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Towards the Unnecessity of Human Development Index: the Case of Sensitivity Analysis

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Abstract

The Human development index is one of the most frequently used indicators of living conditions of population. We can find three dimensions in its structure – education, health and living standard. Since HDI represents a composite indicator combining three different indicators it is necessary to measure the sensitivity of each of its components. HDI is widely used to compare countries from any part of the world and therefore the variability of the indicators is high. The aim of this article is to show the dependency and mutual influence of individual imputed indicators to HDI. The construction of HDI and theoretical methods of sensitivity are also covered. Results show that the influence of individual inputs on the final HDI and its robustness differ among individual types of input and the strongest correlation of HDI occurs with the dimension of living standard. The influence of other indicators is affected by some other technical parameters of HDI construction.

Keywords	***JEL code***
Human Development Index, Sensitivity Analysis, Gross National Income, Education, Health	*O15, C14*

INTRODUCTION

Economic development and its relation to living conditions and living standard is very close. In the 1960s, opinions started to grow stronger criticising simplified views of economic development and the focus exclusively on the Gross Domestic Product. This only measures the value of the manufactured goods and rendered services, totally ignoring other aspects of human life (see Sixta, 2014; or Sixta and Vltavska, 2015; or Sixta and Fischer, 2014). However, a problem with the interpretation of macro- indicators from

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National accounts can be identified in many other ways (see Hindls and Hronová, 2015). The Human Development Index (hereafter HDI) was first introduced by the United Nations Development Programme (hereafter UNDP) in the Human Development Report in 1990 (UNDP, 1990). The purpose of the report was to draw attention towards human development. The index and its construction aims at adequation of various phenomena by means of indicators that are subsequently aggregated into one figure (in essence, it actually comprises a composite indicator – Hudrlíková, 2013).

The HDI includes three basic dimensions with an equal importance for the calculation – an ability to lead a long and healthy life; an ability to get educated and gain knowledge; an ability to live a life with a certain minimal living standard. Although the specific style of the calculation of the indicator differs throughout the history of HDI, these basic dimensions do not change (Syrovátka, 2008, p. 13).

As it is important to measure the progress of society many authors discussed the possibility to estimate the level and compare countries as Vopravil, 2009 did or to venture beyond the GPD in order to measure the real true wealth and welfare of a nation (Křovák, Ritchelová, 2008; or Dubská, Drápal, 2010). Some studies also analyzed the types of indicator-related initiatives run by respective bodies (Hák, Janoušková, 2013).

The article aims – by means of suitable methods – to describe the dependency and the influence among individual HDI input indicators, and among these inputs and the index itself. Sensitivity analysis is applied in order to achieve this goal, including its various methods estimating the influence of individual inputs on the final HDI and to determine – in combination with the knowledge of HDI construction – whether this calculation is sufficiently robust. Results and conclusion were presented by Stanek (2015).

1 METHODOLOGY

1.1 HDI construction

To enable the construction of a composite indicator that includes several different indicators with various ranges of values, the following steps are taken: two dimensions (health and living standard) are measured by means of one indicator while the education factor by means of two. Each indicator is measured in a different unit and reaches completely different values and therefore the data are standardised. To this end, UNDP transforms the values to a range between zero and one, with zero being the worst and one the best possible score. This standardisation uses formula 1 (UNDP, 2014b):

$$component\ index = \frac{the\ real\ value - minimal\ value}{maximal\ value - minimal\ value}. \qquad (1)$$

Hereby, component indices are created – the Index of Life Expectancy at Birth, the Education Index and the Index of Gross National Product – which are subsequently averaged via geometrical mean.

The extreme values for the Index of Life Expectancy at Birth are 20 and 85 years. All countries fall within this interval and none has an index lower than zero or higher than one. The highest values in the report from 2014 are reached in Japan with 83.6 years of life expectancy at birth and the value of the component index of 0.987. On the other hand, Sierra Leone with the life expectancy at birth of 45.6 years and the value of the component Index of Life Expectancy at Birth of 0.393 remains last in the ranking (UNDP, 2014a).

The Education Index consists of two indicators – the average length of schooling and expected length of schooling. Both indicators lack the minimum level (theoretically, it is zero and zero is also applied as minimum in the calculation of the index) and the maximum reaches 15 and 18 years, respectively (UNDP, 2014b). The lowest values of the average length of schooling were registered in Burkina Faso with 1.3 years and the highest were recorded in Germany and the USA with 12.9 years. Concerning the expected length of schooling, the countries at the opposing ends of the ranking are Eritrea with 4.1 years and Australia with 19.9 years (UNDP, 2014a). The arithmetic mean of the average and expected length of schooling represents the Education Index.

The Index of the Gross National Product (GNP) has to undergo another adjustment, unlike the other indicators. Large differences among countries call for a more sophisticated approach to GNP than to the other indicators. If the maximal value was set as GNP value of the leading country or an exact limit was set – which would have to be even higher or at least very close to the leading country – the differences would open up much more than in the other dimensions of HDI. Half of the countries would achieve less than 50% of the maximum value (Syrovátka, 2008). UNDP solves this problem by calculating the natural logarithm of GNP values. Therefore, the same nominal increase in developed countries causes a smaller increase of the index (UNDP, 2010). 100 USD of GNP in the purchasing power parity sets the minimal value, while the maximal value reaches 75 000 USD (UNDP, 2014b). The worst country in this respect in the report from 2014 is the Democratic Republic of Congo with the GNP of 444 USD and the index value of 0.225. The highest ranking country was Qatar, reaching 119 029 USD of the GNP (UNDP, 2014a). Thus, Qatar exceeded the limit set for the maximal value and its component index equals one. Two more countries, namely Lichtenstein and Kuwait, exceeded the limit. Formula 2 represents the calculation of the Gross National Product index:

$$GNP\ Index = \frac{ln(GNP_{country}) - ln(100)}{ln(75\ 000) - ln(100)}\ . \tag{2}$$

The total index is then calculated as a geometric mean of component indices of its individual dimensions. (UNDP, 2010).

Although the result of HDI is a measurable and a continuous quantity, countries are typically divided according to the following table.

Table 1 Dividing countries into groups according to HDI

Group	HDI limit
Very high human development	> 0.800
High human development	0.700 – 0.800
Medium human development	0.550 – 0.700
Low human development	< 0.550

Source: UNDP, 2014b

1.2 Sensitivity analysis

Sensitivity analysis works with already finalized models and its main target is determining the importance of individual inputs or the impact of interactions among more variables on the final output (Saltelli et al., 2008). Sensitivity analysis uses a whole range of approaches for assessment (for more, see Saltelli et al., 2008). This article uses the following ones: a scatter plot, methods based on variance, a one-at-a-time method.

1.2.1 Scatter Plot

A scatter plot (i.e. a diagram of correlations) works with a graphic demonstration of the effects of different variables. One axis represents a certain variable and the other the final output (Saltelli et al., 2008). Although other kinds of input naturally participate in the output as well, with a large number of occurrences, one can draw conclusions from the graph which creates ground for further work. Working with the given data offers another advantage. If we only know the model, on the other hand, we can randomly generate values of inputs and outputs and present them afterwards (Saltelli et al., 2008).

In this case, the basic tool of the analysis is a traditional graphic representation although other methods of scatter plots may be used as well. The input variable can be divided into arbitrarily chosen parts and subsequently the conditional average of input for each category is calculated. Even this leads to the same conclusion as the analysis of the traditional scatter plot. The method of conditional average looks more transparent, but it can hide some important information. For example, it totally neglects the spread of the points in individual categories and thus the average may be influenced by several close values or the spread may differ dramatically among the various categories.

1.2.2 Methods based on variance

Methods based on variance aim to decompose variance of the output and assign it relatively to various inputs or input groups (Saltelli et al., 2008). Such effort may result in a simplified statement that the final variance of the output depends in 20% on input A and in 60% on input B and in 20% on the combination of both inputs. Afterwards, these values may be interpreted as the impact of the input on the final output.

Deriving formulas are observed by Sobol's theory of variance decomposition (Sobol, 1993) which assumes independency and even distribution of input variables. Sobol (1993) proves that the overall variance may be decomposed in the following way:

$$Var(Y) = \sum_{i=1}^{d} V_i + \sum_{i<j}^{d} V_{ij} + \ldots + V_{12\ldots d}\,, \tag{3}$$

where i and j represent individual inputs, d is the number of inputs and

$$V_i = Var_{X_i}(E_{X_{\sim i}}(Y|X_i),$$

$$V_{ij} = Var_{X_{ij}}(E_{X_{\sim ij}}(Y|X_{ij}).$$

Mark $\sim X_i$ stands for a combination of all input variables except X_i. V_i marks the variance of conditional averages for the X_i categories limitary in size as presented in the part of the scatter spot analysis. The overall Sobol's (1993) decomposition does not include only conditional variance of individual inputs but also all their conceivable combinations. In total, it consists of 2^d–1 components.

This decomposition leads to two statistics used for the sensitivity analysis. One is the **first-order index** (Saltelli et al., 2008):

$$S_i = \frac{V_i}{V(Y)}\,, \tag{4}$$

which determines the effect of the variance of an input on the overall variance of output. Indices may be calculated even by means of the combination of the S_{ij} input. The total of all these indices are – as a direct consequence of Sobol's decomposition – 1 (Sobol, 1993). According to another interpretation, the first-order index indicates how large a drop in variance would occur if input i gets fixed.

The other statistic is the **total-effect index** (Saltelli et al., 2008). For the first input, this may be calculated by means of formula 5:

$$S_{T_1} = S_1 + S_{12} + S_{13} + S_{123} + \ldots + S_{1d}\,, \tag{5}$$

where S_{T_1} is the total variance of inputs caused either directly by the first input or by the interactions of the first input and other inputs. S_1 is a first-order index and the other addends consist of first-order indices as well, i.e. indices of various interactions of inputs where the first input occurs.

The total-effect index adds up all first-order indices with the occurrence of the given input, i.e. all possible interactions that include the given input. The sum of these indices for all inputs is higher than 1 because interactions among inputs are counted in with all included inputs. Only in the case of a strictly additive model, when there are no interactions among inputs, the total-effect indices equal those of the first-order and their total reaches one again (Saltelli et al., 2008).

The calculation of these indices mostly employs the Monte Carlo method. This comprises the estimation of individual effects based on multiple sightings or rather based on a high number of simulations of the model with random inputs (Fabian, Kluiber, 1998). Due to the complexity and demands in terms of the computing power, various more sophisticated algorithms are used as well. They simplify the calculation, e.g. by neglecting first-order indices with many interactions which practice proves less important. Two examples of these algorithms are HDMR (High-Dimensional Model Representations) and FAST (Fourier Amplitude Sensitivity Test) (Saltelli et al., 2008).

Methods based on variance are very popular, especially due to independence of the model when it is unnecessary to limit or even know the basic relationships among inputs and outputs (linear or not, etc.). Another advantage is the emphasis on interactions among variables which are easy to interpret when using methods based on variance. More complicated models often show inadequate demands on the computing power in order to achieve a robust result (Saltelli et al., 2008).

1.2.3 Monte Carlo

Monte Carlo is a class of algorithms that use multiple repetition of random processes in order to reach numerical results. The beginnings of this method date back to the 1940s to the Los Alamos laboratories with Stanislav Ulam and Nicholas Metropolis being among the first scientists using and publishing this method (Metropolis, Ulam, 1949). The quality of results with the Monte Carlo Method is influenced by the following factors (Fabian, Kluiber, 1998, p. 152):

- The quality of the random number generator;
- The selection of a rational algorithm for the calculation;
- Monitoring of the precision of the acquired result.

For our purpose, the Monte Carlo Method was employed to estimate the above mentioned statistics used in methods based on variance. The given approach corresponds to Saltelli et al. (2008).

1.2.4 One-at-a-time Method

The One-at-a-time Method represents a basic and intuitive approach that only changes one variable among multiple input variables and monitors the result in the final output. Although this is a simple procedure – if used and interpreted correctly – it may – as other simple methods of sensitivity analysis – bring highly relevant information (Panell, 1997).

The approach used in such analysis is simple and understandable and any change in the output is attributed to the change in the specific input. The calculation is not complicated and the interpretation is easy as well. A problem which commonly occurs with this method is the difference in inputs. They tend to have various ranges and probability division and therefore it is difficult to compare different changes throughout variables. Besides, it requires knowledge of the model and it is not possible to analyse mere data. Also, the possibility of interactions among variables is neglected (Saltelli et al., 2008).

On the other hand, analysing which dimensions represent the thinnest change and what dimensions – if improved – bring the highest effect on HDI value might comprise an interesting use of the One-at-a-time method. To this end, each individual category in each country gained one hundredth of the defined interval in the given dimension. After recalculating the results, the change showing the highest effect of the three possibilities was identified.

The One-at-a-time method can be used for another purpose. It does not assess the importance of inputs with regard to the value of the output but examines the robustness of the results depending on wrong data and other inaccuracies. Other researchers (Wolff et al., 2011) have already estimated standard deviations of HDI values for various countries. Provided that we accept the notion that the errancy (based on errors in measuring compared during data revision) remained approximately the same, we can measure how these inaccuracies may reflect in the ranking of individual countries based on new data. An interval of reliability is constructed for each country, arising from the assumption of normal distribution. Subsequently, the change of the position of the country in the ranking is determined for a case when the extremes of the interval were used instead of its mean. This procedure repeats with each state and the resulting number to work with represents the average change of places in the ranking.

1.3 Data

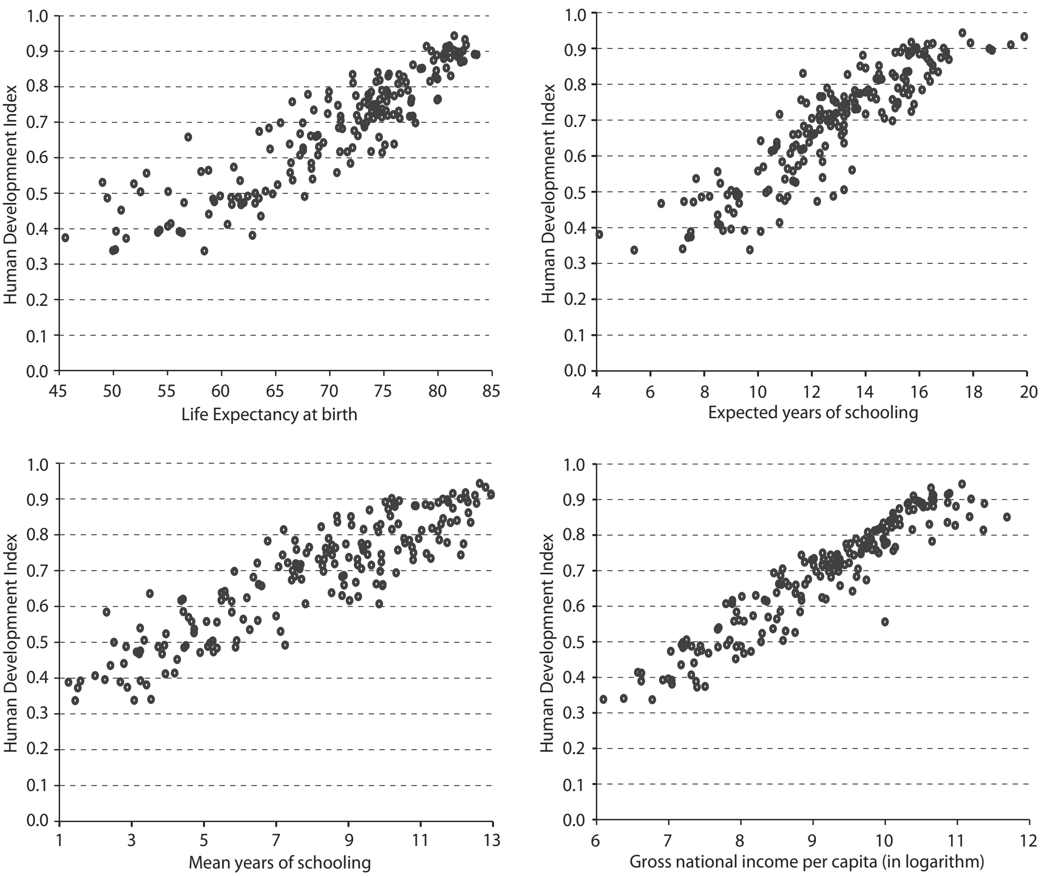
For calculations, the data published by UNDP and employed for the calculation of HDI index in the 2014 report (UNDP, 2014a) were used. The data offer complete sets of all input components for 187 countries and we eliminated countries with incomplete information. The data in the report cover the years 2012 and 2013 – life expectancy and GNP per capita are from 2013 and the data for the dimension of education are from 2012.

2 RESULTS

2.1 Scatter Plot

A simple scatter plot is a basic method of sensitivity analysis where the *x*-axis represents the input variable and the y-axis represents the output (dependent) variable.

Figure 1 Scatter plots for various inputs



Source: Authors' computation

With all variables, we can track a clear linear coherence with the output. In this particular case, we are more interested in the power of dependency which seems to be strongest with the logarithmed GNP values. This causes that the progress in GNP is more important for countries with lower level of this indicator and the progress of GNP could hide poor quality in the other areas.

2.2 Methods based on variance

The first-order index may be interpreted as "by how much the variance of output could drop if the appropriate input was fixed" (Saltelli et al., 2008). It quantifies the direct effect of a variable without examining interactions with other inputs. First-order indices with the use of the described approximation are shown in Table 2.

Table 2 First-order indices

Input	S_i
Life expectancy	0.2790
Average length of education	0.0512
Expected length of education	0.0513
Gross National Product	0.5540

Source: Authors' results

With the declared equality of all dimensions, the results of the first-order indices seem discordant. The cause of this lies in an even distribution of inputs and the method of HDI calculation – especially the geometrical mean. First, average and expected length of education co-build one dimension of three. Both indices are equal in these variables, which corresponds to the same amount of importance within the dimension. Even after adding them up though, they do not amount to the same importance as the other two dimensions. This is attributed to the nature of the calculation of the education dimension which averages two values. With the condition of independence and equal distribution, this results in the values being closer to the mean of the interval with a smaller spread than when using one variable as in the case of the health dimension. This better stability in combination with the geometric mean, which reflects much more the remote and digressional values, leads to lower importance for the final variance of the model.

Life expectancy is the simplest case and therefore the health dimension directly causes almost a third of the spread of the output, just as one would expect. Anyway, even this value is noticeably lower than a precise third. This arises in the misbalance in the third dimension, i.e. the standard of living which requires the values to be logarithmed.

Another important aspect of the model is the sum of all first-order indices that amounts to 0.9354. For a completely additive model, i.e. without any interactions and compound effects of variables, the sum equals 1. In comparison, due to an approach being based on the geometrical mean HDI is not fully additive and is influenced by interactions among variables.

Another statistic – the total-effect index – quantifies the overall impact of the given input with all higher orders of various interactions. These indices are either identical with first-order indices or higher and their sum does not have to equal 1 or less because the interactions are added to all included inputs. Therefore, they appear multiple times frequently in the sum, according to the order of the interaction. The results of the indices for our model are shown in Table 3.

Table 3 Total-effect indices and the difference from first-order indices

Input	S_{Ti}	S_{Ti} - S_i
Life expectancy	0.3299	0.0509
Average length of education	0.0692	0.0180
Expected length of education	0.0691	0.0179
Gross National Product	0.6057	0.0517

Source: Authors' results

The differences between the total-effect and first-order indices are significant. The discrepancy between these statistics indicates the amount of inclusion in interactions among inputs influencing the output. Clearly, neither expected nor average length of education gained more importance in this respect as the education dimension is more stable with the average of 0.5. Therefore, interactions are not so significant due to geometrical mean. The effect with the other two dimensions is balanced. The sum of the total-effect indices is 1.0739.

2.3 Identification of the relatively weakest dimensions for various countries

Table 4 shows overall numbers of countries which achieve the highest improvement in the given dimension with the One-at-a-time method.

Table 4 Numbers of countries with a relatively weakest dimension

Dimensions	Number of countries
Health	11
Education	88
Living standard	88

Source: Authors' results

Health is the dimension with the lowest number of countries for which this area represents the largest space for improvement. The other two dimensions are equal. This means that the level of life expectancy of a new-born child is a critical indicator for only a few countries whose HDI indicator is drawn lower in consequence.

The list of those countries proves interesting. This little group – ranking digressively in terms of HDI – consists of Australia, New Zealand, Ireland, Estonia, Lithuania, Latvia, Belorussia, Russian Federation, Kazakhstan and the Republic of South Africa. The countries mentioned in the first four places are among the top places in HDI. They surpass other European countries which are at the top along with them especially in terms of the expected length of education which is longer approximately by three years compared to similar countries. Therefore, it does not make too much sense to further extend the length of education. Also, nominal increase of GNP in such developed countries is of little significance. Life expectancy itself is not strikingly lower than in comparable countries.

Another significant unit was created among post-Soviet countries where this occurrence obviously arises from large differences in the life expectancy compared to similar countries. This discrepancy amounts to approximately five years in comparison to countries with a similar HDI. This group encompasses the most developed countries of the Soviet bloc. However, other countries of the bloc (Ukraine, Azerbaijan) record a worse life expectancy as well, with Azerbaijan showing comparably worse education and Ukraine trailing in terms of GNP. This difference is not so apparent with other Caucasus post-Soviet countries (Georgia, Armenia) but these countries are rather low in HDI ranking. The logical conclusion behind HDI and One-at-a-time method calculation indicated prevailing lower life expectancy in post-soviet countries in contrast with their human development. The last country is the Republic of South Africa which demonstrates dramatically low life expectancy compared to its education and especially income. The difference in life expectancy from the Philippines, a country one position higher in the ranking, amounts to 12 years.

The numbers of countries with the highest improvement potential in the given category are divided according to Table 1 into four categories of development.

Table 5 Division of countries according to the relatively weakest dimension into categories of human development

	Very high human development	High human development	Medium human development	Low human development
Health	7	3	1	0
Education	42	37	9	0
Living standard	0	13	32	43

Source: Authors' results

This clearly illustrates the gradual change in the importance of education and living standard. While the most developed countries share the most effective way of improving the index in education, on the other hand, in the countries with lower level of human development this relationship between education and living standard is changing and for countries from the lowest group the most important is a growing GNP.

Although the most developed countries demonstrate the highest values even in education this reflects the relativity of the numbers when an increase in GNP does not gain any significance due to logarithming and neither does prolonging the life expectancy. Only such countries comprise an exception in the first category that have a considerably lower life expectancy (post-communist countries) or countries that exceeded the maximal length of expected education and further extension would prove useless. In contrast, developing countries can achieve a relatively high Health Index because even in really dire conditions such figure exceeds the set minimum of 20 years. Moreover, in the education dimension these countries move upwards especially due to the expected length of education. Therefore, their largest relative loss is GNP where very low values result in a difference between the linear increase in GNP and its real logarithmed impact that is not so high.

The initial notion of equality of all dimensions within HDI may be disturbed if we realize that relatively identical changes in various components bear different impacts for a very diverse number of countries according to a dimension. In other words, a change in life expectancy is for most countries less important than changes in other dimensions and thus it loses importance. A potential solution would be moving the minimum limit above 20 years because in the 2014 report even the lowest country, Sierra Leone, has the life expectancy of 45.6 years (UNDP, 2014a).

2.4 The impact of error on the result

Table 6 shows the influence of a potential error in data on the ranking of countries according to human development. A change in the ranking in this respect shows how many countries with an unchanged HDI ended up within the reliability interval of the given country. The average change of ranking describes the average of this count among all countries or among categories.

Table 6 Average change of ranking based on the correction of data according to the human development category

Category of countries	Average change of ranking
All	11.1
Very high human development	6.2
High human development	13.7
Medium human development	11.9
Low human development	12.2

Source: Authors' results

Although the results need to be taken with some reserve, changes in ranking due to errors in data which are discovered in a follow-up revision clearly occur quite frequently. In comparison with the previous set, these numbers grew especially due to a larger amount of countries examined. These countries create a denser net of HDI values and changes in such ranking are nominally higher. This clearly illustrates the danger of simple comparison in time. Newly entering countries or countries which have been excluded may influence the results significantly. The higher the number of the countries, the stronger influence a similar error bears. Countries with very high human development tend to face much lower risk of error in ranking. This is due to more reliable data and thus a lower standard deviation. For comparison, standard deviations in retrograde according to categories of development were: 0.013, 0.023, 0.032 and 0.029.

3 DISCUSSION

HDI has been subject to harsh criticism for various reasons since its very beginning. This criticism is understandable because the index is closely watched, often presented and it tries to quantify a very wide and to a large extent hazy concept of human development in an exact manner.

T.N. Srinavasan (1994) describes HDI in his work as "conceptually weak and empirically unsolid, containing a lot of problematic issues – incomparability in time and space, errors of measurement and bias. Sensible conclusions of the process of human development, output or impact of various political decisions can be hardly made on the basis of the variance of the HDI" (Srinavasan, 1994). Although this text was written shortly after the beginning of the index calculations, it still proves topical. Even nowadays, UNDP has to face criticism of the whole concept of human development, its division into these three specific dimensions with equal weights, the individual indicators, the data gathering, the calculation and many more issues. UNDP itself has published a document summarizing the criticism (Kovacevic, 2010).

Probably the most serious criticism aims at the whole ***concept*** of HDI. For example, the before-mentioned economist Srinavasan called it redundant and literally "reinventing the wheel" in his article (Srinavasan, 1994). HDI as such brings no new information; it only reacts to data which are already known and relatively well monitored. HDI shifts the attention from these fundamental numbers and although it seems comprehensible for the lay audience it does not represent any specific value. On the contrary, HDI shields specific problems according to this approach. Another opinion which may be included in refusing the whole concept of HDI claims that human development defies any kind of quantification in principle (Negussie, 2015).

Defining the ***dimensions*** and their weights are also a frequently criticised area. The index totally lacks for example any information on ecology or on political and human liberties which play an absolutely crucial role in assessing human opportunities which actually form the basis of the theory of the whole index (UNDP, 1990). The equality of the constituents represents a further, frequently criticised fact.

The introduction of the geometrical mean partially solved this problem which prevented the absolute substitutability. Moreover, via the geometrical mean the index gained a higher informative value as it does not hide the way in which specific countries achieved their respective values of the index (UNDP, 2010).

The choice of the ***specific indicators*** presents another disputable factor. Besides the difficulties with expressing individual elements of human development with a definite number, statisticians also have to estimate the correctness and availability of data. Moreover, the whole index must be very simple and comprehensible. The measurement of the living standard as GNP represents the least of the problems from this point of view. Health, expressed as life expectancy, also constitutes a rather understandable figure although it disregards the quality of life or health in general. We deem the third dimension the most vulnerable to criticism though. The level of the system of education is characterised by the average and expected length of education which actually describe the real erudition of the population to a rather limited extent. For example, some states in Germany decided to shorten the length of the study at their grammar schools (Gymnasiums) by 1 year to 8 years, i.e. 13 years in total compared to previous 14 (Economist, 2014). However, the federal states in Germany with a lower length of education achieved better academic results in the long run (Economist, 2014). No HDI indicator should be debatable in the sense that it might prove more beneficial to a country to decrease it. Germany found itself under no pressure – economic or any other; the country only wanted to straighten the length of its education among individual states. Thus, Germany actually decided to lower its HDI. Anyway, an incessant increase in qualification requirements and studies at schools which bring no real deepening of knowledge or skills is a problem discussed a lot in the Czech Republic. For instance, the former minister of Ministry of Education, Sports and Youth was trying to increase the number of apprentices at vocational schools at the expense of the number of students of grammar schools (EDUin, 2015). This, in effect, would mean shorter length of education. Hence, this indicator seems problematic. Although rich and successful countries can afford a longer period of education – which without a doubt reflects the level of their development – the longest period of education is not an indisputable aim for every society. On the other hand, this is true about the other dimensions – life expectancy and GNP.

Another problem frequently debated is comparing development throughout the world although given countries are on a totally different level of development. The criticism aims at the question whether it is even possible to compare e.g. Finland and Nigeria by means of one composite indicator and whether such comparison brings any relevant information at all (Syrovátka, 2008). This problem already played an obvious role in the calculation of HDI itself. The dimension of education used to include even literacy. However, this statistic proves dead for current developed countries as most of them achieve 99%. Although developing countries undoubtedly consider the proportion of people able to read and write very important, for example almost all European countries have already solved this issue. Therefore, this category brings no relevant information and cannot describe differences and variance among such states. This particular display of the problem was solved by changing the indicator. Nevertheless, the underlying essence of the problem is still present. A potential solution is simple – to employ various indicators in various groups of development, for example as suggested by Anand and Sen (1994).

