

EVALUATION OF RELATION BETWEEN INVESTMENTS AND SAVINGS IN CENTRAL EUROPEAN COUNTRIES

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Abstract

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The paper is aimed at the evaluation of a relationship between the rate of investments and the rate of savings in selected Central European countries. A reference period for the analysis is 1995–2009. In all analysed Central European countries, the rate of investments permanently exceeded (but exceptions) the rate of savings in the period under investigation. Through fitting the development series of a calculated indicator as a difference of the rate of investments and the rate of savings in monitored countries by a polynomial of the second degree it was possible to compare developmental trends of this indicator in particular countries involved in this analysis. Polynomial trends of the difference indicator of the rate of investments and the rate of savings in Central European countries in the monitored period indicate similar developmental tendencies characterized (at the beginning of the reference period) by increasing the imbalance of the rate of investments and the rate of savings (on average until about 2003) and then by follow-up tendencies towards the gradual return to the balance. For the purpose of comparison, a difference was also monitored between the rate of investments and the rate of savings in EU15 countries as a whole, which permanently fluctuated around zero. The mean value of this indicator amounted to 0.11% for the period 1995–2009. Thus, in EU15 countries, the rate of investments roughly corresponded to the rate of savings (on a long-term basis). Based on this analysis, it follows that there is a correlation between the rate of investments and the rate of savings. Calculated parameters of particular regression functions are presented as Results in this paper. Indices of correlation and types of a regression function were calculated for particular countries. For the Czech Republic, these results are statistically highly significant using all three types of regression functions. In Poland, they can be indicated as statistically significant using the polynomial of the second and third degrees similarly as in Slovakia. In Hungary, already the use of a polynomial of the first degree results in statistically significant results. Using a polynomial of the third degree gives statistically highly significant results. The intertemporal analysis of investments and savings presented in this paper can be also used and developed as part of the problem of an intertemporal approach to the balance of payments.

rate of investments, rate of savings, correlation, Central European countries

After the fall of totalitarian regimes in countries of Central and Eastern Europe in the 90s, basic changes took place, which affected their future economic development. Trends in the development of indices of savings and investments in new member countries of EU considerably differ from the development in its original member countries. The paper is focussed on problems of the development and relationships of the rate of investments and the rate of savings. Its

objective is to evaluate relationships of the rate of investments and the rate of savings in selected Central European countries (Czech Republic, Poland, Hungary, Slovakia) using quantitative methods including testing the statistical significance. The applied intertemporal analysis of investments and savings can create a basis to deal with problems of an intertemporal approach to the balance of payments.

METHODS

A starting point of the paper is the study of domestic and foreign specialized literature. Relationships between the rate of savings and the rate of investments in selected OECD (Organization for Economic Cooperation and Development) countries were dealt with, for example, by Feldstein, Horioka (1980), Obstfeld, Rogoff (1994) and Brada et al. (2008). The basic source of the collection of data was represented by the Statistical Office of the European Union (EUROSTAT) or also by the Czech Statistical Office. After obtaining information on the character of data a decision followed concerning the use of methods suitable for the evaluation of relationships between the rate of investments and the rate of savings. In this analysis, four Central European countries are included: Czech Republic, Poland, Hungary and Slovakia. For the purpose of comparison, e.g. with regard to the development of monitored indicators, the average of new or old (original) EU countries can be also added.

The evaluation of relationships between the rate of investments and the rate of savings in Central European countries, which is the objective of this paper, can be carried out using methods of regression and correlation analysis including testing the statistical significance. A model presented by Feldstein and Horioka (1980) can be used for needs of this paper. Moreover, it can be completed by means of other variables on the basis of knowledge obtained from the study of literature. A reference period for the given analysis was selected (with respect to the availability of data) for the period 1995–2009. Feldstein and Horioka (1980) used a reference period of the same duration.

The use of statistical methods was described by Aczel (1989) or Mason, Lind (1990). The factual data processing comes from the methodology published by Hindls et al. (2003), Dirschedl, Osteermann (2001).

Minařík (1996, p. 97) states, that the statistical dependence of two characteristics (numeric figures) can be expressed as their functional relation by a formula, table or graph. We recognize these types of statistical dependence: fix, functional alias deterministic dependence and free, statistic alias stochastic dependence. The stochastic dependence makes itself felt like more or less significant repeatable tendency, which realizes in different form on different place and in different time. It is characteristic for its variability of individual causes and makes itself felt under a row of noteless, variously reacting factors. The stochastic dependence is referred to as a correlation dependency. For this dependency, we distinguish from dependent and independent variable. The correlation analysis of two variables is called pair or simple analysis.

