Earnings Information System (the Czech Structure of Earnings Survey) in order to be able to identify comprehensive and more informative labour market indicators compared with the generally known basic set of indicators. With data on job flows and employee flows from the data source mentioned above, we show that the economic crisis has probably taken some effect in the economic subjects classified into our sample. Furthermore, we show that jobs in some industries have been destroyed more frequently than jobs in the others.

## Keywords

*Labour market, employment, wages and salaries, job flows, employee flows*

## JEL code

*E24, F23, J63*

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## INTRODUCTION

Current economic crisis has hit the Czech economy in a less severe way compared with other economies (see e.g. Blanchard et al, 2010, Frankel, Saravelos, 2010, Singer, 2009, 2010, Tong, Wei, 2009) nevertheless it is important to analyse the Czech economic situation in detail in order to identify the point during the economic cycle that the economy is approaching. In doing so, there is a lot of indicators available that could be used.

Since the economic crisis set in, interesting findings concerning above all social indicators could have been made. The Czech labour market has been hit slightly during the current economic crisis, but there have been affected employees who have lost their jobs as well as those who have remained employed but their

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<sup>1</sup> Nm. W. Churchilla 4, 130 67 Prague, Czech Republic. Corresponding author: e-mail: duspivova@trexima.cz, katerina.duspivova@vse.cz, phone: (+420) 257 220 974. Working also in TREXIMA, spol. s r.o.

<sup>2</sup> TREXIMA, spol. s r.o., t. T. Bati 299, 764 21 Zln-Louky, Czech Republic.

wages have been reduced. Trying to measure labour market changes, 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 in the Czech Republic is the fact that each of the key aspects of the labour market (i.e. employment as well as remuneration) is so far surveyed and evaluated separately, even if these two aspects are closely related.

The main aim of this paper is to investigate the possibility of a wider use of linked employer-employee microdata from the Average Earnings Information System (the Structure of Earnings Survey family) in order to be able to identify comprehensive and more accurate labour market indicators compared with the generally known basic set of indicators. As for the alternative labour market indicators, we will use indicators concerning job flows and employee flows in order to be able to analyse the effect of the recent economic crisis in more detail.

The indicators concerning job and employee flows have never been quantified using the linked employer-employee data in the Czech Republic,<sup>3</sup> so the pilot results will be introduced in this paper.

The structure of the paper is as follows: section 1 presents the dataset and methods used, the main empirical results are presented in sections 2, 3 and 4, the last section concludes the paper.

## 1 DATA AND 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 data linking and the set of indicators proposed by Davis et al (e.g. Davis, Haltiwanger, 1989, 1990, Davis et al, 1996). Data linking issues are closely connected with the indicators, so the close attention will be devoted above all to them.

### 1.1 The Average Earnings Information System

The Average Earnings Information System (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 guidelines since 2006.

The sample in the business sphere contains c. 3 500 economic subjects with total employment about 1.3 million workers. Only economic subjects with more than 10 employees are sampled in the ISPV.

### 1.2 The sample for analysis

The impact of the recent economic crisis will be quantified for economic subjects in the business sphere that employed *more than 10 employees* at least at one year taken into consideration (i.e. in one year from 2006 to 2009). This sample consists of more than 40 thousand economic subjects and 2.6 million of employees in individual years of interest. The grossing up method was based on the stratified random sample with the known (non-zero) chance of individual economic subjects of being selected to be a part of the sample. For more detailed information on the sample and the grossing up method of the ISPV see e.g. ISPV (2009) and ISPV (2011).

### 1.3 Linking of the data

Before quantifying the indicators, it is necessary to link individual records in the ISPV between the consecutive years. Linking the data may affect the results, so the close attention will be paid to it.

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<sup>3</sup> Jurajda, Terrell (2001) and Jurajda, Terrell (2002) quantified these indicators using other data sources (namely the labour force survey). For this reason, the results were limited.

After the data were checked and cleaned, linking of the ISPV records was realized in two steps. First of all, the records concerning economic subjects were linked using the registration numbers.<sup>4</sup> These IDs are unique, so the direct linking could be used in the case of economic subjects.

As for our sample, there were two problems identified. The first problem concerns records of economic subjects. Some economic subjects were identified to be the start ups or exits even if they were not. By checking IDs of these subjects in the Czech Business Register (RES), we found out, that all these exits or start ups were caused by mergers and acquisitions or splits. All these subjects were taken from our sample because job creation/destruction as well as hires / separations measures could be distorted. The second problem concerns faulty records of employees that could not have been matched with each other because it was impossible to identify the employee in the consecutive years even if the employee was employed in the economic subject for the whole period. Because of this reason, all the subjects were taken from the sample if more than 60 % of the employee records did not meet the condition that employee was employed in the subject on the last day of the previous year and on the first day of the forthcoming year (i.e. the item with code KONECEP equals zero in the previous year) and this employee was not identified in the records of the forthcoming year. By way of illustration, the Table 1 compares pro-

**Table 1** Probability of inclusion of an economic subject in the sample of ISPV in the business sphere in the Czech Republic in 2009 specified according to the purpose

Size category of economic subjects	Number of employees	Probability of inclusion of an economic subject in the sample of ISPV for	
		Standard ISPV results (%)	Quantification of job and employee flows (%)
1	10–49	4.5	3.0
2	50–249	15.0	12.7
3	250 and over	100.0	81.6

Source: ISPV (MoLSA), own calculation

**Table 2** Number of economic subjects in the sample of ISPV in the business sphere in the Czech Republic in 2009 according to the sector of economic activity specified according to the purpose

Sector of economic activity CZ-NACE	Number of economic subjects in the sample of ISPV for	
	Standard ISPV results	Quantification of job and employee flows
Agriculture, forestry and fishing	175	150
Industry and transportation	1 761	1 424
Construction	273	214
Wholesale and retail trade	440	332
Market services	400	328
Other services	429	306
<b>Total</b>	<b>3 478</b>	<b>2 754</b>

Note: For NACE sections classified into the individual sectors of economic activity groups see the Annex.

Source: ISPV (MoLSA), own calculation

<sup>4</sup> Every economic subject in the Czech Republic has been assigned the only one registration number of 8 digits (ICO), which is to be used to identify the subject in an easy way for the business as well as public administration purposes. These figures are unique and are assigned by the public authorities (e.g. the CZSO, the Ministry of the Interior of the Czech Republic, etc.).



babilities of inclusion of economic subjects in the sample of the ISPV in the business sphere in 2009 for standard ISPV results with the sample for quantification of job and employee flows. In the Table 2, there is shown the structure of the sample according to the sector of economic activity.

Another situation occurs in the case of the employee records matching. The *employee records* are to be matched after the economic subjects linking was realized. The reason is obvious — employee records have to be matched using statistical data matching procedures based on more variables, because there is no name, address or personal ID surveyed in the ISPV. Some records were linked using the *employee ID* which is assigned to the employee by the employer. Doing so, one could encounter problems concerning instability of these IDs (caused e.g. by a change of an accounting software), so the next step — *matching procedure based on other variables* was to be taken. Employee records were matched if individual variables (sex, age, education) of the employee were in accord at the same time.

The second approach concerning employee records matching suffers from the non-perfect match of the datasets but there is no other way how the employee records could be linked in the ISPV.

#### 1.4 Period

All the figures presented in the next part will be the *annual* measures in the period 2006–2009. Because of the annual measures, the international comparison is limited due to the fact that indicators for other countries are in most cases quantified as quarterly measures (e.g. Geurts, Vets, 2009, Ibsen, Westergaard-Nielsen, 2005, Stiglbauer et al, 2002, Blanchflower, Burgess, 1996, Baldwin et al, 1998, or Davis et al, 1996).

#### 1.5 Indicators of employee and job flows

Indicators, that will be used below, are defined in accord with the internationally accepted methodology developed by Davis and Haltiwanger (see e.g. Davis et al, 1996) and are as follows:

*Job creation* in individual economic subject during the given period will be quantified as the positive difference between the total number of employees in this subject at the time  $t$  and  $t-1$ . The sum of the job creation in the sample is the sum of individual job creations.

*Job destruction* in individual economic subject during the given period will be quantified as the negative difference between the total number of employees in this subject at the time  $t$  and  $t-1$ . The sum of the job destruction in the sample is the sum of individual job destructions.

*Hires* (i.e. new employees) in individual economic subject are those who were not identified in the economic subject at the end of the time  $t-1$ , but were identified at the end of time  $t$ . The sum of the hires in the sample is the sum of hires in individual subjects.

*Separations* (i.e. leaving employees) in individual economic subject are those who were not identified in the economic subject at the end of the time  $t$ , but were identified at the end of time  $t-1$ . The sum of the separations in the sample is the sum of separations in individual subjects.

The employers' and employees' points of views meet via the net employment change and other aggregate indicators mentioned e.g. by Davis, Haltiwanger (1992), Moscarini (2001), Schuh, Triest (1998) and Kiyotaki, Lagos (2007).

More formally, in accord with Stiglbauer et al (2002), consider an employee  $y$  of an economic subject  $e$  in the subset of economic subjects  $s$  between the sampling dates in  $t$  and  $t-1$ . The net employment change in the economic subject  $s$  is defined as follows (1):

$$\Delta E_{e,s,t} = E_{e,s,t} - E_{e,s,t-1}, \quad (1)$$

job creation as follows (2):

$$JC_{s,t} = \sum \left| \Delta E_{e,s,t} \right|, \text{ where } \Delta E_{e,s,t} > 0, \quad (2)$$

job destruction as follows (3):

$$JD_{s,t} = \sum \left| \Delta E_{e,s,t} \right|, \text{ where } \Delta E_{e,s,t} < 0, \quad (3)$$

hires as follows (4):

$$H_{s,t} = \sum y_{e,s,t}, \text{ where } (y \in e_t) \wedge (y \notin e_{t-1}), \quad (4)$$

separations as follows (5):

$$S_{s,t} = \sum y_{e,s,t}, \text{ where } (y \in e_{t-1}) \wedge (y \notin e_t), \quad (5)$$

net employment change as follows (6):

$$NEC_{s,t} = JC_{s,t} - JD_{s,t} = H_{s,t} - S_{s,t}, \quad (6)$$

job reallocation as follows (7):

$$JR_{s,t} = JC_{s,t} + JD_{s,t}, \quad (7)$$

and worker reallocation as follows (8):

$$WR_{s,t} = H_{s,t} + S_{s,t}. \quad (8)$$

According to Davis et al (1996) and Tornquist (1985), *to convert time- $t$  measures to rates we divide the corresponding figure by the average of employment at  $t$  and  $t-1$ , i.e. (9):*

$$\bar{E}_{s,t} = \frac{\bar{E}_{s,t} + \bar{E}_{s,t-1}}{2}. \quad (9)$$

Hence (using lower case letters for the rates):

$$jc_{s,t} = \frac{JC_{s,t}}{\bar{E}_{s,t}}, \quad (10)$$

$$jd_{s,t} = \frac{JD_{s,t}}{\bar{E}_{s,t}}, \quad (11)$$

$$h_{s,t} = \frac{H_{s,t}}{\bar{E}_{s,t}}, \quad (12)$$

$$s_{s,t} = \frac{S_{s,t}}{\bar{E}_{s,t}}, \quad (13)$$

$$nec_{s,t} = \frac{NEC_{s,t}}{\bar{E}_{s,t}}, \quad (14)$$

$$jr_{s,t} = \frac{JR_{s,t}}{\bar{E}_{s,t}} \text{ and} \quad (15)$$

$$wr_{s,t} = \frac{WR_{s,t}}{\bar{E}_{s,t}}. \quad (16)$$

## 1.6 Remuneration

As was mentioned above, it is important to analyse both aspects of the labour market, i.e. employment as well as remuneration. The ISPV makes it possible to quantify wages and salaries of individual groups of employees. Because of the purpose of this analysis, we will use the *median wage* in the next part.

## 2 THE RESULTS

Using the linked employer-employee data from the ISPV, we will quantify the set of the above mentioned labour market indicators concerning job and employee flows. The following results will correspond to the methodology mentioned in the previous chapter. Main results of the analysis carried out on the data from the ISPV are shown in the Table 3.

**Table 3** Job and employee flows in the business sphere in the Czech Republic in the period 2007–2009

Relative indicator (%)	2007 / 2006	2008 / 2007	2009 / 2008
Job creation rate	11.1	9.4	6.6
Job destruction rate	7.2	8.9	15.7
Hires rate	25.2	27.0	20.5
Separations rate	21.3	26.5	29.7
<b>Net employment change rate</b>	<b>3.9</b>	<b>0.5</b>	<b>-9.2</b>

Source: ISPV (MoLSA), own calculation

In the Table 3, there is shown that net employment change rate decreased over the whole period, and in the year 2009 net employment rate was negative. Apparently, development of all indicators worsened during the year 2009, no matter whether the indicator concerned employee flows (hires and separations rates) or job flows (job creation and job destruction rates). In the year 2009, every 15<sup>th</sup> job was newly created and every 6<sup>th</sup> job destroyed. As far as employee flows are concerned, every 5<sup>th</sup> employee was newly hired and every 3<sup>rd</sup> employee was separated in this year.

As for the separations, the figure may seem to be high, but we should keep in mind that we *cannot confuse the number of the separated with the unemployed (and in a broader sense with the flows between the economically actives and the inactives)*, because the separated might leave their jobs and enter another without delay, so they did not belong to the unemployed (or to the economically inactives as the case may be).

**Table 4** Monthly gross wage median according to the category of employees in the business sphere in the period 2007–2009

Monthly gross wage median (CZK)	2007	2008	2009
Stable employees	21 025	23 026	22 245
Hires	16 835	18 463	17 746
Separations	16 008	17 848	18 673

Note: Stable employees mean employees staying with the economic subject for the whole period.

Source: ISPV (MoLSA), own calculation

The situation as far as the remuneration is concerned can be sketched in by the Table 4 that compares wage medians of three categories of employees, namely of those staying with the economic subject over the whole year, those hired and those separated.

It is evident that in all years wages of stable employees remained higher than those of newly hired employees. Secondly, wages of separated employees were lower than those of stable employees, but what is more, wages of separated employees were lower than wages of hired employees in the years 2007 and 2008. The inverse development started in 2009 when wages of separated employees were higher than those of newly hired. The newly hired in the year 2009 were employed for lower initial wage than in the year 2008. In the year 2009, wages of stable employees decreased, as well. All the findings mentioned above may indicate that the situation worsened in the year 2009.

### 3 THE RESULTS ACCORDING TO THE SECTOR OF ECONOMIC ACTIVITY

The indicators introduced in the previous chapter can be quantified according to all variables surveyed in the ISPV. Because it is supposed that the impact of the current economic crisis differs according to the sector of economic activity, we will devote this chapter to job and employee flows as well as wages and salaries in individual economic activity groups in the period 2007–2009.

#### 3.1 Job and employee flows

First of all, we will focus on job and employee flows according to the sector of economic activity. The Table 5 shows results concerning job flows.

**Table 5** Job flows according to the sector of economic activity in the business sphere in the Czech Republic in the period 2007–2009

Job flows indicators according to the sector of economic activity	Job creation rate			Job destruction rate			Net employment change rate		
	2007 / 2006	2008 / 2007	2009 / 2008	2007 / 2006	2008 / 2007	2009 / 2008	2007 / 2006	2008 / 2007	2009 / 2008
	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
Agriculture, forestry and fishing	4.4	4.1	3.3	10.9	9.0	16.1	-6.5	-4.9	-12.8
Industry and transportation	9.4	6.8	4.6	6.8	9.6	17.5	2.5	-2.8	-12.9
Construction	11.6	10.3	8.7	8.9	8.0	13.9	2.7	2.3	-5.2
Wholesale and retail trade	13.4	13.6	8.8	5.6	6.8	13.5	7.8	6.8	-4.6
Market services	13.7	14.6	9.4	6.4	5.3	12.0	7.3	9.4	-2.7
Other services	17.0	12.9	9.6	9.0	12.1	14.9	8.0	0.9	-5.3
<b>Total</b>	<b>11.1</b>	<b>9.4</b>	<b>6.6</b>	<b>7.2</b>	<b>8.9</b>	<b>15.7</b>	<b>3.9</b>	<b>0.5</b>	<b>-9.2</b>

**Note:** For NACE sections classified into the individual sectors of economic activity groups see the Annex.

**Source:** ISPV (MoLSA), own calculation

It is obvious that some sectors of economic activity were hit in a more severe way compared with the others. In the year 2009, the economic crisis probably affected industry and transportation in the most severe way because the jobs were the most often destructed (17.5 %) and on the other hand, almost the least often created (4.6 %) compared with others.