3.1 What the results of sensitivity analysis showed

In sensitivity analysis, it is necessary to trivially state the importance of all inputs again, i.e. the direct importance and further the importance caused by the dependency of the remaining indicators which affect the output. Due to this, appropriate application and interpretation of all acquired results proves difficult since the theory of sensitivity analysis assumes inputs to be mainly uncorrelated. A failure to fulfil this condition leads to rather unexpected results with the use of variance methods, with an increased impact of the dimension of living standard – i.e. GNP – on the final HDI output. Meanwhile, the apparent non-additivity of the model comes up as the source of this problem. This finding directly negates the base of the calculation of the index where all dimensions are supposed to be equal. However, this problem does not practically occur with real data and we acquired no significant drop in average values of component indices of dimensions. On the contrary, the values tend to be rather even-tempered. From a purely theoretical point of view though, this model does not weigh the three components equally.

It is an interesting point to find out the most important dimensions for various countries, i.e. dimensions that – with the relatively same increase of an indicator – push the given country's HDI index the furthest. Such analysis brings clear results and interpretations. The lowest countries can profit the most (in terms of the value of the index) on improving the living standard while the highest countries from promoting education. A small specific group of countries with a maximum length of education and some post-soviet countries have their weakest point in the health dimension. The results may be looked upon from several points of view. Firstly, it is definitely positive that two dimensions are almost equal in terms of the number of countries. On the other hand, the third dimension – health – is obviously weaker, which denies the precondition of equality among the components. The health dimension is on average higher in total (although we are not claiming the difference to be dramatic) and the number of countries with the most effective impact in this dimension proved the smallest. In general, this is mostly caused by the fact that even with a really low level of development life expectancy is still much higher than the bottom limit of 20 years. Hence, even developing countries with a minimum GNP and practically non-existing education achieve a relatively strong health index. Therefore, we believe that it would prove beneficial to increase the minimum limit in the health index in order to move more countries into the group with the most effective impacts in the health dimension. The numbers of countries within the groups would even out and the component indices would be equal. This would lead to fulfilling the precondition of the equality of dimensions. There is no reason to assume that the 20-year mark is really the minimum limit when even the lowest countries achieve results far above.

The division of the importance of various dimensions for countries on different levels of development offers another possible field for interpretation. On one hand, the most important factor to improve for countries which are only little developed represents the GNP. This leads to an uplift of both education and health. On the other hand, developed countries have sufficient means and it is only necessary to redirect them in the right course. This interpretation may be too generalizing, simplifying and based on the notions of HDI authors who imprinted the index with exactly this calculation. Nevertheless, it may bring interesting reflections.

Finally, one should take into account the fact that errors in the data set used may alter the results of individual countries significantly. This does not comprise a larger problem for developed countries where data are rarely incoherent. On the other hand, the differences in the HDI among countries on medium and poor level of development proved small due to a high number of countries included. Among these countries, data far from reality may be used and thus grossly distort the ranking. The results should be analysed carefully and attention should be paid to gaining more reliable data and assessing the risks and advantages of involving a maximal number of countries.

CONCLUSION

HDI in itself constitutes a rather debatable and often criticised phenomenon not only for the reasons stated in the article. It is appropriate to question the need for such a problematic index that offers only a little more informational value than GDP or GNP whose dominance the authors tried to escape. The importance of the index does not lie in its specific values and results but in its existence which incessantly fuels the debate about the real life situation of people in various countries. If one looks for primary information on a given country, one will often find HDI among the fundamental data, which shows its importance and the success of its authors. The broadest public needs a slightly simplifying view of this field and a basic figure, serving as a starting point – which is exactly what the index offers. Due to the index, UNDP brings the attention of a broad audience towards its annual reports where various problems of human development in more depth are discussed and provide data available to the public. One cannot claim what strongest needs the most poorly developed countries have but the most developed countries show that the level of wealth indicated by GNP proves sufficient for decent life and all relevant and necessary human needs. Afterwards, the attention of the society should focus to another area with the aim to improve the life of all citizens – no matter how this general aim is defined. Anyway, discussion may prove crucial in bringing us further in this rather subjective field.

Aim of the paper was to describe the dependency and the influence among individual HDI input indicators, and among these inputs and the index itself but the analysis is influenced also by fact that HDI is composite indicator and as can be found in Hudrlikova (2013) composite indicators by its nature are very susceptible to many factors from the very beginning of their construction.

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Assessment of the Ability of the Business and Consumer Surveys to Predict the Gross Value Added of the Czech Republic

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Abstract

Business and Consumer surveys are designed to signal turning points and provide in advance the information about potential changes in the economic cycle. The authors, using advanced methods of time series analysis, especially Granger causality and vector autoregressive models, deal with the question of to what extent the results of the surveys in the form of confidence indicators are able to outpace the development of the Czech economy represented by gross value added. In addition, the authors, experimenting with the structure of surveyed questions and used weights, propose some modifications in the construction of confidence indicators as stipulated by the European Commission with the aim to improve their forecasting abilities.

Keywords	***JEL code***
Business and consumer survey, gross value added, vector autoregressive model, Granger causality, economic sentiment indicator, stationarity test of variables	*C10, C22, C51, C52, C83*

INTRODUCTION

Business and Consumer Surveys (hereafter referred to as BCS) compiled under the Joint Harmonised EU Programme of Business and Consumer Surveys (hereafter referred as the BCS programme) provide mainly qualitative information on a wide range of variables useful for monitoring economic developments and detection of turning points in the economic cycle.

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The results are widely used for qualitative and quantitative analysis, surveillance and short-term forecasting by the Directorate General for Economic and Financial Affairs (hereafter referred to as DG ECFIN), European Central Bank, central banks, research institutes and financial institutions.

Compared to traditional statistical surveys, which usually cover only variables on one aspect of an enterprise's activity, BCS, especially business tendency surveys collect information about a wide range of variables selected for their ability, when analysed together, to give an overall picture of a sector of the economy. Moreover, the range of information covered by business tendency surveys goes beyond variables that can be easily captured in conventional quantitative statistics. Qualitative information may be collected for variables that are difficult or impossible to measure by conventional methods (e.g. capacity utilisation, factors limiting production, production capacity, expectation for the immediate future and others).

From the respondents' point of view, the provision of qualitative information within BCS is less burdensome and time consuming comparing to the provision of accounting or other quantitative information for conventional quantitative statistics. This enables BCS to conduct monthly surveys as early as in the first two or three weeks of each month and publish the results already before the end of month.

The BCS are therefore appreciated for high frequency, timeliness and harmonisation at least among the Member States and candidate countries.

The BCS programme was launched by the Commission decision of 15 November 1961. The first survey was the harmonised business survey in the manufacturing industry conducted in 1962. Since then, the sector coverage as well as geographical coverage has widened considerably covering now besides manufacturing sector, construction sector, retail trade, services sector and consumers of all Member States and candidate countries.

As the results of BCS are often used as a tool for forecasting of economic development represented by the development of the basic macroaggregates – gross domestic product (hereafter referred to as GDP) and / or gross value added (hereafter referred to as GVA) – in our work we first focused on the evaluation of the Czech Economic Sentiment Indicator‘s ability to predict the development of country's GVA. Afterwards, we tested several alternative approaches to the design of ESI in order to construct a model that would offer better conformity with the development of the original GVA time series.

Our analysis is based on the Granger causality test and the construction of standard vector autoregressive (hereafter referred to as VAR) models.

The paper is divided into the three chapters. The first one provides brief information on the organisation of the business and consumer surveys in the Czech Republic and mentions the connection between business tendency surveys, consumer opinion surveys and business cycle.

The second chapter describes the methods employed in the analysis and necessary adjustments of analysed data.

The last chapter presents the most important outcomes of the analysis.

Conclusion summarises the work done, results, findings for further thoughts and plans for further work.

1 RELATION OF BUSINESS TENDENCY AND CONSUMER OPINION SURVEYS TO BUSINESS CYCLE

1.1 Business and Consumer Surveys in the Czech Republic

The business tendency surveys in the Czech Republic are carried out by the Czech statistical office (hereafter referred to as CZSO), while the consumer opinion survey is conducted by the private market research organisation GFK Czech Republic. Both surveys are conducted according to a common methodology stipulated by the BCS programme.

The harmonisation within the BCS programme is governed by two basic principles:

1. all the national institutes involved in the BCS programme are obliged to use the same harmonised set of questions; and

2. they should conduct the surveys and transmit the results to DG ECFIN in conformity with the common timetable.

The BCS programme allows the national institutes to include additional questions, beyond the harmonised ones, in their questionnaires. The CZSO has used this option and supplemented the harmonised questions with the set of additional questions having predictive potential. Both sets of questions, harmonised and non-harmonised ones, were used in our analysis for construction of the alternative models to test their ability to forecast/predict the GVA development.

As regards surveys, CZSO conducts four surveys on a monthly basis in the following areas: manufacturing industry, construction, retail trade and services including financial services. All the questionnaires include additional questions that are asked on a quarterly basis. In addition, an investment survey of the manufacturing sector, which gathers information on companies' investment plans, is conducted twice a year.

Answers obtained from the surveys are aggregated in the form of "balances". Balances are constructed as a difference between the percentages of respondents giving positive and negative replies.

The balance series are then used to build composite indicators. The composite indicators for all surveyed sectors (manufacturing industry, construction, retail trade, services and consumers) are calculated as the simple arithmetic mean of the selected questions (seasonally adjusted balances). The questions included in the calculation (see Table 1, questions in bold) have been determined by the DG ECFIN. They were chosen with the aim of achieving an as highly as possible coincident correlation of the individual confidence indicators with a reference series (e.g. industrial production for the industrial confidence indicator). These indicators thus provide information on economic developments in different sectors.

The results for the individual business confidence indicators are consequently aggregated through the weighted arithmetic mean into the Business Climate Indicator (hereafter referred to as BCI). Economic Sentiment Indicator (hereafter referred to as ESI), whose purpose is to track GDP/GVA growth is then weighted arithmetic mean of the BCI and the Consumer Confidence Indicator (hereafter referred to as CCI). The weights used to calculate composite indicators are as follows:

- Manufacturing Industry: 40%,
- Services: 30%,
- Consumers: 20%,
- Construction: 5%,
- Retail Trade: 5%.

The weights have been set according to two criteria, namely "representativeness" of the sector in question and tracking performance vis-a-vis the reference variable.

1.2 Business and Consumer Surveys and their relationship to the Business Cycle

Business cycles are an important feature of the economies of market-oriented industrialised countries. The statistical series derived from Business Tendency and Consumer Opinion Surveys are particularly suitable for monitoring and forecasting business cycles. Data are available rapidly and survey information focuses on assessments and expectations of the economic situation by actors on the market. The cyclical profiles of the series are in many cases easy to detect because they contain no trend. The series are/should be seasonally adjusted, at least to some extent, already by the respondents. All these and the fact that they usually do not need revisions facilitate their use in forecasting and, in particular, in predicting turning points in the business cycle. For example, Zeman (2013) uses the Czech BCS data (together with other indicators having forecasting potential in relation to the business cycle) for construction of a leading composite indicator aiming at the forecasting of q-o-q changes of GDP using VAR models, Granger causality and co-integration analysis for testing the presence of long-term statistically significant relations.

Table 1 The questions harmonized by DG ECFIN through the BCS programme

Statement	Question	Rank of Question in the Statement
BTS in Manufacturing Industry	**Assessment of Current Overall Demand for Production**	**2**
	Assessment of Foreign Demand	3
	Development of Production Activity in the Past 3 Months	5
	Assessment of Current Stocks of Finished Products	**6**
	Expected Development of Production Activity in the Next 3 Months	**10**
	Expected Development of Number of Employees in the Next 3 Months	11
	Expected Development of Selling Prices in the Next 3 Months	12
BTS in Construction	Development of Construction Activity in the Past 3 Months	2
	Assessment of Current Overall Demand for Production	**3**
	Expected Development of Employment	**10**
	Expected Selling Prices Development in the Next 3 Months	11
BTS in Retail Trade	**Sales Development in the Past 3 Months**	**2**
	Expected Sales Development in the Next 3 Months	**3**
	Expected Development of Employment in the Next 3 Months	4
	Expected Selling Prices Development in the Next 3 Months	5
	Assessment of Current Stocks	**6**
	Expected Development of Requirements on Suppliers in the Next 3 Months	7
BTS in Selected Services	**Assessment of Current Overall Business Situation**	**1**
	Assessment of Demand in the Past 3 Months	**2**
	Expected Development of Demand in the Next 3 Months	**3**
	Number of Employees in the Past 3 Months	4
	Expected Development of Employment in the Next 3 Months	5
	Expected Price Development in the Next 3 Months	6
Consumer Tendency Survey	**Financial Situation of the Consumer Expected**	**x**
	Expected general economic situation in the country	**x**
	Total Unemployment Expected	**x**
	Expected Savings of the Consumer in the Next 12 Months	**x**

Note: 1) Consumer Tendency Survey is performed by GFK Organisation.
2) The questions in bold enter the calculation of the composite indicators, i.e. the industrial confidence indicator, the construction confidence indicator, the retail trade confidence indicator, the services confidence indicator and the consumer confidence indicator.
Source: Czech Statistical Office, own construction

Fischer (2004) uses besides other things Czech BCS data for the construction of the model forecasting year-on-year quarterly GDP data development. For construction of models he uses regression analysis with the y-o-y changes of quarterly GDP at 1995 constant prices as dependent variable and confidence indicators as explanatory variables. The most successful model employs the retail trade confidence indicator as one of the explanatory variables. The forecast is carried out 40 days prior to the official data publication.

A similar use of Business Tendency and Consumer Opinion Survey data can be found abroad. For example, Abberger (2007) uses regression based on principal components and autoregressive time series models to predict the quarterly changes of German GDP.

KOF Swiss Economic Institute publishes one of the most observed leading indicators of economic activity so-called KOF Economic Barometer. Its predictive ability in forecasting y-o-y changes in real quarterly GDP growth in a relatively short period of time (16 quarters) is elaborated in the work of Silivestrovs (2010). In his tests he uses univariate autoregressive model. The important findings are that KOF Economic Barometer Granger-causes GDP and that a relatively high-quality predictions were achieved. The model enables to predict GDP up to seven months before the publication of the official estimate.

However, BCS data do not have to serve only to the GDP forecast and the economic cycle as such, but they can be used to predict the development of other economic indicators. Hansson et al. (2003) proved using the standard VAR models that the BCS can be useful as well for forecasting of other indicators such as unemployment, inflation or the exchange rate.

2 DATA AND METHODOLOGY

As already outlined in the previous chapter, we decided to apply one of the possible approaches to evaluate the ability of the BCS to predict the development of GVA, namely Granger causality with associated analysis by using standard VAR models. Eventual verification of co-integration relationships between examined time series is also a part of the analysis due to the possibility of the potential presence of statistically significant long-term relationship under certain conditions (Arlt, 1997).

2.1 Granger causality test and vector autoregressive models as tools for analysis of the relationships

Granger causality in connection with VAR models and co-integration analysis represent relatively popular methods for analysing the relationships among time series. There are several possible approaches to the analysis of time series. Given that we try to find the best possible prediction model, we decided to use standard VAR models in which both analysed variables are considered endogenous. This allows for a deeper analysis and revealing actual relationships between considered variables. The concept of the VAR model is generally considered useful for describing the dynamic behaviour of economic and financial time series and predictions.

In our paper, we decided to investigate the relationship among GVA and indicators from BCS. For our analysis we used software EViews 8 representing relatively widely used tool for studying time series and creation of econometric models.

In time series analysis we often wish to know whether changes of one variable have an impact on the changes of some other variable. The Granger causality test copes with this question. It can be used as a test for whether one of the variables is exogenous and therefore is not systematically affected by changes in another variable or a group of the other variables in the model. The concept of the causality that is fairly easy to deal with in the context of VAR models was for the first time defined by Granger (1969).

Granger causality can be described, using the interpretation provided by Arlt and Arltová (2009) or similarly by Lütkepohl and Krätzig (2004), as follows: if the variable *X* Granger causes the variable *Y*, the latter one can be predicted more accurately using the information supplied by the former variable, i.e. if for the following mean squared errors applies:

$$MSE\left[Y_t\left(h\middle|\Omega_t\right)\right] < MSE\left[Y_t\left(h\middle|\Omega_t \setminus \{X_{t-s}, s \geq 0\}\right)\right], \qquad (1)$$

for at least one of the horizons h = 1, 2, …, where Ω_t is the set of all the past and present information existing at time *t* and $\Omega_t \setminus \{X_{t-s},\ s \geq 0\}$ is the set of all the information except the past and present information of the X_t process.

One should notice that Granger causality is not real causality in a deep sense of the word but only a statistical concept of causality based on prediction.

Foresti (2007) lists three different types of situations where Granger causality can be applied:

a) In a simple Granger causality test with two variables (with no model framework),

b) In Granger causality test with more than two variables (it is supposed that more than one variable can influence the results, two groups of variables are tested),

c) Within VAR models (test for the simultaneity of all included variables).

Our work deals with the latter approach to the Granger causality testing.

We considered matrix representation (2) describing the dependence of the process $Y_{1,t}$ on its lagged values and lagged values of the process $Y_{2,t}$ and furthermore, describing the dependence of the process $Y_{2,t}$ on the lagged values of the process $Y_{1,t}$ and on its own lagged values:

$$\begin{bmatrix} y_{1,t} \\ y_{2,t} \end{bmatrix} = \begin{bmatrix} c_1 \\ c_2 \end{bmatrix} + \begin{bmatrix} a_{1,1}^1 & a_{1,2}^1 \\ a_{2,1}^1 & a_{2,2}^1 \end{bmatrix} \begin{bmatrix} y_{1,t-1} \\ y_{2,t-1} \end{bmatrix} + \dots + \begin{bmatrix} a_{1,1}^p & a_{1,2}^p \\ a_{2,1}^p & a_{2,2}^p \end{bmatrix} \begin{bmatrix} y_{1,t-p} \\ y_{2,t-p} \end{bmatrix} + \begin{bmatrix} e_{1,t} \\ e_{2,t} \end{bmatrix}, \tag{2}$$

where p stands for the length of lag per time point t, $a_{1,1}$, $a_{1,2}$, $a_{2,1}$ and $a_{2,2}$ stand for the regression coefficients for the corresponding lagged variables, c_1, c_2 stand for the constants and e_1, e_2 stand for random components of the models.

In this contribution we tried to identify the existence of such relationships so that we can say that the development of a single series is the cause of the development of the other series on one hand and the direction of the relationship to confirm the presence of the direction desired – whether base indices' past values (t–s) of ESI (and other tested indicators or past values of GVA) satisfactorily explain the development of GVA at time t – on the other hand.

Also a situation may occur when bidirectional dependencies are identified. In this case it is necessary to decide on the basis of relevant criteria.

Considering the fact that the construction of VAR model is based largely on the regression analysis there may be common misconception that the model obtained is appropriate and desirable.

Generally known and frequently used criterion for evaluating the quality of the regressive model is determination index. However, the latter should not be used as quality criterion for the time series containing trend (Hebák et al., 2013). Not only due to this fact it is necessary to work with time-effect adjusted (stationary) time series. For testing stationarity we used the augmented Dickey-Fuller (hereafter referred to as ADF) test and significance level of 5%. If the test shows that time series tested is not stationary, it is necessary to stationarize it. Since the stochastic trend is present in the time series that is subject of analysis, differencing is sufficient for its stationarization and we call it difference-stationary.

For finding the most appropriate model performing better than the others (in the case of several comparable models) there is a related question of the order of model chosen. Order of VAR model represents the number of lags of individual variables occurring in the model. Arlt and Arltová (2009) recommend Akaike Information Criterion (hereafter referred to as AIC) as one of the criteria for order selection that should be minimized. In connection with this fact, Vrieze (2012) recommends to take into account AIC as more efficient in cases when the true model is not in the candidate model set. This is common for exploratory analyses and the case of our paper. Other frequently used criteria describe e.g. Lütkepohl and Krätzig (2004). For VAR model of order p, i.e. VAR(p) with a constant, AIC can be expressed as follows:

$$AIC(p) = \ln\left|\hat{\Sigma}_a\right| + \frac{2l(pl+1)}{T}, \tag{3}$$

where $\hat{\Sigma}_a$ stands for estimated residual covariance matrix based on the corresponding VAR model, p stands for model order, l stands for process dimension (number of variables in the system) and T stands for the number of periods (in given time series according to the corresponding VAR model).

A substantial criterion is then the compliance of the estimated values by selected VAR model with the observed values of the response variable. The aim of our contribution was directly related to this as we assumed that the response variable should be represented by the q-o-q GVA change or its absolute changes in the case the differencing of series is necessary. Additionally, we strived to demonstrate the desired direction of the relationship between time series tested.

2.2 Co-integration analysis

In econometric analysis and their modelling short-term and long-term relationships are usually distinguished. Short-term relationships exist only in a relatively short time period and after a certain time they disappear. On the contrary, long-term relationships are long lasting and do not disappear. When the diversion of the trends is only short-term, disappears over time and there is a boundary that cannot be exceeded, we talk about co-integration of time series (Arlt, 1997) and it applies:

$$\{X_t\} \sim I(1) \text{ and } \{Y_t\} \sim I(1), \text{ then } \{aX_t + bY_t\} \sim I(0), \qquad (4)$$

where $\{X_t\}$ and $\{Y_t\}$ are processes integrated of order 1, therefore non-stationary and their linear combination with constants a and b is integrated of order 0, therefore stationary. This thesis can be generalized and we can say that co-integration occurs when certain linear combination of the variables in vector process is integrated of lower order than the process itself (Juselius, 2006).

The presence of co-integration implies the presence of short-term and long-term relationships that can be captured and separated by the Error Correction model (EC model) according to the formula (5):

$$\Delta Y_t = \alpha(1-p) + \beta \Delta X_t + (p-1)[Y_{t-1} - \beta X_{t-1}] + a_t, \qquad (5)$$

where α and β are the estimated model parameters, a_t is white noise process and $(p-1)$ term is the loading parameter expressing how strongly the long-term relationship between time series is promoted. The inclusion of co-integrated variables into VAR model would mean an incorrect specification.

There is a variety of tests for verification the presence of co-integration. The best known ones include e.g. Engel and Granger two-stage test based in the first stage on the estimation of co-integration vector by static regression using least squares method and in the second stage the resulting residues from this static regression model are applied to the EC model. Another frequently used test, suitable especially if the presence of more co-integration relationships is expected, is Johansen co-integration test based on the rank identification in the matrix of long-term relationships. To determine the number of co-integration vectors the maximum likelihood method is used. For more information see Arlt and Arltová (2009).

2.3 Data adjustment

All the analyses referred to the exploration of relationships between q-o-q GVA changes at 2010 constant prices and the series of base indices of the confidence indicators based on balances computed as arithmetic mean for selected seasonally adjusted questions. We chose the period from the first quarter of 2003 to the third quarter of 2014 as there are all indicators recalculated according to the current classification CZ-NACE since 2003.

Series of q-o-q GVA changes was not further modified due to the fact that after conversion to base indices the course of series and results are almost identical. Likewise, there are no different results if we include only the cyclical component of GVA into the analysis (tested by using Hodrick-Prescott filter).

ESI is generally calculated as weighted arithmetic mean of seasonally adjusted confidence indicators in manufacturing industry, construction, retail trade, selected services and CCI. The calculation of confidence indicators in the individual sectors and CCI is briefly described in the chapter 1.1, for more detailed information see the relevant methodology of the Czech Statistical Office.

Base indices of ESI and other confidence indicators respectively which are based on the average value of 2010 were calculated according to the following formula:

$$B = 100\frac{X}{\overline{X}}, \tag{6}$$

where B stands for confidence indicator's base index, X stands for averaged business cycle balance in a given sector + 100 and $\overline{X}$ stands for the average value of X in 2010.

The average balance in the denominator (base period) was calculated for 2010 and not for 2005 as in the data published by the Czech Statistical Office for reasons of consistency with GVA valued at constant prices of 2010 published since September 2014 by implementation of the new European standard of national accounts ESA 2010 which brought several significant changes in comparison to the former ESA 1995 (Sixta et al., 2016). The advantage of such base indices is the fact that we avoid negative values in analysis. Further, the monthly series of indices was aggregated to quarterly series by ordinary arithmetic mean to be consistent with GVA series.

In order to be able to perform the analysis and get relevant and unbiased results, it was necessary to seasonally adjust all the series though the usual practice is that respondents of BCS are requested for seasonally adjusted data. We chose TRAMO/SEATS method for seasonal adjustment as there is no problem with negative values occurring in series of balances. It is one of the methods along with X-12 ARIMA suggested by official OECD manual (2003).

The initial state at the beginning of the analysis was therefore seasonally adjusted time series of q-o-q GVA changes at 2010 constant prices and seasonally adjusted quarterly series of ESI base indices consisting of sectors' confidence indicators and CCI that were based on the balances of the questions stipulated by the BCS programme.

2.4 Procedure specification

We divided the analysis into the two steps. In the first step we tested the initial state, i.e. we assessed the nature of the relationship between the time series of q-o-q indices of GVA and base indices of ESI.

Subsequently, we experimented with the questions surveyed within the Czech BCS and weights used for the calculation of ESI in order to find such an alternative ESI that would be able to better predict the GVA development. As for the questions, we started with the tests of predictive ability of the harmonized questions – the questions included in the questionnaires in conformity with the BCS programme (see Table 1). Then, we proceeded to test the predictive ability of the other surveyed (non-harmonized) questions (see Table 3 of the Annex). We tested only those questions for which we could calculate balances (i.e. the difference between the percentages of respondents giving positive and negative replies) and tests were performed for each question separately.

On the basis of the results we divided those questions for which it was confirmed a statistically significant relationship with the development of q-o-q changes of GVA into two groups. In the first group we included all the questions for which it was confirmed statistically significant relationship with the development of q-o-q changes of GVA, in the second one only those for which it was confirmed a statistically significant relationship with a certain quality of the regression model measured by the modified index of determination. The boundaries of the modified index of determination were set subjectively, on empirical basis and separately for each sector.

Subsequently, separately for the two groups of questions, we tested individual sector confidence indicators aggregating them afterwards to the BCI. This is how we calculated the two types of the BCIs – the first one was calculated on the basis of the questions which showed a statistically significant relationship with the development of q-o-q changes of GVA, the other is calculated on the basis of the questions which showed a statistically significant relationship with the development of q-o-q changes of GVA having the certain quality of the regression model (see chapter 3).

As regards weighting the sector confidence indicators when computing the BCI, we tested two sets of weights. The first set was derived from the share of GVA of individual sectors (manufacturing industry, construction, retail trade, services) in total 2010 GVA. As the population of the business part of the BCS includes only the enterprises classified in the sectors of non-financial corporations, financial corporations, employers and own-account workers of the institutional sectors classification of the National Accounts (i.e. S.11, S.12, S.141 and S.142) and the sample includes in fact almost exclusively only enterprises classified in the sectors S.11 and S.12, the second set of weights was derived from the shares of the individual sectors/industries in combination with the institutional sectors S.11 and S.12 in total 2010 GVA for institutional sectors in question.

In the same way as in the case of BCI we were looking for a better model for CCI. Having two versions of BCI and CCI, we could derive the two versions of ESI. As it is presented in the next chapter both models show better predictive characteristic comparing the model based on the BCS programme.

After assembling the models we supplement our analysis with out-of-sample forecasts of q-o-q GVA for the period from the fourth quarter of 2014 to the second quarter of 2016.

3 MAIN RESULTS

After the necessary data adjustment, we first analysed the initial state considering the nature of relationships between q-o-q GVA changes and ESI in the form of base indices related to the 2010 average (see Figure 1).

ADF test results for GVA and the key confidence indicators indicate that the null hypothesis of non-stationarity of q-o-q GVA changes time series is rejected. Regarding confidence indicators in levels, the null hypothesis was not rejected in all the cases. After its first differencing the null hypothesis is rejected, i.e. for all confidence indicators it was proved that only first difference is needed to stationarize them. All models are presented with statistically significant variables. Greek letter delta indicates that the specific series was differentiated to stationarize it. The number in the square brackets stands for the modified determination index obtained from the model. All models have undergone diagnostic tests for residuals (no autocorrelation, constant variance and normal distribution of residuals). Response variables in the following models are estimates.