The main graphical data presentation tool for examining the dependence between two variables is a point diagram, where we mark particular cases as points in a reference frame with coordinates, which

are the values of particular dependent and independent variables.

The equation for a linear model is: $y' = b_0 + b_1x$

The equation for a quadratic model is: $y' = b_0 + b_1x + b_2x^2$

The equation for a cubic model is: $y' = b_0 + b_1x + b_2x^2 + b_3x^3$

The equations for a bisector or second-degree parabola are the same as trend determination in temporal series.

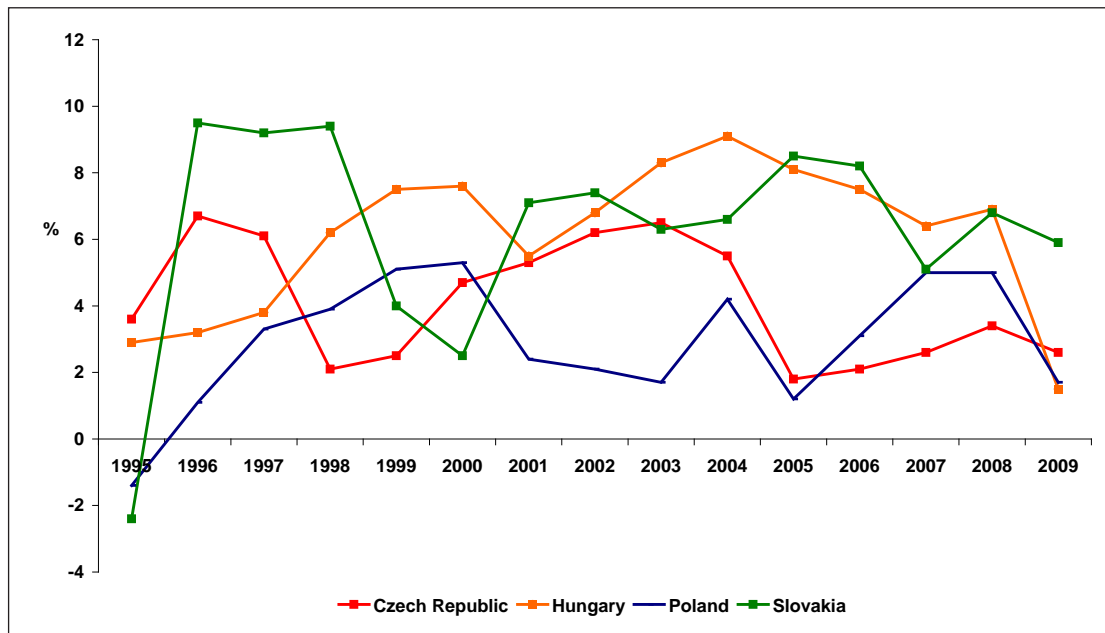
In this paper, particular characteristics are calculated of tightness of the dependency of variables. Conjugate regression lines show the same values of the tightness dependency characteristics, the correlation coefficient $r_{yx} = r_{xy}$, determination coefficient $r_{yx}^2 = r_{xy}^2$ (at the first place in this index is stated variable thought to be dependent). The correlation index I_{yx} is a dependency tightness characteristics for any type of regression function (for simple as well as multiple dependencies of variables). Its second power is determination index I_{yx}^2 . Determination index multiplied by 100 presents the explanation percentage of the calculated regression function – how the changes of dependent variable Y are explained by the changes of independent variable(s).

Statistical software Unistat 5.11 for Windows and Microsoft Excel has been used for the calculation of following results.