Contrary to the industry and transportation, the market services have undergone another development. We can say that this economic activity was the most successful one in getting over the crisis, because even while the jobs were more often destructed (12.0 %) and less often created (9.4 %) in 2009 compared to 2008, the net employment change rate fell only slightly (-2.7 %) compared to others. It may be surprising because financial intermediation as well as real estate activities are classified into this economic activity group.

The results concerning job flows are closely related to those concerning employee flows, as we can see in the Table 6.

**Table 6** Employee flows according to the sector of economic activity in the business sphere in the Czech Republic in the period 2007–2009

Employee flows indicators according to the sector of economic activity	Hires rate			Separations rate			Net employment change rate		
	2007 / 2006	2008 / 2007	2009 / 2008	2007 / 2006	2008 / 2007	2009 / 2008	2007 / 2006	2008 / 2007	2009 / 2008
	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
Agriculture, forestry and fishing	12.1	12.5	11.8	18.5	17.4	24.6	-6.5	-4.9	-12.8
Industry and transportation	21.7	21.7	15.2	19.2	24.5	28.1	2.5	-2.8	-12.9
Construction	24.3	22.3	20.4	21.6	20.0	25.7	2.7	2.3	-5.2
Wholesale and retail trade	28.6	38.1	30.2	20.8	31.3	34.9	7.8	6.8	-4.6
Market services	27.7	36.5	24.4	20.4	27.1	27.1	7.3	9.4	-2.7
Other services	41.5	37.1	31.0	33.5	36.2	36.3	8.0	0.9	-5.3
<b>Total</b>	<b>25.2</b>	<b>27.0</b>	<b>20.5</b>	<b>21.3</b>	<b>26.5</b>	<b>29.7</b>	<b>3.9</b>	<b>0.5</b>	<b>-9.2</b>

Note: For NACE sections classified into the individual sectors of economic activity groups see the Annex.

Source: ISPV (MoLSA), own calculation

The Table 6 shows, that the employees were more often separated and less often hired in all sectors of economic activity groups in 2009. Because the hires rate was lower than the separations rate, the net employment change rate fell in all activity groups in 2009. Development of employee flows in individual activity groups did not fully correspond to the job flows development because the employees in other services separated most often but — on the other hand — they were the most often hired ones. Apparently, the higher turnover of employees does not imply here the higher net employment change.

### 3.2 Remuneration

As in the previous chapter, we will sketch the situation in by the Table 7 that compares wage medians of three categories of employees, namely of those staying with the economic subject over the whole year, those hired and those separated.

In the Table 7, the results imply that results concerning remuneration in individual sectors of economic activity groups are similar to those in the business sphere on the whole. In all activity groups, there remained wages of stable employees higher than those of newly hired as well as separated employees in the whole period. There we can see the inverse development mentioned above in all activity groups in 2009, i.e. the wages of separated employees were higher than those of newly hired, and new hired in 2009 were employed for a lower initial wage than in 2008. Except other services, wages of stable employees decreased in all activity groups, as well.

## 4 THE RESULTS ACCORDING TO THE OCCUPATION

Results in the previous chapter show that the economic crisis has hit some sectors of economic activities in a more severe way compared to others. On the basis of these results, we can assume, that the situation of individual occupations went in hand with the situation of individual economic activities. In other words, we can suppose, that blue-collar workers were separated more often than white-collar workers because the industry and transportation were the economic activities that were hit in a most severe way.

**Table 7** Monthly gross wage median in individual categories of employees according to the sector of economic activity in the business sphere in the Czech Republic in the period 2007–2009

Wages and salaries of individual categories of employees according to the sector of economic activity	Stable employees			Hires			Separations		
	2007 / 2006	2008 / 2007	2009 / 2008	2007 / 2006	2008 / 2007	2009 / 2008	2007 / 2006	2008 / 2007	2009 / 2008
	(CZK)	(CZK)	(CZK)	(CZK)	(CZK)	(CZK)	(CZK)	(CZK)	(CZK)
Agriculture, forestry and fishing	17 174	19 286	19 191	15 479	17 215	16 645	14 133	16 170	16 931
Industry and transportation	21 183	22 973	21 985	17 024	18 315	17 719	16 815	18 414	18 692
Construction	21 960	24 536	23 107	18 932	21 372	20 479	16 971	19 362	20 734
Wholesale and retail trade	19 881	20 912	20 076	15 681	17 191	15 806	14 155	16 609	17 793
Market services	28 739	33 352	33 090	23 135	24 847	24 937	23 056	26 819	27 887
Other services	17 096	18 996	19 583	14 096	14 239	14 224	12 545	12 892	14 960
<b>Total</b>	<b>21 025</b>	<b>23 026</b>	<b>22 245</b>	<b>16 835</b>	<b>18 463</b>	<b>17 746</b>	<b>16 008</b>	<b>17 848</b>	<b>18 673</b>

**Note:** For NACE sections classified into the individual sectors of economic activity groups see the Annex. Stable employees mean employees staying with the economic subject for the whole period.

**Source:** ISPV (MoLSA), own calculation

Because of the assumptions mentioned above, there we will devote to employee flows as well as wages and salaries in individual occupations. We may emphasise that the results concerning job flows are non-sense in the case of occupations.<sup>5</sup>

**Table 8** Employee flows according to the occupation (KZAM-R) in the business sphere in the Czech Republic in the period 2007–2009

Employee flows indicators according to the occupation (KZAM-R)	Hires rate			Separations rate			Net employment change rate		
	2007 / 2006	2008 / 2007	2009 / 2008	2007 / 2006	2008 / 2007	2009 / 2008	2007 / 2006	2008 / 2007	2009 / 2008
	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
Legislators, senior officials and managers	13.5	16.0	13.2	14.7	20.7	21.1	-1.2	-4.7	-7.9
Professionals	25.2	29.3	19.0	16.3	23.2	22.7	8.9	6.1	-3.7
Technicians and associate professionals	22.0	26.7	18.5	19.2	23.6	25.3	2.8	3.1	-6.9
Clerks	26.3	36.7	24.8	22.1	30.5	27.9	4.2	6.2	-3.1
Service workers and shop and market sales workers	43.3	46.2	37.9	34.1	41.8	41.2	9.2	4.4	-3.3
Skilled agricultural and fishery workers	16.3	15.6	17.0	23.3	19.3	26.4	-7.0	-3.6	-9.4
Craft and related trade workers	22.5	21.2	17.5	19.4	24.1	31.5	3.2	-2.9	-13.9
Plant and machine operators and assemblers	25.6	23.6	17.5	22.0	25.5	30.9	3.6	-1.9	-13.3
Elementary occupations	33.0	32.4	27.2	27.4	34.5	40.8	5.6	-2.1	-13.6
<b>Total</b>	<b>25.2</b>	<b>27.0</b>	<b>20.5</b>	<b>21.3</b>	<b>26.5</b>	<b>29.7</b>	<b>3.9</b>	<b>0.5</b>	<b>-9.2</b>

**Note:** Stable employees mean employees staying with the economic subject for the whole period.

**Source:** ISPV (MoLSA), own calculation

### 4.1 Employee flows

Results concerning employee flows are shown in the Table 8. The Table 8 shows that the net employment change rate decreased more in blue-collar workers' occupations where it decreased by two-digit pace almost in all occupations in 2009. These workers were the most often separated in 2009 and the frequency of separations has increased rapidly since 2008 in these occupations. It is evident that economic crisis hit the blue-collar workers in 2008, because the net employment change rate decreased already in this year.

Another occupation that is worth mentioning is the occupation of the senior officials and managers. Surprisingly, the net employment change rate decreased in this occupation in the whole period, and what is more, the employment change rate of managers showed a decrease by 4.7 % in 2008 that was the highest one. We can suppose that this development is related to restructuring that economic subjects underwent during the period taken into consideration.

### 4.2 Remuneration

The results concerning employee flows will be completed by the Table 9 that shows wages and salaries in individual categories of employees.

**Table 9** Monthly gross wage median in individual categories of employees according to the occupation (KZAM-R) in the business sphere in the Czech Republic in the period 2007–2009

Wages and salaries of individual categories of employees according to the occupation (KZAM-R)	Stable employees			Hires			Separations		
	2007 / 2006	2008 / 2007	2009 / 2008	2007 / 2006	2008 / 2007	2009 / 2008	2007 / 2006	2008 / 2007	2009 / 2008
	(CZK)	(CZK)	(CZK)	(CZK)	(CZK)	(CZK)	(CZK)	(CZK)	(CZK)
Legislators, senior officials and managers	37 120	41 049	39 447	32 525	35 859	30 000	32 049	34 383	36 462
Professionals	32 635	36 299	35 872	24 456	27 757	29 164	27 010	29 341	32 144
Technicians and associate professionals	25 005	26 980	26 599	20 635	22 950	22 442	20 723	22 536	23 671
Clerks	18 105	20 086	19 808	16 353	17 435	17 240	15 875	17 235	18 147
Service workers and shop and market sales workers	13 286	14 697	14 214	12 250	13 137	12 351	11 001	12 585	12 774
Skilled agricultural and fishery workers	16 211	17 820	17 403	14 798	16 361	16 145	13 426	14 928	16 100
Craft and related trade workers	20 263	22 027	20 783	16 958	18 201	17 919	15 679	17 585	18 191
Plant and machine operators and assemblers	19 899	21 262	20 493	16 513	17 426	16 838	15 738	16 889	17 735
Elementary occupations	13 481	14 499	14 009	11 870	12 864	12 311	11 407	12 511	13 021
<b>Total</b>	<b>21 025</b>	<b>23 026</b>	<b>22 245</b>	<b>16 835</b>	<b>18 463</b>	<b>17 746</b>	<b>16 008</b>	<b>17 848</b>	<b>18 673</b>

**Note:** Stable employees mean employees staying with the economic subject for the whole period.

**Source:** ISPV (MoLSA), own calculation

<sup>5</sup> E.g. job destruction in an economic subject equals the negative difference between the total number of employees at the time  $t$  and  $t-1$ . For example, if 5 jobs were destructed and 4 jobs created in this subject during the period taken into consideration, then — according to the definition — job destruction equals 1 job. If all the destructed / created jobs were not classified into the same occupations, it is impossible to assign any occupation to the destructed job.

The Table 9 shows that the results concerning remuneration were in the most occupations similar to those in the business sphere on the whole. Wages of stable employees in all occupations remained higher than those of newly hired as well as separated employees in the whole period. Except professionals and technicians and associate professionals, wages of separated employees were lower than wages of those hired in the years 2007 and 2008. Wages of separated employees were higher than those of newly hired in 2009, with the exception of skilled agricultural and fishery workers. The inverse development in 2009 seems to be proved by the facts, that new hired in the year 2009 were employed for lower initial wage than in the year 2008 in all occupations (except professionals) and that the wages of stable employees decreased in all occupations.

## CONCLUSION

The main aim of this paper was to investigate the possibility of a wider use of linked employer-employee microdata in the Czech Republic. Using the employer-employee data from the Average Earnings Information System (the Structure of Earnings Survey family) we were able to quantify more accurate labour market indicators compared with the generally known basic set of indicators.

As for the job flows in the business sphere in the Czech Republic, there was found out that every 15<sup>th</sup> job was created and every 6<sup>th</sup> job destroyed in the year 2009 in economic subjects with more than 10 employees. As far as employee flows are concerned, every 5<sup>th</sup> employee was newly hired and every 3<sup>rd</sup> employee was separated in the Czech business sphere in the year 2009. These figures may seem to be high, but we should remember that the number of the separated cannot be equal to the unemployed, because of the fact that employees may leave their jobs and enter another job without delay, so they would not necessarily become unemployed.

Both aspects of the labour market (employment as well as remuneration) were analysed together using the same data. We focused on the median wage of three categories of employees, namely of those staying with the economic subject over the whole year, those hired and those separated. We found out that in the period 2007–2009, wages of stable employees remained higher than those of newly hired. Wages of separated employees were lower than wages of hired employees in the years 2007 and 2008 but the turning point set in during the year 2009, when wages of separated employees were higher than those of newly hired. The newly hired in the year 2009 were employed for lower initial wage than in the year 2008. In the year 2009, wages of stable employees decreased, as well.

As far as economic activity is concerned, we showed that jobs in some industries have been destroyed more frequently (e.g. industry and transportation) than jobs in the others (e.g. market services).

Last but not least we showed that employees, who have left economic subjects (voluntarily or involuntarily) more often than other employees, have been blue-collar workers.

It is obvious, that using employer-employee data we could prove some hypotheses that were impossible to prove using standard set of indicators. For example we showed that the low-earning employees separated from the enterprises more often. This phenomenon may have caused that the median wages and salaries increased in the Czech Republic, even if the economic crisis set in and wages of the stable employees were negatively affected.

The analysis proved that new set of the labour market indicators could bring new insights to the dynamic of the Czech labour market. Secondly, the findings in this paper may indicate that situation on the Czech labour market worsened during the economic crisis.



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## ANNEX

**NACE sections classified into the individual economic activity groups**

<b>Economic activity group</b>	<b>NACE section</b>	<b>Title</b>
Agriculture, forestry and fishing	A	Agriculture, forestry and fishing
Industry and transportation	B	Mining and quarrying
	C	Manufacturing
	D	Electricity, gas, steam and air conditioning supply
	E	Water supply, sewerage, waste management and remediation activities
	H	Transportation and storage
Construction	F	Construction
Wholesale and retail trade	G	Wholesale and retail trade, repair of motor vehicles and motorcycles
Market services	J	Information and communication
	K	Financial and insurance activities
	L	Real estate activities
	M	Professional, scientific and technical activities
Other services	I	Accommodation and food service activities
	N	Administrative and support service activities
	O	Public administration and defence, compulsory social security
	P	Education
	Q	Human health and social work activities
	R	Arts, entertainment and recreation
	S	Other service activities
	T	Activities of households as employers, undifferentiated goods- and services-producing activities of households for own use
	U	Activities of extraterritorial organisations and bodies

# The Possibilities to Estimate Labour Productivity and Total Factor Productivity for Czech Regions

Kristýna Vltavská<sup>1</sup> | *University of Economics, Prague, Czech Republic*

Jaroslav Sixta<sup>2</sup> | *University of Economics, Prague, Czech Republic*

## Abstract

Productivity measuring is a popular part of economic and statistical analysis of a country. The simplest productivity measure is based on labour productivity. It is a revealing indicator among economic indicators because it offers dynamic measures of economic growth, competitiveness and living standard. Besides labour productivity, it is common to carry out total factor productivity measurement including both labour and capital input. This paper focuses on the total factor productivity measurement on a regional level between the years 2006 and 2009. Regional productivity measurements show a different approach to regional analyses. There are very few analyses focusing on regional capital formation and capital stocks. This paper describes the possibility of using regional factors (labour and capital stocks) to complete total factor productivity measurement.

## Keywords

*Gross value added, labour productivity, region, total factor productivity*

## JEL code

*E01, O47*

## INTRODUCTION

Productivity is one of the most important tools to evaluate economic growth of the country. In the case of the Czech Republic, this issue was mainly dealt with on the industrial level of national data but there is a possibility to apply the productivity measurement on regions. Employing regional indicators has become very popular. The supply of regional indicators is slowly and continuously rising with the importance of regional analyses. From the economic point of view, regional statistics may allow us to identify more statistical patterns and the difference in trends in comparison with national data.

<sup>1</sup> Faculty of Informatics and Statistics, nám. W. Churchilla 4, 130 67 Prague 3, Czech Republic. Corresponding author: e-mail: kristyna.vltavska@vse.cz, phone: (+420) 224 095 451.

<sup>2</sup> Faculty of Informatics and Statistics, nám. W. Churchilla 4, 130 67 Prague 3, Czech Republic. Author is working also at the Czech Statistical Office.

Labour productivity, which is defined as the volume of output divided by the input used, is probably the most important part of economic and statistical analysis of a country. It is a revealing indicator that offers dynamic measures of economic growth, competitiveness and living standards. It helps to explain the principal economic foundations that are necessary for economic growth and social development (OECD, 2001). As the input variable, one can use hours worked, total number of employees or labour services which reflect the quality of labour force. As the output variable, gross value added is recommended instead of gross domestic product because gross value added excludes taxes.