In the case of initial state, we came to the system of models:

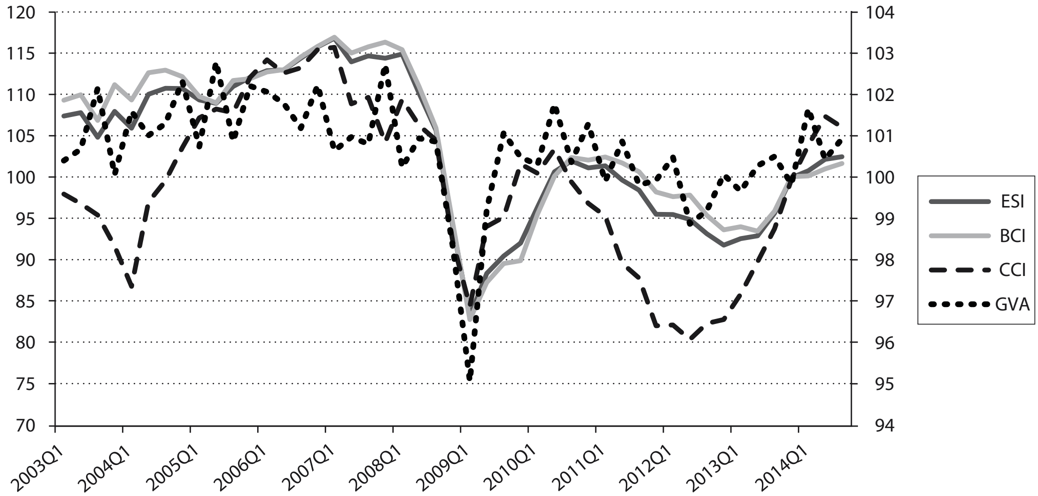
$$\begin{aligned} \hat{GVA}_t &= 49.949 + 0.193\, GVA_{t\text{-}2} + 0.453\, GVA_{t\text{-}3} + 0.321\, \Delta ESI_{t\text{-}1} && [0.502] \\ \Delta \hat{ESI}_t &= 115.587 - 1.138\, GVA_{t\text{-}2} + 0.692\, GVA_{t\text{-}3} + 0.547\, \Delta ESI_{t\text{-}1} && [0.257] \end{aligned} \quad (7)$$

Upon closer examination we conclude that there is statistically significant short-term relationship between the time series but it cannot be characterized as too tight. Q-o-q GVA changes are influenced both by its lagged value of two and three quarters and one quarter lagged value of the ESI change. A similar conclusion was reached in case of BCI assessment. However, in this case the q-o-q GVA changes are influenced by only its lagged value of three quarters and one quarter lagged value of the BCI change,

$$\begin{aligned} \hat{GVA}_t &= 0.469\, GVA_{t\text{-}3} + 0.311\, \Delta BCI_{t\text{-}1} && [0.431] \\ \Delta \hat{BCI}_t &= 1.241\, GVA_{t\text{-}3} + 0.706\, \Delta BCI_{t\text{-}1} && [0.353] \end{aligned} \quad (8)$$

In both above mentioned cases it was proved that the series of changes in the corresponding confidence indicator Granger causes the series of q-o-q GVA. This and the following results of Granger causality tests are presented in Table 4 of the Annex.

Figure 1 Seasonally adjusted series of q-o-q GVA changes in % (right axis) and base indices of ESI, BCI and CCI in % (average of 2010 = 100, left axis)



Source: Own construction

Since we rejected the null hypothesis that the series of q-o-q GVA changes contains unit root within ADF test, we conclude that there cannot be long-term statistically significant relationships and therefore we leave co-integration analysis aside.

In the next step we searched for ways to ensure the improvement of the relationship's nature between confidence indicators and GVA. First, we tested in a similar way, besides the harmonised questions (see Table 1), other (non-harmonised) questions listed in Table 3 of the Annex. Numbers in the next part indicate the rank of the question in the statement in question.

In manufacturing industry, we proved the relationship for questions 1, 2, 4, 5, 8, 9, 10, 11, 12, 13, 14, 15, 16 and 18. According to the results, boundary of determination index (see chapter 2.4) was set to 0.4, which is met for questions 1, 10, 14 and 15.

In construction sector we identified statistically significant relationship for questions 3, 6 and 11. For last two questions the determination index reaches at least 0.15.

In retail trade sector relationship was proved for questions 2, 3, 7, 9 and 10. Questions 2, 9 and 10 reach determination index of at least 0.19.

In the sector of services there is only one question with relationship to GVA, namely Expected Development of Overall Business Situation in the Next 3 Months (number 7 in the statement) with determination index of 0.18.

Finally, we tested questions from the consumer survey with statistically significant relationship for Expected general economic situation in the country and Expected Total Unemployment both reaching determination index above 0.16.

The results for the individual confidence indicators obtained from questions with proved short-term relationship (marked by *a*) and from questions reaching the threshold of modified determination index (marked by *b*) are as follows:

Manufacturing Industry

$$a)\ \hat{GVA}_t = 0.457\ GVA_{t-3} + 0.321\ \Delta CI_{t-1} \qquad [0.481]$$
$$\Delta\hat{CI}_t = 0.993\ GVA_{t-3} + 0.653\ \Delta CI_{t-1} \qquad [0.335] \qquad (9)$$

$$b)\ \hat{GVA}_t = 55.372 + 0.334\ GVA_{t\text{-}3} + 0.174\ \Delta CI_{t\text{-}1} \quad [0.504]$$
$$\Delta\hat{CI}_t = 203.837 + 0.927\ GVA_{t\text{-}3} + 0.390\ \Delta CI_{t\text{-}1} \quad [0.150] \qquad (10)$$

Construction

$$a)\ \hat{GVA}_t = 53.993 + 0.463\ GVA_{t\text{-}1} \quad [0.120]$$
$$\Delta\hat{CI}_t = -203.809 + 2.014\ GVA_{t\text{-}1} \quad [0.096] \qquad (11)$$

$$b)\ \hat{GVA}_t = 44.444 + 0.558\ GVA_{t\text{-}1} \quad [0.167]$$
$$\Delta\hat{CI}_t = -173.378 + 1.714\ GVA_{t\text{-}1} \quad [0.049] \qquad (12)$$

Retail Trade

$$a)\ \hat{GVA}_t = 67.454 + 0.330\ GVA_{t\text{-}1} + 0.082\ \Delta CI_{t\text{-}1} \quad [0.195]$$
$$\Delta\hat{CI}_t = -38.516 + 0.379\ GVA_{t\text{-}1} - 0.298\ \Delta CI_{t\text{-}1} \quad [0.044] \qquad (13)$$

$$b)\ \hat{GVA}_t = 71.604 + 0.289\ GVA_{t\text{-}1} + 0.147\ \Delta CI_{t\text{-}1} \quad [0.302]$$
$$\Delta\hat{CI}_t = -59.695 + 0.590\ GVA_{t\text{-}1} - 0.107\ \Delta CI_{t\text{-}1} \quad [-0.005] \qquad (14)$$

Services

$$a)\ \hat{GVA}_t = 77.565 + 0.105\ \Delta CI_{t\text{-}1} \quad [0.184]$$
$$\Delta\hat{CI}_t = -98.190 - 0.146\ \Delta CI_{t\text{-}1} \quad [0.038] \qquad (15)$$

b) the same as *a*)

Consumers

$$a)\ \hat{GVA}_t = 39.159 + 0.492\ GVA_{t\text{-}3} + 0.145\ \Delta CI_{t\text{-}1} - 0.057\ \Delta CI_{t\text{-}3} \quad [0.477]$$
$$\Delta\hat{CI}_t = 241.049 + 1.567\ GVA_{t\text{-}3} + 0.351\ \Delta CI_{t\text{-}1} - 0.029\ \Delta CI_{t\text{-}3} \quad [0.225] \qquad (16)$$

b) the same as *a*)

Generally, the better results were obtained if the balances of questions with statistically significant proved relationship and determination index exceeding certain chosen limit are used for construction of partial confidence indicators.

Subsequently, we approached to the construction of BCI and ESI. Again, they are based on questions identified by the existence of relationship (models 17 and 19) and questions identified by the boundary of determination index (models 18 and 20). In order to construct BCI it was necessary to find a clue how to weigh partial confidence indicators. Therefore, we decided to use weights specified by given sector's GVA share on the total GVA in 2010 from data supplied by National Accounts. Weighting scheme has the following form:

- Manufacturing Industry: 30.39%,
- Services: 43.66%,
- Construction: 6.98%,
- Retail Trade: 18.97%.

When designing ESI, the weight of consumers was set to 20%. Therefore, the weights of individual sectors were multiplied by the value of 0.8.

Business Climate Indicator

$$\text{a)}\quad \hat{GVA}_t = 89.497 + 0.217\ \Delta BCI_{t-1} \qquad [0.314]$$
$$\Delta \hat{BCI}_t = -18.315 + 0.188\ \Delta BCI_{t-1} \qquad [0.010] \qquad (17)$$

$$\text{b)}\quad \hat{GVA}_t = 0.475\ GVA_{t-3} + 0.371\ GVA_{t-4} + 0.313\ \Delta BCI_{t-1} + 0.148\ \Delta BCI_{t-2} - 0.149\ \Delta BCI_{t-4} \qquad [0.468]$$
$$\Delta \hat{BCI}_t = 0.834\ GVA_{t-3} + 0.313\ GVA_{t-4} + 0.375\ \Delta BCI_{t-1} + 0.536\ \Delta BCI_{t-2} - 0.507\ \Delta BCI_{t-4} \qquad [0.168] \qquad (18)$$

Economic Sentiment Indicator

$$\text{a)}\quad \hat{GVA}_t = 53.892 + 0.458\ GVA_{t-3} + 0.331\ GVA_{t-4} + 0.318\ \Delta ESI_{t-1} + 0.159\ \Delta ESI_{t-2} \qquad [0.488]$$
$$\Delta \hat{ESI}_t = 62.065 + 0.873\ GVA_{t-3} + 0.080\ GVA_{t-4} + 0.479\ \Delta ESI_{t-1} + 0.450\ \Delta ESI_{t-2} \qquad [0.143] \qquad (19)$$

$$\text{b)}\quad \hat{GVA}_t = 50.459 - 0.442\ GVA_{t-1} + 0.544\ GVA_{t-3} + 0.386\ GVA_{t-4} + 0.287\ \Delta ESI_{t-1} + 0.153\ \Delta ESI_{t-2} - 0.100\ \Delta ESI_{t-4} \qquad [0.563]$$
$$\Delta \hat{ESI}_t = 99.160 - 1.288\ GVA_{t-1} + 1.285\ GVA_{t-3} + 0.345\ GVA_{t-4} + 0.538\ \Delta ESI_{t-1} + 0.476\ \Delta ESI_{t-2} - 0.436\ \Delta ESI_{t-4} \qquad [0.257] \qquad (20)$$

At this stage we reached a slight improvement in BCI and ESI model due to higher number of statistically significant variables in models.

There are 7 common questions in retail trade and services sectors. We decided to merge these questions to increase their predictive potential and test the character of relationships for each merged question separately, then for confidence indicator of retail trade + services and in the final phase for BCI and ESI.

Based on the results we conclude that statistically significant short-term relationship was found for the following questions: Assessment of Current Overall Business Situation, Expected Development of Overall Business Situation in the Next 3 Months and Expected Development of Overall Business Situation in the Next 6 Months. All with modified determination index above 0.18. We constructed confidence indicator according to these questions with weight of retail trade 12.5% and services 87.5%. These weights were derived from the scheme shown below (services with weight of 40.41% and retail trade with weight of 5.77% are in the ratio of 87.5% and 12.5%). Even in this case we proved that confidence indicator of these two linked sectors Granger causes q-o-q GVA changes.

The system of models is as follows:

$$\hat{GVA}_t = 84.236 + 0.178\ \Delta CI_{t-1} \qquad [0.236]$$
$$\Delta \hat{CI}_t = -42.160 + 0.120\ \Delta CI_{t-1} \qquad [0.027] \qquad (21)$$

At the same time, we tried to find a different weighting scheme that would better reflect the structure of the business tendency surveys samples. This scheme is again represented by the share of GVA for given sector on the total GVA in 2010. However, at this point we took into account only institutional sectors of non-financial corporations and financial corporations (see also the chapter 2.4). In this case:

- Manufacturing Industry: 46.27%,
- Services: 40.41%,
- Construction: 7.55%,
- Retail Trade: 5.77%.

Using merged retail trade and services confidence indicator and adjusted weighting scheme the following systems were derived:

For Business Climate Indicator:

$$\begin{aligned} a)\ & \hat{GVA}_t = 0.548\ GVA_{t\text{-}3} + 0.380\ GVA_{t\text{-}4} + 0.385\ \Delta BCI_{t\text{-}1} - 0.162\ \Delta BCI_{t\text{-}4} && [0.483] \\ & \Delta \hat{BCI}_t = 0.910\ GVA_{t\text{-}3} + 0.223\ GVA_{t\text{-}4} + 0.630\ \Delta BCI_{t\text{-}1} - 0.441\ \Delta BCI_{t\text{-}4} && [0.263] \end{aligned} \tag{22}$$

$$\begin{aligned} b)\ & \hat{GVA}_t = 0.506\ GVA_{t\text{-}3} + 0.354\ GVA_{t\text{-}4} + 0.300\ \Delta BCI_{t\text{-}1} - 0.146\ \Delta BCI_{t\text{-}4} && [0.498] \\ & \Delta \hat{BCI}_t = 1.007\ GVA_{t\text{-}3} + 0.185\ GVA_{t\text{-}4} + 0.453\ \Delta BCI_{t\text{-}1} - 0.451\ \Delta BCI_{t\text{-}4} && [0.203] \end{aligned} \tag{23}$$

For Economic Sentiment Indicator:

$$\begin{aligned} a)\ & \hat{GVA}_t = 44.983 - 0.489\ GVA_{t\text{-}1} + 0.596\ GVA_{t\text{-}3} + 0.400\ GVA_{t\text{-}4} + 0.366\ \Delta ESI_{t\text{-}1} + 0.165\ \Delta ESI_{t\text{-}2} \\ & && [0.562] \\ & \Delta \hat{ESI}_t = 70.722 - 1.156\ GVA_{t\text{-}1} + 1.185\ GVA_{t\text{-}3} + 0.206\ GVA_{t\text{-}4} + 0.683\ \Delta ESI_{t\text{-}1} + 0.386\ \Delta ESI_{t\text{-}2} \\ & && [0.319] \end{aligned} \tag{24}$$

$$\begin{aligned} b)\ & \hat{GVA}_t = 47.221 - 0.419\ GVA_{t\text{-}1} + 0.546\ GVA_{t\text{-}3} + 0.379\ GVA_{t\text{-}4} + \\ & \quad + 0.297\ \Delta ESI_{t\text{-}1} + 0.149\ \Delta ESI_{t\text{-}2} - 0.114^{*}\ \Delta ESI_{t\text{-}4} && [0.557] \\ & \Delta \hat{ESI}_t = 95.584 - 1.182\ GVA_{t\text{-}1} + 1.260\ GVA_{t\text{-}3} + 0.221\ GVA_{t\text{-}4} + \\ & \quad + 0.534\ \Delta ESI_{t\text{-}1} + 0.446\ \Delta ESI_{t\text{-}2} - 0.427\ \Delta ESI_{t\text{-}4} && [0.259] \end{aligned} \tag{25}$$

When comparing the results of the initial state with the results after the above described adjustments of the confidence indicators' composition and weighting scheme, we can conclude, at least on the basis of the number of statistically significant variables and the modified indices of determination that the adjustment led to certain improvements of the predictive capability of the models.

In order to practically prove that the adjustments helped to improve the predictive capability of the models, we proceeded to construct out-of-sample forecasts of GVA for the period from the fourth quarter of 2014 to the second quarter of 2016. Evaluation was carried out for VAR models containing the BSI and ESI variables, as they are the core of our analysis, by using root mean squared error (RMSE) as a measure of differences between values predicted by model ($\hat{y}_t$) and values actually observed (y_t).

$$RMSE = \sqrt{\frac{\sum_{t=1}^{n}(\hat{y}_t - y_t)^2}{n}} \tag{26}$$

Results are listed in Table 2.

From the results for Economic Sentiment Indicator in Table 2 we can conclude that by comparing the initial state of ESI with the modification based on the adjustment of the weighting scheme (share of GVA of particular industry on the total GVA in 2010) we obtain worse results with inclusion of all the questions with statistically significant short-term relationship with GVA. Conversely, there is a significant improvement in results if only the questions exceeding aforementioned boundaries of modified determination index are included into the confidence indicators with RMSE of 0.469. If we consider the same weights given by share of GVA on the total GVA in 2010 but considering only non-financial and financial corporations and merging questions in retail trade and services industries, there is also

Table 2 Root Mean Square Errors for Out-of-Sample Forecasts 2014Q4–2016Q2

System of Equations	Response Variable	RMSE (AIC)
7	$\hat{GVA}_t$	0.525
	$\Delta\hat{ESI}_t$	1.456
8	$\hat{GVA}_t$	0.484
	$\Delta\hat{BCI}_t$	1.617
17	$\hat{GVA}_t$	0.406
	$\Delta\hat{BCI}_t$	1.279
18	$\hat{GVA}_t$	0.446
	$\Delta\hat{BCI}_t$	1.829
19	$\hat{GVA}_t$	0.604
	$\Delta\hat{ESI}_t$	2.732
20	$\hat{GVA}_t$	0.469
	$\Delta\hat{ESI}_t$	2.589
22	$\hat{GVA}_t$	0.470
	$\Delta\hat{BCI}_t$	1.319
23	$\hat{GVA}_t$	0.433
	$\Delta\hat{BCI}_t$	1.934
24	$\hat{GVA}_t$	0.488
	$\Delta\hat{ESI}_t$	1.898
25	$\hat{GVA}_t$	0.373
	$\Delta\hat{ESI}_t$	2.014

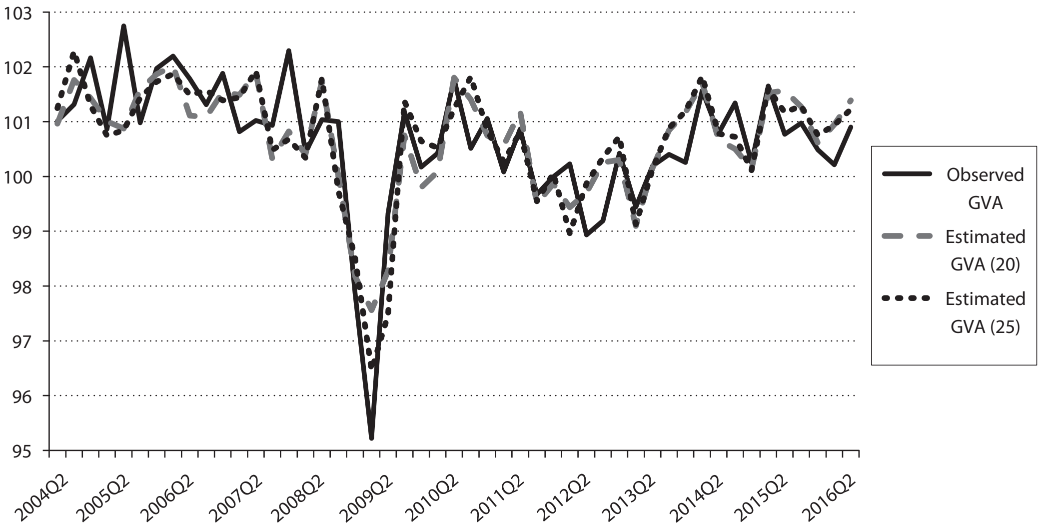
Source: Own calculation

an improvement over the initial state in both cases. However, overall the greatest conformity with the evolution of GVA is achieved in system (25). The course of actual and estimated values of q-o-q GVA according to the aforementioned system (25) and the second best system (20) is depicted in Figure 2.

Regarding Business Climate Indicator, in comparison to the initial state there is an improvement when using the weighting scheme of the GVA share on the total GVA in 2010 (RMSE decreases from 0.484 to 0.406). If we consider the weighting scheme with the inclusion of only non-financial and financial corporations and merging the common questions in retail trade and services industries, we obtain slightly better results when RMSE decreases to 0.470 (statistically significant short-term relationship between given questions and GVA) and to 0.433 (questions exceeding given boundary of determination index).

For models with BCI and ESI occurring as response variables there are values of RMSE relatively high and therefore the predictive ability of such models is poor. Overall, we can conclude that neither differences of ESI nor BCI tend to be explained well by development in q-o-q GVA, whereas relatively low levels of RMSE are achieved by models where q-o-q GVA is explained by differences of BCI and ESI. Although there is a leeway for improvement of the results, the results confirm to some extent the leading character of BCS indicators.

Figure 2 Observed and estimated values of q-o-q GVA changes in % based on system (20) and (25)



Source: Own construction

CONCLUSION

The aim of this paper was to assess the ability of ESI to predict the development of GVA expressed in the form of q-o-q changes. Initial state with parameters set as they are currently used officially in conformity with the methodology determined by the European Commission was analysed. Furthermore, the predictive ability of individual questions surveyed within as well as beyond the BCS programme was analysed and alternative models of BCI, CCI and ESI were suggested.

The results of the models of those questions currently used to construct sectors' confidence indicators show that except for the manufacturing industry (2 out of 3 questions with significant short-term relationship) they do not evince predictive ability towards q-o-q GVA changes.

Generally, the worst situation seems to be in services sector where no question currently used shows any relationship with q-o-q GVA changes. Just a little better situation was detected in construction and retail trade sector with short-term relationship proved for 1 out of 2 questions in construction and 1 out of 3 questions in retail trade. As regards consumers a relationship was identified for only 2 out of 4 questions entering the calculation of CCI.

Experimenting with the alternative questions surveyed within the BCS and weights of sectors in question derived from National Accounts statistics we managed to find the alternative models showing some improvements in the predictive ability of the ESI towards GVA development.

Considering all the obtained results we can conclude that the predictive ability of BCS could be considerably improved. When speaking about improvements there are several factors that should be taken into account. Questions entering BCS are largely harmonized across the European Union countries and therefore proper understanding and their accurate translation is crucial.

Analysis made by the CZSO showed that the answers reported by the units under survey do not always correspond to the results later reported by the same units within the conventional statistics. The CZSO in cooperation with the University of Economics, Prague, plans in this regard to realize a "survey on survey" project which aims to more detailed analysis of BCS with respect to the evaluation of respondents' answers quality, how far they provide the relevant information with respect to other business statistics and what are the reasons for inconsistencies.

One of the reasons affecting the relevance of the results might be the issue of to what extent are the people responding to the questionnaire informed about the current economic situation of the enterprise in question, its investment plans, factors influencing investments and about other information necessary for the correct completion of the questionnaire. The questionnaire is designated for people familiar with the current economic situation and plans of the respective enterprise, ideally for managers. However, answering the questionnaire is often delegated to subordinates who may not have the information required. This is closely connected with the fact that people who do not have the access to the relevant information might be easily influenced by the past and particularly by the presence in their prospects for future. This subsequently causes the leading character of survey's results disappear.

Last but not least, it is necessary to stress that the test results of the predictive ability of the BCS towards the development of the reference indicators might be influenced by the methodology selected. We are aware of the fact that the methodology chosen for our tests is just one of many other possible ways and alternative methodologies may give better results. Therefore, we plan to continue analysing the issue with the aim to suggest an alternative construction of ESI better reflecting the specificities of the Czech economy having strong relationship with the GVA development. We have already started the testing of alternative weights derived from the structural business statistics with promising results. Moreover, besides VAR models, we consider to employ alternative ways of assessing the relationships between time series. One of the possible alternatives could be so called bridge equations models based on the linking high and low frequency variable.

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ANNEX

Table 3 The questions included in the Czech BCS, beyond the harmonized questions, used in the analysis

Statement	Question	Rank of Question in the Statement
BTS in Manufacturing Industry	Assessment of Current Overall Business Situation	1
	Assessment of Total Demand in the Past 3 Months	4
	Assessment of Current Insolvency	7
	Expected Development of Overall Business Situation in the Next 3 Months	8
	Expected Development of Overall Business Situation in the Next 6 Months	9
	Expected Development of Total Demand in the Next 3 Months	13
	Expected Development of Total Export in the Next 3 Months	14
	Expected Development of Total Import in the Next 3 Months	15
	Expected Ability to Meet Liabilities in Time in the Next 3 Months	16
	Expected Development of Production Capacity in the Next 3 Months	18
	Expected Development of Stocks of Raw Materials and Supplies in the Next 3 Months	20
BTS in Construction	Assessment of Current Overall Business Situation	1
	Assessment Current Insolvency (Liabilities in Time)	5
	Expected Development of the Overall Business Situation in the Next 3 Months	6
	Expected Development of the Overall Demand for Construction Work in the Next 3 Months	8
	Expected Development of Construction Activity in the Next 3 Months	9
BTS in Retail Trade	Assessment of Current Overall Business Situation	1
	Assessment of Overall Business Situation in the Past 3 Months	8
	Expected Development of Overall Business Situation in the Next 3 Months	9
	Expected Development of Overall Business Situation in the Next 6 Months	10
BTS in Selected Services	Expected Development of Overall Business Situation in the Next 3 Months	7
	Expected Development of Overall Business Situation in the Next 6 Months	8

Source: Czech Statistical Office, own construction

Table 4 Granger Causality Test in VAR Models

System of Equations	Response Variable	P-value	Does Explanatory Variable Granger Cause Response Variable?
7	$G\hat{V}A_t$	0.000	Yes
	$\Delta E\hat{S}I_t$	0.022	Yes
8	$G\hat{V}A_t$	0.000	Yes
	$\Delta B\hat{C}I_t$	0.011	Yes
9	$G\hat{V}A_t$	0.000	Yes
	$\Delta \hat{C}I_t$	0.013	Yes
10	$G\hat{V}A_t$	0.000	Yes
	$\Delta \hat{C}I_t$	0.045	Yes
11	$G\hat{V}A_t$	0.366	No
	$\Delta \hat{C}I_t$	0.010	Yes
12	$G\hat{V}A_t$	0.073	No
	$\Delta \hat{C}I_t$	0.039	Yes
13	$G\hat{V}A_t$	0.029	Yes
	$\Delta \hat{C}I_t$	0.494	No
14	$G\hat{V}A_t$	0.001	Yes
	$\Delta \hat{C}I_t$	0.210	No
15	$G\hat{V}A_t$	0.041	Yes
	$\Delta \hat{C}I_t$	0.054	No
16	$G\hat{V}A_t$	0.000	Yes
	$\Delta \hat{C}I_t$	0.012	Yes
17	$G\hat{V}A_t$	0.000	Yes
	$\Delta B\hat{C}I_t$	0.669	No
18	$G\hat{V}A_t$	0.000	Yes
	$\Delta B\hat{C}I_t$	0.209	No
19	$G\hat{V}A_t$	0.000	Yes
	$\Delta E\hat{S}I_t$	0.286	No
20	$G\hat{V}A_t$	0.000	Yes
	$\Delta E\hat{S}I_t$	0.043	Yes
21	$G\hat{V}A_t$	0.007	Yes
	$\Delta \hat{C}I_t$	0.296	No
22	$G\hat{V}A_t$	0.000	Yes
	$\Delta B\hat{C}I_t$	0.110	No
23	$G\hat{V}A_t$	0.000	Yes
	$\Delta B\hat{C}I_t$	0.093	No
24	$G\hat{V}A_t$	0.000	Yes
	$\Delta E\hat{S}I_t$	0.033	Yes
25	$G\hat{V}A_t$	0.000	Yes
	$\Delta E\hat{S}I_t$	0.040	Yes

Note: Tests evaluated at the 5% significance level.
Source: Own calculation

An Estimated DSGE Model with a Housing Sector for the Czech Economy

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Abstract

This paper uses an estimated DSGE model with an explicit housing sector to analyse the role of the housing sector and housing collateral for business cycle fluctuations in the Czech economy. The baseline results show that the development in the housing market has negligible effect on the rest of the economy. Counterfactual experiments indicate that the spill-overs increases with looser credit standards, if banks provide loans for higher value of houses. Similarly, with the higher loan-to-value ratios the transmission mechanism of monetary policy also seems to strengthen, with the key rates having bigger influence on the consumption and output. Looking at the development in house prices, the recent boom and bust is found to have been caused primarily by housing preference shocks (demand side shocks). Supply shocks are also found to have been significant, but to a much lesser extent.

Keywords	***JEL code***
Housing, loan-to-value ratio, DSGE model, collateral constraint, Bayesian estimation	*E37*

INTRODUCTION

The development of the housing market in recent years has attracted widespread attention, especially in the U.S., where it was considered to be a major trigger for the financial crisis. Even if the housing sector represents a relatively small part of the economy, it can have large impacts on macroeconomic variables. Compared to U.S. the situation in the Czech Republic was not so severe, but the connection between the housing market and the macroeconomy still deserves a detailed examination. Another motivation is recent announcement of the Czech National Bank (2014) about possibility of regulation of mortgage loans. Hence, the goal of this empirical paper is to offer a quantitative assessment of the links between the housing (or real estate) sector and the rest of the economy. Specifically, I focus on two issues. First, I intend to find out what impacts housing specific shocks have on the rest of the economy, and which other (non-housing) shocks have an impact on housing sector variables. Second, with regard to the influence of housing collateral on the monetary policy transmission mechanism, I aim to quantify the effects of changes in loan-to-value ratio for the ability of monetary policy to influence macroeconomic variables. Thus the paper also contributes to the debate about

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macroprudential monetary policy, concretely about setting limits on loan-to-value ratio.[2] The approach relies on an estimation of a DSGE model with housing sector using Czech data and Bayesian techniques. In order to answer the research questions, I perform several quantitative exercises using impulse responses and variance and shock decompositions.