RESULTS

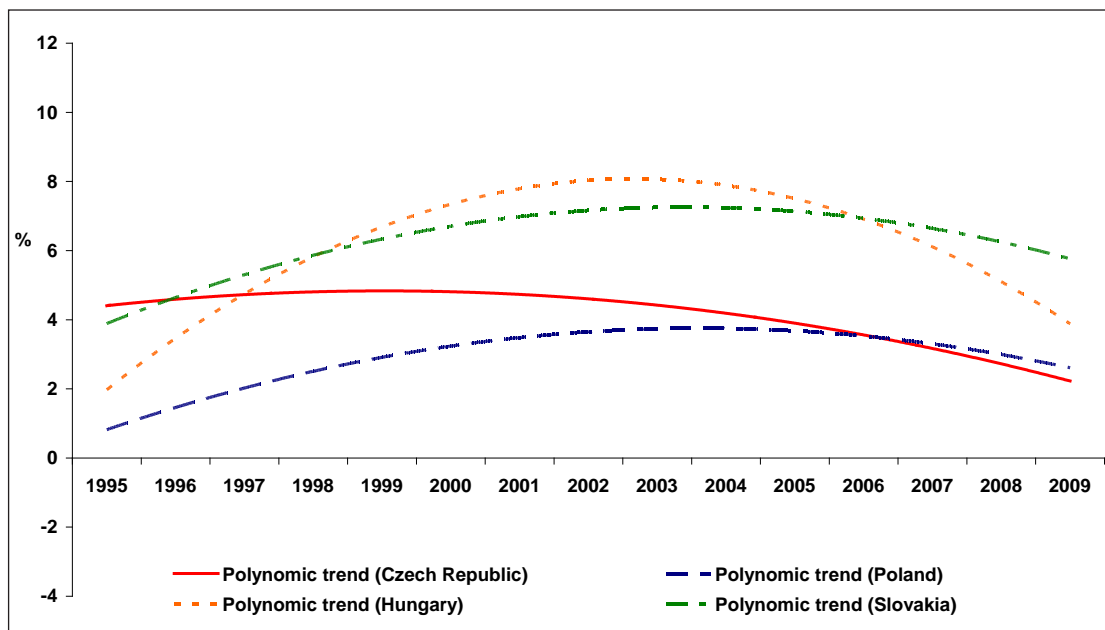
The rate of savings is expressed by means of the indicator of gross savings as the percentage of GDP. For the rate of investments an indicator of the gross creation of capital is used as the percentage of GDP. Values of indicators of the rate of investments and the rate of savings result from the data of EUROSTAT. A reference period has been determined for 1995–2009. First, it is possible to meet the development of an indicator, which was calculated as a difference between the rate of investments and the rate of savings in selected countries. This development is illustrated in Fig. 1.

In Central European countries, the rate of investments permanently exceeded the rate of savings within the monitored period. Out of sixty calculated differences of the rate of investments and the rate of savings in these four new member countries of EU only two data reached negative values, namely in Poland and Slovakia in 1995, namely at the very beginning of the monitored period. Within the rest of a reference period, distance values of the rate of investments and savings fluctuated in positive values. I fitted developmental series in particular countries by a polynomial of the second degree to indicate and compare trends at this indicator. Polynomial trends of the difference indicator of the rate of investments and the rate of savings in Central European countries in the monitored period are evident in Fig. 2 when all countries show similar developmental ten-



Source: own processing

1: A difference indicator of the rate of investments and the rate of savings in Central European countries in 1995–2009 (%)



Source of data: own calculations

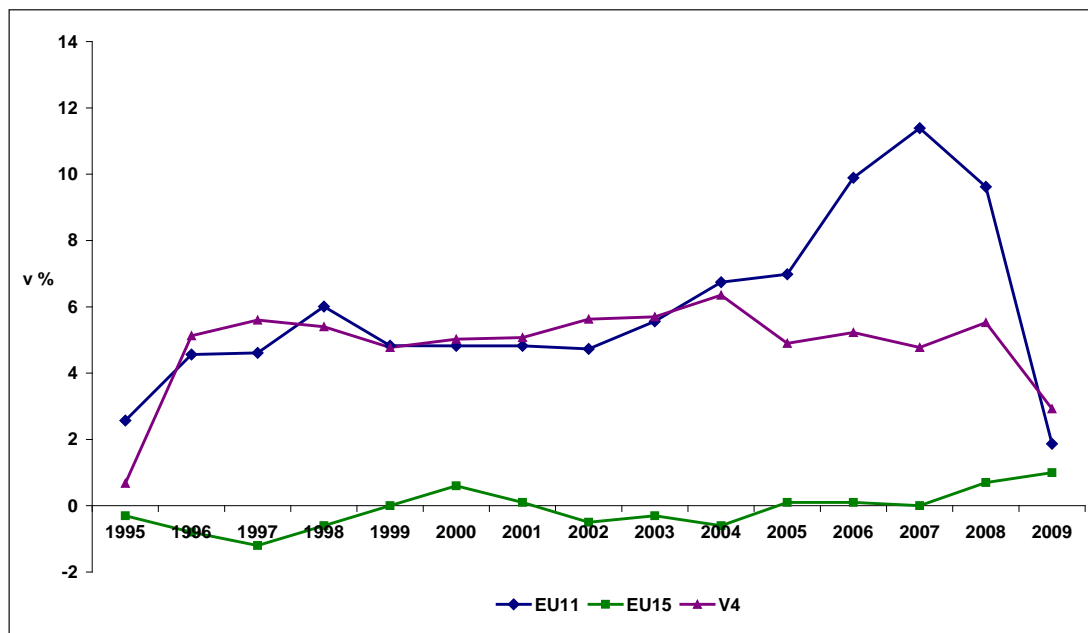
2: Polynomial trends of a difference indicator of the rate of investments and the rate of savings in the Central European countries in the period 1995–2009