The simplest version of total factor productivity deals with two input variables — labour and capital. Total employment, hours worked and labour services can be used in terms of labour input (OECD, 2001, ESA, 1995<sup>3</sup>). As the capital input, net capital stock of fixed assets or capital services can be used. Capital stocks are easily accessible on the national level but on the regional level such data are not usually published and users have to carry out these estimates themselves. Capital services can serve as a better input of capital because the quality of the capital is taken into account (Sixta, Fischer, 2009). Capital services can also be constructed on the regional level but this is very demanding in terms of data and therefore capital stocks are used.

The aim of this paper is to show another possible way of regional analysis via productivity. Firstly, one estimates labour productivity and consequently total factor productivity. The analysis is made for eight Czech regions in the period between 2006 and 2009. Obtained results using different input variables are compared between the regions and the differences are discussed. Besides, the process of construction of regional stocks is described as a useful source for other users.

## 1 DATA AND METHODOLOGY

The Czech Republic is divided into eight regions: Praha, Střední Čechy, Jihozápad, Severozápad, Severovýchod, Jihovýchod, Střední Morava and Moravskoslezsko. The division is based on the Nomenclature of Territorial Units for Statistics<sup>4</sup> (NUTS) which is used to subdivide the territory of the European Union into regions at 3 different levels. The regions mentioned are at level 2 (NUTS 2).

For an analysis of regional labour productivity and total factor productivity, it is necessary to investigate the most suitable data for the input and output variable. The output variable reflects the goods and services produced by the labour force. This variable is measured either by gross domestic product (GDP) or gross value added (GVA) in constant prices. In the case when both indicators are available, there is a preference towards using value added as taxes are excluded. Since the Czech Statistical Office publishes regional gross value added in constant prices of the previous year and in current prices, the chain linked method was used to calculate the volume index of output:

$$I_{GVA\frac{09}{06}} = \frac{GVA\frac{09}{08}}{GVA\frac{08}{08}} \times \frac{GVA\frac{08}{07}}{GVA\frac{07}{07}} \times \frac{GVA\frac{07}{06}}{GVA\frac{06}{06}} \quad (1)$$

For the measurement of labour input, the dataset from the Average Earnings Information System (hereafter: ISPV)<sup>5</sup> and Czech Statistical Office were used.<sup>6</sup> This dataset includes regional data of hours worked, average wage and number of employees divided by the level of education. The input variable reflects the

<sup>3</sup> ESA 1995 is an European modification of international standard SNA 1993.

<sup>4</sup> This classification is based on the Act of the European Parliament No. 1888/2005.

<sup>5</sup> ISPV = Average Earnings Information System survey is the system of regular inspection of earnings and working hours of the employees in the Czech Republic. The main indicators monitored are hourly wage and gross monthly wage.

time, effort and skills of the labour force. It is the most important factor that influences the measurement of labour productivity. Labour input is measured either by hours worked, total employment or the latest option — labour services. All the possible inputs mentioned have their advantages and disadvantages. According to ESA 95, the hours worked are the most suitable for labour input because a simple headcount of labour force can hide changes in average hours worked, caused by the evolution of part-time work or the effect of variations in overtime, absence from work or shifts in normal hours. On the other hand, total employment is easy to measure but less recommended for not reflecting changes in the average work time per employee and changes in multiple job holdings and the role of self-employed persons. Labour services<sup>7</sup> are the only one input measure which reflects the skills of the labour force. This paper discriminates four levels of education — primary, secondary without A-levels, secondary with A-levels and tertiary. Standard measures of labour input do not take the education differences into account. Labour services respect differences in the amount of services delivered per unit of labour in the output growth. It is assumed that the flow of labour services for each labour type is proportional to hours worked, and workers are paid according to their marginal productivities.<sup>8</sup> Then the index of labour services input *LS* is given by:

$$\Delta \ln LS_t = \sum_l \bar{v}_{l,t} \Delta \ln H_{l,t}, \tag{2}$$

where  $\Delta \ln H_{l,t}$  indicates the growth of hours worked by labour type *l* and weights (*v*) are given by the average share of each type in the values of labour compensation in current prices. Thus, aggregation takes into account the changing composition of the labour force. A shift in the share of hours worked by low-skilled workers to high-skilled workers will lead to a growth of labour services which is larger than the growth in total hours worked. This difference is called the labour composition effect.

The index of labour composition is divided into the index of hours worked and the index of labour services (2):

$$\frac{LC_1}{LC_0} = \frac{\left( \frac{LS_1}{LS_0} \right)}{\left( \frac{H_1}{H_0} \right)}. \tag{3}$$

At first, the contribution of the change in labour services to the change in value added is computed; then the contribution of the change in hours worked to the change in value added and the contribution of the change in labour composition to the change in value added are calculated.

The measurement of labour services does not reflect the ability and skills which labour force gains during the work experience. There are several kinds of human capital measurement (Mazouch, Fischer, 2011). Unfortunately, none of them is suitable as a measurement of human capital in production function.

As the capital input for measuring total factor productivity, gross fixed assets or capital services can be used. Even capital services provide comprehensive measures of capital inputs respecting not only changes in the volume of capital but also the quality of services provided. Construction of capital ser-

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<sup>6</sup> ISPV does not cover enterprises with less than 10 employees which is why we use the ratio coefficients employing the data from the Czech Statistical Office. The differences between the data from ISPV and Labour Force Survey are discussed in Čadil et al. (2011).

<sup>7</sup> Analysis of the labour services is discussed by O'Mahony, Timmer, van Ark (2007).

<sup>8</sup> In the analysis average wages are used instead of marginal productivities because one can assume that the average wages are indicators of marginal productivities.

vices on a regional level is very demanding. Capital services<sup>9</sup> show the contribution of capital to the production process and the volume index of capital services is a suitable input indicator to total factor productivity measurement.

General approach to the volume index of capital services is based on the following (OECD, 2001):<sup>10</sup>

$$I_q = \prod_{i=1}^N \left( \frac{C_{i,t}}{C_{i,t-1}} \right)^{\bar{v}_i}, \quad (4)$$

$$v_{i,t} = \frac{f_{i,t} C_{i,t}}{\sum_{i=1}^N f_{i,t} C_{i,t}}, \quad (5)$$

$$\bar{v}_i = \frac{1}{2}(v_{i,t} + v_{i,t-1}), \quad (6)$$

where	$C$	capital stocks in efficiency unit,
	$f$	capital services,
	$v$	weights derived from operating surplus,
	$I$	type of asset,
	$t$	time.

The key element of equation 4 is  $C$ , capital recorded in efficiency units. It means that  $C$  respects the decreasing quality of services provided by capital due to its usage. Capital services became more known when revised international standard (SNA, 2008) was issued.

As an alternative way, one can decide to use capital stocks, which are easier to estimate on a regional level. Estimates of regional net capital stocks at current prices are based on the balancing method. Original estimates for 2006 were prepared in cooperation with Mr. Jaroslav Kahoun.<sup>11</sup> Data for the total economy at current prices were separated according to regions by institutional sectors and industries. This top-down method allowed to accurately record mainly communications and dwellings. Data for non-financial corporations were split by the shares obtained from statistical surveys on local units' property. Subsequently, this analysis used the balancing method where:

$$C_t = C_{t-1} + I_t - CFC_t + HG_t + O_t, \quad (7)$$

where	$C_t$	regional net capital stock on 31 <sup>st</sup> December $t$ ,
	$I_t$	regional gross fixed capital formation,
	$CFC_t$	regional consumption of fixed capital,
	$HG_t$	regional holding gain,
	$O_t$	regional other changes in volume.

Regional data for consumption of fixed capital, holding gains and other changes in volume are usually not available. Therefore one can estimate them proportionally to the regional capital stock for  $t-1$

<sup>9</sup> More information about estimation of capital services for the Czech economy in Sixta, Vltavská, Zbránek (2011).

<sup>10</sup> The methodology of capital services has its own history, recent approaches can be found in (OECD, 2009) but it is less illustrative.

<sup>11</sup> Jaroslav Kahoun is an expert on regional accounts at the Czech Statistical Office.

in different industries. For the total factor productivity measurement, volume indices are required. Therefore, published deflators<sup>12</sup> of capital stocks for industries were used and current prices estimates were recalculated into prices of 2000. The Table 1 shows regional capital stocks at current prices and volume indices.

**Table 1** Regional net capital stocks of fixed assets, 2006–2009, current prices (volumes in %)

	2006	2007		2008		2009	
	Current prices	Current prices	Volumes, PY = 100	Current prices	Volumes, PY = 100	Current prices	Volumes, PY = 100
<b>Total</b>	<b>12 428 799</b>	<b>13 151 638</b>	<b>102.2</b>	<b>13 814 705</b>	<b>101.8</b>	<b>14 066 661</b>	<b>100.4</b>
Praha	2 839 550	3 119 082	105.9	3 396 821	105.2	3 528 292	102.4
Střední Čechy	1 429 491	1 491 187	100.9	1 537 946	100.1	1 551 534	99.5
Jihozápad	1 366 840	1 429 510	101.1	1 474 615	100.0	1 492 374	99.6
Severozápad	1 133 722	1 190 519	101.6	1 238 335	100.9	1 256 468	100.0
Severovýchod	1 512 825	1 567 781	100.2	1 622 554	100.3	1 629 144	99.1
Jihovýchod	1 859 966	1 963 617	102.0	2 053 138	101.3	2 083 673	100.0
Střední Morava	1 108 458	1 155 841	100.8	1 195 597	100.3	1 215 352	100.3
Moravskoslezsko	1 177 946	1 234 101	101.4	1 295 699	102.0	1 309 823	99.8

Note: PY — previous year.

Source: Czech Statistical Office, own calculation

Measuring productivity is a popular part of economic research. For estimation of total factor productivity, the neo-classic Cobb-Douglas production function and the index number approach are recommended. This method is based on the Törnqvist index number formula which can be used if the function is a member of the class of homogeneous of degree one transcendental logarithmic functions (Lau, 1979). This approach assumes a constant return to scale. Recently, a discussion is in progress about the return to scale (represented by the condition  $\alpha_L + \alpha_K = 1$ ) and about the sustainability of the constant return to scale assumption. This paper can not discuss this assumption by employing econometric methods as the time series are too short. Employing traditional inputs, the index of productivity of two factors ( $A1 / A0$ ) originates from the following decomposition (Jílek, Moravová, 2007):

$$\frac{Y_1}{Y_0} = \frac{A_1}{A_0} \left( \frac{C_1}{C_0} \right)^{1-\alpha} \left( \frac{H_1}{H_0} \right)^\alpha, \tag{8}$$

where  $Y_1 / Y_0$  is the index of gross value added in constant prices of 2000,  
 $C_1 / C_0$  is the index of net fixed assets in constant prices of 2000,  
 $H_1 / H_0$  is the index of hours worked,  
 $\alpha$  is the average share of compensation of employees on gross value added at current prices.<sup>13</sup>

<sup>12</sup> All national accounts data can be found at: [www.czso.cz](http://www.czso.cz).

<sup>13</sup> More information about the estimation of return to scales in Hulten (2000).

Using alternative labour input, the index of productivity of two factors originates from the following:

$$\frac{Y_1}{Y_0} = \frac{A_1}{A_0} \left( \frac{C_1}{C_0} \right)^{1-\alpha} \left( \frac{LS_1}{LS_0} \right)^\alpha, \quad (9)$$

where  $LS_1 / LS_0$  is the index of labour services.

This paper designates the indicators used in its formulas based on the national accounts. Therefore the results presented in the tables are labelled as follows: gross value added *GVA* (instead of *Y* used in the equation), capital input *C*, labour input *L* or *LS* and index of total factor productivity *TFP* instead of *A*.

## 2 RESULTS

### 2.1 Regional labour productivity

Firstly, labour productivity using the index of gross value added and index of hours worked by region is estimated.

**Table 2** Change in regional labour productivity, 2006–2009, average annual growth (in %)

Region	LP
Praha	2.12
Střední Čechy	1.34
Jihozápad	-1.56
Severozápad	-0.37
Severovýchod	0.73
Jihovýchod	0.77
Střední Morava	1.31
Moravskoslezsko	-1.00

**Note:** LP — % change in labour productivity using hours worked as input.

**Source:** Czech Statistical Office, ISPV, own calculation

The Table 3 shows the decomposition of labour productivity to the productivity based on hours worked and a part created by labour composition of the labour force in the Czech regions in the period between 2006 and 2009.

By using the decomposition of contribution of labour services into contribution of hours worked and contribution of labour composition one can find out how a shift in the proportion of hours worked by low-skilled workers to high-skilled workers leads to a growth of labour services. This increase is larger than the growth of hours worked.

The value of contribution of labour composition shows that the average annual growth of the

As seen in the Table 2, the highest average annual growth of regional labour productivity in the period between 2006 and 2009 was achieved in Praha. The second most significant average annual growth in the period in question was reached in the region of Střední Čechy. On the other hand, the largest decrease of labour productivity was recorded in regions Jihozápad and Moravskoslezsko.

In this paper, the influence of human capital on regional labour productivity is measured as well. The question is how significant a part of the labour productivity is caused by the skills of the work force.

**Table 3** Change in regional labour productivity using hours worked and labour services as the input, change in labour composition effect, 2006–2009, average annual growth (in %)

Region	LP	LP*	LC
Praha	2.12	1.23	0.88
Střední Čechy	1.34	1.36	-0.02
Jihozápad	-1.56	-1.90	0.35
Severozápad	-0.37	-1.04	0.68
Severovýchod	0.73	0.06	0.67
Jihovýchod	0.77	0.09	0.67
Střední Morava	1.31	1.00	0.31
Moravskoslezsko	-1.00	-1.69	0.70

**Note:** LP — % change in labour productivity using hours worked as the input, LP\* — % change in labour productivity using labour services as the input, LC — % change in labour composition effect.

**Source:** Czech Statistical Office, ISPV, own calculation



level of education in the period in question was recorded in the following regions: Praha (0.88 %), Moravskoslezsko (0.70 %), Severozápad (0.68 %), Severovýchod and Jihovýchod (0.67 %). The decrease of the level of education was reported only in one region, Střední Čechy (−0.02 %). The part of the increase of the level of education of the work force in the regions of Moravskoslezsko and Jihovýchod is caused by research centres being founded in these areas. Such centres obviously need highly qualified work force.

The increase in education level in Praha was caused to a large extent by the region's positive orientation towards real estate, renting and business activities industry. Companies in the region require their work force to gain tertiary education with a possibility to accomplish this during the first years of their careers. Employers commonly cooperate with universities and companies can even found their own colleges or universities to school their staff (e.g. Unicorn).

The decrease in the level of education in the region of Střední Čechy is an interesting fact. This phenomenon reflects the orientation of the region on manufacturing and the inhabitants' frequent commuting to Praha, which correspondingly raises the level of education in the companies based in the capital city.

## 2.2 Regional total factor productivity

Total factor productivity reflects both inputs (labour and capital) and it is closer to economic reality. There are several approaches to total factor productivity measurement (e.g. EU-KLEMS project)<sup>14</sup> but this paper focused on two factors. This analysis uses the index number approach. As the input variables, labour services or hours worked and net stock of fixed assets were used; as the output, variable regional gross value added was used.

**Table 4** Calculation of regional total factor productivity index, using hours worked and net stock of fixed assets as inputs, total growth from 2006 to 2009 (in %)

Region	GVA	C	H	TFP
Praha	11.37	6.95	2.20	1.89
Střední Čechy	11.10	0.32	2.84	7.69
Jihozápad	−3.83	0.39	0.40	−4.58
Severozápad	−2.11	1.27	−0.49	−2.86
Severovýchod	0.79	−0.22	−0.69	1.71
Jihovýchod	4.44	1.65	1.03	1.70
Střední Morava	4.44	0.74	0.21	3.46
Moravskoslezsko	−0.12	1.64	1.44	−3.12

**Note:** GVA — change in gross value added in %, H — contribution of change in hours worked to change in GVA, C — contribution of change in net stock of fixed assets to change in GVA, TFP — total factor productivity growth in %.

**Source:** Czech Statistical Office, ISPV, own calculation

The highest increase of regional gross value added in the period between 2006 and 2009 was achieved in the region of Praha. The main proportion of this growth was constituted by net stock of fixed assets (6.95 %). Hours worked and total factor productivity represents a much lower influence with 2.20 % and 1.89 % respectively. The deepest decrease of regional gross value added was recorded in the region Jihozápad with a decline of 3.83 %. The main proportion of this was constituted by total factor productivity (−4.58 %). The increase of net fixed assets and hours worked was very small. On the other hand, the decrease of gross value added was much more significant.