The results show that there is no tight connection between the housing sector and the rest of the economy. Housing sector shocks (both demand and supply) do not spill over to the rest of the economy much, and thus their implications for macroeconomic variables can be considered to be quantitatively negligible. Moreover, housing sector variables are mostly driven only by housing sector shocks. Booms and busts in house prices are caused primarily by housing preference shocks (demand side shocks); productivity shocks originating in the housing sector contribute only partly, as does the non-housing supply shock. On the other hand, the housing collateral effect on the monetary policy transmission mechanism appears to be quite strong, especially for high loan-to-value ratio values. If households have better access to credit, the impact of monetary policy on consumption and output is substantially increased, while its impact on inflation is only moderately changed. Similarly, a higher loan-to-value ratio amplifies the spill-overs of housing preference shocks to macroeconomic variables, especially consumption and inflation. Hence, this result could justify the macroeconomic policy of setting caps on loan-to-value ratio in order to prevent negative impacts from development in the housing sector.

The rest of this paper is organized as follows: Section 2 introduces literature in the field of housing issues, Section 3 describes the structure of the model, Section 4 briefly comments on the data and estimation technique; the results of the estimation are presented in Section 5, and dynamical properties are discussed in Section 6; the final section concludes.

1 LITERATURE REVIEW

There is some empirical literature on the development of house prices in the Czech Republic. Most papers examine the relationship between fundamentals and house prices, some focus on under/over-valuation in real estate prices. These studies use econometric techniques and are aimed both at the Czech Republic (e.g. Zemčík (2011), Hlaváček and Komárek (2007)), and at a broader group of countries (as in Egert and Mihaljek (2008) or Posedel and Vízek (2011)). Brůha et al. (2013) examined the impact of housing prices on the financial position of households using microeconomic data and statistical methods.

My approach is different and uses a DSGE model.[3] The particular model comes from Iacoviello and Neri (2010) who applied it to the US economy. There are also many other papers that use DSGE models with the housing market and financial frictions: Iacoveillo (2005) developed a model for the U.S., Walentin (2014) estimated a model for Sweden, Aoki et al. (2004) for the UK, Roeger and in't Veld (2009) used a calibrated model for the EU, and Christensen et al. (2009) estimated a small open economy model for Canada.

The model from Iacoviello and Neri (2010) is a closed economy model, which might be considered a crude approximation for the Czech economy. However, one can learn important lessons even from such a model. Closed economy models were successfully estimated and analysed for the U.S. economy and Sweden – both of which are open economies. Furthermore, houses are non-tradable goods, and thus housing demand and housing supply are primarily determined by local forces; any influence from abroad is only indirect. Tonner and Brůha (2014) implement elements from Iacoviello and Neri (2010) into a calibrated forecasting model of the Czech National Bank. Their approach is slightly different from my research questions here, but they also

2 See Galati and Moessner (2011) for a literature review on macroprudential policy and Borio et al. (2001) for a discussion of practises in setting limits on loan-to-value ratio. Zamrazilová (2014) discusses unconventional monetary policy practises used by FED and ECB, Mandel and Tomšík (2014) examine alternative tools for the policy of the Czech National Bank.

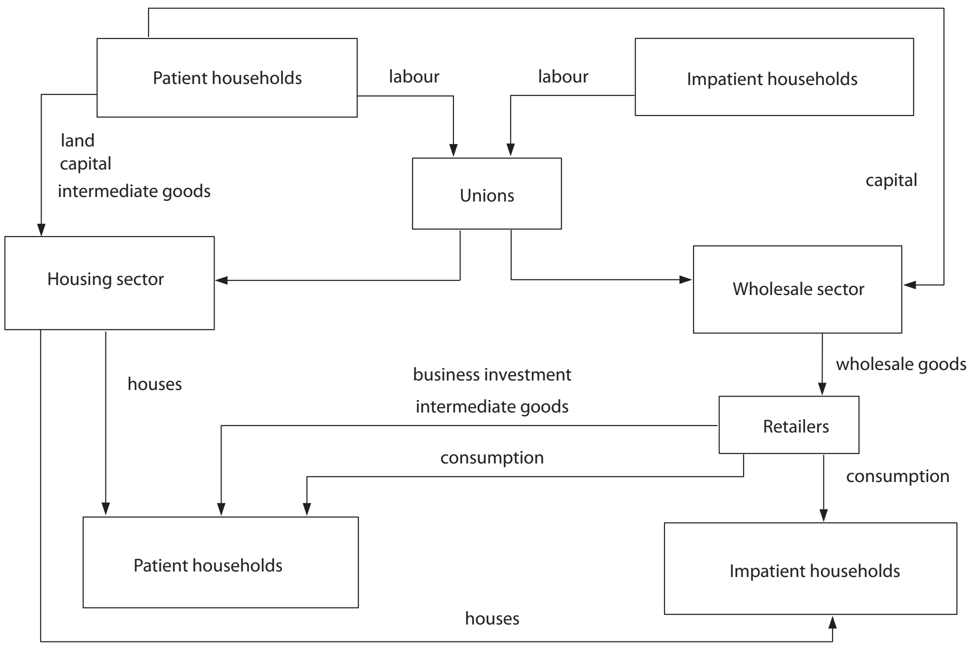
3 Dynamic Stochastic General Equilibrium models. For detailed exposition of DSGE models see e.g. Galí (2008), Woodford (2003) or Walsh (2010).

find a weak relationship between the housing sector and the aggregate economy. Thus, modelling the Czech economy as a closed economy can be regarded as reasonable approximation.

2 MODEL

The model is borrowed from Iacoviello and Neri (2010) and ranks among medium-scale models. This model contains financial friction in the form of collateral constraint. This mechanism originates from Kiyotaki and Moore (1997), and was further elaborated in Iacoviello (2005), who used houses instead of land as collateral. Here, I describe only the main behavioural equations of the model; more detailed exposition is quoted in the online Appendix (available at the website of this journal, see the online version of the *Statistika: Statistics and Economy Journal* No. 4/2016 at: <http://www.czso.cz/statistika_journal>). Figure 1 provides basic orientation in the model structure.

Figure 1 Model structure



Source: Author based on model of Iacoviello and Neri (2010)

2.1 Households

There are two types of households: patient (lenders) and impatient (borrowers). Patient households work, consume and accumulate housing. They also own capital and land, and supply funds to firms and to impatient households. Their utility function is:

$$E_0 \sum_{t=0}^{\infty} (\beta G_C)^t z_t \left(\Gamma_c \ln(c_t - \varepsilon c_{t-1}) + j_t \ln h_t - \frac{\tau_t}{1+\eta} \left(n_{c,t}^{1+\xi} + n_{h,t}^{1+\xi} \right)^{\frac{1+\eta}{1+\xi}} \right), \quad (1)$$

where $c_t, h_t, n_{c,t}, n_{h,t}$ are consumption, housing, worked hours in the consumption sector and worked hours in the housing sector. β is discount factor, ε is habit in consumption, $\xi, \eta \geq 0$ are elasticities of substitution of worked hours in those two sectors. z_t, j_t and τ_t are shock to intertemporal preferences, housing preference shock and shock to labor supply, all modelled as AR(1) processes. G_c is the growth rate of consumption along the balanced growth path. The scaling factor $\Gamma c = (G_C - \varepsilon)/(G_C - \beta\varepsilon G_C)$ ensure that the marginal utility of consumption is $1/c$ in the steady state.

Budged constraint (in real terms) for patient households is:

$$c_t + \frac{k_{c,t}}{A_{k,t}} + k_{h,t} + k_{b,t} + q_t h_t + p_{l,t} l_t - b_t = \frac{w_{c,t} n_{c,t}}{X_{wc,t}} + \frac{w_{h,t} n_{h,t}}{X_{wh,t}}$$
$$+ \left(R_{c,t} z_{c,t} + \frac{1-\delta_{kc}}{A_{k,t}} \right) k_{c,t-1} + \left(R_{h,t} z_{h,t} + 1 - \delta_{kh} \right) k_{h,t} + p_{b,t} k_{b,t-1} - \frac{R_{t-1} b_{t-1}}{\pi_t} \tag{2}$$
$$+ (p_{l,t} + R_{l,t}) l_{t-1} + q_t (1-\delta_h) h_{t-1} + Div_t - \phi_t - \frac{a(z_{c,t}) k_{c,t-1}}{A_{k,t}} - a(z_{h,t}) k_{h,t-1} \cdot$$

Patient households choose consumption c_t, capital in the consumption sector $k_{c,t}$ and housing sector $k_{h,t}$, amount of intermediate goods $k_{b,t}$ (priced at $p_{b,t}$) in the housing sector, housing h_t (priced at q_t), land l_t, (priced at $p_{l,t}$), hours in consumption and housing sector $n_{c,t}$ and $n_{s,t}$, capital utilization rates $z_{c,t}$ and $z_{h,t}$ and borrowing b_t (loans if b_t is negative) to maximize utility function (1) subject to the budget constraint (2). $A_{k,t}$ is investment--specific technology shock which represents the marginal cost of producing capital used in the non-housing sector. Loans are set in nominal terms and yield a riskless nominal return R_l. Real wages are denoted by $w_{c,t}$ and $w_{h,t}$, real rental rates by $R_{c,t}$ and $R_{h,t}$ and depreciation rates by δ_{kc} and δ_{kh}. The terms $X_{wc,t}$ and $X_{wh,t}$ denote markup between the wage paid by the wholesale firm and wage paid to the households by labour unions. $\pi_t = P_t/P_{t-1}$ is inflation rate in the consumption sector, Div_t are lump-sum profits from final goods firms and from labor unions, ϕ_t denotes total convex adjustment costs for capital and $a(.)$ is the convex cost of setting capital utilization rate z.

Impatient households also consume, work and accumulate housing and their utility function is similar to that of patient households:[4]

$$E_0 \sum_{t=0}^{\infty} (\beta' G_C)^t z_t \left(\Gamma_{c'} \ln(c_t' - \varepsilon' c_{t-1}') + j_t \ln h_t' - \frac{\tau_t}{1+\eta} \left((n_{c,t}')^{1+\xi'} + (n_{h,t}')^{1+\xi'} \right)^{\frac{1+\eta'}{1+\xi'}} \right). \tag{3}$$

However, they do not accumulate capital and do not own finished-goods producing firms or land (their dividends come only from labor unions). Their budget constraint is as follows:

$$c_t' + q_t h_t' - b_t' = \frac{w_{c,t}' n_{c,t}'}{X_{wc,t}'} + \frac{w_{h,t}' n_{h,t}'}{X_{wh,t}'} + q_t(1-\delta_h) h_{t-1}' - \frac{R_{t-1} b_{t-1}'}{\pi_t} + Div_t'. \tag{4}$$

The impatient households are credit constrained and use their houses as collateral for loans. Their maximum borrowing b_t' is given by the expected present value of their home times the loan-to-value (LTV) ratio:

$$b_t' \le m E_t \left(\frac{q_{t+1} h_t' \pi_{t+1}}{R_t} \right). \tag{5}$$

[4] The variables of impatient households are denoted with apostrophe ('), the meaning is the same as in case of patient households.

This setting implies that variation in housing values shifts the borrowing constraint and thus affects their borrowing capacity and spending. There is also another channel for propagation of financial shocks into the real part of the economy: the debt-deflation effect. Debt is quoted in nominal terms,[5] which is based on empirical grounds from low-inflation countries. The transmission mechanism then works as follows: positive demand shock increases the price of assets (housing), which increases the borrowing capacity of constrained households and allows them to spend more. The rise in prices reduces the real value of their debt obligations, which further increases value of their net worth. Borrowers have a higher propensity to spend than lenders, and thus net demand is positively affected. This mechanism, connected to housing wealth, works as an accelerator of demand shocks.

2.2 Firms

The production side of the model economy is divided into two sectors with different rates of technological progress. The firms hire labor and capital services and buy intermediate goods from households to produce wholesale goods Y_t and new houses IH_t. Their optimization problem is:

$$\max \frac{Y_t}{X_t} + q_t IH_t - \left(\sum_{i=c,h} w_{i,t} n_{i,t} + \sum_{i=c,h} w_{i,t}' n_{i,t}' + \sum_{i=c,h} R_{i,t} z_{i,t} k_{i,t-1} + R_{l,t} l_{t-1} + p_{b,t} k_{b,t} \right), \tag{6}$$

subject to the production functions:

$$Y_t = \left(A_{c,t} \left(n_{c,t}^{\alpha} n_{c,t}'^{\,1-\alpha} \right) \right)^{1-\mu_c} (z_{c,t} k_{c,t-1})^{\mu_c} \tag{7}$$

$$IH_t = \left(A_{h,t} \left(n_{h,t}^{\alpha} n_{h,t}'^{\,1-\alpha} \right) \right)^{1-\mu_h-\mu_b-\mu_l} (z_{h,t} k_{h,t-1})^{\mu_h} k_{b,t}^{\mu_b} l_{t-1}^{\mu_l}. \tag{8}$$

The wholesale good is produced using technology (7) with labor and capital inputs only. New houses IH_t are produced using technology (8) with labour, capital, land and the intermediate input k_b. The terms $A_{c,t}$ and $A_{h,t}$ denotes productivity in the non-housing and housing sector. Parameter α measures labor income share of patient households.

2.3 Retailer and labour unions

There are nominal wage rigidities in both housing and non-housing sectors, and price rigidity in the retail sector. The rigidities come from the existence of labour unions and retailers that have some market power and can influence setting of the wages and prices. The rigidities are modelled in Calvo (1983) style with partial indexation to previous inflation. Optimization problem of the retailers results in hybrid New Keynesian Phillips curve:

$$\ln \pi_t - \iota_\pi \ln \pi_{t-1} = \beta G_C (E_t \ln \pi_{t+1} - \iota_\pi \ln \pi_t) - \frac{(1-\theta_\pi)(1-\beta G_C \theta_\pi)}{\theta_\pi} \ln(X_t/X) + u_{p,t}, \tag{9}$$

where X_t is a markup over marginal cost, X is the steady state markup, θ_π is the fraction of firms that cannot change the price every period and index it to previous inflation with elasticity ι_π, and $u_{p,t}$ is cost-push shock. Wage setting is analogous to price setting and the optimization problem of labor unions results in four wage Phillips curves (for each type of household in each production sector) that are similar to equation (9).

[5] Expression $R_{t-1} b_{t-1}' / \pi_t$ in equation (4).

2.4 Monetary authority

Monetary authority sets the interest rate R_t according to (linearized) monetary rule with response to past interest rate, inflation and output growth:

$$R_t = r_R \; R_{t-1} + (1 - r_R)[r_\pi \pi_t \; + r_Y(y_t - y_{t-1}) + \overline{rr}] + u_{R,t} - s_t \,, \tag{10}$$

where $\overline{rr}$ is the steady-state real interest rate, $u_{R,t}$ is monetary policy shock and s_t is shock to inflation target.[6]

2.5 Market clearing and equilibrium condition

The non-housing sector produces consumption, business investment and intermediate goods. The housing sector produces new houses that are added to existing stock. The equilibrium conditions for product market and housing market are:

$$C_t + IK_{c,t} / A_{k,t} + IK_{h,t} + k_{b,t} = Y_t - \phi_t \tag{11}$$

$$H_t - (1 - \delta_h) H_{t-1} = IH_t \,, \tag{12}$$

where $C_t = c_l + c_t'$ is aggregate consumption, $H_t = h_l + h_t'$ is aggregate stock of housing, and $IK_{c,t} = k_{c,t} - (1 - \delta_{kc})\, k_{c,t-1}$ and $IK_{h,t} = k_{h,t} - (1 - \delta_{kh})\, k_{h,t-1}$ are two components of business investment.

2.6 Growth rates

The technological progress is allowed to be different across the sectors. The net growth rates of technology in housing sector ($A_{h,t}$), consumption goods sector ($A_{c,t}$) and investment goods sectors ($A_{k,t}$) are denoted as $\gamma_{A,H}$, $\gamma_{A,C}$ and $\gamma_{A,K}$, respectively. Growth rates of the real variables along balanced growth path are then determined by:

$$G_C = G_{IK_h} = G_{q \times IH} = 1 + \gamma_{AC} + \frac{\mu_c}{1 - \mu_c} \gamma_{AK} \tag{13}$$

$$G_{IK_c} = 1 + \gamma_{AC} + \frac{1}{1 - \mu_c} \gamma_{AK} \tag{14}$$

$$G_{IH} = 1 + (\mu_h + \mu_b)\gamma_{AC} + \frac{\mu_c(\mu_h + \mu_b)}{1 - \mu_c} \gamma_{AK} + (1 - \mu_h - \mu_l - \mu_b)\gamma_{AH} \tag{15}$$

$$G_q = 1 + (1 - \mu_h - \mu_b)\gamma_{AC} + \frac{\mu_c(1 - \mu_h - \mu_b)}{1 - \mu_c} \gamma_{AK} + (1 - \mu_h - \mu_l - \mu_b)\gamma_{AH} \,. \tag{16}$$

The trend growth rates of $IK_{h,t}$, $IK_{h,t}/A_{k,t}$ and $q_t IH_t$ are all equal to the trend growth rate of real consumption G_c. Business investment G_{IK_c} grows faster than consumption, as long as $\gamma_{A,K} > 0$ and the trend growth rate in real house prices G_q offsets differences in the productivity growth between the consumption, G_c, and the housing sector G_{IH}. The equilibrium model equations are linearized around balanced growth path before the estimation.

3 DATA AND ESTIMATION

The model is estimated using the data for the following model variables: consumption (C_t); residential investment (IH_t); non-residential investment (IK_t); real house prices (q_t); inflation (π_t); nominal interest rate (R_t); hours worked and wage inflation in housing (NH_t,Wh_t) and in the wholesale sector (NC_t, WC_t). I use quarterly data from the Czech Statistical Office and Czech National Bank databases for the period 1998:Q1–2013:Q2.

[6] This shock is quite suitable for the Czech economy because during the period used for estimation the Czech National Bank changed the targeting variable once (net inflation to headline CPI inflation) and adjusted the targeting band several times.

The beginning of the sample period was determined by the availability of data on house prices, the ending of the sample was chosen with the aim to avoid complications with zero lower bound on interest rates. Time series for C_t, IH_t, IK_t and q_t are in levels and are assumed trend stationary; the trend is estimated within the model. Other time series are demeaned.[7] As the data for the labour market in the housing sector (NH_t,WH_t) might not be very reliable, measurement error for these two series was added.

Some of the model parameters are calibrated according to Iacoviello and Neri (2010) and data from national accounts.[8] One of the calibrated parameters important for the analysis is loan-to-value ratio (LTV). Iacoviello and Neri (2010) calibrate LTV ratio to 0.85 for United States; the same value uses Walentin (2014) for Sweden while Christensen et al. (2009) calibrate it to 0.80. There is not much of empirical evidence about the value of this parameter for the Czech economy. Hloušek (2012) reports estimates of LTV ratios from DSGE model with both constrained households and entrepreneurs. His estimate for households is 0.79 and for entrepreneurs 0.51. Therefore, I set loan-to-value ratio to m = 0.75, taking into account that only constrained households are in the present model and also given the fact that the Czech mortgage market is less developed.

The rest of the model parameters were estimated using Bayesian techniques. The posterior distribution of the parameters was obtained using the Random Walk Chain Metropolis-Hastings algorithm. 1 000 000 draws in two chains with 500 000 replications each were generated, and 80% of replications were discarded so as to avoid influence of initial conditions and to calculate moments of posterior distribution from the draws of converged chains. The convergence was verified using MCMC diagnostics. All computations were carried out using Dynare toolbox (Adjemian et al., 2011).

4 ESTIMATION RESULTS

This section discusses the results of the estimation and examines the behaviour of the model. Table 1 shows prior means, standard deviations and posterior means together with 95% probability intervals for selected estimated deep parameters.[9] The priors for the parameters are mostly set according to the Iacoviello and Neri (2010) as their model exhibits some non-standard features (e.g. labour share of unconstraint households). Many other priors are quite standard in DSGE literature and are also commonly used in empirical studies for the Czech economy. Among those, only the prior mean for capital adjustment cost is set to a lower value of 5 (instead of 10) with reference to Slanicay (2013).

Parameters ε and ε' represent habit formation in consumption, for patient and impatient households respectively. The posterior mean of ε (0.42) is lower than the posterior mean of ε' (0.52). On average, these numbers indicate quite a weak habit in consumption. Typical values obtained for the Czech economy are usually much higher, around 0.8 (see e.g. Slanicay, 2013). Capital adjustment cost is more important in the consumption goods sector; the mean of the parameter $\phi_{k,c}$ is much higher than the prior, and is higher than its counterpart in housing sector, parameter $\phi_{k,h}$. The labour income share of constrained households ($1–\alpha$) was estimated at 0.28. This is slightly higher than the values found in empirical studies for the U.S. economy (0.21) or Sweden (0.18); see Iacoviello and Neri (2010) and Wallentin (2014).

A much higher estimate was obtained by Hloušek (2012) for the Czech economy (0.55) and Christensen et al. (2009) for Canada (0.38). However, these latter two papers used a different model structure. Estimated

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[7] The exception is nominal interest rate, which was detrended using the Hodrick-Prescott filter to obtain more easily interpretable data series. The time series for interest rate exhibits a visible decreasing trend. If it were to be demeaned, the interest rate would be below "equilibrium" level for almost the whole period from 2002–2013 (with a brief exception in 2008), which might not correspond to the view of the Czech National Bank at the time.

[8] For full set of calibrated parameters, see online Appendix (available at the website of this journal, see the online version of the *Statistika: Statistics and Economy Journal* No. 4/2016 at: <*http://www.czso.cz/statistika_journal*>).

[9] Results for other parameters and shocks are quoted in online Appendix (available at the website of this journal, see the online version of the *Statistika: Statistics and Economy Journal* No. 4/2016 at: <*http://www.czso.cz/statistika_journal*>).

values of Calvo parameters indicate that price and wage rigidities are almost equally important. This is in contrast to empirical studies for the Czech economy revealing that wages were more rigid than prices, e.g. Hloušek and Vašíček (2007) or Andrle et al. (2009). Again, the different sector structures of the models could explain this phenomenon. Parameters in the Taylor rule show that the Czech National Bank pays great attention to interest rate smoothing, $r_R = 0.91$, and to output growth, $r_Y = 0.23$. Even if the prior mean for r_Y was set to 0, which corresponds to strict inflation targeting, the information in the data was stronger. On the other hand, the posterior mean of the parameter of inflation $r_\pi = 1.34$ is slightly lower than the mean of the prior, which is usually used in calibrated models.

Table 1 Prior and posterior distribution of structural parameters

Parameter	Prior distribution			Posterior distribution		
	Density	Mean	S.D.	Mean	2.5%	97.5%
Habit formation						
ε	beta	0.50	0.08	0.42	0.33	0.52
ε'	beta	0.50	0.08	0.52	0.38	0.65
Capital adjustment cost						
$\phi_{k,c}$	gamma	5.00	2.50	9.10	0.09	10.97
$\phi_{k,h}$	gamma	5.00	2.50	4.58	1.76	7.34
Labour income share						
α	beta	0.65	0.05	0.72	0.65	0.80
Taylor rule						
r_R	beta	0.75	0.10	0.91	0.89	0.93
r_π	normal	1.50	0.10	1.34	1.17	1.50
r_Y	normal	0.00	0.10	0.23	0.09	0.37
Calvo parameters						
θ_π	beta	0.67	0.05	0.73	0.67	0.79
$\theta_{w,c}$	beta	0.67	0.05	0.76	0.72	0.80
$\theta_{w,h}$	beta	0.67	0.05	0.69	0.62	0.75
Technology growth rates						
$100\,\gamma_{AC}$	normal	0.50	1	0.41	0.37	0.46
$100\,\gamma_{AH}$	normal	0.50	1	– 0.53	– 0.95	–0.09
$100\,\gamma_{AK}$	normal	0.50	1	0.10	0.05	0.14

Source: Author's calculations

The estimated parameters of technology growth rates (γs) can be used to compute trends of the model variables.[10] The quarterly growth rates for consumption (G_C), business investment (G_{IK}), residential investment (G_{IH}) and real house prices (G_Q) are 0.46, 0.56, –0.28 and 0.74, respectively. The simple univariate trend calculated on data delivers the following slopes: 0.63, 0.78, –0.38 and 1.44. The model captures a relative relation between growth rates of the variables ($G_{IH} < G_C < G_{IK} < G_Q$) but fails to capture its magnitude. The model under-predicts growth in consumption, business investment and especially house prices. The reason for this is that the growth rates in the model are mutually connected because of the existence of a balanced growth path, but the growth rate in the data may be influenced by structural changes. To return to the model, the steep trend in house prices was mainly caused by negative technological progress in the housing sector.

[10] Equations (13) to (16).

The model fit on the data was evaluated by comparison of moments calculated from the data, and moments obtained from model simulations. One can argue that the empirical performance of the model is acceptable.[11]

To provide answers to the research questions various methods are used. Comparison of impulse responses for different model specifications is a key tool for examining the effects of housing collateral in the monetary policy transmission mechanism. The relationship between the housing sector and the rest of the economy is studied by variance decomposition of forecast errors, while historical shock decomposition is used to identify the shocks behind developments in real house prices.

4.1 Impulse Response Analysis

This section examines the behaviour of the model in reaction to shocks under different loan-to-value ratio assumptions. First, we will focus on an interpretation of impulse responses, and then we will carry out a quantitative assessment of the transmission mechanism.

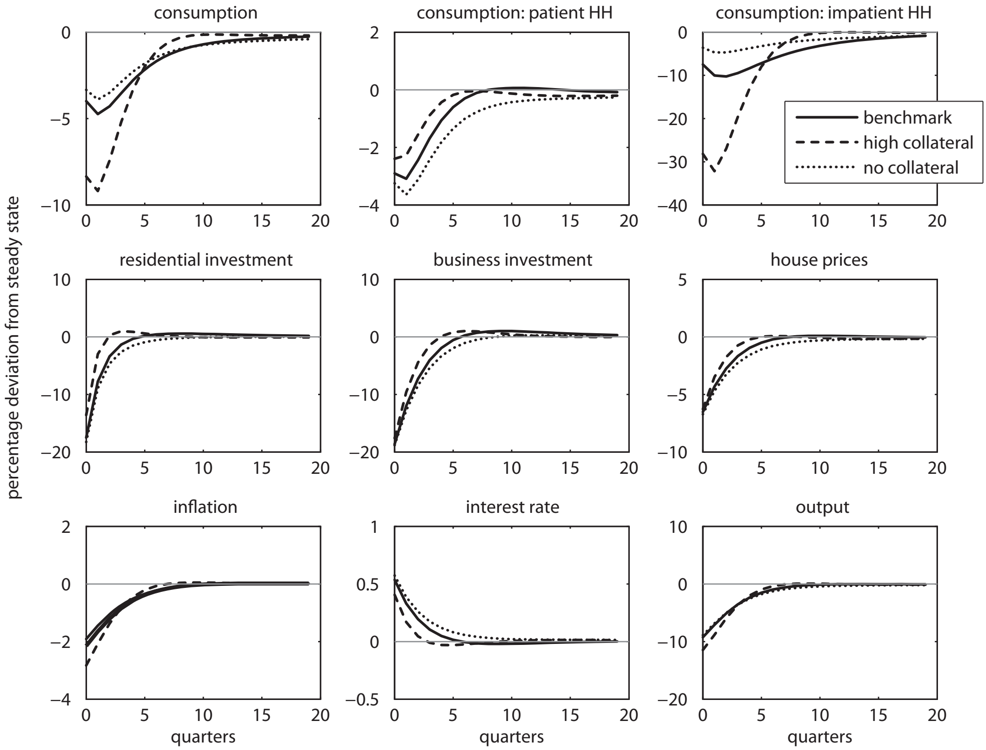
Figure 2 shows the reaction of the model variables to a monetary policy shock – the increase of nominal interest rate by one percentage point. The y-axis measures percentage deviation from the steady state; the reaction of the benchmark model is depicted by a solid line. A temporary increase in the nominal interest rate causes a drop in inflation by 2%; output decreases by as much as 9%, and house prices by 6%. Both types of investment decrease by roughly the same amount; however, residential investment returns faster. The decrease in investment is larger than that in output, which is, in turn, larger than in consumption. The reaction in consumption is hump-shaped, with a trough in the second period following the shock, and is long-lasting, with return after fifteen quarters. The consumption drop is driven primarily by the consumption of impatient (credit constrained) households: the fall in consumption is three times larger for impatient households than for patient households. This is for two reasons: first, collateral constraint becomes tighter because of the fall in house prices; second, there is the Fisher debt-deflation effect – an unexpected fall in inflation increases ex-post real interest rate, and thus results in an increased real debt burden. Therefore, wealth is transferred from borrowers to savers.