dencies characterized, at the beginning of the reference period, by increasing the imbalance of the rate of investments and the rate of savings and then follow-up tendencies towards the gradual return to the balance.

The different development of the given indicator in selected Central European countries, new member EU11 countries and so called old member EU15 countries is presented on Fig. 3. The selected Central European countries include so called Visegrad four

countries (V4), that is: Czech Republic, Poland, Hungary and Slovakia.

As for new EU member countries, Cyprus is not included into this analysis because since 2000, it does not publish data necessary for the calculation of this indicator on EUROSTAT. Therefore, the number of new member countries is limited to 11 and thus, an indication EU11 is used. In EU15 countries as a whole, a difference between the rate of investments and the rate of savings fluctuated



Source: own processing

3: A difference indicator of the rate of investments and the rate of savings in selected Central European countries (V4), EU15 and EU11 countries in the period 1995–2009 (%)

around zero ($\pm 1\%$). The mean value of this indicator for the period 1995–2009 amounted to 0.11%. Thus, in the long term, the rate of investments roughly corresponded to the rate of savings.

For the purpose of a more profound analysis, rates of investments and rates of savings calculated on the basis of data available from EUROSTAT in monitored countries are repeatedly used. A time period 1995–2009¹ is a reference period for the following

analysis. I shall try to prove statistically the existence of correlation between the rate of investments and the rate of savings. Perhaps even other variables can be added to the model. Brada et al. included into the analysis of relationships between the rate of investments and the rate of savings also a variable gross domestic product per capita, which appeared to be, however, statistically insignificant. Therefore, I decided not to include this variable into

I: Parameters of a regression function for the rate of investments with respect to the rate of savings in the Czech Republic, Poland, Hungary and Slovakia in the period 1995–2009

Model		Model parameters				I _{ytytyt}
		b _{yt0}	b _{tytytyt11b}	b _{yt2}	b _{yt3}	
Czech Republic	1	8.4216535242	0.7240768402	-	-	0.8729269367 ⁺⁺
	2	11.0160978343	0.5169941817	0.0040389031	-	0.8733155623 ⁺⁺
	3	32.17172936	5.6869893645	0.1970219199	0.0025501719	0.8753818691 ⁺⁺
Poland	1	1.2978630652	1.0859902556	-	-	0.6493473324
	2	32.552358596	2.3194479516	0.0921707504	-	0.6550043595 ⁺
	3	486.33098311	76.292676449	4.0929239195	0.071802137	0.6624239323 ⁺
Hungary	1	13.169213703	0.6313733326	-	-	0.6334630665 ⁺
	2	59.4595993106	4.1971088946	0.1237500610	-	0.672459861 ⁺
	3	455.908210550	66.207989359	3.3287369613	0.054740230	0.6989643844 ⁺⁺
Slovakia	1	15.2427963660	0.5960914275	-	-	0.4521296704
	2	94.00421665	10.5329305884	0.2232821768	-	0.6163650779 ⁺
	3	600.3716433	83.440774919	3.9807321669	0.062187469	0.6803041101 ⁺

Correlation index: I_{yt}

Significance level: ⁺ $\alpha = 0.05$; ⁺⁺ $\alpha = 0.01$

1 At data for 2009, it refers to the EUROSTAT prediction.

my analysis. To determine parameters of a regression function were used methods of regression and correlation analysis (including testing the statistical significance) described in the part Methods. Parameters of linear, quadratic and cubic regression functions in the given reference period are presented in Tab. I.