<sup>14</sup> For more information about the EU-KLEMS project see: [www.euklems.org](http://www.euklems.org).

**Table 5** Calculation of regional total factor productivity index, using labour services and net stock of fixed assets as inputs, total growth from 2006 to 2009 (in %)

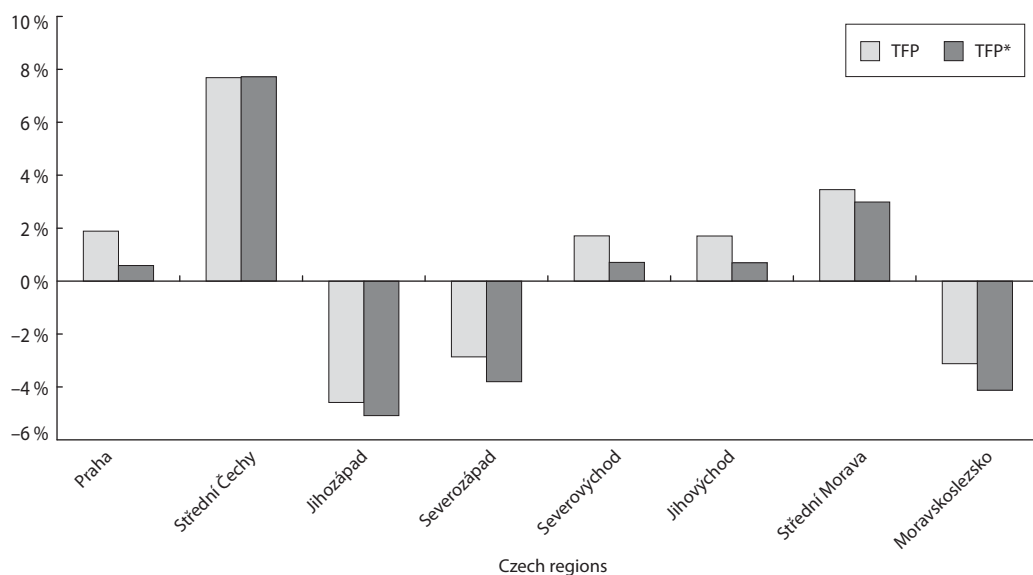
Region	GVA	C	LS	H	LC	TFP*
Praha	11.37	6.95	3.53	2.20	1.30	0.58
Střední Čechy	11.10	0.32	2.81	2.84	-0.03	7.72
Jihozápad	-3.83	0.39	0.93	0.40	0.53	-5.08
Severozápad	-2.11	1.27	0.48	-0.49	0.98	-3.81
Severovýchod	0.79	-0.22	0.30	-0.69	1.00	0.70
Jihovýchod	4.44	1.65	2.04	1.03	1.00	0.69
Střední Morava	4.44	0.74	0.67	0.21	0.46	2.99
Moravskoslezsko	-0.12	1.64	2.50	1.44	1.04	-4.12

**Note:** GVA — change in value added in %, LS — contribution of change in labour services to change in GVA, H — contribution of change in hours worked to change in GVA, LC — contribution of change in labour composition to change in GVA, C — contribution of change in net stock of fixed assets to change in GVA, TFP\* — total factor productivity growth in %, adjusted of labour composition effect.

**Source:** Czech Statistical Office, ISPV, own calculation

In the case of the pre-crisis period between the years 2006 and 2008 the results are quite different. The highest increase of total factor productivity was achieved in the region Střední Čechy (11.80 %). It was caused by a small increase in hours worked (2.53 %) and net fixed assets (0.58 %) and by a much higher increase in gross domestic product (15.30 %).

By using the decomposition of contribution of labour services into contribution of hours worked and contribution of labour composition one can find out how a shift in the proportion of hours worked by low-skilled workers to high-skilled workers leads to a growth of labour services that is larger than the growth of hours worked in the Czech regions.

**Figure 1** Comparison of regional TFP using standard and alternative methodology of computation, total growth from 2006 to 2009 (in %)

**Source:** own calculation

The value of contribution of labour composition shows that the highest growth of the level of education in the period between the years 2006 and 2009 was recorded in regions Praha (1.30 %), Moravskoslezsko (1.04 %), Severovýchod and Jihovýchod (1.00 %). The decrease of the level of education was reported only in one region, Střední Čechy (−0.03 %). The decrease of the level of education in the region Střední Čechy was caused by the daily commuting of the labour force to the capital city of Prague. This caused the increase of the level of education in Prague and the decrease in Střední Čechy at the same time.

Using the labour services as input variable one can see the difference in regional total factor productivity measurement in the given period. The highest difference between standard computation and the alternative computation of *TFP* is within the region Praha (1.3 p.p.). The transformation of the labour input from a stock indicator to a flow indicator which respects the quality of the work force means cutting a part of the residual and giving out more precise results of total factor productivity in the Czech region in the period between the years 2006 and 2009.

## CONCLUSION

Productivity measurement is a popular and useful kind of measurement used for economic growth evaluation. Firstly, this paper discussed the availability of the regional data. As the output variable, gross value added at current prices and prices of the previous year was used for the estimation of the index of gross value added. The data from ISPV (hours worked, average wage, number of employees) were used for the estimation of the input variable. Regional capital input was estimated from the data published by the Czech Statistical Office. Net stock of fixed assets was split according to the regions and revaluated into constant prices. The paper focused mainly on finding out what part of labour productivity and total factor productivity the level of education represents. All regions except for Střední Čechy recorded average annual growth in the level of education between the years 2006 and 2009. The growth in the number of work force with completed tertiary education and placement of European Centres of Excellence will undoubtedly raise the labour productivity through the increase in the level of education among the labour force in Czech regions in the upcoming years.

As in other analyses Praha stands out highly. In the period between 2006 and 2009 the capital city achieved the highest increase of education of the labour force, which is larger than the increase of education of the labour force in the Czech Republic in the period in question. The decrease in the level of education was reported in the region Střední Čechy. This interesting fact does not mean that the education decreased among the population of the region in question. In fact, the education increased in the region Střední Čechy but the labour force with the best education was commuting to Praha. Thus, the level of education recorded an increase in the capital city instead of the region.

This paper shows that the regional analysis brings the possibilities to evaluate an economy further.

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# Polish and Silesian Non-Profit Organizations Liquidity Strategies<sup>1</sup>

Grzegorz Michalski<sup>2</sup> | *Wroclaw University of Economics, Wroclaw, Poland*

Aleksander Mercik<sup>3</sup> | *Wroclaw University of Economics, Wroclaw, Poland*

## Abstract

The kind of realized mission inflows the sensitivity to risk. Among other factors, the risk results from decision about liquid assets investment level and liquid assets financing. The higher the risk exposure, the higher the level of liquid assets. If the specific risk exposure is smaller, the more aggressive could be the net liquid assets strategy. The organization choosing between various solutions in liquid assets needs to decide what level of risk is acceptable for her owners (or donors) and / or capital suppliers. The paper shows how, in authors opinion, decisions, about liquid assets management strategy inflow the risk of the organizations and its economical results during realization of main mission. Comparison of theoretical model with empirical data for over 450 Silesian nonprofit organization results suggests that nonprofit organization managing teams choose more risky aggressive liquid assets solutions than for-profit firms.

## Keywords

*Intrinsic liquidity value, nonprofit financial management, financial liquidity*

## JEL code

*G31, L31, M21*

## INTRODUCTION

Organizations operate as taxed commercial businesses or non-taxed nonprofit organizations (Lane, 2001, pp. 1–17). As widely believed, the advantage of commercially driven businesses subsists in more effective management than in government controlled organizations (Nowicki, 2004, p. 29). In the paper we study the nonprofit organization liquid assets management. There is a group of organizations doing almost the same job as non-taxed government controlled organization, non-taxed nonprofit organization and taxed commercially managed business (Berger, 2008, pp. 46–47). That group of organizations face specific incumbent needs resulting in higher unemployment and other similar factors (Zietlow, 2010, pp. 238–248).

The main financial aim of the nonprofit organization (NPO) is not maximization of firm value but the best realization of the mission of that organization (Zietlow, 2007, pp. 6–7). But for assessment of

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<sup>2</sup> E-mail: grzegorz.michalski@ue.wroc.pl.

<sup>3</sup> E-mail: mercik.aleksander@ue.wroc.pl.

financial decision of NPO analogous rules like for for-profit firms should be used (Brigham, 2006). One of that rules is the fact that higher risk is linked with higher cost of capital rate which should be used to evaluate the future results of decisions made by nonprofit organizations. This is also positively linked with the level of efficiency and effectiveness in realization of the NPO mission. Cost of financing net liquid assets depends on the risk included in the organization strategy of financing and / or investment in liquid assets.

Managing team in non-profit organizations have many good reasons for which their enterprises should possess some money resources reserves even if current interest rate is positive (Kim, 1998). The reasons may be classified into three main groups: the necessity of current expenses financing (transactional reason), fear of future cash flows uncertainty (precautional reason), future interest rate level uncertainty (speculative reason).

Liquid assets, especially cash, understood as money resources in organization safe are not a source of any or small interests. Maintaining liquidity reserve in the non-profit organization results from presumption that the value of lost income on account of interest will be recompensed by the benefits for incumbents of non-profit organization (Kim, 1998, Lee, 1990). The hypothetical benefits come from higher profitability that organization mission will be completed, thanks to adequate liquidity level. Then organizations maintaining such reserves assume that in equilibrium conditions, marginal liquidity value is equal to the interest rate of the Treasury Bonds investments (or interest rate being a cost of short-term credit we took out to obtain liquidity). Without doubt, the statement that investment in liquid assets does not bring any benefits and does not contribute to the realization of NPO mission may be rejected. From such a perspective, liquid assets would be treated as „necessary evil“ linked only to the costs resulting from interests lost. Another incorrect conclusion would be an assumption that present net value always equals zero. It would be a result of the statement that due to the fact that marginal liquidity value is always equal to interests lost, cash reserves size has no significance at all (Henderson, 1989, p. 95, Kim, 1998, Lee, 1990, p. 540).

For organization being in possession of liquid reserves, the marginal utility of liquidity changes. Along with the growth in amount of cash possessed, the marginal cash value decreases. So it may be noticed that for the market Treasury Bond rate or short-term credit rate, it pays to keep some money reserve only to a certain level. There is a point corresponding with the optimal (critical) liquidity level, up to which the amount of liquid assets in the non-profit organization may be increased in a profit (Michalski, 2008b, Washam, 1989, p. 28, Henderson, 1989, Lee, 1990). The term: liquidity degree (or level) is connected with the known from economic literature conception of „liquidity container“. The more liquid assets (which may be easily convertible into known amount of money resources and sensible only to a slight value change risk), the higher is enterprise liquidity level.

After exceeding this critical liquid assets level, the Treasury Bonds sale or taking out a short-term debt is unprofitable for the non-profit organization. The marginal benefit from higher cash reserve is lower than the cost of interests lost (Washam, 1989, Henderson, 1989).

In non-profit organization transactional and precautional liquid assets holdings on sufficient level allow for prompt fulfillment of internal (salary payments etc.) and external creditors (suppliers payment, etc.). The non-profit organization financial liquidity (operational and precautional) usually concerns operational activity and is not linked to investment activity. If it comes to enfeeblement or loss of operational and precautional liquidity in the non-profit organization, there is a menace (Scherr, 1989, Washam, 1989, Beck, 1993) of lowering decision making elasticity, deteriorating non-profit organization ability to set the organization mission, higher foreign capital raising cost, demobilization of donors, worsening non-profit organization position. In order to avoid such dangers, constant monitoring of non-profit organization financial liquidity is necessary as well as taking measures to guarantee its economic-financial equilibrium.

## 1 LIQUID ASSETS STRATEGIES AND COST OF FINANCING

Influence of liquid assets strategy on the rate of cost of capital financing non-profit organization and that influence on the economic results of NPO depend on relation between the kind of business risk taken by NPO, financial risk results from the financial leverage and individual risk characterizing the NPO. Capital providers take into consideration the nonprofit organization liquidity investment strategy while defining their claims as regards the rates of return. Restrictive strategy is perceived as more risky and therefore depending on investors risk aversion level, they tend to ascribe to the financed nonprofit organization applying restrictive strategy an additional expected risk premium. Ascribing the additional risk premium for applied liquidity investment strategy is reflected in the value of  $\beta$  risk coefficient. For each strategy, the  $\beta$  risk coefficient will be corrected by the corrective coefficient SZ corresponding to that specific strategy in relation to the current assets to cash revenues (CA / CR) situation.

Example: The risk free rate is 4 %, and rate of return on market portfolio is 18 %. If XYZ non-profit organization is a representative of W sector for which the non-leveraged risk coefficient  $\beta_u = 0.77$ . On the basis of Hamada relation (Hamada, 1972), we can estimate the equity cost rate that is financing the organization in case of each of the three strategies in the SZ1 variant.

$$\beta_l = \beta_u \times \left( 1 + (1 - T) \times \frac{D}{E} \right) = 0.77 \times \left( 1 + 0.81 \times \frac{0.4}{0.6} \right) = 1.19, \quad (1)$$

where: T — effective tax rate, here the assumption is taken that the NPO uses the tax-exempt debt and as a result there have about the same effective cost of debt as for profit-making organizations (Brigham, 2006, pp. 30–5, 7, 20),<sup>4</sup> D — organization financing capital coming from creditors (a sum of short term debt and long term debt  $D = D_s + D_l$ ), E — organization financing capital coming from founders / owners of the organization,  $\beta$  — risk coefficient,  $\beta_u$  — risk coefficient for an assets of the non-profit organization that not use debt,  $\beta_l$  — risk coefficient for an organization that applying the system of financing by creditors capital (here we have both asset and financial risk).

For restrictive strategy, where CA / CR is 0.3; the SZ risk premium is 0.2:

$$\beta_l^* = \beta_u \times \left( 1 + (1 - T) \times \frac{D}{E} \right) \times (1 + SZ), \quad (2)$$

$$\beta_{lr} = 0.77 \times \left( 1 + 0.81 \times \frac{0.4}{0.6} \right) \times 1.2 = 1.19 \times 1.2 = 1.43, \quad (3)$$

where: SZ — risk premium correction dependent on the liquidity investment strategy.

For moderate strategy, where CA / CR is 0.45 the SZ risk premium is 0.1:

$$\beta_{lm} = 0.77 \times \left( 1 + 0.81 \times \frac{0.4}{0.6} \right) \times 1.1 = 1.19 \times 1.1 = 1.31. \quad (4)$$

For flexible strategy, where CA / CR is 0.6 the SZ risk premium is 0.01:

$$\beta_{lf} = 0.77 \times \left( 1 + 0.81 \times \frac{0.4}{0.6} \right) \times 1.01 = 1.19 \times 1.01 = 1.2. \quad (5)$$

<sup>4</sup> According to Brigham (2006) even non-profit corporations that are exempt from taxation, and have the right to issue tax-exempt debt but individual contributions to these non-profit organizations can be deducted from taxable income by the donor, so: “non-profit businesses have access to tax-advantaged contributed capital”.

Using that information we can calculate cost of equity rates for each liquidity investment strategy. For restrictive strategy:

$$k_{e_r} = \beta_l \times (k_m - k_{RF}) + k_{RF} = 1.43 \times 14 \% + 4 \% = 24 \% . \quad (6)$$

For moderate strategy:

$$k_{e_m} = \beta_l \times (k_m - k_{RF}) + k_{RF} = 1.31 \times 14 \% + 4 \% = 22.3 \% . \quad (7)$$

And for flexible strategy:

$$k_{e_f} = \beta_l \times (k_m - k_{RF}) + k_{RF} = 1.2 \times 14 \% + 4 \% = 20.8 \% , \quad (8)$$

where:  $k$  — rate of return expected by capital donors and at the same time (from nonprofit organization perspective) — cost of financing capital rate,  $k_e$  — for cost rate of the equity,  $k_{dl}$  — for long term debt rate,  $k_{ds}$  — for short term debt rate,  $k_m$  — for average rate of return on typical investment on the market,  $k_{RF}$  — for risk free rate of return whose approximation is an average profitability of treasury bills in the country where the investment is made.