Figure 2 also shows the reaction of variables for other versions of the model. In all three specifications the estimated parameters are kept at their posterior means. In the benchmark model the loan-to-value ratio (parameter) is calibrated to 0.75, in the "high collateral" model it is 0.95, which means that constrained households are in a better position to obtain a loan; in the "no collateral" specification, the LTV is set to 0.0001, which means that houses are not collateralizable and impatient households are excluded from the financial market.

The reactions of the model variables for all three specifications are qualitatively identical but differ in magnitude, especially for consumption and output. Table 2 summarizes these findings. Each row shows the difference at trough of impulse responses for the corresponding variable between the specifications. The presence of collateral constraint (first row) does not produce much difference. However, an increase of LTV ratio from 0.75 to 0.95 (second row) causes a bigger drop in consumption by 4.5 and in output by 2.2 percentage points. On the other hand, the impact for inflation is quantitatively small (0.68 p.p.). Figure 3 shows the amplitude of the impulse responses in reaction to the LTV ratio (up to =0.95). This figure documents the fact that effect of LTV ratio is non-linear: a marginal increase at high values of LTV causes a much higher drop in all variables than a marginal increase at lower values of LTV. The results of this exercise lead to two conclusions: (i) monetary policy shocks are amplified when collateral effect is present and LTV ratio is high, and (ii) the impact for real variables such as consumption and output is much larger than the impact for inflation. Thus, restrictive monetary policy aimed at reducing inflation may result in large drops in real variables, when the LTV ratio is high. These results are in line with the findings of Walentin (2014) for the Swedish economy.

[11] For details see the online Appendix (available at the website of this journal, see the online version of the *Statistika: Statistics and Economy Journal* No. 4/2016 at: <*http://www.czso.cz/statistika_journal*>).

Figure 2 Impulse responses to monetary policy shock



Source: Author's construction

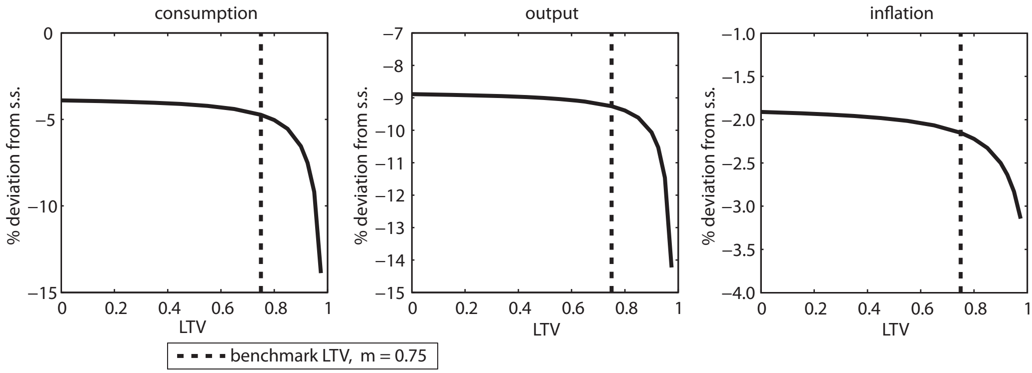
Figure 4 shows a reaction to housing preference shocks that can be interpreted as an increase in demand for housing. This shock causes a very persistent increase in house prices. Since houses serve as collateral for constrained households, any raise in their price increases the households' borrowing capacity and thus their spending. Given the higher propensity of borrowers to consume, the overall impact on aggregate consumption is positive, even if consumption of unconstrained households (savers) falls. Both residential and business investment increase and so does output. Inflation also increases, and the central bank raises the interest rate in order to bring the economy back to steady state. Subsequently, the reaction of the economy to this shock is in line with the results of Walentin (2014) for the Swedish economy, where business investment also rises while it was found to decline for the U.S., as reported by Iacoviello and Neri (2010). Looking at other model specifications, the model with high LTV ratio ($m = 0.95$) produces qualitatively similar results but much larger deviations e.g. for consumption and inflation. On the other hand, when collateral constraint is switched off,

Table 2 Effect of collateral constraint on amplitude of impulse response to monetary policy shock (difference between IRFs at trough in percentage points)

	Consumption	Output	Inflation
IRF no collateral ($m = 0$) – IRF benchmark ($m = 0.75$)	0.84	0.37	0.24
IRF benchmark ($m = 0.75$) IRF high LTV ($m = 0.95$)	4.45	2.20	0.68

Source: Author's calculations

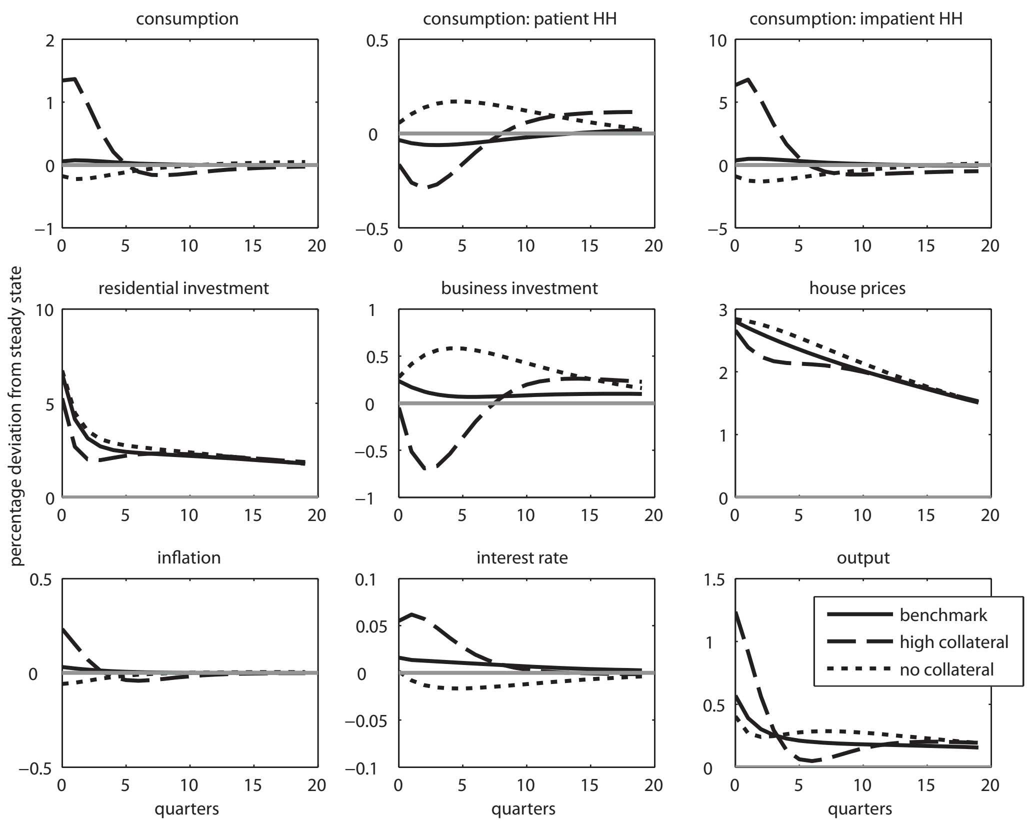
Figure 3 Effect of different LTV on amplitude of impulse responses to monetary policy shock



Source: Author's construction

the reaction of consumption, inflation and interest rate is the very opposite. However, this last model prediction contradicts the empirical evidence. Using the VAR model estimated on Czech data, Hloušek (2012) found that there is a positive co-movement of consumption and house price in response to house price shock.

Figure 4 Impulse responses to housing preference shock

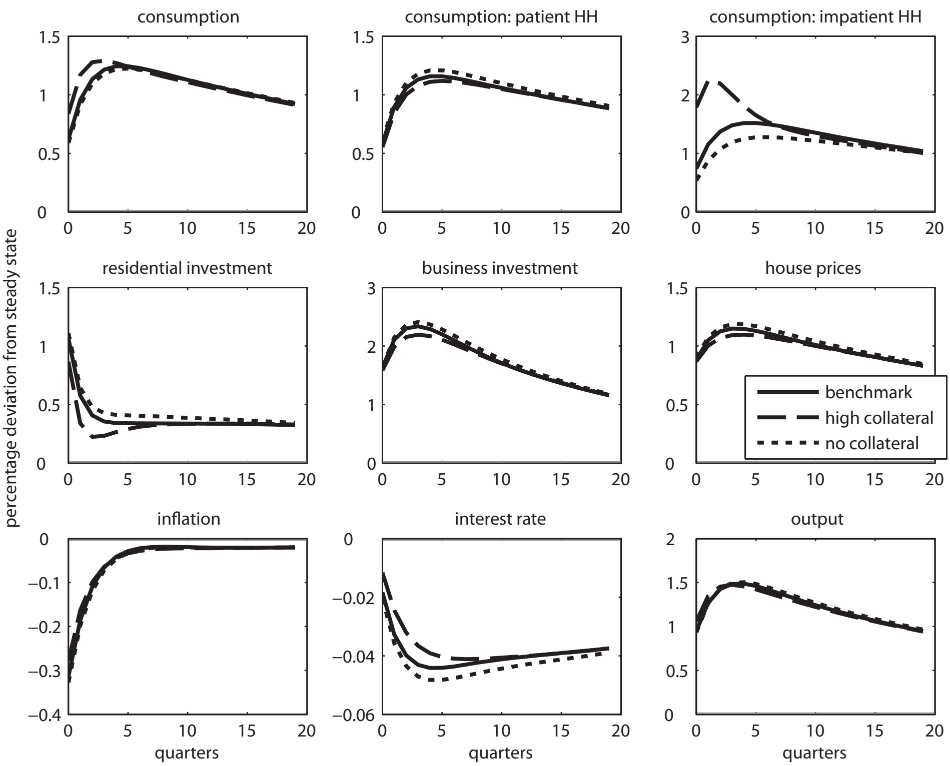


Source: Author's construction

Iacoviello (2005) obtained similar results for the United States. Therefore, the collateral effect is a necessary feature of the model for it to show a positive response in consumption to the house price shock, as is evident in the data.

Figure 5 shows the reaction of the variables to consumption goods technology shock. This shock results in cheaper production of consumption goods; therefore, inflation decreases, whilst consumption increases. Both types of investment increase, and thus output also increases. However, the drop in inflation is more significant than the rise in output and so the central bank lowers the interest rate. This shock is quite persistent and the deviation of the variables from steady state is thus long-lasting. There are only slight differences across the specifications. Collateral effect is not important here because this shock causes opposite reactions in house prices and inflation, and the amplification mechanism is dampened. The rise in house prices increases impatient households' borrowing capacity, while the decrease in inflation increases the real interest rate and causes a negative income effect for borrowers.

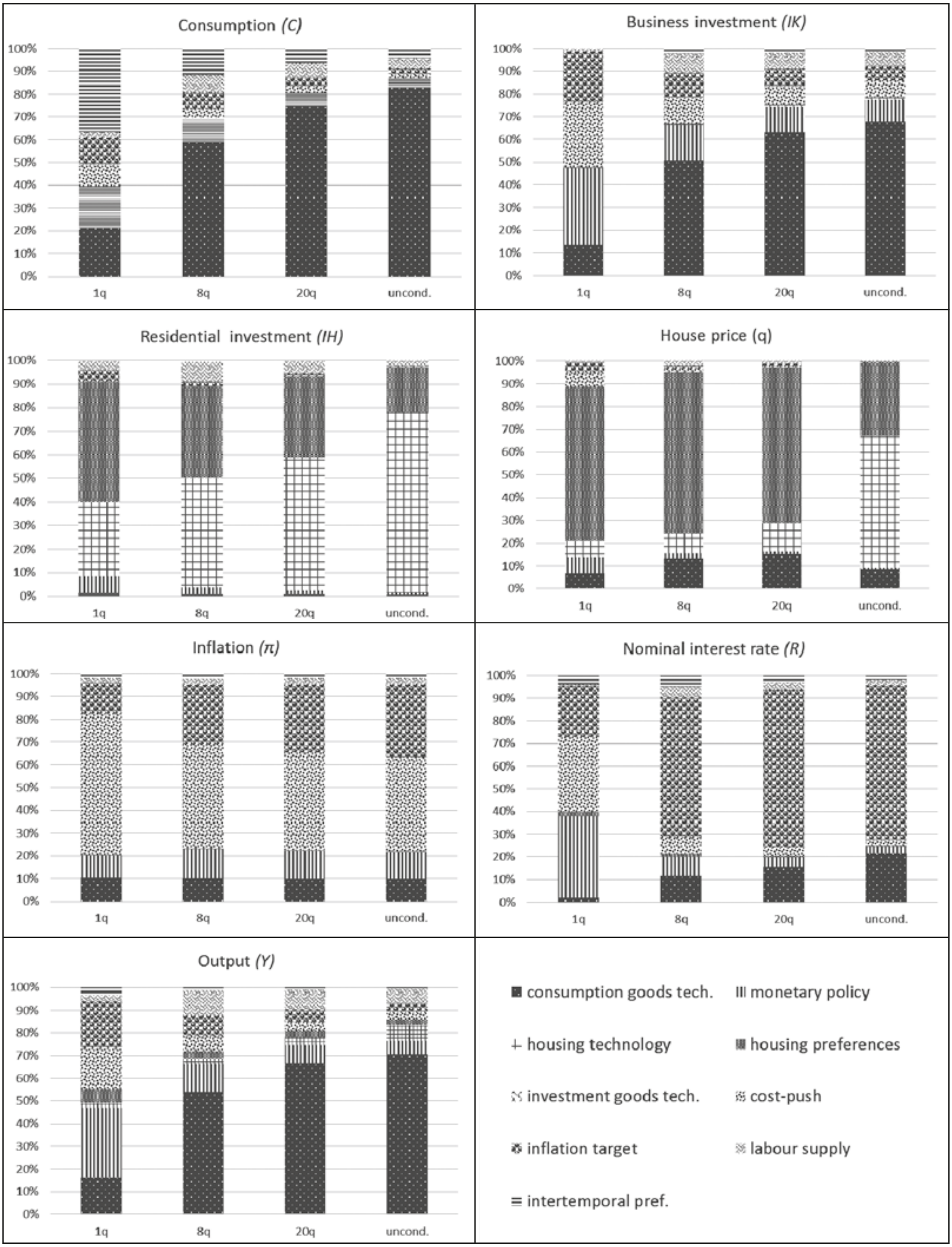
Figure 5 Impulse responses to consumption good technology shock



Source: Author's construction

The collateral effect is important only for some kind of shocks: those that move house prices and inflation in the same direction. These are, specifically, monetary policy shock, housing demand shock, housing technology shock and inflation target shock (the last two are not shown here). The increase of LTV to higher values against the benchmark amplifies short run responses in consumption, output or inflation, whose magnitudes vary according to the type of shock. These effects are quantitatively substantial and support a policy of setting maximum limits on LTV ratios, with the aim of reducing the volatility of the variables.

Figure 6 Variance decomposition



Source: Author's construction

4.2 Variance Decomposition

Figure 6 shows a conditional variance of the model variables explained by each shock for a one-, eight- and twenty-quarter forecast horizon, and an unconditional forecast error variance decomposition. There is an interesting pattern to be observed: monetary policy shock, cost-push shocks and inflation target shocks are quite important in the short term, not only for the nominal variables but also the real variables. However, their influence on the real variables fades over time. The opposite is true for technology shocks, whose influence increases with time. Housing preference shocks are more or less stable in explaining the variance of residential investment and real house prices.

The last columns of the Figure 6 show an unconditional variance decomposition and deserves bigger attention. Productivity shocks in the non-housing sector for consumption goods explain most of the volatility in consumption, business investment and output. On the other hand, investment-specific technology shocks are unimportant even for business investment. Housing technology and preference shocks are important for the behaviour of residential investment (IH) and house prices (q), while the latter is more significant in the shorter term (compare with the previous part). Inflation target shocks are mainly responsible for variance in interest rate (R) and together with cost-push shocks also for variance in inflation (π). Labour supply shocks and intertemporal shocks are relatively unimportant.

The central objective of this paper is to assess the relationship between the housing market and the rest of the economy. One can see that there is a large degree of disconnection. Both housing market shocks (technology and preferences) explain in sum 96% of variance in housing investment and 90% of variance in housing prices.[12] As regards non-housing shocks, only consumption good technology shocks play some role in the variance in housing prices. The opposite also holds: housing market shocks explain about ten percent of output variance (mostly through housing investment) but almost zero variance in inflation. Therefore spill-overs of housing specific shocks into the broader macroeconomy can be considered negligible. Potential problems in the housing sector do not therefore represent any threat for the economy in this benchmark setting.

The effects of LTV ratio on the monetary transmission mechanism that were analysed by impulse responses in the previous section can be further illustrated by looking at the unconditional forecast error variance decomposition. Table 3 shows the variance of consumption, output and inflation accounted for by monetary policy shock for different values of LTV ratio. When the LTV is increased from 0.75 to 0.95, monetary policy shocks have a larger effect, especially on consumption (more than twofold) followed by inflation and output (by 32%). When the collateral effect is switched off ($m = 0$), monetary policy shocks explain a smaller fraction of the variability, but the difference from the benchmark is intangible. These results repeatedly confirm the fact that increasing LTV amplifies the ability of monetary policy to influence consumption, output and inflation, with its largest effect being on consumption. Contrary to the results obtained from impulse responses,

Table 3 Unconditional variance decomposition: effect of monetary policy shock (in %)

	Consumption	Output	Inflation
High LTV (m =0.95)	8.4	7.5	15.6
Benchmark (m =0.75)	3.8	5.7	11.8
No collateral (m = 0)	2.8	5.5	9.6

Source: Author's calculations

[12] See Table 5 in the online Appendix for exact numbers (available at the website of this journal, see the online version of the *Statistika: Statistics and Economy Journal* No. 4/2016 at: <*http://www.czso.cz/statistika_journal*>).

the impact of higher LTV for output and inflation here is quantitatively similar. This is due to the fact that in IRF analysis we considered the very short term impacts, while the forecast error variance decomposition is calculated for the long-term and, as was documented in Figure 6, the effect of monetary policy shock for output strongly decreases with time.

Finally, Table 4 shows the effect of different values of LTV ratio on the variance decomposition of selected variables following housing preference shock. Again, high values of LTV amplify the impacts of the shock, especially for consumption and inflation. In this case, the spill-overs to the broader macroeconomy can be considered nontrivial, and may justify setting caps on the loan-to-value ratio. Regarding housing technology shock (not shown here), the impacts on macroeconomic variables increase only slightly with increasing LTV ratio.

Table 4 Unconditional variance decomposition: effect of housing preference shock (in %)

	Consumption	Output	Inflation
High LTV (m =0.95)	8.6	5.7	4.7
Benchmark (m =0.75)	0.1	2.5	0.1
No collateral (m = 0)	0.6	2.7	0.6

Source: Author's calculations

4.3 Historical Shock Decomposition

While variance decomposition relates to forecast error of exogenous shocks to particular variables, historical shock decomposition performs an error decomposition on historical data. Figure 7 depicts the historical decomposition of real house prices into shocks during the estimated period. It shows that housing preference shocks became more significant from the end of 2001; from this moment onwards, they were the main determinant of rising house prices. The same shocks were responsible for the subsequent house price decline during and after the crisis. Housing technology shocks also contributed to the development of house prices, but in a more stable way. Consumption goods technology shocks also increased their influence on the behaviour of house prices, mainly from 2002. After the peak in 2008, these non-housing technology shocks diminished, just as house prices declined. This analysis shows that both the demand and supply shocks played important roles; however, demand shocks were overall responsible for the fluctuation of house prices.

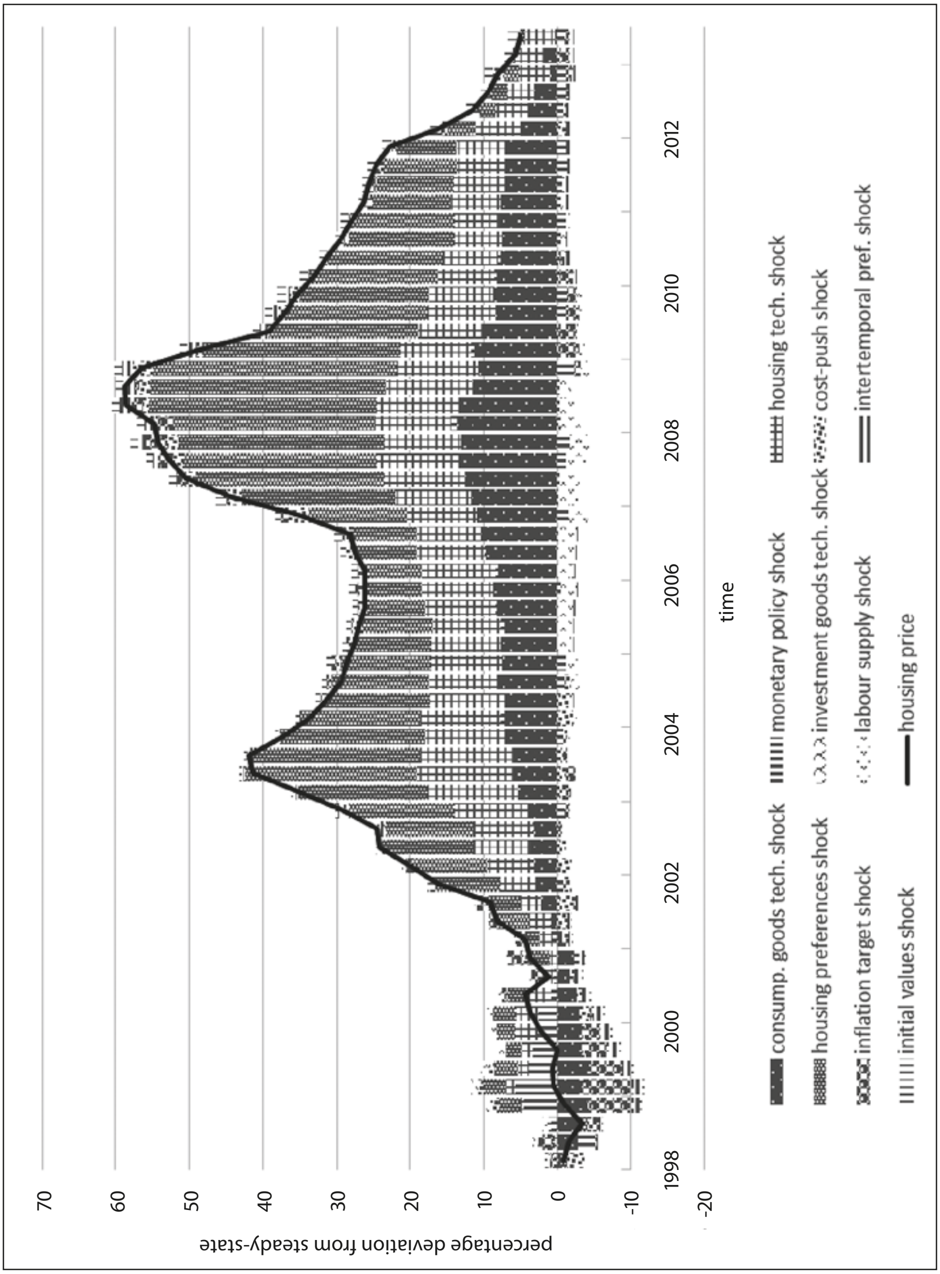
CONCLUSION

This paper presents the results of an estimation of a medium-scale DSGE model with housing sector using Czech data. The answer to the research question, regarding a possible connection between the housing sector and the rest of the economy, is rather complex. According to the forecast error variance decomposition, there is no significant link between these sectors. Housing sector shocks do not transfer to the broader economy, and only consumption good technology shocks explain some of the variability in real house prices.

If we look at the historical behaviour of house prices, shocks to housing preferences were their main driving force, especially during the turbulent past ten years. Technology shocks in the consumption goods sector and housing sector also contributed to raising house prices, but in a more stable manner.

In spite of the high degree of disconnection between the sectors, there is an important channel at work – a collateral constraint mechanism with houses serving as collateral. This mechanism influences transmission of monetary policy shocks to the real variables and crucially depends on loan-to-value ratio. If loans to constrained households are more accessible (high LTV), the reaction of both consumption and output to monetary policy shocks is much more pronounced, especially in the short term. On the other hand, the impact on inflation

Figure 7 Shock decomposition of housing prices



Source: Author's construction

is not so distinctive. Moreover, the value of LTV amplifies these responses in a non-linear way. A marginal increase in LTV at high values of this variable causes a larger impact, especially for consumption and output, than a marginal increase at lower values of LTV.

Similar amplification is also observed for housing preference shock and its impacts on macroeconomic variables. High values of LTV ratio magnify the impacts of this shock, especially for consumption and inflation. This outcome partly modifies the previous results that suggested disconnection between the sectors, instead indicating potential threats from the housing sector. There is also another potential cost connected with high LTV, which was not considered in the model, and that is that high LTV increases the probability of households defaulting on their loans, which can have impacts on the stability of the financial system and consequently on the whole macroeconomy.[13] These results should be taken into consideration in the formation of macroeconomic policy that will set limits on loan-to-value ratio. Such a practice has already been introduced in Sweden where LTV is limited to a maximum 85% (Swedish Financial Supervisory Authority, 2010). The aim of this policy was to decrease risk in the credit market that stems from the inability of heavily indebted borrowers to repay their debts.

The impacts of LTV ratio were illustrated in this paper in reaction to disinflationary (restrictive) monetary policy, which caused welfare losses in terms of consumption or output. As the model assumes symmetry, we would obtain equivalent but opposite effects for the case of a decrease in interest rate by the monetary authority. However, we might see asymmetric behaviour in consumption and output: a lower interest rate increases house prices and housing wealth, but the collateral constraint does not need to be binding. Credit constrained households become unconstrained following such a move, and change their consumption only a little compared with the case of restrictive monetary policy and low house prices. Another related issue is the zero lower bound on interest rate, which prevents the central bank from decreasing the interest rate, and may also contribute to the asymmetric behaviour of consumption and output. Guerrieri and Iacoviello (2014) explore these asymmetries, but focus mainly on house price shocks. This could therefore be an appropriate topic for further research.

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APPENDIX

See the separate PDF file in the online version of the *Statistika: Statistics and Economy Journal* No. 4/2016 at: <*http://www.czso.cz/statistika_journal*>.

Estimation of Regional Price Levels in the Districts of the Czech Republic

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Abstract

The aim of this article is to suggest and to apply a method for estimation of the regional price levels in Czech districts. Its purpose is to enable an assessment of spatial differences in the regional price levels and thereby to provide an instrument for more precise and more realistic comparison of standard of living of households across the regions of the Czech Republic. Authors use data from the extensive price surveys carried out by the Czech Statistical Office and regionalize them by an original approach derived from the Eurostat-OECD International Comparison Program and certified by the Ministry of Regional Development of the Czech Republic. The results reflect regional differences in market prices of goods, services, as well as housing and rentals. The findings underpin the need of a more accurate specification of economic and social disparities on a regional level originating in the recent shifts of regional policies from localities-and-areas-centered to local-people-centered.

Keywords	***JEL code***
Consumer Behavior, Household Expenditure, Price Level, Regionalization, Törnqvist Index	*R11, R21*

INTRODUCTION

The regional policies of the European Union (EU) are targeted among others at sustainable development of regions and improving the citizen's quality of life (Terem et al., 2015). The regional convergence has been one of the major issues of economic analyses, while almost a third of the EU budget is set aside for the cohesion policy (EC, 2015). The primary indicator for assessment of regional economic performance is the regional gross domestic product compared on the European level in so-called purchasing parity standard (PPS). The PPS is calculated by the Eurostat within the Eurostat-OECD International Comparison Program on the national level and as such it does not take into account the differences in price levels across the regions (Čadil and Mazouch, 2011). Although the regional price levels may constitute an important factor when assessing the economic development of a region, this issue has until recently not received much attention either in the world, in the EU, or in the Czech Republic (Čadil et al., 2014).

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The first attempts to measure the regional price levels in the Czech Republic have been carried out by Musil et al. (2012) and Čadil et al. (2014). The aim of this paper is to update and rectify their results using slightly more advanced methods of calculation and data processing. The purpose of this paper is to introduce a transitive superlative indicator of regional price levels (Regional Price-level Index, *RPI*) as an instrument for estimating the real standard of living in the Czech regions. Čadil et al. (2014) discuss the possibility of using their regional price-level indicator to adjust the regional nominal gross domestic product, we, however, aim mainly at the regional households and their real socioeconomic position.