In similar way, we can calculate the risk premiums for XYZ alternative rates. We know that long term debt rates differ for  $9 \% \times (1 + SZ)$  in relation of equity to long term debt. From that we can get long term debt cost rates for each alternative strategy. For restrictive strategy:

$$k_{dl_r} = k_{e_r} - 9 \% \times 1.2 = 24 \% - 10.8 \% = 13.2 \% . \quad (9)$$

For moderate strategy:

$$k_{dl_m} = k_{e_m} - 9 \% \times 1.1 = 22.3 \% - 9.9 \% = 12.4 \% . \quad (10)$$

And for flexible strategy:

$$k_{dl_f} = k_{e_f} - 9 \% \times 1.01 = 20.8 \% - 9.1 \% = 11.7 \% . \quad (11)$$

Next we can calculate the risk premiums for XYZ alternative cost of short term rates. We know that short term debt rates differ for  $12 \% \times (1 + SZ)$  in relation of cost of equity rates to short term debt rates. From that we can get short term debt cost rates for each alternative strategy. For restrictive strategy:

$$k_{ds_r} = k_{e_r} - 12 \% \times 1.2 = 24 \% - 14.4 \% = 9.6 \% . \quad (12)$$

For moderate strategy:

$$k_{ds_m} = k_{e_m} - 12 \% \times 1.1 = 22.3 \% - 13.2 \% = 9.1 \% . \quad (13)$$

And for flexible strategy:

$$k_{ds_f} = k_{e_f} - 12 \% \times 1.01 = 20.8 \% - 12.1 \% = 8.7 \% . \quad (14)$$

As a result, cost of capital rate will amount to:



$$CC = \frac{E}{E+D_l+D_s} \times k_e + \frac{D_l}{E+D_l+D_s} \times k_{dl} \times (1 - T) + \frac{D_s}{E+D_l+D_s} \times k_{ds} \times (1 - T). \quad (15)$$

However, for each strategy — this cost rate will be on another level (calculations in the Table 1).

**Table 1** Cost of capital and changes in economic results depending on the choice of liquidity investment strategy

Liquidity investment strategy	Restrictive	Moderate	Flexible
Cash Revenues (CR)	2 000	2 080	2 142.4
Fixed assets (FA)	1 400	1 445	1 480
Current assets (CA)	600	936	1 285
Total assets (TA) = Total liabilities (TL)	2 000	2 381	2 765
Accounts payable (AP)	300	468	643
Capital invested ( $E + D_l + D_s$ )	1 700	1 913	2 122
Equity ( $E$ )	680	765	849
Long-term debt ( $D_l$ )	340	383	424
Short-term debt ( $D_s$ )	680	765	849
EBIT share in CR	0.5	0.45	0.40
Earnings before interests and taxes (EBIT) <sup>5</sup>	1 000	936	857
Free Cash Flows in 1 to n periods ( $FCF_{1..n}$ )	1 000	936	857
Initial Free Cash Flows in year 0 ( $FCF_0$ )	-1 700	-1 913	-2 122
SZ risk premium correction	0.2	0.1	0.01
Leveraged and corrected risk coefficient $\beta$	1.428	1.309	1.2019
Cost of equity rate ( $k_e$ )	23.99 %	22.33 %	20.83 %
Long-term debt rate ( $k_{dl}$ )	13.19 %	12.43 %	11.74 %
Short-term debt rate ( $k_{ds}$ )	9.59 %	9.13 %	8.71 %
Cost of capital (CC)	14.84 %	13.90 %	13.05 %
<b>Economic result of liquidity strategy</b>	<b>5 037.77</b>	<b>4 821.18</b>	<b>4 443.17</b>

Source: Hypothetical data

As shown in the Table 1, rates of the cost of capital financing of non-profit organization are different due to different approaches to liquidity investment. The lowest rate:  $CC = 13.1\%$ ; is observed in flexible strategy because that strategy is linked with the smallest level of risk but the highest economic effect is bound to restrictive strategy of investment in liquidity.

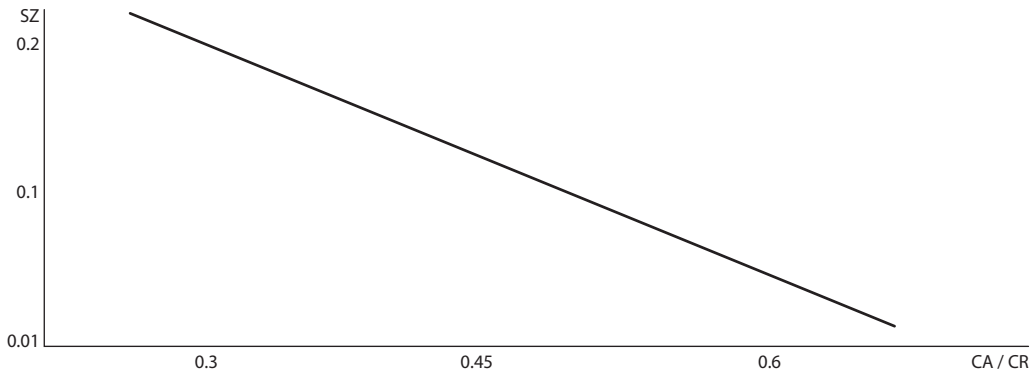
Cost of capital for restrictive strategy of investment in liquidity:

$$CC_r = \frac{680}{1700} \times 24\% + \frac{340}{1700} \times 13.2\% \times (1 - 0.19) + \frac{680}{1700} \times 9.6\% \times (1 - 0.19) = 14.8\%. \quad (16)$$

Expected growth of economic result of liquidity strategy:

$$\Delta ER_r = FCF_0 + \frac{FCF_{1..n}}{CC} = -1700 + \frac{1000}{0.148} = 5057. \quad (17)$$

<sup>5</sup> Because of exempt of taxation, EBIT is equal to net operating profit after taxes (NOPAT).

**Figure 1** The shape of line of correction SZ as a function of CA / CR in the SZ1 variant

Source: Hypothetical data

Cost of capital for moderate strategy of investment in liquidity:

$$CC_m = \frac{765}{1\,913} \times 22.3\% + \frac{383}{1\,913} \times 12.4\% \times (1 - 0.19) + \frac{765}{1\,913} \times 9.1\% \times (1 - 0.19) = 13.9\% \quad (18)$$

Expected growth of economic result for that strategy:

$$\Delta ER_m = -1\,913 + \frac{936}{0.139} = 4\,821. \quad (19)$$

Cost of capital for flexible strategy of investment in liquidity:

$$CC_f = \frac{849}{2\,122} \times 20.8\% + \frac{424}{2\,122} \times 11.7\% \times (1 - 0.19) + \frac{849}{2\,122} \times 8.7\% \times (1 - 0.19) = 13.1\% \quad (20)$$

Expected growth of economic result for flexible strategy:

$$\Delta ER_f = -2\,122 + \frac{857}{0.131} = 4\,420. \quad (21)$$

The expected after crisis changes will correct both the market liquidity value and the cost of capital rate. Both factors influence the target (and optimal) liquidity level for nonprofit organization. That will result with more restrictive liquidity levels because of change in equilibrium point for intrinsic and market liquidity values (Michalski, 2010, Golawska-Witkowska, 2006, p. 144, Jaworski, 2010, pp. 366–368). The cost of capital will be higher after crisis than before (Fernandez, 2011, pp. 4–7, Fernandez, 2010, pp. 4–7, Fernandez, 2008, pp. 5–8). That will result in changes in efficiency of liquidity policy for nonprofit organizations (as shown in the Table 2).

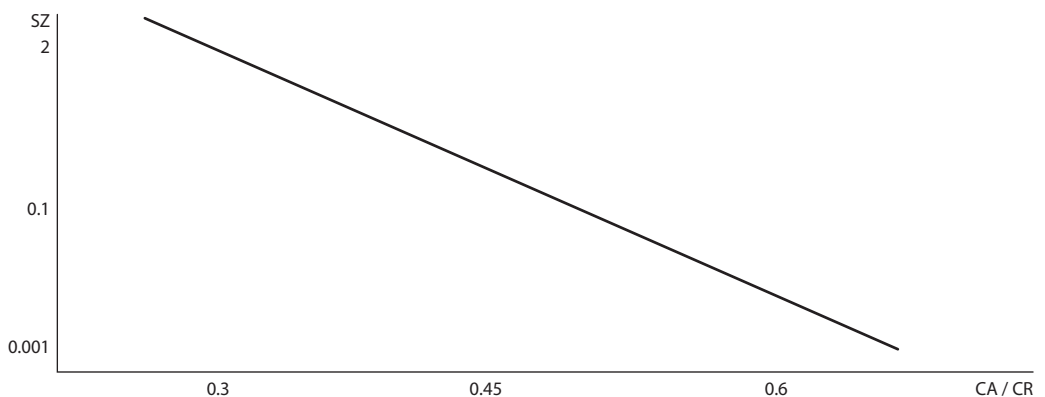
**Table 2** Cost of capital and changes in economic results depending on the choice of liquidity investment strategy

Liquidity investment strategy	Restrictive	Moderate	Flexible
Cash Revenues (CR)	2 000	2 080	2 142.4
Fixed assets (FA)	1 400	1 445	1 480
Current assets (CA)	600	936	1 285
Total assets (TA) = Total liabilities (TL)	2 000	2 381	2 765
Accounts payable (AP)	300	468	643
Capital invested ( $E + D_l + D_s$ )	1 700	1 913	2 122
Equity (E)	680	765	849
Long-term debt ( $D_l$ )	340	383	424
Short-term debt ( $D_s$ )	680	765	849
EBIT share in CR	0.5	0.45	0.40
Earnings before interests and taxes (EBIT)	1 000	936	857
Free Cash Flows in 1 to n periods ( $FCF_{1..n}$ )	1 000	936	857
Initial Free Cash Flows in year 0 ( $FCF_0$ )	-1 700	-1 913	-2 122
SZ risk premium correction	0.2	0.1	0.01
Leveraged and corrected risk coefficient $\beta_l$	1.428	1.309	1.2019
Cost of equity rate ( $k_e$ )	27.85 %	25.94 %	24.23 %
Long-term debt rate ( $k_{dl}$ )	17.05 %	16.04 %	15.14 %
Short-term debt rate ( $k_{ds}$ )	13.45 %	12.74 %	12.11 %
Cost of capital (CC)	18.26 %	17.10 %	16.07 %
<b>Economic result of liquidity strategy</b>	<b>3 777</b>	<b>3 559.18</b>	<b>3 211.06</b>

Source: Hypothetical data

As shown in the Table 2, the after crisis changes influence the efficiency of the liquidity investment of nonprofit organization. It is natural that changes depend on NPO risk sensitivity. Depending on their risk sensitivity, an additional risk premium for an NPO that implemented this type of strategy should be used. As presented in the Figure 2, we have stronger risk sensitivity than in previous situation.

**Figure 2** The shape of line of correction SZ as a function of CA / CR in the SZ2 variant



Source: Hypothetical data

In the Table 3 there are calculations for that variant. For each strategy the cost of capital rate  $CC$  will be on another level.

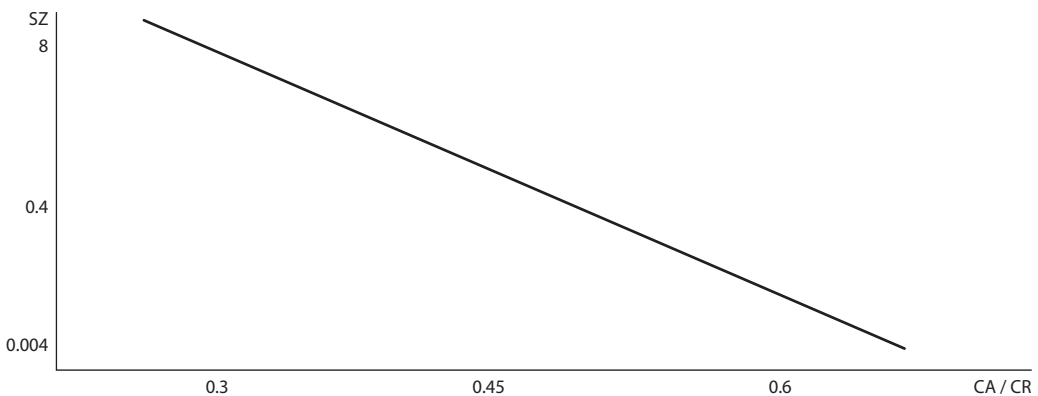
**Table 3** Cost of capital and changes in economic results depending on the choice of liquidity investment strategy (before the crisis influence)

Liquidity investment strategy	Restrictive	Moderate	Flexible
Cash Revenues (CR)	2 000	2 080	2 142.4
Fixed assets (FA)	1 400	1 445	1 480
Current assets (CA)	600	936	1 285
Total assets (TA) = Total liabilities (TL)	2 000	2 381	2 765
Accounts payable (AP)	300	468	643
Capital invested ( $E + D_l + D_s$ )	1 700	1 913	2 122
Equity ( $E$ )	680	765	849
Long-term debt ( $D_l$ )	340	383	424
Short-term debt ( $D_s$ )	680	765	849
EBIT share in CR	0.5	0.45	0.40
Earnings before interests and taxes (EBIT)	1 000	936	857
Free Cash Flows in 1 to $n$ periods ( $FCF_{1..n}$ )	1 000	936	857
Initial Free Cash Flows in year 0 ( $FCF_0$ )	-1 700	-1 913	-2 122
SZ risk premium correction	2	0.1	0.001
Leveraged and corrected risk coefficient $\beta_l$	3.5574	1.30438	1.186986
Cost of equity rate ( $k_e$ )	53.80 %	22.26 %	20.62 %
Long-term debt rate ( $k_{dl}$ )	26.80 %	12.36 %	11.61 %
Short-term debt rate ( $k_{ds}$ )	17.80 %	9.06 %	8.61 %
Cost of capital (CC)	31.63 %	13.84 %	12.92 %
<b>Economic result of liquidity strategy</b>	<b>1 461</b>	<b>4 849</b>	<b>4 513</b>

Source: Hypothetical data

In similar way we can calculate for situation with higher after crisis cost of capital rates levels. The result is presented in the Table 4.

**Figure 3** The shape of line of correction SZ as a function of CA / CR in the SZ3 variant



Source: Hypothetical data

**Table 4** Cost of capital and changes in economic results depending on the choice of liquidity investment strategy

Liquidity investment strategy	Restrictive	Moderate	Flexible
Cash Revenues (CR)	2 000	2 080	2 142.4
Fixed assets (FA)	1 400	1 445	1 480
Current assets (CA)	600	936	1 285
Total assets (TA) = Total liabilities (TL)	2 000	2 381	2 765
Accounts payable (AP)	300	468	643
Capital invested ( $E + D_l + D_s$ )	1 700	1 913	2 122
Equity (E)	680	765	849
Long-term debt ( $D_l$ )	340	383	424
Short-term debt ( $D_s$ )	680	765	849
EBIT share in CR	0.5	0.45	0.40
Earnings before interests and taxes (EBIT)	1 000	936	857
Free Cash Flows in 1 to n periods ( $FCF_{1..n}$ )	1 000	936	857
Initial Free Cash Flows in year 0 ( $FCF_0$ )	-1 700	-1 913	-2 122
SZ risk premium correction	2	0.1	0.001
Leveraged and corrected risk coefficient $\beta_l$	3.5574	1.30438	1.186986
Cost of equity rate ( $k_e$ )	61.92 %	25.87 %	23.99 %
Long-term debt rate ( $k_{dl}$ )	34.92 %	15.97 %	14.98 %
Short-term debt rate ( $k_{ds}$ )	25.92 %	12.67 %	11.98 %
Cost of capital (CC)	38.82 %	17.04 %	15.91 %
<b>Economic result of liquidity strategy</b>	<b>877</b>	<b>3 580</b>	<b>3 266</b>

Source: Hypothetical data

## 2 EMPIRICAL DATA FOR POLAND

Data collected about Polish NPO show their liquidity strategies for 2009 and 2010. If we compare it with the results of profit-oriented Polish organizations we can conclude that the average length of operating cycle and net operating cycle (cash cycle) is shorter than for average for profit organizations. Observation of NPO data can inform us about interesting customs of NPO managing teams. Generally, basing on the data collected from Opolskie area in Poland, for 2009 and 2010 years, we can see that average operating cycle for such group of organizations vary differ, in 2009 was short (about 5.89 days for 2009 data, with standard deviation = SD = 22.69 days) and in 2010 was shorter (about 3.59 days for 2010 data, with SD = 9.35 days).

**Table 5** Operating cycle indicators for Opolskie nonprofit organizations in 2009 and 2010

	Operating cycle	Cash cycle	ROA	ROE
M 2009	5.89	-1.47	-169.96 %	7.15 %
SD 2009	22.69	33.55	1 272.09 %	533.11 %
M 2010	3.59	-7.1	2.21 %	1 258.21 %
SD 2010	9.35	50.34	120.35 %	11 463.45 %

Note: SD = standard deviation, M = arithmetic mean.

Source: Own calculation for 80 selected nonprofits in OPOLSKIE (Bopp, 2011)

Selected data shows that there is no hard link between operating cycle and ROA and ROE results. Operating cycle policy must be first of all a slave of the best realization of the mission nonprofit organization. The economic results are important, but the second or even third in the queue of the aims.

**Table 6** Liquid assets indicators for Polish nonprofit organizations in 2009 and 2010

2009	CR	Assets	CA	Current Ratio	Quick Ratio	Cash Ratio	INV
Number of observations	2 283	2 292	2 294	1 473	1 471	1 467	2 291
Mean	483 699	834 187	201 034	1 092	526	474	6 284
SD	1 636 492	13 073 895	1 315 942	23 069	5 201	4 998	46 105
Median	76 979	24 732	19 062	5.6	5.42	4.54	–
Winsorized mean	693 825	352 948	172 751	63	62	56.3	–
Truncated (trimmed) mean	141 493	58 492	34 793	12	12	10.21	–

2010	AR	Cash equivalents	E	DI	Ds	ROA	ROE
Number of observations	2 290	2 292	2 294	2 293	2 293	2 266	2 247
Mean	32 043	172 066	688 121	11 026	47 152	–0.57	–0.04
SD	605 949	1 291 873	12 967 335	112 797	312 128	23	23
Median	–	13 902	17 037	–	607	0	0.30
Winsorized mean	11 318	116 842	207 907	–	35 605	1	1
Truncated (trimmed) mean	2 282	25 330	37 026	–	6 822	0	0.31

Note: SD = standard deviation, M = arithmetic mean, AR = accounts receivable, E = fund capital, DI = long-term debt, Ds = short-term debt, INV = inventories.

Source: Own calculation for 1000+ selected nonprofits in Poland (Bopp, 2011)

According to data received from 1000+ Polish NPOs, the average NPO investment in liquid assets is more aggressive than in profit-oriented organizations. Average Polish NPO accounts receivable period for 2009–2010 data is about 23 days (5.8 days using winsorized mean and 5.8 days using truncated mean). Average Polish for profit accounts receivable period for 2009–2010 data is about 46 days (Dudycz, 2011). Average Polish NPO inventory period for 2009–2010 data is about 4.7 days. Average Polish for profit inventory period for 2009–2010 data is about 39 days.

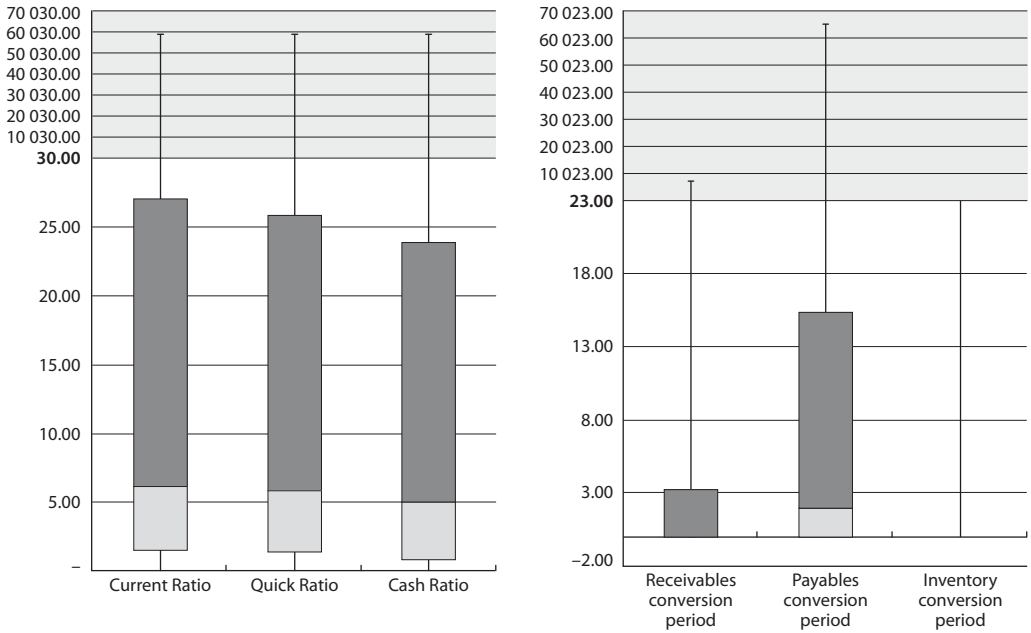
The above observation suggests that in case of Polish NPO we have figure 6 situation. Is it small risk exposition or rather smaller aversion of managing teams? Unfortunately rather the second.

### 3 SILESIA EMPIRICAL DATA

Distribution analysis commands to understand the financial management process in Silesian NPO. Probability distribution function and statistical dispersion of financial data could provide valuable information about current financial conditions in not-for-profit businesses.

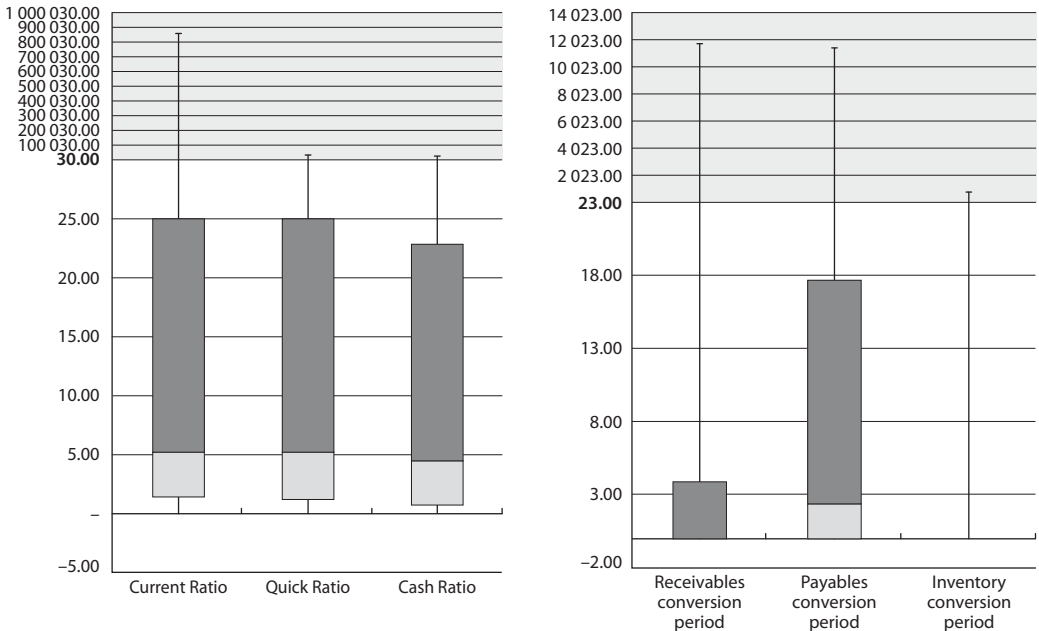
An important aspect is the shape of a distribution, showing the frequency of values from different ranges of the variable. The analysis of all financial ratios produced some interesting results. Skewness (a measure of the asymmetry of the probability distribution) is clearly different from 0, which means that distribution is asymmetrical. Boxplots (the Figures 4 and 5) testify that all analyzed data are not normally distributed. Especially a boxplot is a convenient way of graphically depicting groups of numerical data through their summaries: minimum, lower quartile (Q1), median, upper quartile (Q3), maximum. The location of the box within the whiskers provides an insight into the asymmetry of the sample's distribution. The samples are extremely positively skewed. A thinner box relative to the whiskers indicates a thinner peak.

**Figure 4** Boxplots — liquid ratios nad conversion periods (2009)



Source: Own calculation for over 450 selected nonprofits in Silesia (Bopp, 2011)

**Figure 5** Boxplots — liquid ratios and conversion periods (2010)



Source: Own calculation for over 450 selected nonprofits in Silesia (Bopp, 2011)

**Table 7** Liquid assets indicators for Silesian nonprofit organizations in 2009 and 2010

2009	Receivables conversion period	Payables conversion period	Inventory conversion period	Current Ratio	Quick Ratio	Cash Ratio
Size of population	707	709	708	449	448	448
Average	124.95	1 171.96	7.64	370.14	369.40	296.87
Standard deviation	2 755.26	24 858.80	82.81	3 405.82	3 408.52	3 220.69
Median	0.00	2.00	0.00	6.26	5.99	4.98
Truncated mean	2.58	8.86	–	12.41	12.06	10.95
Winsorized mean	8.56	31.86	0.00	71.08	71.14	62.60
Skewness	26.29	25.49	17.37	13.81	13.80	15.65
Maximum	73 000.00	651 462.75	1 724.32	58 415.22	58 415.22	58 396.28
Minimum	0.00	0.00	0.00	0.00	0.00	0.00

2010	Receivables conversion period	Payables conversion period	Inventory conversion period	Current Ratio	Quick Ratio	Cash Ratio
Size of population	711	712	711	459	458	457
Average	58.47	89.53	6.02	1 980.06	167.24	156.68
Standard deviation	604.86	692.38	46.55	40 314.73	1 627.38	1 575.16
Median	0.00	2.33	0.00	5.24	5.19	4.48
Truncated mean	2.99	9.92	–	11.65	11.45	9.87
Winsorized mean	11.31	39.66	0.00	62.60	62.77	55.70
Skewness	14.72	12.39	11.05	21.42	18.88	18.96
Maximum	11 643.87	11 360.33	769.10	863 747.33	33 331.90	32 281.67
Minimum	0.00	0.00	0.00	0.00	0.00	–0.07

Source: Own calculation for over 450 selected nonprofits in Silesia (Bopp, 2011)

The right side tail of the probability density function is much longer than the left side. The mean (and standard deviation) can be heavily influenced by extreme values in the tails of a variable. In this case a truncated mean and a Winsorized mean are more useful estimators. Comparing to the mean, they are less sensitive to outliers than the mean (Heilpern, 1999) but it still gives a reasonable estimate of central tendency. Truncated mean rejects some parts of the data from the top or from the bottom end, (typically an equal amount at each end) and then calculate the arithmetic mean of the remaining data (Rothenberg, 1966). On the other hand, a Winsorized mean involves the calculation of the mean after replacing given parts of a probability distribution or sample at the high and low end with the most extreme remaining values (Wilcox, 2003).

Data presented in the Table 8 show the values of liquid assets indicators for specific mission. Most of the analyzed NPOs can qualify for several “sectors”. For this reason data from the same organizations are included in several tables.



**Table 8** Liquid assets indicators for Silesian nonprofit organizations (social assistance, including assistance to families and individuals in difficult situations, and equalization of opportunities for those families and individuals) in 2009 and 2010

2009–2010	Receivables conversion period	Payables conversion period	Inventory conversion period	Current Ratio	Quick Ratio	Cash Ratio
Size of population	610	610	610	409	409	409
Average	11.26	1 303.49	11.24	2 433.75	399.51	328.69
Standard deviation	79.23	26 759.15	98.08	42 810.49	3 557.42	3 348.06
Median	–	2.22	–	6.74	6.41	5.42
Truncated mean	2.14	7.76	–	14.46	14.13	12.96
Winsorized mean	7.36	30.43	0.00	82.80	82.56	81.41
Skewness	17.52	23.75	13.16	20.06	13.27	15.06
Maximum	1 718	651 463	1 724	863 747	58 415	58 396
Minimum	0	0	0	0	0	0

Source: Own calculation for over 450 selected nonprofits in Silesia (Bopp, 2011)

**Table 9** Liquid assets indicators for Silesian nonprofit organizations (activities for the integration and professional and social reintegration of those at risk of social exclusion) in 2009 and 2010

2009–2010	Receivables conversion period	Payables conversion period	Inventory conversion period	Current Ratio	Quick Ratio	Cash Ratio
Size of population	463	463	463	303	303	303
Average	12.72	1 442.49	12.67	3 219.17	472.51	387.33
Standard deviation	87.24	30 274.87	109.70	49 731.35	4 080.96	3 856.45
Median	–	2.34	–	10.09	8.77	7.45
Truncated mean	1.78	7.84	–	15.44	15.03	13.47
Winsorized mean	6.46	26.88	–	80.66	80.37	69.75
Skewness	16.72	21.52	12.21	17.27	11.80	13.26
Maximum	1 718	651 463	1 724	863 747	58 415	58 396
Minimum	0	0	0	0	0	0

Source: Own calculation for over 450 selected nonprofits in Silesia (Bopp, 2011)

**Table 10** Liquid assets indicators for Silesian nonprofit organizations (charitable activities) in 2009 and 2010

2009–2010	Receivables conversion period	Payables conversion period	Inventory conversion period	Current Ratio	Quick Ratio	Cash Ratio
Size of population	264	264	264	156	156	156
Average	288.54	34.59	8.21	134.80	134.38	114.64
Standard deviation	4 492.34	165.71	40.94	887.26	887.32	758.27
Median	–	1.48	–	6.45	5.72	4.58
Truncated mean	3.50	8.06	–	10.60	10.00	8.65
Winsorized mean	10.28	25.67	–	47.13	46.15	44.97
Skewness	16.25	9.39	6.24	10.62	10.62	10.36
Maximum	73 000	2 030	365	10 463	10 463	8 815
Minimum	0	0	0	0	0	0

Source: Own calculation for over 450 selected nonprofits in Silesia (Bopp, 2011)

**Table 11** Liquid assets indicators for Silesian nonprofit organizations (activities for national and ethnic minorities and regional language) in 2009 and 2010

2009–2010	Receivables conversion period	Payables conversion period	Inventory conversion period	Current Ratio	Quick Ratio	Cash Ratio
Size of population	548	548	548	346	346	346
Average	166.89	1 520.99	10.98	2 851.70	446.75	375.91
Standard deviation	3 138.39	28 274.52	102.15	46 541.48	3 845.26	3 633.77
Median	–	1.52	–	7.39	7.32	6.12
Truncated mean	2.22	7.63	–	16.89	16.78	15.29
Winsorized mean	7.48	28.76	–	96.43	95.35	92.48
Skewness	22.96	22.40	12.92	18.46	12.37	13.89
Maximum	73 000	651 463	1 724	863 747	58 415	58 396
Minimum	0	0	0	0	0	0

Source: Own calculation for over 450 selected nonprofits in Silesia (Bopp, 2011)

**Table 12** Liquid assets indicators for Silesian nonprofit organizations (health protection and promotion) in 2009 and 2010

2009–2010	Receivables conversion period	Payables conversion period	Inventory conversion period	Current Ratio	Quick Ratio	Cash Ratio
Size of population	530	530	530	358	358	358
Average	147.58	1 495.75	12.10	2 873.91	549.22	464.82
Standard deviation	3 170.71	28 706.30	101.46	45 784.82	4 185.91	3 978.99
Median	–	2.73	–	7.42	6.71	5.79
Truncated mean	2.61	8.96	–	14.47	14.18	12.67
Winsorized mean	10.24	32.31	–	85.80	85.60	77.94
Skewness	23.02	22.13	13.00	18.73	10.58	11.74
Maximum	73 000	651 463	1 724	863 747	58 415	58 396
Minimum	0	0	0	0.01	0.0014	0

Source: Own calculation for over 450 selected nonprofits in Silesia (Bopp, 2011)

**Table 13** Liquid assets indicators for Silesian nonprofit organizations (support economic development activities, including the development of entrepreneurship) in 2009 and 2010

2009–2010	Receivables conversion period	Payables conversion period	Inventory conversion period	Current Ratio	Quick Ratio	Cash Ratio
Size of population	684	684	684	424	424	424
Average	138.93	1 245.81	6.69	2 290.32	329.67	314.45
Standard deviation	2 815.96	25 311.65	57.82	42 036.50	3 331.97	3 295.33
Median	–	1.90	–	6.30	5.96	5.24
Truncated mean	2.67	8.91	–	12.45	12.18	10.80
Winsorized mean	9.63	32.52	–	60.87	60.68	55.26
Skewness	25.48	25.02	15.57	20.45	14.99	15.25
Maximum	73 000	651 463	1 222	863 747	58 415	58 396
Minimum	0	0	0	0	0	0

Source: Own calculation for over 450 selected nonprofits in Silesia (Bopp, 2011)

**Table 14** Liquid assets indicators for Silesian nonprofit organizations (science, education, higher education) in 2009 and 2010