The paper is divided into three major parts: At first, we discuss several approaches to regional price-level estimates applied in the world, in some EU countries, and also in the Czech Republic. In the second part, we introduce our method of data processing and calculation derived from the Eurostat-OECD International Comparison Program. Then, we comment our results and compare them to those published by Musil et al. (2012) and Čadil et al. (2014).

1 IMPORTANCE AND TOPICALITY

The need to measure regional price levels originated in the new concept of regional policies which should be generally focused more on the people living in the region than on the area of the region (Gibbons et al., 2011). The problem is that the nominal income indicators provide distorted information about social and economic position of inhabitants of a region because they do not reflect the regional differences in the costs of living. After all, even Kahoun (2011) and Viturka (2007) admit the price levels can vary locally and regionally, especially due to different prices of services and real estate.

In the last ten years, the issue of regional price levels has been addressed by several authors, whose works are often based on regionalization of national price indexes. In the European countries, the attempts to regionalize the price indexes are usually hindered by insufficient or random investigation of prices in the respective regions. At present, the regional price levels are systematically measured and published in the USA, in the UK, and in Australia.

- The Bureau of Labor Statistics in the United States is the most ambitious one in the area of regional price levels. They use the hedonic regression extensively to determine the regional consumer baskets under the condition of constant households' utility across the country. They also apply the methods of the rent equivalent to estimate the prices of services connected with housing. Their consumer basket includes 800 representatives. The results are published every two years. Regional price index is calculated for 366 metropolitan areas which are defined by an urban center of more than 50 000 inhabitants. They also calculate the price levels for whole individual states using weighted geometric mean of the corresponding metropolitan indexes (Aten and d'Souza, 2008; Aten et al., 2013).
- In 2011, the Australian Bureau of Statistics extended the list of areas for price survey by 22 cities and since then, they publish the regional price index for 30 city districts. The consumer basket contains 500 representatives divided into 8 headings. Results are published every second year (RDL.WA, 2011; Waschka et al., 2003).
- The Office of National Statistics in the United Kingdom has been publishing the results of the spatial price comparison every two years since 2000. Their consumer basket consists of 380 representatives surveyed in 65 regions. The collection of data is carried out by a commercial marketing company Research International (Fenwick and O'Donoghue, 2003; Ball and Fenwick, 2004).

In Germany, the published estimates of regional price levels are based on price survey carried out in 50 German cities in 1994. The first German author, who exploited the price investigation from the viewpoint of regional price levels, was Ströhl (1994). His followers, Schultze (2003), Kosfeld et al. (2008), Kosfeld and Eckey (2010), and Roos (2006a, 2006b) look for possible ways of price level estimation in the regions where they have explanatory data at their disposal. They frequently apply econometric modelling and complement the calculation of regional price levels with a real estate price index (Roos, 2003; Kosfeld et al., 2008; Kosfeld and Eckey, 2010). Other, often one-off attempts to calculate the regional price levels have been carried out in Italy (Pittau, Zelli; and Massari, 2006), China (Brandt and Holz, 2006) or (Gong and Meng, 2008), Austria (Matzka and Nachbagauer, 2009) or also in Slovakia (Radvanský and Fuchs, 2009).

In the Czech Republic, the regional price levels were estimated by Musil et al. (2012) on a common consumer basket and by Čadil et al. (2014) on a set of regional consumer baskets. They applied the Eurostat-OECD International Comparison Program methods with a certain simplification. They used a national concept (rather than domestic) and calculated the regional price levels for the Czech regions (NUTS 3) based on the historical data from 2007 (Musil et al., 2012; Čadil et al., 2014).

2 METHODS AND DATA SOURCES

The process of *RPI* construction was certified by the Ministry of Regional Development of the Czech Republic in December 2015. It is based on the Eurostat-OECD International Comparison Program methods and its core is therefore similar to the approach applied by Musil et al. (2012) and Čadil et al. (2014). The major differences appear in the following five aspects.

2.1 Area Segmentation for Regional Price Level

Without any doubt, the segmentation of the area into smaller spatial units is always more appropriate as it provides more detailed information and offers a possibility to target the regional policies more accurately. In the Czech Republic (as elsewhere), reliable estimates are limited by the data available from price surveys (for the purpose of the construction of the national consumer price index) and from household expenditure surveys (Household Budget Survey).

- The Czech Statistical Office performs price surveys in 35 districts and in the Capital of Praha, i.e. on the level of selected LAU 1 (formerly NUTS 4). These data are the main source for the *RPI* calculation and therefore their localization will be respected. Raw monthly data from price surveys in 2011–2013 were used.
- Household expenditures in the classification of individual consumption by purpose (CZ-COICOP) are recorded only on the level of cohesion regions (NUTS 2). Thus, the Household Budget Survey represents the only official data source on regional household expenditure structure.

The primary spatial level selected for our calculations are the former districts (LAU 1). The expenditure weights for these lower territorial administrative units will be approximated (see 2.3 for details).

2.2 Price Data Adjustment

The prices are investigated by the Czech Statistical Office in 35 districts (LAU 1) and the Capital of Praha for approximately 700 price representatives. The main purpose of this price investigation is the construction of time indexes (national consumer price index). Thus, the diversity of varieties[2] investigated for each price representative is an advantage here, because it increases the robustness of the basic set for the calculation of the consumer price index.

We use the same price data, but for a brand new purpose – to calculate the regional price levels. Therefore, the spatial diversity of the investigated varieties of each price representative is undesirable and

[2] Here, *variety of a price representative* is a concrete and in the reporting unit permanently investigated product or service respecting specific conditions of the offer at the place of investigation which do not deviate from the characteristics (general description) of the price representative.

can significantly bias the results. In each region, identical or qualitatively very similar goods should be surveyed so that the spatial comparability is ensured. In this respect, the headings containing the price representatives of a wide range of qualitatively different varieties are the most questionable – typically these are clothing and footwear (Heading 03) and furnishing, household equipment, and routine maintenance of the house (Heading 05).

The procedure of raw data adjustment (from monthly surveys carried out in 2011–2013) was divided into three steps:

- Qualitative adjustment: All prices surveyed for each price representative were clustered into several varieties using a specialized text-mining software based on the principles of Levenshtein distance chain metric. This procedure analyzed the text information in "notes" attached to each of the 1 717 102 surveyed prices from years 2011–2013. Obtained varieties were then checked and rectified manually. The 560 price representatives[3] surveyed by the Czech Statistical Office regionally were split into 4 673 varieties.
- Quantitative adjustment: The three-sigma rule was applied repeatedly in each year and each region (LAU 1) on each variety of a price representative to remove the outliers. This procedure is inspired by Eurostat (2012) and represents a tool for removing errors in the data file and ensuring higher qualitative homogeneity of each variety.
- Completing the data matrix: Similarly to Eurostat (2012), where products in each basic heading are classified as representative or non-representative, we decided to choose for each price representative one characteristic variety (which was surveyed in the most of the districts). In those regions, where the characteristic variety of a price representative was not surveyed, its price was estimated using the least square method according to the prices of non-characteristic varieties of the same price representative (similar to the method of bridging – see Eurostat, 2012), according to the price of characteristic and non-characteristic varieties in other regions (similar to approach of Musil et al., 2012) and/or according to the development of the price in time (methods of panel data analysis). If filling the gaps of the data matrix failed for a particular price representative in any region (LAU 1), it was completely removed from further computation (which was the case for 68 price representatives).

2.3 Expenditure Weights

The selection of expenditure weights influences the results, index interpretation, and also its application. If national weights are used, indexes have a form of comparison on the basis of fixed consumer basket and the index does not reflect individual consumer habits of regional households. The disadvantage of such a procedure is that if expenditure shares (or more generally weights) are related to another set of households, it is not possible to speak about an index on the basis of regional cost of living. The method of fixed basket decreases regional distinctiveness of the result.

The comparison on the basis of regional weights brings more illustrative results, better reflecting the regional specifics in consumer behavior, but it requires transitivity of price indexes. The most widely used method of transitivity implementation is Éltető-Köves-Szulc method (EKS). The EKS method ensures transitivity by means of geometric averages of all direct and indirect price comparisons (for more details see Eurostat, 2012).

The only source of official information about regional household expenditures in relation to their income in the Czech Republic is the Household Budget Survey. The data are investigated on a set of

[3] Out of the 700 price representatives included in the Czech consumer basket; some are investigated centrally (such as prices of electricity, gas, etc.) and some record regionally constant price (such as cigarettes, post stamps, etc.).

2 850 households selected by quota sampling. Regional results are published only on NUTS 2 level (which in the case of Moravskoslezský region and the Capital of Praha corresponds with the regional level NUTS 3) and therefore the weights on the level of NUTS 3 and LAU 1 had to be estimated. We applied the Small Area Estimation method (see e.g. Pfeffermann, 2002; or Rao and Molina, 2015) based on multiple linear regression to the weight structure of twelve CZ-COICOP Headings. The results show the regional differences in structure of household expenditures in all districts of the Czech Republic. Unfortunately, the expenditures of households are underestimated by the Household Budget Survey in some cases. Typically, CZ-COICOP Heading 02 (Alcoholic Beverages and Tobacco) has the weight of 2.6% according to Household Budget Survey, but 9.6% according to the national CPI basket. Therefore, the estimated regional weight structure of the twelve CZ-COICOP Headings had to be adjusted so that it reflects the regional differences, but also matches the CPI basket when aggregated to the national level (Kramulová and Musil, 2013).

The weight decomposition of the CZ-COICOP Headings of regional baskets down to the level of the individual price representatives was then carried out by linear approximation based on shares of the representatives in the national basket used for consumer price index calculations.

Following the payment method suggested by Melser and Hill (2007), we decided to replace the imputed rent in the CZ-COICOP Heading 04 of the consumer basket with expenditures on households' own dwelling financed by mortgages. The intention is to incorporate into the index the real expenditures on the repayment of mortgages, which affect the purchasing power of Czech households with increasing significance. The mortgage repayments are characterized by higher regional variability as they are influenced by the price of real property including land (plots). In the years 2011–2013, approximately CZK 115 billion was allocated annually for the repayment of mortgages according to authors' calculations. Data for these calculations were provided by the Czech National Bank, the Ministry of Regional Development, and the Ministry of Finance of the Czech Republic. The General Financial Directorate of the Ministry of Finance of the Czech Republic was the source of data about applied interests as a part of income tax return of physical persons which enabled detailed segmentation of the mortgage repayments to the regional level of LAU 1. For details on application of the payment method see Kraft et al. (2015).

2.4 Period and Frequency of Investigation

The current approaches to regional price level estimation and the results published e.g. by Slesnick (2002) or Tabuchi (2001) show, the regional differences in prices are rather stable over time. To ensure the consistency of the data in the Czech Republic (the rent deregulation started in 2011 and the data on household expenditures in CZ-COICOP classification are available for the NUTS 2 since 2011), we suggest computing the regional price levels for a period 2011–2013. Since the procedure of qualitative data adjustment is very time-consuming and capacity-demanding, we recommend to repeat the procedure in at least three-year (but preferably longer) periods. The longer time span offers more data and thus increases robustness of the results.

2.5 Aggregation Method

The method of price aggregation of individual price representative into one overall number is generally a formula for the calculation of a price index. An index which is intended to be used as a spatial index should include information about weights from different areas, it means it should be superlative.

Generally, three superlative indexes are distinguished: Fisher, Törnqvist, and Walsh index. Fisher ndex is a geometric average of Laspeyres and Paasche indexes. Törnqvist index is a geometric average of geometric Laspeyres and geometric Paasche indexes. Walsh index compares expenditures on the purchase of an average consumer basket which is a geometric average of consumer baskets of regions *A* and *B* (Melser and Hill, 2007).

Unlike Fisher index, the Törnqvist index (and also geometric Laspeyres and Paasche index) has an extra quality as it can be decomposed so that the share of each price representative (or of any CZ-COICOP Heading) in the total price level can be easily determined. The use of EKS method when calculating unweighted price parities and the choice of Törnqvist index for aggregation enable better economic interpretation of results due to the relative representation of the expenditure function. The EKS method along with the application of a superlative index reflects the substitutional effect. A price index created in the way described above complies with the condition of transitivity and also satisfies the condition of characteristicity (Eurostat, 2012).

The calculation of the Regional Price-level Index (*RPI*) starts by computing the unweighted price parities. We follow the EKS method simplified by the fact that our price matrix is complete and all price representatives are characteristic in all regions (although in some of the regions their prices had to be estimated). Thus, the unweighted price parity of a region *A* can be written as:

$$p_A = \left(\prod_{k=1}^{36} P_{A,k} \right)^{1/36}, \tag{1}$$

where $P_{A,k}$ is the ratio of the price of the representative (more precisely of a characteristic variety of the price representative) in the region *A* to the price of the same representative in the *k*-th region, where $k = 1,2,\ldots,36$; p_A is the unweighted price parity of the region *A* on the level of a particular price representative (its characteristic variety).

In the next step, the geometric Laspeyres and Paasche price indexes are calculated (Eurostat, 2012). The geometric Laspeyres index (2) is a weighted geometric mean of unweighted price parities of a region *A* using the weights of the region *A*. The Paasche geometric price index (3) is a weighted geometric mean of unweighted price parities of a region *A* using the weights of the benchmark region *B*.

$$P_A^{GL} = \prod_{n=1}^{N} (p_A)^{s_n^A}, \text{ where} \sum_{n=1}^{N} s_n^A = 1, \tag{2}$$

$$P_A^{GP} = \prod_{n=1}^{N} (p_A)^{s_n^B}, \text{ where} \sum_{n=1}^{N} s_n^B = 1, \tag{3}$$

where *A* is the particular region, *B* is the benchmark region (here characterized by an average regional expenditure structure corresponding to the national expenditure structure of the *CPI*), P^{GL} is geometric Laspeyres index and P^{GP} is geometric Paasche index, p_A is the unweighted price parity of the region *A* on the level of a particular price representative, s_n is the share of a particular price representative *n* (from a basket of *N* representatives) on the total household expenditures.

The regional price level is calculated into the shape of an index number using the Törnqvist price index:

$$RPI_A = P_A^T = \sqrt{P_A^{GL} P_A^{GP}}, \tag{4}$$

where $RPI_A = P_A^T$ is Törnqvist regional price-level index for a region *A*.

The properties of the *RPI* enable to recalculate its values to the level of region NUTS 3 and cohesion region NUTS 2 as a geometric weighted average of district (LAU 1) indexes, where the weight is the proportion of the particular LAU 1 total household expenditures on the total household expenditures in the corresponding NUTS 3 or NUTS 2 region.

Since the coverage of regions (NUTS 3 or NUTS 2) by the price surveys of the Czech Statistical Office is rather uneven, it was necessary to estimate the price levels of the remaining districts. We followed a procedure similar to Roos (2006b), but estimated the partial regional price levels for each of the twelve

CZ-COICOP Headings (RPI_{COI}). We processed data of fifty potential predictors available for the period 2011–2013 for all 78 districts (LAU 1) of the Czech Republic (including the Capital of Praha). Unfortunately, neither average wage, nor net disposable household income were available at the time of estimation on the LAU 1 level. Data on average income after taxation were provided by the General Financial Directorate of the Czech Republic at the regional breakdown corresponding to LAU 1.

For higher robustness, the *RPI* is calculated as a mean value for a three-year period, therefore, also all the predictors are three-years averages. Data for all the predictors were recalculated so that they express the mean share of a certain district when bilaterally compared to all other districts of the Czech Republic. For each CZ-COICOP Heading, we tested a specific group of potential predictors whose relation to a particular RPI_{COI} seemed relevant and reasonable. We used stepwise procedure when building our models to control for multicollinearity (and we ran tests for multicollinearity among the potential predictors) and we also checked whether the sign on each predictor in the model matches with the common sense and logical anticipations. The selected predictors are listed in Table 1.

Table 1 List of Predictors and Their Codes

Code	Explanation
$pop_{15\text{-}60}$	Share of population at the age from 15 to 60 years
$pop_{<5K}$	Share of population living in cities with less than 5 000 inhabitants
$pop_{>20K}$	Share of population living in cities with more than 20 000 inhabitants
pop_{dis}	Share of population living in the district city
dens	Specific population density
income	Share of average income of economically active person in the district to an average income in the Czech Republic
unemp	Share of unemployed persons on economically active population
phys	Count of physicians per 100 000 inhabitants
house	Average market price of a dwelling
$road_{high}$	Number of kilometres of highways/motorways per 10 000 inhabitants
$road_{1st}$	Number of kilometres of 1st class roads per 10 000 inhabitants
BU_{ind}	Number of individual business units based in the district per 1 000 inhabitants
BU_A	Number of business units operating in agriculture, forestry, and fishery per 1 000 inhabitants
BU_G	Number of business units operating in wholesale and retail trade per 1 000 inhabitants
BU_H	Number of business units operating in transportation and storage per 1 000 inhabitants
BU_I	Number of business units operating in the field of accommodation and food service activities per 1 000 inhabitants
BU_L	Number of business units operating in the field of real estate activities per 1 000 inhabitants
BU_R	Number of business units operating in the field of arts, entertainment, and recreation per 1 000 inhabitants

Source: Own construction

The outcomes of our estimations are summed up in the following set of equations (5)–(16). The statistical significance of all the parameters was proved at the 95% confidence level by *t*-test and the statistical reliability of the model was verified by *F*-test at the same confidence level. All models of the partial regional price-level indexes for CZ-COICOP Headings (RPI_{COI}) also passed the Durbin-Watson test on residual autocorrelation.

$$RPI_{COI01} = 0.991 - 0.020dens + 0.048income - 0.018BU_A \quad (5)$$

$$RPI_{COI02} = 1.069BU_{ind} - 0.026BU_I - 0.044BU_R \quad (6)$$

$$RPI_{COI03} = 0.041income + 1.002BU_{ind} - 0.043BU_G \quad (7)$$

$$RPI_{COI04} = 0.721 + 0.292house - 0.023BU_L \quad (8)$$

$$RPI_{COI05} = 0.961 + 0.148pop_{dis} - 0.107BU_G \quad (9)$$

$$RPI_{COI06} = 1.952 - 0.977pop_{15-60} + 0.013pop_{>20K} + 0.055income - 0.062phys \quad (10)$$

$$RPI_{COI07} = 0.906 - 0.040road_{1st} + 0.135BU_H \quad (11)$$

$$RPI_{COI08} = 1.035 - 0.022pop_{<5K} - 0.011dens \quad (12)$$

$$RPI_{COI09} = 1.060 + 0.003dens - 0.601unemp \quad (13)$$

$$RPI_{COI10} = 0.527 + 0.268pop_{dis} + 0.193income \quad (14)$$

$$RPI_{COI11} = 0.931 + 0.101income - 0.034road_{high} \quad (15)$$

$$RPI_{COI12} = 0.933 + 0.113pop_{dis} - 0.052BU_A \quad (16)$$

The aggregation of the twelve fractional regional price-level indexes for each CZ-COICOP Heading (RPI_{COI}) to the overall value of regional price-level index followed a procedure analogical to aggregation of the *RPI* itself.

Achieved values of adjusted coefficients of determination ($R^2_{adj.}$) and of standard errors of estimates (SEE) are summed up in the Table 2. Their values indicate varying, but still acceptable statistical qualities of the twelve regression models as well as of the whole *RCI* estimates.

Table 2 Adjusted Coefficients of Determination (R2adj.) and Standard Errors of Estimates (SEE)

	RPI	*COI01*	*COI02*	*COI03*	*COI04*	*COI05*	*COI06*	*COI07*	*COI08*	*COI09*	*COI10*	*COI11*	*COI12*
$R^2_{adj.}$	**0.801**	0.358	0.272	0.299	0.743	0.232	0.247	0.598	0.225	0.354	0.645	0.364	0.451
SEE	**0.012**	0.016	0.015	0.040	0.032	0.021	0.034	0.029	0.009	0.026	0.073	0.046	0.037

Source: Own construction

The signs of the predictors in the equations (5)–(16) induce the following findings: Income (*income*) and housing prices (*house*) tend to increase the price levels, while unemployment (*unemp*) and also share of economically active population (pop_{15-60}) pull the prices down (larger share of population in economically active age tends to decrease the demand for health-care services). All of them represent the demand-side factors.

Share of population living in the district city (pop_{dis}) or in large cities ($pop_{>20K}$), as well as the overall number of individual business units (BU_{ind}) represent the agglomeration factors and increase the price levels. Intensity of competition in particular industries and sectors (*phys*, BU_A, BU_G, BU_H, BU_I, BU_L, or BU_R) and the quality of infrastructure in the districts ($road_{high}$ and $road_{1st}$) are identified as the supply-side factors contributing to lower price levels (Kraft, 2015).

Only the specific density of population falls in some cases to the group of agglomeration factors increasing the price levels, while in other cases its supply-side features prevail, decreasing the regional price levels (higher specific density of population probably makes it easier and cheaper to supply the products and services to the customers).

3 RESULTS

The results of our calculations are recorded in the Table 3 bellow. They indicate that the differences in the regional price levels are to the highest extent influenced by the CZ-COICOP Heading 04 (Housing, Water, Gas, Electricity, and Other Fuels), Heading 10 (Education), and Heading 11 (Restaurants and Hotels) – i.e. immobile commodities.

Table 3 Regional Price-Level Index (RPI) and Its Breakdown to CZ-COICOP Headings

Code	District	*RPI*	*COI01*	*COI02*	*COI03*	*COI04*	*COI05*	*COI06*	*COI07*	*COI08*	*COI09*	*COI10*	*COI11*	*COI12*
CZ0100	Praha	1.171	1.012	1.007	1.057	1.424	1.007	1.047	1.158	1.009	1.099	1.472	1.117	1.130
CZ0201	Benešov *	1.022	1.003	1.029	1.029	1.063	1.014	0.997	1.039	0.996	1.019	1.051	0.905	0.989
CZ0202	Beroun *	1.044	1.016	1.007	1.011	1.116	1.000	0.993	1.103	0.994	1.013	1.050	0.945	1.020
CZ0203	Kladno	1.046	1.004	0.995	0.982	1.108	0.988	1.055	1.030	0.985	1.005	1.214	1.044	1.082
CZ0204	Kolín	1.039	1.037	1.020	1.060	1.062	0.976	1.029	1.008	1.005	1.060	1.091	1.019	1.041
CZ0205	Kutná Hora *	1.017	1.009	1.011	1.001	1.057	0.999	1.023	0.997	1.000	0.989	0.987	1.013	0.998
CZ0206	Mělník *	1.038	1.007	1.009	1.002	1.114	1.001	0.981	1.067	1.003	1.000	1.002	0.999	1.004
CZ0207	Mladá Boleslav *	1.027	1.022	0.989	0.995	1.091	0.985	0.997	0.971	1.002	1.025	1.039	1.041	1.013
CZ0208	Nymburk	1.022	1.022	1.016	1.026	1.096	1.011	0.942	0.984	1.011	0.986	1.048	0.930	0.958
CZ0209	Praha-východ *	1.102	1.059	1.024	1.060	1.244	1.000	1.059	1.131	0.992	1.041	1.264	1.076	1.041
CZ020A	Praha-západ *	1.123	1.056	1.024	1.065	1.308	1.008	1.072	1.137	0.984	1.040	1.291	1.137	1.054
CZ020B	Příbram	1.028	1.010	0.990	1.054	1.037	1.005	1.074	1.029	0.998	1.034	1.022	1.026	1.040
CZ020C	Rakovník *	1.002	0.999	0.993	0.983	1.024	0.992	0.978	1.000	0.998	0.995	0.976	1.008	0.975
CZ0311	České Budějovice	1.027	1.033	0.987	1.043	1.035	1.026	0.979	1.020	1.000	1.053	1.046	1.067	0.985
CZ0312	Český Krumlov *	0.978	0.982	0.972	1.017	0.954	1.037	0.957	0.966	0.990	0.993	1.010	1.009	0.966
CZ0313	Jindřichův Hradec *	0.977	0.992	0.987	0.999	0.966	1.012	1.005	0.905	0.998	1.012	0.984	1.011	0.959
CZ0314	Písek *	0.992	1.002	0.998	1.014	0.984	1.017	1.042	0.932	1.006	1.011	1.015	1.018	0.983
CZ0315	Prachatice *	0.973	0.969	0.993	1.013	0.946	1.027	0.967	0.956	0.994	1.019	1.002	1.005	0.920
CZ0316	Strakonice	0.977	1.032	0.980	0.939	0.955	1.022	0.970	0.917	1.011	0.985	0.924	0.982	0.976
CZ0317	Tábor	1.000	1.002	0.995	1.069	0.977	0.990	0.976	1.001	0.994	0.986	0.959	1.076	1.028
CZ0321	Domažlice *	0.978	0.995	0.980	0.984	0.946	0.991	0.985	0.986	0.991	1.004	0.962	0.999	0.982
CZ0322	Klatovy	0.959	0.977	0.990	0.960	0.914	1.018	1.006	0.945	1.005	0.993	0.987	1.029	0.943
CZ0323	Plzeň-město	1.037	1.013	1.006	0.992	1.071	0.986	0.975	1.039	1.001	0.993	1.262	1.073	1.077
CZ0324	Plzeň-jih *	0.995	1.003	1.003	0.994	0.991	0.998	0.984	0.980	0.989	1.018	0.974	1.008	0.968
CZ0325	Plzeň-sever *	1.003	1.001	1.016	1.002	1.017	0.998	1.001	0.990	0.981	1.011	0.982	0.967	0.984
CZ0326	Rokycany *	1.010	1.007	1.006	1.004	1.016	0.996	0.993	1.085	0.991	1.018	1.014	0.889	0.996
CZ0327	Tachov *	0.963	0.982	0.985	0.977	0.932	0.992	0.942	1.044	1.003	0.982	0.978	0.779	0.952
CZ0411	Cheb	0.970	0.999	1.013	0.929	0.907	0.990	0.980	0.997	1.006	1.018	0.975	1.020	0.997
Z0412	Karlovy Vary	0.995	0.993	1.015	1.131	0.947	1.029	0.971	1.052	1.002	1.016	1.118	0.921	1.019
CZ0413	Sokolov *	0.963	0.979	0.993	0.972	0.896	0.986	0.967	0.999	0.998	0.986	0.898	0.982	1.006
CZ0421	Děčín	0.993	1.007	0.962	0.989	0.915	1.019	1.013	1.048	1.016	1.008	0.914	1.016	1.105
CZ0422	Chomutov *	0.947	0.992	0.975	0.968	0.848	0.984	0.999	0.981	1.013	0.975	0.918	0.996	1.004
CZ0423	Litoměřice *	0.992	0.998	1.007	0.997	0.975	1.003	0.997	1.012	1.000	0.989	0.968	0.958	1.001
CZ0424	Louny *	0.971	1.001	0.993	0.981	0.929	0.990	0.978	0.960	1.006	0.970	0.946	1.002	0.988
CZ0425	Most *	0.943	0.981	0.984	0.962	0.836	0.970	1.031	0.986	1.006	0.968	0.905	0.986	1.023
CZ0426	Teplice	0.999	1.010	1.001	0.968	0.969	0.975	1.015	1.074	1.000	0.984	0.938	1.011	1.024