2009–2010	Receivables conversion period	Payables conversion period	Inventory conversion period	Current Ratio	Quick Ratio	Cash Ratio
Size of population	560	560	560	347	347	347
Average	205.84	308.22	7.73	2 573.31	177.24	162.98
Standard deviation	3 159.28	4 808.22	67.65	46 367.95	1 886.03	1 806.79
Median	–	2.11	–	3.52	3.44	2.60
Truncated mean	3.05	11.07	–	7.37	7.13	6.03
Winsorized mean	10.11	39.89	–	40.95	40.78	34.02
Skewness	22.09	22.73	13.84	18.62	16.28	16.67
Maximum	73 000	112 290	1 222	863 747	33 332	32 282
Minimum	0	0	0	0	0	0

Source: Own calculation for over 450 selected nonprofits in Silesia (Bopp, 2011)

**Table 15** Liquid assets indicators for Silesian nonprofit organizations (rescue and civil protection) in 2009 and 2010

2009–2010	Receivables conversion period	Payables conversion period	Inventory conversion period	Current Ratio	Quick Ratio	Cash Ratio
Size of population	309	309	309	221	221	221
Average	7.56	2 151.28	6.60	4 369.62	610.76	501.47
Standard deviation	27.76	37 058.53	74.63	58 225.75	4 786.83	4 512.45
Median	–	3.52	–	5.73	5.59	5.43
Truncated mean	2.20	8.10	–	13.38	13.25	12.32
Winsorized mean	7.74	29.21	–	74.79	74.70	73.98
Skewness	6.63	17.58	14.88	14.75	9.99	11.32
Maximum	286	651 463	1 222	863 747	58 415	58 396
Minimum	0	0	0	0	0	0

Source: Own calculation for over 450 selected nonprofits in Silesia (Bopp, 2011)

**Table 16** Liquid assets indicators for Silesian nonprofit organizations (other sectors) in 2009 and 2010

2009–2010	Receivables conversion period	Payables conversion period	Inventory conversion period	Current Ratio	Quick Ratio	Cash Ratio
Size of population	813	813	813	507	507	507
Average	121.65	1 051.93	5.86	1 967.92	327.80	270.45
Standard deviation	2 584.79	23 218.35	51.84	38 453.58	3 196.00	3 010.05
Median	–	1.66	–	6.37	6.20	5.18
Truncated mean	2.38	8.10	–	12.73	12.32	10.86
Winsorized mean	9.71	30.37	–	64.02	63.53	56.50
Skewness	27.72	27.28	17.82	22.34	14.81	16.75
Maximum	73 000	651 463	1 222	863 747	58 415	58 396
Minimum	0	0	0	0	0	0

Source: Own calculation for over 450 selected nonprofits in Silesia (Bopp, 2011)

## CONCLUSION

As shown in our findings, depending on kind of realized mission and sensitivity to risk NPOs should chose liquid assets investment level and corresponding (based on liquid assets) financing. The kind of organization influences the best strategy choice. If a risk exposure is greater, the higher level of inventories, accounts receivable and operating cash should occur. (Michalski, 2008a). If the risk exposure is smaller, the more aggressive will be the net liquid assets strategy and smaller level of inventories. The organization choosing between various solutions in liquid assets needs to decide what level of risk is acceptable for its owners and capital suppliers. That choice results in financing consequences, especially in cost level. It is a basis for considerations about relations between risk and expected benefits from the liquid assets decision and its impact on financing costs for both nonprofit or profit-oriented organizations. Decisions on liquid assets management strategy and choice between kind of taxed or non-taxed form inflow the risk of the organizations and its economical results during realization of main mission. Comparing theoretical model with empirical data for over 450 Silesian nonprofit organization result, suggests that nonprofit organization managing teams choose more risky aggressive liquid assets solutions than for-profit firms. That observation suggests that here, in Silesian NPO case we have the Figure 1 situation with smallest risk exposure solution in managing team mind. But in fact probably there is not a smaller risk exposition but rather smaller aversion of managing teams of Silesian NPOs.

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# Alternative Approaches to the Analysis of Multidimensional Contingency Tables

Iva Pecáková<sup>1</sup> | *University of Economics, Prague, Czech Republic*

## Abstract

The practical analyses of interactions between categorical variables in various areas (such as public opinion research or marketing research) are often only applications of chi-square tests in two-way contingency tables. However, in many situations it is impossible to use large-sample approximations to sampling distributions when their adequacy can be in doubt. It is known, that these approximations may be very poor when the contingency table contains very small expected frequencies. However, recent work has shown that these approximations can be very poor when the contingency table contains both small and large expected frequencies. Of course, the rule of thumb of a minimum expected frequency is not met either in the case of sparse table. The article deals with alternative approaches to the data analysis in such cases. It points out other possibilities and shows that thanks to the development of computer technology exact methods previously only difficult usable are available for this purpose.

## Keywords

*Contingency tables, categorical data analysis, exact inference about associations*

## JEL code

C39

## INTRODUCTION

Using data drawn from the population concerned via certain form of random sampling, the statistical inference makes propositions about this population, about its underlying probability model. Categorical variables have a measurement scale consisting of a small set of discrete categories. The discrete probability distributions (particularly binomial, multinomial and Poisson ones) have then the key importance for statistical inference in categorical data analysis. Given a sufficiently large sample size, the discrete distributions of test statistics converge to normal distribution or chi-square one. It is known, that the sample size must be large enough to use the continuous approximations.

When the assumptions of the asymptotic method cannot be met and the validity of the corresponding large sample theory is doubtful, the results can be unreliable. Sometimes the data file can be small, sparse, unbalanced. However, recent work has shown that these approximations may not be optimal even in cases of a relatively large sample size. In all such cases procedures based on exact distribution of the test statistics should be applied.

The distribution of discrete test statistics under the independence hypothesis can be obtained by calculating all its possible values under rearrangements of data. The statistical methodology underlying these

<sup>1</sup> Nám. W. Churchilla 4, 130 67 Prague 3, Czech Republic. E-mail: pecakova@vse.cz.

exact tests (also called permutation tests or randomization tests) exists already some time and is included into numerous statistical papers, monographs and textbooks. R. A. Fisher is known to be “a father” of exact methods for small samples: his well-known example with milk in tea for  $2 \times 2$  contingency tables is mentioned in almost every statistical resource in this area.

Fisher’s exact approach is conditional. To conduct exact inference about an association, or about the odds ratio in  $2 \times 2$  table, the conditional distribution of one cell frequency given the sample size and the corresponding marginal totals is considered. The use of this conditional approach is still intensively discussed, particularly when both types of marginal totals in the table are not fixed naturally. However, it can be said that Fisher’s approach dominates. In addition, it can be relatively easily expanded for larger tables, which is questionable for other proposed methods.

The computational demands of exact methods, especially in larger tables, can be severe, since all the outcomes that could occur must be enumerated to compute the  $P$ -value of an exact test. The actually observed data are compared to what might have been observed. Mehta and Patel (1996) present for example, that the set of all possible  $5 \times 6$  contingency tables with relatively small marginal frequencies ( $n = 34$ ) contains 1.6 billion tables. Thus practical applications of exact methods had to wait for development of computers and especially for new, fast and efficient computational algorithms.

According to Mehta and Patel, the  $P$ -value for independence tests in two-way contingency tables can be computed quickly only if  $\min(r, c) \leq 3$ ,  $r$  is number of rows and  $c$  is number of columns in the table, and the sample size is relatively small. In larger tables the computational algorithm can take even many hours. In such case any repeated sampling (*resampling*) method can provide an estimate very close to the exact result.

The resampling methods do not enumerate all possible outcomes, but a random sample of them. The estimate of the  $P$ -value is usually obtained as a proportion of these replicates that produce a test statistic greater or equal that calculated for the actual data in the number of all replicated samples. Thus the  $P$ -value estimate is unbiased, the standard error is also available and so the confidence interval can be assembled. In the case of large number of replications, the width of this interval can be very small (the accuracy from 10 000 random permutations is not more than 0.01). This type of resampling method is known as Monte Carlo or approximate permutation test.

## 1 TWO-DIMENSIONAL CONTINGENCY TABLES

Consider now a data sample of size  $n$ ; the data are cross-classified into a contingency table with  $r$  rows and  $c$  columns. Most often the hypothesis of interest is whether an association exists between the two classifications in the table. To test the hypothesis of independence between two categorical variables, Pearson and likelihood-ratio chi-squared tests are well-known. The test statistics:

$$\chi^2 = \sum_i \sum_j \frac{(n_{ij} - m_{ij})^2}{m_{ij}}, \tag{1}$$

and

$$G^2 = -2 \sum_i \sum_j n_{ij} \ln \frac{n_{ij}}{m_{ij}}, \quad i = 1, 2, \dots, r; j = 1, 2, \dots, c, \tag{2}$$

where  $n_{ij}$  denotes observed frequencies and  $m_{ij}$  estimated expected frequencies,  $m_{ij} = n_{i.}n_{.j} / n$ , have the same limiting null chi-squared distribution with  $df = (r - 1)(c - 1)$  and are asymptotically equivalent. The adequacy of the chi-squared distribution depends both on the sample size and on the number of cells in the table. The condition of a minimum expected count of 1 and no more than 20 % of  $m_{ij}$  less than 5 is commonly used (in the  $2 \times 2$  table, the expected frequencies should exceed 10).

However, the approximations can be poor in sparse tables, in tables with both small and large expected frequencies. Other findings concerning the quality of approximations can be found in many works; they are summarized for example in Agresti (2002): first of all, the statistic  $\chi^2$  is preferable than  $G^2$  in sparser tables and in case of smaller  $n$ . When the sample size requirements for the chi-square tests are not met, Fisher's exact test is an alternative.

This test of independence in the  $2 \times 2$  table assumes fixed row and column marginal frequencies. Then  $n_{11}$  (for example), which determines all other three cell counts, can be used as a test statistic. It follows the hypergeometric distribution and so the exact test  $P$ -value can be calculated. This  $P$ -value is the sum of hypergeometric probabilities for tables at least as favorable to the null hypothesis as the observed table. To order the tables according to this "favorableness", different criteria can be used: larger  $n_{11}$ , or larger odds ratio  $\theta = n_{11}n_{22} / n_{12}n_{21}$ , or larger Pearson statistic  $\chi^2$  (different criteria can lead to different  $P$ -values). Because of distribution discreteness, the test is highly conservative for small samples. Some authors then recommend involving in the test  $P$ -value only half probability for the observed table (so called *mid-P-value* — Agresti, 2002).

Freeman and Halton generalized the Fisher's test for the  $r \times c$  contingency table. When the row totals  $n_{i\cdot}$ ,  $i = 1, 2, \dots, r$ , and the column totals  $n_{\cdot j}$ ,  $j = 1, 2, \dots, c$ , in the table are fixed, the simultaneous distribution of the set of  $n_{ij}$ ,  $i = 1, 2, \dots, r - 1$  and  $j = 1, 2, \dots, c - 1$ , is multiple hypergeometric. The test  $P$ -value includes the probability of tables with the given margins that are at least as favorable to the null hypothesis as the observed table. To order the tables, Pearson statistic is usually used; otherwise, when the classification variables are ordinal, for example the gamma statistic can be used for this purpose.

To analyze complicated associations in multidimensional contingency tables, the log-linear model as a generalized linear model using the log link function can be also useful. For the two-dimensional  $r \times c$  contingency table, the *saturated* loglinear model (when  $m_{ij} = n_{ij}$ ) has the form:

$$\ln m_{ij} = \lambda + \lambda_i^X + \lambda_j^Y + \lambda_{ij}^{XY}. \tag{3}$$

Here  $\lambda$  is a cell effect,  $\lambda_i^X$  are row effects,  $\lambda_j^Y$  are column effects and  $\lambda_{ij}^{XY}$  are association parameters that reflect deviations from independence. In the simplest case of the  $2 \times 2$  table, when we consider dummy indicators with  $\lambda_2^X = \lambda_2^Y = \lambda_{12}^{XY} = \lambda_{21}^{XY} = \lambda_{22}^{XY} = 0$ , then:

$$\lambda_{11}^{XY} = \ln \theta = \ln \frac{n_{11}n_{22}}{n_{12}n_{21}}, \tag{4}$$

here  $\theta$  denotes the odds ratio. Thus, the independence hypothesis for model (3) in  $2 \times 2$  contingency tables can be written as  $\lambda_{11}^{XY} = \ln \theta = 0$ , or  $\theta = 1$ , or  $\ln m_{ij} = \lambda + \lambda_i^X + \lambda_j^Y$  (the *tested* model).

In the  $r \times c$  table, when we consider dummy indicators again and set:

$$\lambda_r^X = \lambda_c^Y = \lambda_{1c}^{XY} = \lambda_{2c}^{XY} = \dots = \lambda_{r1}^{XY} = \lambda_{r2}^{XY} = \dots \lambda_{rc}^{XY} = 0, \text{ then}$$

$$\lambda_{ij}^{XY} = \ln \theta_{ij} = \ln \frac{n_{ij}n_{rc}}{n_{ic}n_{rj}}, \tag{5}$$

$$i = 1, 2, \dots, r - 1; j = 1, 2, \dots, c - 1.$$

Test of independence states  $\lambda_{ij}^{XY} = \ln \theta_{ij} = 0$  for these  $(r - 1)(c - 1)$  association parameters.

## 2 MULTIDIMENSIONAL CONTINGENCY TABLES

The associations between variables in multidimensional contingency tables can be very complicated. The influence of other variables on an association can be confounding. The model can be qualified as very useful particularly in such situation.



In the case of three variables, the loglinear model can be written as:

$$\ln m_{ijk} = \lambda + \lambda_i^X + \lambda_j^Y + \lambda_k^Z + \lambda_{ij}^{XY} + \lambda_{ik}^{XZ} + \lambda_{jk}^{YZ} + \lambda_{ijk}^{XYZ}, \tag{6}$$

$i = 1, 2, \dots, r; j = 1, 2, \dots, c; k = 1, 2, \dots, s$  ( $s$  denotes the number of layers — or strata — in the table).

The model includes two-factor parameters  $\lambda_{ij}^{XY}, \lambda_{ik}^{XZ}, \lambda_{jk}^{YZ}$  to describe the *conditional* association for each pair of variables given the third variable. In the  $r \times c \times s$  table, when we consider dummy indicators, in general there are  $(r - 1)(c - 1)$  non-null parameters  $\lambda_{ij}^{XY}$ ,  $(r - 1)(s - 1)$  non-null parameters  $\lambda_{ik}^{XZ}$ ,  $(c - 1)(s - 1)$  non-null parameters  $\lambda_{jk}^{YZ}$  and  $(r - 1)(c - 1)(s - 1)$  non-null parameters  $\lambda_{ijk}^{XYZ}$ . It represents  $(r - 1)(c - 1)$  odds ratios (5) at each level of variable  $Z$ ,  $(r - 1)(s - 1)$  odds ratios at each level of variable  $Y$  and  $(c - 1)(s - 1)$  odds ratios at each level of variable  $X$ . The three-factor interactions  $\lambda_{ijk}^{XYZ}$  then describe how the odds ratio between two variables changes across categories of the third variable. Any model not having the three-factor interaction term has a homogenous association for each pair of variables (see Agresti, 1999).

When the loglinear model includes all lower-order terms composed from variables contained in a high-order model term, the model is called hierarchical. For example, the hierarchical model with  $\lambda_{ij}^{XY}$  terms includes  $\lambda_i^X, \lambda_j^Y$ , the hierarchical model without  $\lambda_{ijk}^{XYZ}$  includes all two-factor parameters etc. The established symbols usually used for hierarchical loglinear models list the highest-order terms for each variable. Thus, the model with all the two-factor parameters but without three-factor parameters has a symbol  $(XY, XZ, YZ)$ , the model with three-factor parameters a symbol  $(XYZ)$  etc.

The statistic  $G^2$  written in (2) for a two-dimensional table is a special case of the likelihood-ratio statistic called *deviance*. In general, the deviance compares the maximum of the log likelihood for a tested model and the maximum achievable log likelihood for the most general model with the perfect fit of cell frequencies — saturated model. Simpler models have larger deviances, more complicated models smaller deviances. As can be shown, the likelihood statistic comparing the two models is simply the difference between their deviances. This statistic has also approximately chi-square distribution with degrees of freedom equal to the difference between the numbers of parameters in the two compared models.

Thus, the tests about conditional associations can be based on the comparison of the loglinear models without and with relevant parameters. For example, the hypothesis of the conditional independence between  $X$  and  $Y$  can be tested by:

$$G^2(XZ, YZ) - G^2(XY, XZ, YZ), \tag{7}$$

where  $G^2(XZ, YZ)$  is the deviance of the model without tested parameters (here  $\lambda_{ij}^{XY}$ ) and  $G^2(XY, XZ, YZ)$  is the deviance of the model with these parameters. The difference between the numbers of parameters,  $(r - 1)(c - 1)$  in this example, determines the parameter of chi-square distribution of the test statistic. According to Agresti (2002), for given  $n$  and a number of cells in the contingency table, chi-squared approximation is better for tests with smaller *df*. Of course, conditions of chi-square approximation should be met. The extension of the loglinear model for more than three classifications is straightforward.

Cochran-Mantel-Haenszel approach is an alternative to the above procedure. The conditional distribution of a cell frequency given the sample size and the corresponding marginal totals (the hypergeometric distribution) is considered in this method.

In the  $2 \times 2$  table, Mantel-Haenszel (MH) statistic, so-called randomization chi-square statistic  $Q$ ,

$$Q = \frac{(n_{11} - m_{11})^2}{v_{11}}, m_{11} = \frac{n_{1+}n_{+1}}{n}, v_{11} = \frac{n_{1+}n_{2+}n_{+1}n_{+2}}{n^2(n-1)}, \tag{8}$$

has an asymptotic chi-square distribution with one degree of freedom. Then, in a set of  $s$  contingency tables  $2 \times 2$  arising by sorting data by other variable (or by an combination of other variables), the MH statistic  $Q_{MH}$ ,

$$Q_{MH} = \frac{\left( \sum_k n_{11k} - \sum_k m_{11k} \right)^2}{\sum_k v_{11k}}, \tag{9}$$

$$m_{11k} = \frac{n_{1+k} n_{+1k}}{n_k}, v_{11k} = \frac{n_{1+k} n_{2+k} n_{+1k} n_{+2k}}{n_k^2 (n_k - 1)}, k = 1, 2, \dots, s,$$

has approximately chi-square distribution with one degree of freedom when overall sample sizes are large (individual cell counts and table sizes may be relatively small).

According to Stokes, Davis and Koch (1995), Mantel and Fleiss proposed a criterion to determine whether the chi-square approximation is appropriate for the MH statistic (9):

$$\min \left\{ \left[ \sum_k m_{11k} - \sum_k L_k \right], \left[ \sum_k U_k - \sum_k m_{11k} \right] \right\}, \tag{10}$$

where  $L_k = \max(0, n_{1+k} - n_{+2k})$ ,  $U_k = \min(n_{+1k}, n_{1+k})$ .

It should be noted, that W. Cochran proposed a statistic similar to (9), but he used the unconditional approach: he treated the rows in the table as independent binomials with corresponding variance. The difference of both approaches is small, ( $n_k^3$  in the denominator of  $v_{11k}$ ). Because of their basic similarity, the approach is usually referred to as Cochran-Mantel-Haenszel (CMH) approach. The continuity correction (-0.5) is sometimes used in the numerator of the CMH statistics (see Stokes, Davis, Koch, 1995).

For a tree-dimensional contingency table, or in the set of  $s$  contingency tables  $r \times c$ , denote as:

$$\mathbf{n}_k^T = [n_{11k}, n_{12k}, \dots, n_{1,c-1,k}, \dots, n_{21k}, n_{22k}, \dots, n_{2,c-1,k}, \dots, n_{r-1,c-1,k}], k = 1, 2, \dots, s,$$

the vector of  $(r - 1)(c - 1)$  simultaneous frequencies in all  $s$  strata, denote as:

$$\mathbf{m}_k^T = [m_{11k}, m_{12k}, \dots, m_{1,c-1,k}, \dots, m_{21k}, m_{22k}, \dots, m_{2,c-1,k}, \dots, m_{r-1,c-1,k}], k = 1, 2, \dots, s,$$

$$m_{ijk} = n_{i+k} n_{+jk} / n_{++k}, i = 1, 2, \dots, r - 1, j = 1, 2, \dots, c - 1,$$

the vector of corresponding expected frequencies and denote as  $C_k$  the covariance matrix with elements:

$$C(n_{ijk}, n_{ij'k}) = \frac{n_{i+k}(\delta_{ii'} n_{++k} - n_{i'+k}) n_{+jk}(\delta_{jj'} n_{++k} - n_{j'+k})}{n_{++k}^2 (n_{++k} - 1)},$$

where for  $i = i'$   $\delta_{ii'} = 1$ , for  $i \neq i'$   $\delta_{ii'} = 0$   
 $j = j'$   $\delta_{jj'} = 1$ , for  $j \neq j'$   $\delta_{jj'} = 0$ .

The MH statistic  $Q_{MH}(YX.Z)$  can be then written (according to Pecáková, 2011 for example) as:

$$Q_{MH}(YX.Z) = (\mathbf{n} - \mathbf{m})^T \mathbf{C}^{-1} (\mathbf{n} - \mathbf{m}), \tag{11}$$

$$\mathbf{n} = \sum_k \mathbf{n}_k, \mathbf{m} = \sum_k \mathbf{m}_k, \mathbf{C} = \sum_k \mathbf{C}_k.$$

The distribution of this statistic is chi-square with  $df = (r - 1)(c - 1)$ . Sample size requirements are yet based on total frequencies, summed across tables, rather than individual cell quantities. However, the MH (CMH) test has low power in the case of associations of opposite patterns in various strata. (To test these circumstances, Breslow-Day test was developed; if it is insignificant, then MH test can be used successfully — see Pecáková, 2002).

Violations of the conditions of approximate methods in the multidimensional table can be very often expected, particularly when the number of classifications and also the number of categories of variables is large and the sample size disregards this fact. For use of the approximation strategy, the number of variables reduction can arise from combining of more classifications. For example, instead of two variables sex and age (with categories younger — older) we can use only one variable with four categories: younger male, younger female, older male, older female.

This is also the way how to test some parameters of loglinear models for multidimensional tables. Some methods of their exact testing are actually special cases of one's developed for a two-way table. The comparison of two hierarchical loglinear models,  $(X, YZ)$  and  $(XYZ)$  for example, actually represents a test of independence for a two-way  $r \times cs$  table; the model  $(X, Y, Z)$  against  $(X, YZ)$  can be used to test the independence of  $Y$  and  $Z$  in the two-way table, etc. However, the exact algorithms are not still available for some types of loglinear models parameters, or there is not available their computational form for the use of Monte Carlo method.

### 3 ANALYSES

#### 3.1 Analysis 1<sup>2</sup>

At first, consider data from Pecáková (2011) in the Table 1. Here  $X$  represents the variable Age (three age groups: until 35 years, 36–50 years, above 50 years),  $Y$  is the variable Sex and  $Z$  represents the variable Willingness (a willingness to switch to a new soft drink brand with categories: yes, no). The sample size  $n$  is 230.

Table 1 Willingness to switch to a new soft drink brand							
Age	Bellow 35		36–50		Above 50		
Sex	Female	Male	Female	Male	Female	Male	Total
Yes	45	28	3	24	3	21	124
No	25	5	14	25	14	23	106
Total	70	33	17	49	17	44	230

Source: Pecáková (2011)

Two-way analysis:

Willingness is associated with Age. The  $P$ -values of both chi-square tests are 0.000. However, Willingness is not associated with Sex. The  $P$ -values are 0.178. The expected values in the table are quite large, the chi-squared approximations are possible. For comparison, the  $P$ -value of the exact test is 0.187.

As we can see in the Table 1, some cell frequencies in the subtables acquired according to the levels of the variable Age are small. The conditions of chi-squared approximations are not met everywhere. The exact  $P$ -values of Fisher's test of association between Willingness and Sex in different age groups are consecutively 0.038, 0.043 and 0.042. Thus, the variables Willingness and Sex are associated in the subtables. Thus, the results of both analyses are in conflict. Is the influence of the variable Age confounding?

<sup>2</sup> All the calculations were accomplished by using SPSS 18.0 and SAS Enterprise Guide 4.1;  $\alpha = 0.05$ .

Three-way analysis:

The difference between the deviances for the loglinear models without and with the association parameter is 15.314 ( $P$ -value = 0.000) and the association of the variables Willingness and Sex is confirmed.

MH statistic on the value of 12.856 (or CMH statistic on the value of 14.158) exposes the association of Willingness and Sex (the  $P$ -value the test is 0.000). The procedure is suitable; Breslow-Day test of odd ratio homogeneity is insignificant.

### 3.2 Analysis 2

Now consider data in the Table 2. The variables are the same like in the Table 1. The sample size is small,  $n = 72$ .

**Table 2** Willingness to switch to a new soft drink brand

Age	Bellow 35		36–50		Above 50		
Sex	Female	Male	Female	Male	Female	Male	Total
Yes	9	2	2	11	0	10	34
No	6	7	7	5	5	8	38
Total	15	9	9	16	5	18	72

Source: Own construction

Two-way analysis:

The table is sparse. The Willingness is not associated with Age (the  $P$ -values of the chi-square tests are about 0.830) and it is not associated with Sex again (the  $P$ -values of the chi-square test are about 0.195; the chi-squared approximations are possible, but the asymptotic tests are somewhat liberal: the  $P$ -value of the exact test is 0.234).

In all the subtables, only the exact test can be used. The exact  $P$ -values of Fisher’s test of association between Willingness and Sex in different age groups are consecutively 0.105, 0.041 and 0.046. The sample sizes are quite small, so the exact tests are somewhat conservative now.

Three-way analysis:

The test of the three-factor interaction in the loglinear model is significant ( $P$ -value 0.003): the odds ratio between two variables changes across categories of the third variable. However, further increase in deviance in the test of association between Willingness and Sex is not significant (however, chi-square approximation can be doubtful in this analysis).

The previous result is evident from the MH approach again: the MH statistic of 1.255 (or CMH statistic 1.962) is not significant in this case. According to the criterion (10), the chi-square approximation is appropriate for this test:

$$\sum_k L_k = 2 + 0 + 0 = 2,$$

$$\sum_k U_k = 11 + 9 + 5 = 25,$$

$$\sum_k m_{11k} = 6.9 + 4.7 + 2.2 = 13.8,$$

$$\min\{[13.8 - 2], [25 - 13.8]\} > 5.$$

However, the power of the test is small because of result of Breslow-Day test ( $P$ -value is 0.003).

### 3.3 Analysis 3

The data file<sup>3</sup> comes from a survey sampling of the interest in getting work in the EU. The file was used in Pecáková (2010). We examine associations between the variable Interest (the interest in getting work in EU) with values:

- 1 = “yes, will definitely or probably try”,
- 2 = “would be interested if offered a job”,
- 3 = “no, probably or definitely will not be interested”,

the variable Income (the ordinal variable with seven income groups) and the variable Age (four age groups). The sample size is 1 203, but there are missing values in the sample. The disposable sample size for examined three variables is 862.

Two-way analysis:

In the  $3 \times 7$  table for the variables Interest and Income there are no cells with expected frequencies less than 5. The variables Interest and Income are nearly associated; the  $P$ -values of the asymptotic tests are about 0.06.

The subtables in the classification according to the age groups are very sparse. To calculate the exact tests, Monte Carlo method with 10 000 samples was applied. The results of the exact tests are 0.251, 0.763, 0.047 and 0.752. Only in the third group are variables associated, the results of both analyses disagree, the marginal association might be only apparent.

Three-way analysis:

The test of the three-factor interaction in the loglinear model is not significant again; the  $P$ -value is 0.125; the chi-square approximation can be doubtful in this analysis again.

CMH statistic on the value of 17 851 is not significant ( $P$ -value = 0.120). However, it should be noted that marginal frequencies are not all sufficiently large and the chi-square approximation might be in question. The sample size is not very large for the tests in multidimensional classification.

## CONCLUSION

Sorting data by multiple categorical variables almost always causes a problem of vacant and few occupied fields in the table. In such a case, the conditions for the use of approximate methods are not met. It is necessary to take into account this fact when considering the sample size.

Small, sparse or unbalanced data sets limit the usability of tests on the loglinear model parameters in the analysis of multidimensional contingency tables. The use of MH (CMH) strategy is potential. The distribution of MH (or CMH) statistic depends on marginal frequencies, not on cell frequencies in single sub-tables; the sub-tables can be relatively sparse.

The exact procedures should be used in the case of violation of the conditions of approximate methods. Computers and statistical software have recently enabled the use of some exact procedures to analyze multidimensional tables (SPSS or SAS for example). Some methods of exact testing of loglinear models parameters are actually special cases of one's developed for a two-way table. However, the exact algorithms are not still available for some types of loglinear models parameters. In addition, the exact methods are computationally very demanding and standard statistical software may fail. The solution may involve the use a resampling algorithm, such as Monte Carlo.

<sup>3</sup> The data provided the Czech Public Opinion Research Centre (CVVM) in 2006 for a students' school-leaving work.

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# Recent Publications and Events

## *New Publications of the Czech Statistical Office*

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*Statistical Yearbook of the Czech Republic 2011*. Prague: Czech Statistical Office, 2011.

*Population Development of Prague from 2001 to 2010*. Prague: Czech Statistical Office, 2011.

## *Other Selected Publications*

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HŮLOVÁ, M., JAROŠOVÁ, E. *Statistické metody v managementu kvality, environmentu a bezpečnosti* (Statistical Methods in the Management of Quality, the Environment and Safety). Prague: University of Economics, 2011.

KRKOŠKOVÁ, Š., RÁČKOVÁ, A., ZOUHAR, J. *Základy ekonometrie v příkladech* (Principles of Econometrics in Examples). Prague: University of Economics, 2011.

OECD, WTO. *Aid for Trade at a Glance 2011: Showing Results*. Paris: OECD, WTO, 2011.

## *Information*

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The first preliminary results of the “project of a decade” — 2011 *Population and Housing Census (SLDB 2011)* in the Czech Republic were published **on 15 December 2011** at a press conference attended by the President of the Czech Statistical Office Iva Ritschelová and the Vice-President of the Czech Statistical Office Stanislav Drápal.

Information and presentation from the conference can be found at: [www.scitani.cz](http://www.scitani.cz).

## *Conferences*

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The *workshop Analytical Methods in Statistics (AMISTAT)* was held in honour of Professor Abram Kagan in Prague, the Czech Republic **from 28 to 30 October 2011**. Organizing institutes were the Center of Jaroslav Hájek for Theoretical and Applied Statistics and the Department of Probability and Mathematical Statistics of the Charles University in Prague.

The agenda, list of participants and speakers, and other information on the event are available at: <http://amistat2011.karlin.mff.cuni.cz/index.htm>.

**The 20<sup>th</sup> International Input-Output Conference** will be held in Bratislava, the Slovak Republic, **from 26 to 29 June 2012**. The goal of the conference is to promote and stimulate the worldwide exchange of ideas among economists and government officials, policy makers, engineers, national accountants and managers with interests in input-output analysis and related methods.

More information is available at: <http://www.iioa.org/conferences-20th.html>.

**The 27<sup>th</sup> annual International Workshop on Statistical Modelling (IWSM'27)** will be held at the premises of the University of Economics, Prague **from 16 to 20 July 2012 in Prague**, the Czech Republic. The workshop is organised as the major activity of the Statistical Modelling Society, which was founded with the purpose of promoting and encouraging statistical modelling in its widest sense. With the workshop, the organisers try to address people working in academia but also individuals outside research, who solve applied problems based on data. Having many returning participants they believe that the workshops are friendly and supportive, and they particularly encourage students to attend and to present, giving them the opportunity to speak to many of the worlds experts on statistical modelling.

More information is available at: <http://iws2012.karlin.mff.cuni.cz>.

**The 31<sup>st</sup> CIRET Conference** will be held in Vienna, Austria **from 5 to 8 September 2012**. The overall aim of CIRET conferences is to encourage and improve communication, exchange and co-operation between academics and practitioners, who conduct economic surveys, analyse survey data and develop or make use of cyclical indicators. CIRET, the Centre for International Research on Economic Tendency Surveys, is also a forum for discussion and application of new methodological developments and their results.

More information is available at: [https://www.ciret.org/files/CfP\\_Vienna\\_2012\\_def.pdf](https://www.ciret.org/files/CfP_Vienna_2012_def.pdf).

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## Papers

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.

## 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 New Roman 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)**  
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## 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, 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>>.

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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).

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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.

## Formulas

Formulas should be prepared in formula editor in the same text format (Times New Roman 12) as the main text.

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## Contact us

**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

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