End of Table

Table 3 Regional Price-Level Index (RPI) and Its Breakdown to CZ-COICOP Headings

Code	District	***RPI***	*COI01*	*COI02*	*COI03*	*COI04*	*COI05*	*COI06*	*COI07*	*COI08*	*COI09*	*COI10*	*COI11*	*COI12*
CZ0427	Ústí nad Labem	0.972	0.976	0.995	0.939	0.938	0.909	0.984	1.038	1.016	0.983	1.027	0.943	1.023
CZ0511	Česká Lípa *	0.984	0.994	1.006	0.997	0.953	0.998	0.991	0.979	1.006	0.984	0.946	0.989	1.010
CZ0512	Jablonec n. Nisou *	1.001	0.991	1.013	1.020	0.984	1.011	1.038	0.988	1.002	1.014	1.013	1.001	1.042
CZ0513	Liberec	1.043	0.994	1.008	1.067	1.076	1.030	1.049	1.042	1.009	1.027	1.083	1.052	1.061
CZ0514	Semily *	1.008	0.997	0.987	1.028	1.036	1.017	0.987	0.982	0.998	0.998	1.042	1.022	0.992
CZ0521	Hradec Králové	1.056	1.016	1.023	1.001	1.164	0.977	1.051	1.040	1.027	0.987	1.028	1.064	0.980
CZ0522	Jičín *	1.008	1.005	1.009	1.005	1.024	0.998	0.983	0.992	1.001	1.009	1.003	1.010	0.999
CZ0523	Náchod	0.983	1.001	1.005	0.988	0.985	0.977	1.064	0.977	0.994	0.979	0.943	0.950	0.941
CZ0524	Rychnov n. Kněž. *	0.998	1.002	0.999	1.000	1.000	0.997	0.998	0.983	0.998	1.015	0.989	1.015	0.976
CZ0525	Trutnov *	0.993	0.994	0.988	1.006	0.993	1.006	1.009	0.957	1.002	1.000	0.992	1.004	1.002
CZ0531	Chrudim	0.977	1.017	1.002	0.951	0.957	0.973	0.985	0.966	0.993	1.022	0.983	1.027	0.913
CZ0532	Pardubice	1.045	1.016	1.027	1.070	1.055	1.012	1.047	1.049	1.007	1.039	1.148	1.099	1.067
CZ0533	Svitavy *	0.978	0.997	0.994	0.982	0.965	0.994	0.965	0.931	0.998	0.990	0.942	1.007	0.977
CZ0534	Ústí nad Orlicí *	0.986	1.000	0.995	0.989	0.973	0.986	0.986	0.948	1.001	1.007	0.976	1.015	0.992
CZ0631	Havlíčkův Brod *	0.978	0.999	0.994	0.992	0.952	1.011	0.997	0.941	1.001	1.003	0.960	1.006	0.967
CZ0632	Jihlava	0.985	0.997	1.007	1.008	0.948	0.999	1.076	1.039	1.008	0.984	0.896	0.953	0.999
CZ0633	Pelhřimov *	0.984	0.997	1.008	1.001	0.959	1.011	0.996	0.969	0.997	1.018	0.992	0.964	0.964
CZ0634	Třebíč *	0.976	0.996	0.991	0.987	0.944	1.011	0.995	0.971	0.997	0.979	0.953	1.010	0.966
CZ0635	Žďár nad Sázavou	0.967	1.000	0.992	0.998	0.943	0.993	0.939	0.969	0.993	0.975	0.973	0.900	0.961
CZ0641	Blansko *	1.001	0.997	0.985	0.984	1.024	1.001	0.994	0.977	0.991	1.007	0.937	1.006	0.989
CZ0642	Brno-město	1.091	1.021	1.014	0.989	1.221	1.015	1.016	0.991	0.999	1.036	1.165	1.164	1.118
CZ0643	Brno-venkov *	1.026	1.010	1.005	1.005	1.074	1.006	1.018	1.037	0.983	1.012	1.020	1.004	0.997
CZ0644	Břeclav *	0.989	0.992	0.996	0.988	0.990	1.002	0.975	1.020	0.993	0.989	0.970	0.924	0.964
CZ0645	Hodonín	0.992	1.001	1.005	0.984	0.986	1.018	0.990	0.972	0.999	0.981	0.953	0.997	1.008
CZ0646	Vyškov *	1.004	0.999	1.006	1.001	1.023	1.011	0.991	1.002	0.998	1.006	0.972	0.938	0.990
CZ0647	Znojmo	0.981	1.009	1.000	1.006	0.940	1.030	1.005	0.947	0.990	0.981	0.829	1.000	1.018
CZ0711	Jeseník *	0.969	0.976	1.010	1.024	0.918	1.034	0.964	0.982	0.990	0.963	0.982	0.992	0.960
CZ0712	Olomouc	1.008	0.986	0.994	1.004	1.017	1.000	0.960	1.042	0.999	0.997	0.954	1.084	0.995
CZ0713	Prostějov *	0.993	1.001	0.988	0.989	0.973	0.993	1.018	1.003	0.994	0.999	0.960	1.015	1.002
CZ0714	Přerov	0.989	0.992	1.013	0.969	0.996	0.993	0.973	0.961	1.003	0.958	0.987	1.063	0.983
CZ0715	Šumperk	0.970	0.971	1.008	1.018	0.962	1.028	1.010	0.946	1.002	0.962	0.800	1.022	0.923
CZ0721	Kroměříž *	0.993	1.002	0.991	0.993	0.979	1.006	0.986	1.006	1.004	0.991	0.970	0.995	0.998
CZ0722	Uherské Hradiště	1.014	1.002	1.017	0.967	1.037	1.015	1.009	0.980	0.977	1.010	0.923	1.020	1.049
CZ0723	Vsetín	1.001	0.991	1.000	1.004	1.038	1.010	1.024	0.989	0.998	0.945	0.932	0.907	1.024
CZ0724	Zlín	1.037	1.007	1.002	0.987	1.112	0.983	0.972	1.030	0.998	0.989	1.110	0.989	1.042
CZ0801	Bruntál	0.938	0.938	0.992	0.986	0.901	0.992	0.990	0.915	1.015	0.939	0.874	0.945	0.948
CZ0802	Frýdek-Místek *	0.998	0.997	0.995	0.983	1.002	0.988	1.001	0.985	0.999	1.013	0.951	1.011	0.996
CZ0803	Karviná	0.975	0.990	0.995	1.011	0.959	0.987	1.026	0.962	1.001	0.944	0.921	0.954	0.993
CZ0804	Nový Jičín	0.979	0.957	0.984	0.980	0.948	1.001	1.031	0.966	1.023	1.016	1.050	0.997	1.036
CZ0805	Opava	1.009	0.984	1.004	0.905	1.061	0.970	0.926	1.045	1.001	0.964	0.957	1.053	0.985
CZ0806	Ostrava-město	1.006	0.992	1.006	1.007	1.015	0.978	1.039	1.043	1.019	1.015	1.074	0.955	0.984

Note: Results for districts with asterisks * are based on estimates.
Source: Authors' calculations, based on CZSO (2014)

Table 4 shows the regional price levels in higher territorial administrative units (region NUTS 3 and cohesion region NUTS 2). Apparently, the price levels are higher in the districts with the most populated, economically strong centers, such as Praha, Brno, Hradec Králové, Pardubice or Liberec (Bednářová, 2015).

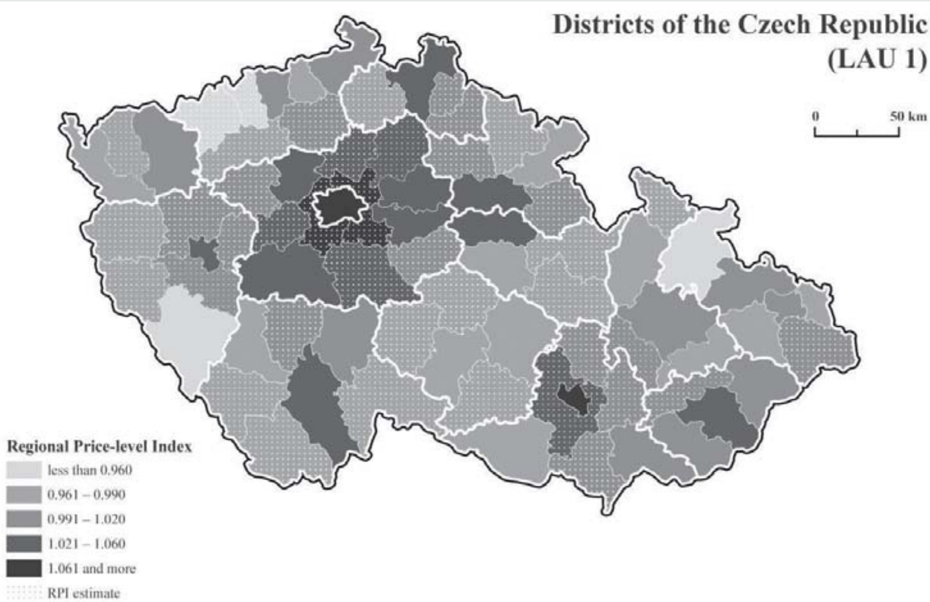
Table 4 Regional Price-Level Index (RPI) at NUTS 3 and NUTS 2 Spatial Segmentation

Code	Region (NUTS 3)	RPI	Code	Cohesion Region (NUTS 2)	RPI
C010	Hlavní město Praha	1.171	CZ01	Praha	1.171
CZ020	Středočeský kraj	1.048	CZ02	Střední Čechy	1.048
CZ031	Jihočeský kraj	0.997	CZ03	Jihozápad	0.998
CZ032	Plzeňský kraj	1.001			
CZ041	Karlovarský kraj	0.977	CZ04	Severozápad	0.975
CZ042	Ústecký kraj	0.974			
CZ051	Liberecký kraj	1.014	CZ05	Severovýchod	1.009
CZ052	Královéhradecký kraj	1.012			
CZ053	Pardubický kraj	1.001			
CZ063	Kraj Vysočina	0.977	CZ06	Jihovýchod	1.013
CZ064	Jihomoravský kraj	1.030			
CZ071	Olomoucký kraj	0.992	CZ07	Střední Morava	1.003
CZ072	Zlínský kraj	1.015			
CZ080	Moravskoslezský kraj	0.989	CZ08	Moravskoslezsko	0.989

Source: Authors' calculations, based on CZSO (2014)

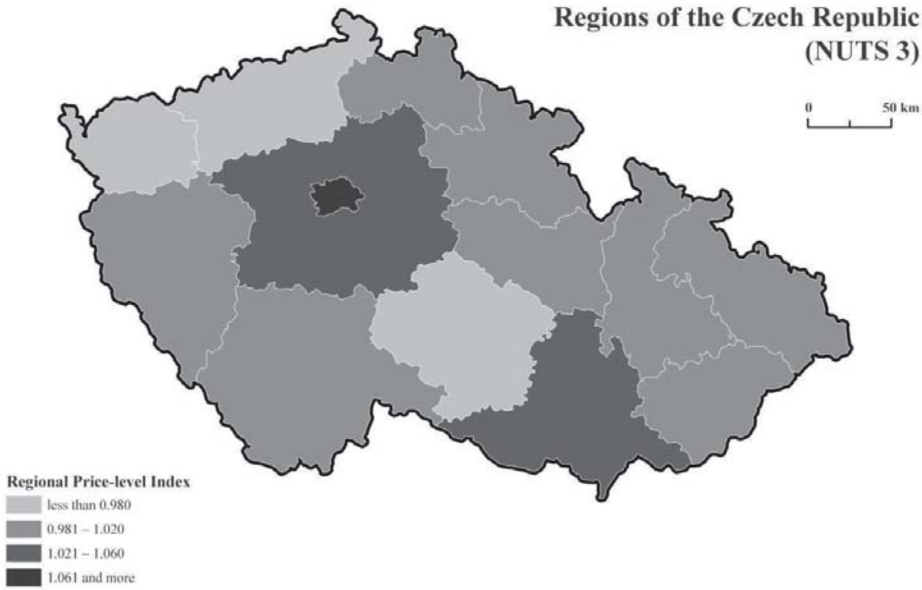
The regional price-level results also reflect themselves well in the structurally affected and economically weak regions (lower price levels in Chomutov, Most, Ústí nad Labem, Šumperk, Bruntál, Karviná, Nový Jičín). Ostrava, Opava or Vsetín remain very close to the mean value (Kocourek et al., 2016). Figure 2 indicates the regional price levels for NUTS 3, while their sources in the districts of the Czech Republic are depicted in Figure 1.

Figure 1 Regional Price Levels at LAU 1 of the Czech Republic in 2011–2013



Source: Authors' own calculations and processing based on ARCDATA (2014), CZSO (2014)

Figure 2 Regional Price Levels at NUTS 3 of the Czech Republic in 2011–2013



Source: Authors' own calculations and processing based on ARCDATA (2014), CZSO (2014)

It is apparent, our results indicate smaller regional variability in price levels than those published by Musil et al. (2012) and Čadil et al. (2014). The standard deviation of our regional price levels is 0.0480 (at the NUTS 3 level), while Musil et al. (2012) recorded 0.0599 and Čadil et al. (2014) even 0.0640. Among reasons explaining these differences, the following are worth mentioning:

1. We performed careful qualitative adjustment of the raw data, which ensures the goods and services are comparable across the regions or districts of the Czech Republic. Therefore, the distortion of results caused by different quality of goods and services surveyed in different localities is minimized and this fact certainly reduces the differences in measured regional price levels.
2. Musil et al. (2012) and Čadil et al. (2014) use data from price surveys as if they represented the price levels in the whole regions (NUTS 3), while we keep the data ascribed to the district (LAU 1) where they were actually collected. On the other hand, this triggers the need to estimate the regional price levels in those districts, where the price surveys have not been carried out.
3. Musil et al. (2012) are using a common consumer basket, therefore the results show smaller standard deviation than when regional consumer baskets are employed as in Čadil et al. (2014). Nevertheless, even Čadil et al. (2014) argues, that particular system of regional weights does not affect the results significantly.
4. The more pronounced differences between our results and those published earlier (Musil et al., 2012; Čadil et al., 2014) have been recorded in Karlovarský kraj, and Královéhradecký kraj. The less significant differences appeared in Plzeňský kraj, Ústecký kraj, Středočeský kraj and the Capital of Praha. They are most probably caused by a different approach applied to CZ-COICOP Heading 04 (esp. to imputed rent) and also by the rent deregulation triggered in 2011.
5. A part of the differences may be also attributed to slightly different procedure of the regional price level computation. We based our approach on the price representatives (similarly to computation of consumer price index, for example) and not on the wider concept of basic headings (typical for purchasing power parities).
6. Some minor changes may be attributed to the year of origin of the data sources too.

CONCLUSION

Regional price level can represent a valuable information when making decisions on the level of regional economic and social policy. Its ambition is a more precise definition of economic and social disparities in spatial comparison. The issue of low validity of interregional comparison by means of nominal income indicators, which do not include costs of living in the regions, was pointed out by Kahoun (2011), Gibbons et al. (2010), Viturka (2007) and others. In the strategy of regional development of the Czech Republic, however, the nominal net disposable income is one of the crucial indicators determining the social position of inhabitants of a region.

The purpose of Regional Price-level Index is to enable an assessment of spatial differences in the costs of living of an average household. In terms of spatial comparison, the index should include all relevant expenditures which can indicate interregional differences and which are purchased by households. These are mainly goods and services which cannot be provided supra-regionally (common food, local services) and market prices of rentals and real estate. The immobile commodities (housing, education, accommodation, catering) represent the main source of regional price-level differences.

The purpose of the *RPI*, however, becomes also a source of its shortcoming. It should be used and applied carefully, as it is clear, that the average household is not a household of the unemployed, or pensioners. The social status is usually connected with a consumer behavior, differing significantly from the consumer behavior of an average household. Therefore, it shall be strictly used together with or applied to average income indicators (average wage in a certain region, average net disposable household income, etc.).

The real income indicator would make the level and development of social and economic disparities on regional and sub-regional levels more precise. (Viturka, 2007; Martinčík, 2008; Kahoun, 2011). According to the preliminary results of Kocourek and Šimanová (2015) and Kocourek et al. (2014), the real regional disparities in the income of households in the Czech Republic are smaller than so far published nominal ones, which is consistent with findings of Čadil et al. (2014).

Therefore, it seems very useful (if not necessary) to measure or at least estimate the price levels on the most detailed scale available. Significant differences in cost of living can be identified even within the former districts in the Czech Republic (LAU 1). From this point of view, a price level homogeneity on the level of NUTS 3 or NUTS 2 is a very strong and hardly justifiable precondition (Abrhám and Horváthová, 2010).

Although on the lower levels of territorial division (LAU 1 and smaller) the income indicators are also very difficult to measure or reliably estimate, even the regional price-level index alone can provide a very valuable information.

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FIS, University of Economics in Prague: Twenty Five

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Abstract

FIS (Faculty of Informatics and Statistics) of the University of Economics in Prague, was founded in 1991. Since 2001, so for 15 years, master's degree survey is performed at the graduation ceremonies of all the faculties of University of Economics in Prague. Its aim is to explore some of the circumstances of their studies, their jobs during the study, but especially their likely future labor involvement, their salary expectations and their satisfaction with studies at the university. Paper presents some data about students and graduates of the faculty from this survey, but also the information about the students and graduates from the project Reflex 2013. This survey was conducted in 2013 for the third time in a row by SVP PedF of Charles University in Prague with the aim to map out the exercise of university graduates in the labor market shortly after obtaining a diploma. Therein respondents rated their university studies, characterized his professional history, and expressed their professional competencies in relation to the requirements of their employment.

Keywords

Faculty of informatics and statistics, a survey of new graduates, Reflex 2013

JEL code

A23, Y1

INTRODUCTION

During the reorganization of the University of Economics in Prague in 1991 the Faculty of Informatics and Statistics was established. "It merges departments and fields of study dealing with information systems with the use of computers and statistical, econometric and other mathematical methods applied in all areas of the business life, as well as philosophy problematic" (<*http://fis.vse.cz/en/o-fakulte/profil-fakulty*>).

After its establishment, the faculty had about one thousand students in the bachelor's and master's degree (see Table 1). After ten years of the faculty existence, only the students of bachelor program exceeded such a number (1 086 in 2002). Number of master graduates of the faculty in the 90s was below one hundred, in 2008 reached over two hundred, in 2012–2013 have exceeded even 300. In recent years the master students are 900–1 000, the master graduates is roughly one third.

Since 2000, master's degree survey is performed at the graduation ceremonies of the university's faculties. Its aim is to explore some of the circumstances of their studies, their jobs during the study, but especially their likely future labor involvement. Initially, there were changes in the interviewing, but since 2004 questionnaire for ten years has stabilized. Additional updates of the questionnaire occurred in 2014, when the request for the inclusion of new questions, ascertaining the particular expectations of graduates of their future salary and satisfaction with studies at the chosen faculty, was accepted. Participation in the survey is high, around 90% of graduates.

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Table 1 FIS – the number of students and graduates of master's program

Year	1992	1996	2001	2006	2011	2015
Total number of students	954	1 427	1 723	2 578	3 229	2 793
of which in bachelor's program	590	1 053	625	1 708	2 118	1 707
in master's follow-up pr.	273	332	467	398	953	988
in master's program	-	-	541	355	25	-
in doctoral program	-	42	90	117	133	98
in distance study	91	-	-	-	-	-
Number of graduates masters	-	46	154	188	285	277

Source: Výroční zpráva o činnosti fakulty informatiky a statistiky za rok 2015 <http://fis.vse.cz/wp-content/uploads/2015/10/VZ_FIS_2015_final.pdf>

Some additional interesting information on the faculty graduates was obtained from the survey Reflex 2013. According to Koucký, Ryška and Zelenka (2014), the source file contains data about graduates of public and private universities in the Czech Republic including, of course, the University of Economics in Prague (1 531 respondents, of which 250 reported the study FIS). This survey builds on major international projects implemented in previous years; its principal investigator and coordinator of the SVP PedF UK in Prague. This survey provides further information on the faculty graduates, but of course also on the graduates from other universities. The survey was focused on graduates in 2008–2012; by year of birth is their age range of fifteen. It was conducted online, unfortunately, further details regarding the method of selecting respondents the source does not provide. However, we do not intend to strive any broader generalizations. It is also necessary to consider that both surveys included only successful graduates; their answers can be systematically different from the responses of unsuccessful students.

Graduates of the faculty either studied computer science fields, or quantitative methods in economics; their numbers are in a ratio of about three to one. The proportion of women among all college graduates in the Czech Republic is about 60% (Řezanka, 2016). However, the Faculty of informatics and statistics belong to the schools, which are lower interesting for women: their proportion is less than 30%. The composition of the respondents in the survey Reflex 2013 – graduates of FIS corresponds to these facts.

Data from the master's degree survey are collected for 15 years, so they enable to analyze the changes occurring at that time. However, it is quite surprising, how the structural changes in data over time are small and uninteresting.

1 FIS AND ITS STUDY FROM A VIEW OF STUDENTS

The main motivation to study at the faculty according to the graduates: "the study helps me for good career prospects" (average rating of 1.65 on a five point scale; 1 = strongly agree, 5 = strongly disagree; variability, var[2] = 32%) and "it was an interesting and attractive field of study" (average rating of 1.67; var = 35%). It is obvious that students perceive the reality of the labor market. Sometimes the students are suspected to be coming to the faculty being attracted by relatively simple admission procedure and then moving to another, "easier" fields of study at the university. The responses of graduates showed this rather as a marginal motivation (average rating 3.68; var = 65%). Less than 5% of respondents stated as the reason for studying at the faculty, that they have not been accepted to study elsewhere. However, it should be noted that the answers of unsuccessful students of faculty may differ.

Study of mathematical disciplines (statistics) being considered somewhat more challenging than studying computer science (3.7 vs 3.4; 1 = study was easy, 5 = study was not easy). As for the study itself,

[2] Variability (var) is expressed relative to the maximum achievable (on the used scale) standard deviation; it is 2 for the five point scale (namely, when are present only outer categories, each of the 50%).

most students appreciate its time flexibility (the availability of required courses; the time that they have to fulfill degree requirements; the possibility to combine study and a job; all about 1.8 with var = 40%; the five point scale, 1 = very good, 5 = very bad). Also the professional level of teaching, contacts with teachers and experience in oral presentation shows good rating (all about 2.0 with var from 45% to 55%). On the contrary, they would appreciate better higher standard of foreign language teaching: they are not satisfied with preparation to communicate in a foreign language in the studied field (3.6; 56%) and neither with the preparation for the use of literature in foreign languages (3.2; 55%).

However, the median proportion of the declared high quality teachers is 70% (its distribution is heavily skewed to the left) and among all universities in the Czech Republic, they evaluated their faculty as above-average = 3 to highly above-average = 2 (2.6; 45%). The seven point scale was used for this evaluation (1 = best, 7 = worst); besides two responses, the worst evaluation the faculty obtained was average (4). The study by rating of graduates is a good basis for "personal development" (2.1; 47%) and for "further learning within the employment" (2.2; 56%). On the contrary, often they consider this as not sufficient basis for the development of business skills (3.2; 61%). Asked whether sought in their study of the best marks, 42% of respondents answered "probably yes" or "definitely yes" (but also 38% "rather not" and "definitely not").

2 EMPLOYMENT OF GRADUATES DURING THEIR STUDIES

Various evaluation of university study programs agree on the fact, that teaching is focused on the acquisition of theoretical knowledge and less on practical skills and experience. This may also be the reason for a rapidly growing share of employed students: at a later employer, the practice is a considerable advantage. The question on employment of students during their studies led in the past to the conclusion that the proportion of master students employed in the study is slightly more than half. After the question upgrade in 2014, however, it turned out that this percentage is much higher. Almost a quarter of the FIS graduates, who replied to the question, said full-time work while studying, 60% part-time work.

As expected employment during studies plays a role in finding job after graduation. Graduates who worked already during their studies full time, often get a job in the same company after graduation.

Table 2 Employment with the same company, like when studying

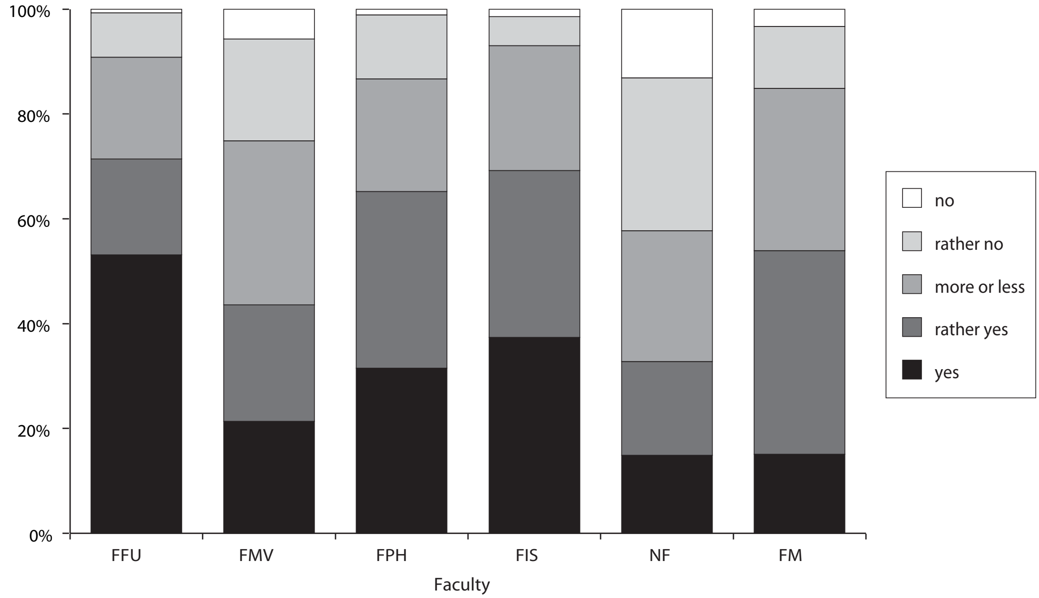
		Employment with the same company, like when studying	
Job while studying		yes	no
part time	%	50.5	49.5
full time	%	85.2	14.8

Source: Author, Master's degree survey, FIS, 2015 (internal material of the faculty)

The employers have an interest in the graduates of the faculty. Over 80% of graduates know for a long time in advance, where they will work. Since 10% of graduates yet postpones their future employment for various reasons (holidays, motherhood, journey abroad, parallel or further study), the proportion of graduates so far (in the time of graduation) unsuccessful in finding a job is relatively low.

The most similar structure of responses to the question on knowledge of future employment is in the context of the university at the Faculty of Finance and Accounting (FFU). The graduates of these two faculties also have the most benefit from their major specialization (a five point scale; 1 = strongly agree, 5 = strongly disagree): 70% of responses are "yes" or "rather yes". The other faculties of the university does not have the proportion of those responses so high.

Figure 1 The use of major specialization in 2015



Source: Author

In contrary, a specific feature of the faculty is the choice of minor specialization. University students usually choose the minor specialization at their own faculty. However, the FIS students usually choose the minor specialization at another faculty. It seems that if the faculty is characterized by lower utilization of main specialization, the minor specialization is understood as the continuing professional development. If the usage of the main specialization is high, the minor specialization is perceived as an alternative, as a „backup" option. While exploring the usage of major and minor specialization, the lowest level of consensus (measured by Cohen kappa) was found just for the FIS and FFU.

3 EMPLOYMENT OF GRADUATES AFTER THEIR STUDIES

A large majority of graduates of the University of Economics (nearly 80%), and this also applies to FIS, remains to work in Prague and is aimed primarily to large private companies (over 50 employees). Doing so they often continue a job they performed while studying. Nearly 80% of the FIS graduates (who responded to this question) has a contract for an indefinite period. Graduates mostly work in the field of information technology and communications (over 50%); but also in trade, finance and insurance etc.

It has been found that about 10% of graduates in the long term is not concerned about future employment at the time of graduation due to various reasons – further studies, planned trip abroad, motherhood, or an extension of the holidays eventually. In the sample survey Reflex 2013, the proportion of unemployed graduates FIS is under 4%, moreover, mostly it comes only a few months. The most frequently cited reasons for non-acceptance by the employer in this case are insufficient practice.

Since 2014 the questionnaire master's degree survey contains several issues relating to the salaries of graduates. More than half of University graduates is expected starting salary at intervals around the average wage in the Czech Republic. However, the FIS graduates are somewhat more demanding. Table 3 contains a comparison of the structure of the responses of University graduates and FIS graduates.

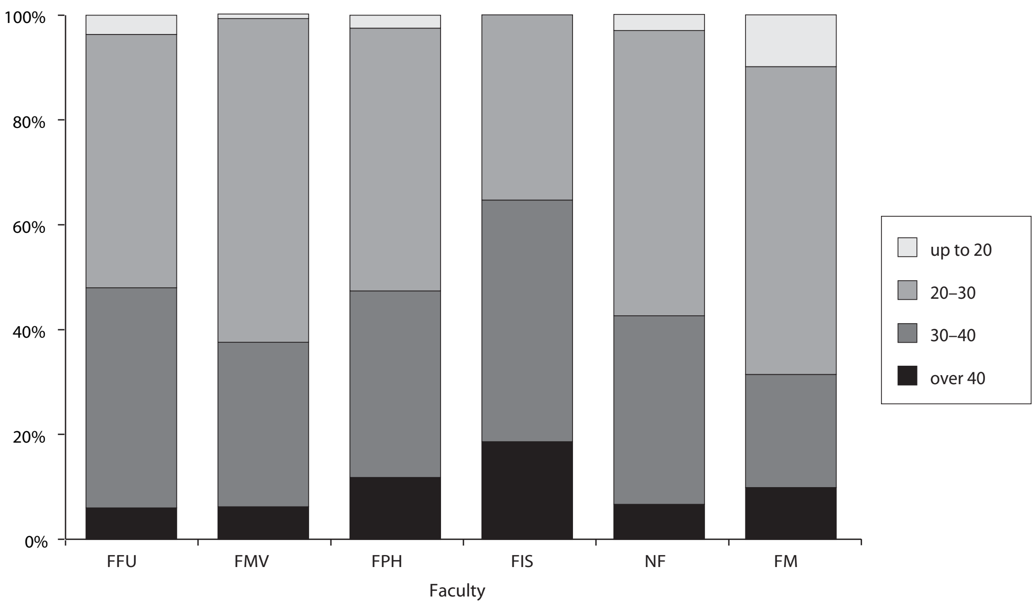
Table 3 Expected starting salary (2015; in thousands of CZK)

	University	FIS
Up to 20	10.5%	6.8%
20–30	51.5%	36.8%
30–40	27.5%	36.1%
over 40	10.5%	20.3%

Source: Author, Master's degree survey, FIS, 2015 (internal material of the faculty)

Another question associated with the starting salary in master's graduates survey ascertains,what their satisfaction with the starting salary is, or, more precisely, what salary would be considered adequate. As Figure 2 shows, the FIS graduates attach best value to their qualification compared to other faculties.

Figure 2 Adequacy of starting salary (in thousands CZK)



Source: Author

Regarding expectations in the short term (three years), the graduates expecting the lower starting salary then often think that it will not change, or it will change only a little. On the contrary, graduates with high demands on the starting salary expected soon its more substantial increase.

What is the reality? What incomes of faculty graduates result from survey Reflex 2013? Nearly two hundred graduates responded to this question. However, although the year 2013 falls into a period of economic recession in the Czech Republic, respondents reported incomes even higher – see Table 4.

Table 4 Graduates: starting and actual salary (in thousands of CZK)

	Starting	Actual
Up to 20	25.1%	19.8%
20–30	31.5%	17.4%
30–40	27.1%	25.2%
over 40	16.3%	37.6%

Source: Author, Master's degree survey, FIS, 2015 (internal material of the faculty)

4 BENEFITS OF STUDY AT FIS FOR JOB PLACEMENT OF GRADUATES

The graduates from the faculty are employed in accordance with what they studied. Almost 80% of them do the work for which, in their opinion, their completed study field or possibly a related field fits best. Table 5 shows the extent to which they think they will be able to use their current knowledge and skills in their job.

Table 5 Utilization of expertise in the employment

	%
1– in large extent	20.8
2	27.6
3	26.0
4	12.8
5 – not at all	2.0

Source: Author's calculations

During the project Reflex 2013, the graduates were also asked about their competencies. In the set of 26 items the students evaluated on the 10-point scale (1 = lowest level, 10 = highest level) their level of competencies acquired at school, their own current level and the level required by their employer. Researched competencies were divided into seven groups representing professional qualification, flexibility, innovation and knowledge management, mobilization of human resources, international orientation, drive, business presentations (Koucký, Ryška and Zelenka, 2014).

A comparison of the average level of competencies acquired at school and own current competencies implies an expected fact that in the latter case it is the same or higher. In some competencies plays a role, albeit short, work experience, not in others. Graduates of FIS evaluate competence levels acquired at school and own current competencies roughly equally for example in terms of professional theoretical and methodological knowledge, legal competence and presentation skills (in this respect the faculty has prepared them obviously good). Conversely, the biggest inherent contribution graduates indicate in the case of foreign language skills, but, somewhat surprisingly, also in the case of mother tongue, further in creative thinking, independent decision making, drive and the ability to bear responsibility, manage the team or work in an international environment (items with differences in level by more than one degree on the used scale; the maximum difference is about 1.5 degrees).

Like the graduates of other schools (Koucký, Ryška and Zelenka, 2014), also the FIS-graduates perceive their *current* competencies for employment as sufficient. The average level of achieved competencies in all seven categories is always higher than the average level of required competencies – see Table 6. This relationship is inversed in only a few of the 26 questioned items, such as ability to utilize expertise in practice, knowledge of the conditions for the use of professional theories in practice, ability to identify and solve problems or the ability to communicate with people. Thus, the graduates perceive certain reserves in these competencies.

Table 6 Level of achieved and required competencies of FIS graduates

	Competencies	
	Achieved	**Required**
Professional qualification	7.06	6.87
Flexibility	7.29	7.00
Innovation and knowledge management	7.61	7.18
Mobilization of human resources	7.19	6.93
International orientation	6.81	6.31
Drive	6.89	6.33
Business presentations	7.36	6.59

Source: Author's calculations

5 FIS GRADUATES' SATISFACTION WITH THE STUDY, EMPLOYMENT AND LIFE

According to the master's degree survey, over 80% of graduates would choose the same field of study at the faculty again. It's more than the average for high schools in the country (about two-thirds of responses, Koucký, Ryška and Zelenka, 2014; it also applies to the rest of the University of Economics). In addition, about 10% of graduates would remain in University of Economics, but would have chosen another field.

In the Reflex survey there was also ascertained the satisfaction of graduates in various fields of life (five point scale, 1 = very satisfied, 5 = not satisfied at all). The average level of satisfaction with the employment of graduates is 1.95 (var = 46%). Only 5% of graduates state an experience with unemployment, almost always short-term. The satisfaction is significantly influenced by the feeling of a sufficient use of knowledge and skills and, of course, by the size of salary (significance level 0.05; the exact test, sparse contingency tables).

The average level of satisfaction with the economic situation of households is 2.00 (var = 44%), of satisfaction with family life is 2.18 (var = 55%). Unfortunately, further information about households in which respondents are living, has not been surveyed. In view of age of respondents, it can be assumed, that many still live in the household of their parents. It should be added to the last statement that only 6% of the corresponding graduates stated, they had children. However, due to shifting of reproductive age into the later years, it is also not surprising.

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Using Tablets for the 2018 Algerian Census: Mobile Census Application Quality Assessment

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Abstract

Algeria is planning to carry out its sixth General Census of Population and Housing (RGPH) in 2018. This paper mainly concentrates on ONS' vision of census data collection through the use of mobile technology, namely 3G and 4G LTE technologies. A challenge in this method is the accuracy of data entered: the mobile applications environment has a multitude of particularities. This requires an adaptable approach for performance analysis in terms of total quality management for software projects. Thus, our paper will address the issues related to the implementation of this mobile solution through a mobile application quality estimation model that requires the identification of features (e.g. interaction time, volume of provided information, error management, data security, transaction security, …). The paper proposes to look at a set of indicators normalized on the [0; 1] interval as to measure the application quality level.[2]

Keywords	JEL code
Census Mobile Application, Total Quality Management, Aggregate Indicator	*C89*

INTRODUCTION

The rapid emergence of new technologies brings about some concern. What the world needs now is not the aptitude in the production of new technologies but the capacity of understanding the impact of technology on society and individuals as well as the capability to implement ICT as to positively impact human development. This is, once more, a challenge for statistics. We need to produce statistics with a certain depth of understanding of the environment and the difference between technological development and human development.

The main feature of the first 2011 Economic Census (RE) was the use, for the first time, of the optical scanning technology for the exploitation of questionnaires. Moreover and through The Office for National Statistics (ONS), Algeria is planning to carry out its sixth General Census of Population and Housing

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(RGPH) in 2018. As part of the framework of the United Nations recommendations for the 2020 round of censuses of population and housing, advocating greater use of Information and Communication Technology (ICT) in statistical operations, Algeria's plans to use for the first time, tablets as a collection tool instead of the paper questionnaire, namely tablets equipped with mobile chips.

The usual census data collection system involves an enumerator, who collects the census data manually on a paper questionnaire. So in today's world of data communication, a mobile tool for a portable system becomes important to access and update a database.

Innovative technology helps us to improve the existing system. So, we thought the finest solution for this handicap would be using a tablet. We are in the process of designing and developing an ICT solution using mobile technology, mainly 3G, as a communication tool. Our idea is to implement this by providing a tablet containing the census application to every authorized enumerator through which they can collect census data and update the collected data to the census database. A second and important module of the solution is the supervision and monitoring platform. We are motivated by the fact that "*Technology*" allows statistical processes to meet important society requirements and expectations, namely:

- Timeliness of data;
- Accuracy;
- Relevance;

so, as to achieve "*Quality*" improvements as it is recommended by all international guidelines on the subject.

1 PROBLEM DESCRIPTION

1.1 Census preparation

In the RGPH census preparation, generally these steps are to be followed:

- Identifying the houses i.e., dwelling places and places that are usually used for living. This is the first step.
- Then the municipal delegate prepares the construction list. Once the list is prepared, he prepares sketches of blocks of houses that give the primary information about the type of houses and facilities that are being used by the population in that area.

1.2 Census execution

With this information in hand census enumerators go to the census houses and collect data. The collected data would be used for analysis of the population in various aspects like finding population ratio, employment reports, and facilities available to people etc.

Nowadays, in this fast world of technology, it is very important to complete a work in an efficient manner. In the traditional method, collecting data takes a long time, because enumerators have to manually fill in the census form then again sort out the data, etc. So we need a system that segregates data as and when data is entered (Vijaray and Dinesh Kumar, 2010; Yacob Zewaldi, 2011; and Dan, 2013). Another test for this method is the accuracy of data entered. In a census, age of people should be entered accurately because these details would be used in employment analysis, etc. Efficiency is another issue; efficient data collection is needed because this data will be used for further analysis.

2 PROPOSED SOLUTION

For RGPH 2018, 50 000 agents will be recruited and trained as enumerators and 13 000 agents will be recruited and trained as controllers, in addition to the municipal delegates used in the preparation.

2.1 Census agents

Each enumerator will be equipped with a tablet for data entry and a paper district notebook that is provided by the municipal delegate (The first five district notebook columns are already filled by the municipal delegate, the remaining columns will be filled in throughout the execution of the census). Each controller is also equipped with a Notebook tablet (for an overall vision of the questionnaire) to verify the quality of work of the five enumerators, under his supervision, and have a status of the collection in the field and daily statistics on households surveyed and enumerator performance.

2.2 Authentication of enumerators and controllers

For the purposes of authentication of enumerators and controllers, login lists (username and password) will be defined following the use of mobile chips' PINs affected by the mobile operator: the login could be defined as the concatenation of the wilaya (territorial administration), municipality and district codes (given at the conclusion of cartographic updates), which is an exact identification of the enumerator.

2.3 Technical requirements

In order to insure that the process of data collection goes as planned, a few technical elements need to be in place such as:

- A relational database management system such as SQL Server is needed to administer and manage the RGPH database to guarantee quality, continuity and confidentiality of information.
- A global database at the central site to store and retrieve real-time data entirety.
- An implementation of database levels at regional collection sites.
- Software installed at regional levels for supervision, control and monitoring of the implementation on the field.
- Entry applications for entering data collected on tablets as well as the transcript of paper questionnaires.[3]
- Establishment of specialized interconnection links between the central site (headquarters) and various regional sites.

2.4 Information flow estimates

We base our preliminary estimates on what follows:

i. 50 000 enumerators spread over the four regional annexes.
ii. 150 questionnaires per enumerator during the period of execution (average of 10 daily).

As per our benchmark, the size of a questionnaire is about few Kilobytes (we assume 50 Ko per questionnaire). As bandwidth is the rate of a connection expressed in bits per second, we can estimate that we will face a rate of transfer of 100Ko/s and the necessary bandwidth should be around 2Mo.

3 QUALITY ASSESSMENT

In software engineering literature (Aksit, 2004; and Pressman, 2009), software quality and software quality management are treated separately and the important role that they play in successfully completing software applications projects is highlighted.

Mobile applications are a special category of software applications as mobile devices and mobile applications are seeing continuous development. Hence, their quality management processes are influenced by their particular specifications. It is considered that the implementation of specific total quality management (TQM) methods and techniques will help developers meet the objectives related to the continuous quality improvement of the processes and results (Hoyle, 2007).

The mode of interaction (MI) represents the use of appropriate controls to build the application user interface so that the user will have a natural interaction with it. The mode of interaction is influenced

[3] As per international recommendations, 10% of the questionnaires will be on paper as to take charge of the specific cases on the field.

by the number of displayed controls at a time and their complexity. The measurement is a score received from the user after he/she interacts with the application. The mark, MImark, is a value in the range [A_{inf} ; A_{sup}], where:

$A_{inf} < A_{sup}$; A_{inf} , $A_{sup} \in \mathbf{IN}$; for this case we have $A_{inf} = 0$, $A_{sup} = 10$.

The mode of interaction indicator, MII, is determined as follows:

$$\text{MII} = \frac{\text{MImark}}{10}. \tag{1}$$

Error management (EM) is the ability of mobile applications to function even in cases where operational errors appear (ISO/IEC 25010:2011). Measuring is done by observing the number of instructions successfully fulfilled compared to the total number of instructions given by the user. Thus, the error management indicator (EMI) is calculated using the following relation:

$$\text{EMI} = \frac{\text{NT}}{\text{Ntotal}}, \tag{2}$$

where NT is the number of successful instructions and N_{total} is the number of total instructions.

Data security (DS) ensures data privacy in the portable device. When used by an unauthorized person, the accessing of confidential data on the device may harm the operation, and thus it is necessary to secure access to this information if the mobile device is lost or stolen, (Popa, 2012). The data security indicator (DSI) is given by the number of cases where the application does not use the mobile device resources correctly, thus allowing uncontrolled events to occur per unit time (UT):

$$\text{DSI} = 1 - \frac{\text{TNEU}}{\text{UT}}, \tag{3}$$

where TNEU is the total number of events that are unpredictable and uncontrolled.

Hence, taking into account file transfer issues and using (1), (2) and (3), we consider the following 2018 Census specific total quality management indicator (TQMI):

$$\text{TQMI} = \text{TQI*MII*EMI*DSI}, \tag{4}$$

where TQI = (successful transfers per UT)/(total transfers per UT), transfers expressed in Ko/s, represents the transfer quality indicator.

Since TQMI, clearly, belongs to the interval [0; 1], we will be able to assess the quality of our mobile application by the closeness of its TQMI to 1.

CONCLUSION

As we are well aware of the mains risks and challenges in implementing such a solution, we always keep in mind the fact not underestimate how much work it takes to properly implement a census, even with the use of the latest technology (IT or ICT). Thus, our paper comforts us in knowing that this solution will make it possible for ONS to enumerate and present the census data meticulously with minimum hardship. A key ingredient also, is our ongoing consultation with the different users and producers of statistical information as well as our national technology partners, namely mobile operators, internet providers and IT manufacturers. In order to test and validate these indicators, the following activities will be conducted:

- development of the census mobile application;
- consultation with specialists in order to determine the different values;
- application of these indicators to the developed mobile application.

Because use and evolution of such technology is growing rapidly, it may be helpful to carry out, post census, further detailed research on improved data quality through the use of technology.

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European Conference on Quality in Official Statistics (Q2016)[1]

Marek Rojíček [2] | *Czech Statistical Office, Prague, Czech Republic*

During May 31st–June 3rd, traditional biennial conference focused on the quality in statistics, organised jointly by Statistical office of Spain (INE) and Eurostat, took place in Madrid. Around 450 participants from European as well as other countries representing statistical offices, central banks, universities, research institutes and multinational institutions (Eurostat, OECD) participated at this prestigious event in the statistical community.

The Conference aimed to cover relevant and innovative topics on quality ranging from the challenges and the new paradigm of quality in an information and knowledge-driven society including big data and multi-source statistics, to governance and management aspects like the ones linked to the ESS Vision 2020 or the lessons learned from 2013–2015 peer reviews in the European Statistical System. Furthermore, as an open forum of debate, it represented an opportunity to introduce innovation in the measurement and management of the quality in statistical domains and in specific statistical products.

The conference took place in the Círculo de Bellas Artes of Madrid, non-profit cultural institution, which is favourite venue for many events because of its perfect location, spectacular historical rooms and unique personality. The opening ceremony was delivered by Gregorio Izquierdo, President of INE, Miguel De Castro, Director of INE and Mariana Kotzeva, Deputy DG of Eurostat. The key lecture focused on the quality in official statistics from the point of view of highly respected statistical institution was held by Wayne Smith, Chief statistician of Statistics Canada.

The programme included invited lectures in plenary sessions, special (speed) sessions and oral contributions of other participants held in five parallel sessions. Participants heard many interesting contributions, whose abstracts and full papers have been published on conference webpage. The first day of the Conference the presentations of the representatives of the Czech Statistical Office (CZSO) were introduced. Marie Bohatá, former President of CZSO and Deputy DG of Eurostat, and Iva Ritschelová, President of CZSO, presented their view on the practical experience updated framework regulation of quality in European statistics and especially the role of so called Commitment of Confidence. Marek Rojíček, Vice-president of CZSO, presented the experience of the Office with the redesign of the statistical information system, which has been implemented in the last ten years.

Besides general statistical methodology issues and institutional aspects of quality many presentations were devoted to special statistical areas, for example national accounts, household surveys or demographic statistics. Several sessions were traditionally focused on the statistical literacy and the relations between

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producers and users of official statistics. The programme of the Conference was concluded by the session "High Quality Statistics in Changing Landscape – Challenges ahead" represented by high-level discussants, i.e. Mariana Kotzeva (Eurostat), Konrad Pesendorfer (Statistics Austria), Alfredo Cristobal (INE), Martti Hetemäki (ESGAB) and Juan Peñalosa (Bank of Spain).

Applications of Mathematics and Statistics in Economics (AMSE 2016) International Conference

Stanislava Hronová [1] | *University of Economics, Prague, Czech Republic*

From 31st August to 4th September 2016, already the 19th international conference called *Applications of Mathematics and Statistics in Economics (AMSE)* took place in a magnificent environment of the historical city of Banská Štiavnica. This year, the conference was organized by the Department of Quantitative Methods and Information Systems of the Faculty of Economics of the Matej Bel University in Banská Bystrica. More than 60 experts from the Czech Republic, Slovakia, Poland, and the Netherlands participated in the conference representing the University of Economics, Prague, the Matej Bel University in Banská Bystrica, the Pavol Jozef Šafárik University in Košice, the Technical University of Košice, the Wroclaw University of Economics, the University of Silesia, the University of Economics in Katowice, and the University of Groningen.

It was already the 19th conference on the topic. In 1998, when it took place for the first time, representatives of departments of statistics from the Faculty of Informatics and Statistics of the University of Economics, Prague and the Department of Applied Informatics of the Faculty of Economics of the Matej Bel University in Banská Bystrica agreed to deepen cooperation of the mentioned workplaces. Thus, besides personal professional contacts between members of the aforementioned departments, a tradition of alternating in organisation of international conferences with the same or a similar topic was founded. In 2000, also Polish statisticians from the Wroclaw University of Economics were invited to participate and co-organize the conference, because there already had been very good relationships between their statistical workplaces and departments of statistics of the University of Economics, Prague for a long time. The conference was gradually developing both as for its programme as well as regarding its participants (a higher share of postgraduate students) and it became a "natural" part of professional contacts of experts from departments of statistics from the aforementioned universities and, of course, also a place of regular friendly meetings.

The aim of the yearly international conference is to acquaint participants with the latest statistical and mathematical methods, which can be used to solve theoretical and practical issues of economics and economy. The AMSE conference thus offers a possibility to present results of scientific work of European university workplaces.

Conference papers delivered this year pertained to eight thematic groups: Macroeconomics, Public Economics and Methodological Issues of Economics, Social Economics, Economic Sustainability and

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Demographic Economics, Financial Markets, Risk Measurement and Insurance, Microeconomic Issues, Multidimensional Statistics in Economics. Meetings took place in two sections. For AMSE 2016 programme visit: *http://amse.umb.sk/conference.html*. You can find there also information on the history of the AMSE and links to the previous AMSE international conferences.

Papers presented at the conference AMSE 2016 will be published in the book of proceedings that will be sent to Thomson Reuters to be considered for inclusion in the Conference Proceedings Citation Index (CPCI). The proceedings of the past two AMSE conferences (i.e. AMSE 2014 and AMSE 2015) have been successfully indexed and are available in the Web of Science database.

The tradition of alternating organisation (Slovakia – Poland – the Czech Republic) continues and the jubilee 20th AMSE conference (the organiser of which will be the department of statistics of the Wroclaw University of Economics) will take place in Poland, in a mountainous environment of the town of Sklarska Poreba, at the turn of August and September 2017.

Mathematical Methods in Economics (MME 2016) International Conference[1]

Josef Jablonský [2] | *University of Economics, Prague, Czech Republic*

The 34th international conference *Mathematical Methods in Economics* (MME) was held in the city of Liberec since 6th until 9th September 2016. This series of conferences is a traditional meeting of professionals in operations research, econometrics, mathematical economics, and related research areas organized by the *Czech Society for Operations Research* (CSOR), *Czech Econometric Society*, and the local organizing faculty or university. The conference in 2016 was organized by the Faculty of Economics and Faculty of Mechanical Engineering of the Technical University Liberec.

This year's conference *Mathematical Methods in Economics* has been attracted by almost 200 participants from Czech Republic, Slovakia, Egypt, Italy, Lithuania, Poland and Germany. The scientific program started by the plenary session that was introduced by the chair of the organizing committee of the conference and the Dean of the Faculty of Economics Professor Miroslav Žižka. Then, the President of the CSOR, Professor Jana Talašová highlighted a long tradition and importance of MME conferences. Main plenary speaker was Professor Sigitas Vaitkevicius from the Kaunas University of Technology (Lithuania). The title of his talk was *Research Hermeneutics: The Origins of Scientific Knowledge*. After the plenary session the program of the conference was divided into 6 parallel sessions and the total number of presentations was almost 160.

It has been a long tradition that during MME conferences a PhD student's competition for the best paper takes place. This competition is organized and honored by the CSOR. All conference participants enrolled in PhD studies can participate in the competition. This year, the competition was attended by 15 PhD students from 9 Czech, Italian and Polish faculties and research institutions. They presented their papers before the evaluation committee consisting mainly of representatives of the CSOR. The winner of the competition is Martin Dlask from the Faculty of Nuclear Sciences and Physical Engineering of the Czech Technical University in Prague with his paper *Fractional Brownian Bridge as a Tool for Short Time Series Analysis*.

The conference was very well organized in the new campus of the Technical University Liberec that offers excellent facilities for this kind of events. The scientific program was complemented by a social program that is always an opportunity to discuss various problems in an informal environment. Welcome party in the first evening of the conference with live music was organized in the campus of the University. The main social event was half-day tour on the second conference day in the afternoon. There were offered several tour destinations, among them probably the most attractive was visiting of the Jested hill by cable car. After the tour the social program was concluded by gala dinner with awards ceremony of the PhD competition. The dinner took place in a beautiful historical building of the city hall.

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During the annual meeting of the CSOR it was decided that the 35th MME conference will be organized by the Faculty of Informatics and Management, University of Hradec Králové, as usual in the first half of September next year.

10th Anniversary of the *International Days of Statistics and Economics (MSED 2016)*[1]

Tomáš Löster [2] | *University of Economics, Prague, Czech Republic*

From 8th to 10th September 2016 there was held the annual conference of the International Days of Statistics and Economics (MSED) at the University of Economics Prague. This conference belongs between the traditional professional events, and this year was held the tenth anniversary. The main organizer is the University of Economics Prague, the Department of Statistics and Probability and the Department of Microeconomics. Since this year there is also the new partner university the Faculty of Economics, The Technical University of Košice and Ton Duc Thang University. Affiliation between the important statistical and economic conferences proves the fact that Online Conference Proceedings have been included into the Conference Proceedings Citation Index (CPCI), which is integrated index within the Web of Science, Thomson Reuters. This year there was registered 356 participants at this conference from various countries, such as Poland, Russia, Slovakia, Vietnam, Turkey, Lithuania, etc. In comparison can be seen the growing interest of participants to this conference. Since the first volume there was a threefold increase in interest, especially by foreign researchers. Among the conference participants were traditionally doctoral students and young scientists of various universities abroad. The aim of the conference was the presentation of scientific papers and discussions on current issues in the field of statistics, demography, economics and human resources, including their mutual interconnection. From the statistical topics we can say that the interest is traditionally given to the cluster analysis, computational statistics and statistical models. This year was presented a significant invited contribution by assoc. prof. Eva Zamrazilová – The Chief Economist of the Czech Banking Association. Lecture hall was full and due to the high erudition of assoc. prof. Zamrazilová, which demonstrates the importance of combining statistics and economics, the presentation was accompanied by a rich discussion to this topic. To conclude we wish the success to this conference at least to the next ten years. It is important, that through this professional event will be established the deeper connections between important disciplines such as statistics and economics and professional community realize that the mutual cooperation is the foundation of the entire system.

1 More at: *http://msed.vse.cz.*

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ROBUST 2016 (Jeseníky) International Statistical Conference[1]

Ondřej Vozár [2] | *Czech Statistical Office, Prague, Czech Republic*

The 19th event of the well-established biannual Statistical Conference ROBUST 2016 took place in the Kurzovní Hotel in the Jeseníky Mountains during September 11–16, 2016. More than 110 participants presented and discussed contributions covering a broad spectrum ranging from Theoretical Statistics, Probability and Stochastic Analysis to Applied Statistics in several fields, including insurance mathematics, medicine, image processing, metrology and demography.

The idea behind the ROBUST Conferences has always been to bring together statisticians of all generations and all fields from different Czech and Slovak institutions to enable their exchange of ideas and to provide them with interdisciplinary insight into the research in statistics.

The leading experts, Prof. Johanna Nešlehová and Prof. Christian Genest (McGill University, Toronto, Canada) gave a two-hour Opening Lecture on Dependence Modeling through Copulas. The copula approach is a statistical tool for modeling the dependence between several random variables.

Five Invited Lectures were given. Prof. Marie Hušková and Zdeněk Hlávka (MFF UK, Prague) discussed both recent theoretical advances and computational issues of statistical procedures based on empirical characteristic functions. Doc. Viktor Witkovský (Ústav merania SAV, Bratislava) presented applications of numerical inverting characteristic functions in statistical inference. Doc. Miloš Kopa (MFF UK, Prague) dealt with robustness in stochastic programming with decision-dependent randomness. Dr. Daniel Ševčovič (FMF UK, Bratislava) lectured on the Riccati transformation method for solving the Hamilton-Jacobi-Bellman equation. Dr. Tomáš Jurczyk (Dell Computers, Prague) provided a presentation on new features and trends in complex analytical software, such as Statistica.

This Conference was focused on participation of doctoral and master degree students, who presented 38 posters. Prizes were awarded in three categories: Methodology and Theory, Computational Statistics and Applications of Statistics. The prices were sponsored by RSJ, a.s., and Dell Computers. The honorable mentions – monographs and textbooks of the publishing house Matfyzpress were provided by anonymous sponsors. Conference fees for almost 10% of participants (mostly master and first-year doctoral students) were covered by RSJ, Dell, Data Script Praha and the Czech Statistical Society.

Editor-in-Chief of the *Statistika: Statistics and Economy Journal* kindly invited participants to submit relevant papers to the journal.

[1] More at: *https://robust.nipax.cz*.

[2] Na padesátém 81, 100 82 Prague 10, Czech Republic. E-mail: ondrej.vozar@czso.cz.

Recent Publications and Events

New publications of the Czech Statistical Office

Demographic Yearbook of the Czech Republic 2015. Prague: CZSO, 2016.
External trade of the Czech Republic in 2015. Prague: CZSO, 2016.
Generation, recovery and disposal of waste 2015. Prague: CZSO, 2016.
Statistical Yearbook of the Czech Republic 2016. Prague: CZSO, 2016.
Tendence makoroekonomického vývoje a kvality života v České republice v roce 2015. Prague: CZSO, 2016.
Vývoj obyvatelstva České republiky 2015. Prague: CZSO, 2016.

Other selected publications

Cultural statistics. Luxembourg: Eurostat, 2016.
Development of the basic living standard indicators in the Czech Republic 1993–2015. Prague: MoLSA, 2016.
LÖSTER, T. *Metody shlukové analýzy a jejich hodnocení*. Prague: Melandrium, 2014.
LÖSTER, T. *Příklady ze statistiky*. Prague: Melandrium, 2016.
OECD Economic Surveys Czech Republic 2016. Paris: OECD, 2016.
Statistická ročenka trhu práce v ČR v roce 2015. Prague: MoLSA, 2016.
Urban Europe 2016. Luxembourg: Eurostat, 2016.
World Trade Statistical Review 2016. Geneva: WTO, 2016.

Conferences

The 25th international ***Computational Statistics Seminar*** for young statisticians and demographers was held **during 1–2 December 2016** in the **Faculty of Natural Science, Comenius University in Bratislava, Slovakia**. More information available at: *http://www.ssds.sk*.

The 61st ISI World Statistics Congress will take place in **Marrakech, Morocco from 16th to 21st July 2017**. More information available at: *http://www.isi2017.org*.

The 19th issue of the ***Joint Czech-German-Slovak Conference on Mathematical Methods in Economy and Industry*** will be held **during 11–15 September 2017 in Jindřichův Hradec, Czech Republic**. More information available at: *http://www.karlin.mff.cuni.cz*.

Papers
We publish articles focused at theoretical and applied statistics, mathematical and statistical methods, conception of official (state) statistics, statistical education, applied economics and econometrics, economic, social and environmental analyses, economic indicators, social and environmental issues in terms of statistics or economics, and regional development issues.

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

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

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