Based on the results, the existence of correlation is evident between the rate of investments and the rate of savings in all monitored countries. Indices of correlation were calculated for particular countries and types of a regression function. For the Czech Republic, these results are statistically highly significant using all three types of a regression function. In Poland, they can be indicated as statistically significant using the polynomial of the second and third degrees. The situation is similar also in Slovakia. In Hungary, already the use of a polynomial of the first degree gives significant results. The use of a polynomial of the third degree means achieving highly significant results.

DISCUSSION

Brada et al. dealt with relationships between the rate of savings and the rate of investments at a global level. For the purpose of analysis, they divide particular countries into following categories: developed, poor and transitive. It is possible to mention some conditions concerning the movement of an international capital into categories, which correspond to the division of particular countries of the world:

- a) Rich countries show the higher rate of savings than poor countries.

- b) Rich countries "suffer" from a tendency to the positive difference between the rate of savings and the rate of investments.
- c) In the intermediate period, the limiting rate of yield from investments is higher in poor countries than in rich countries, which stimulates the movement of capital from rich countries to poor countries.
- d) No institutional, financial and exchange restrictions protect the movement of capital between developed and poor countries (Brada et al., 2008)

According to the authors, after the accomplishment of these conditions, it is possible to expect a regression line describing relationships between the rate of savings and the rate of investments with a positive level constant and with a regression coefficient higher than zero but smaller than one. Moreover, the authors mention conditions when the level constant reaches relatively high values and a regression coefficient is near zero than one:

- a) Low financial and exchange restrictions (limitations) for the movement of capital.
- b) Comparable institutional preparation in poor countries with respect to rich countries.
- c) The higher marginal rate of yield in poor countries than in rich countries.
- d) The same investment risk in poor and rich countries (Brada et al., 2008, adapted).

It is evident that it refers rather to an idyllic situation and it would be possible to find a number of explanations, which would, however, exceed the extent of this paper.

SUMMARY

After the fall of totalitarian regimes in countries of Central and Eastern Europe in the 90s, fundamental changes took place, which affected their further economic development. Trends in the development of indices of savings and investments in new member countries of EU considerably differ from the development in its original member countries. The aim of the paper is to evaluate relationships between the rate of investments and the rate of savings in selected Central European countries using quantitative methods including testing the statistical significance. The starting point of the paper presents the study of domestic as well as foreign specialized literature. Relationships between the rate of savings and the rate of investments in selected OECD countries were dealt with, e.g. by Feldstein, Horioka (1980), Obstfeld, Rogoff (1994) and Brada et al. (2008). The Statistical Office of the European Union (EUROSTAT) or also the Czech Statistical Office was the basic source of data. In the analysis, four Central European countries are included: Czech Republic, Poland, Hungary and Slovakia. To compare the development of monitored indicators the mean is also added of new or old member countries of EU. After obtaining information on the character of data a decision followed on the use of methods suitable to evaluate relationships between the development of the rate of investments and the rate of savings. Evaluation of relationships between the rate of investments and the rate of savings in Central European countries is carried out using methods of regression and correlation analysis including testing the statistical significance.

A model mentioned by Feldstein can be used for purposes of this paper. It would be also possible to complete it by other variables. A reference period for the given analysis is selected with respect (not only) to the availability of data for the period 1995–2009.

Also Feldstein and Horioka used a reference period of the same duration. For calculations and expressions of results, I used UNISTAT 5.11 statistical software for Windows or statistical functions in the Microsoft Excel 2002 program.

Values of indicators of the rate of investments and the rate of savings are based on data of EUROSTAT. The rate of savings is expressed by means of the indicator of gross saving as the GDP per cent. For the rate of investments, an indicator of the gross creation of capital as the GDP per cent is used. As first, it is possible to get acquainted with the development of an indicator, which was calculated as a difference between the rate of investments and the rate of savings in selected countries. Based on values of this indicator, it is evident that in examined Central European countries, the rate of investments permanently exceeded the rate of savings within the monitored period. Out of sixty calculated differences between the rate of investments and the rate of savings in these four new member countries of EU, only two data reached negative values, namely in Poland and Slovakia in 1995, ie at the very beginning of the monitored period. For the rest of the reference period, difference values between the rate of investments and the rate of savings fluctuated in positive values. Through fitting the developmental series of an indicator calculated as a difference between the rate of investments and the rate of savings in monitored countries using a polynomial of the second degree it would be possible to compare trends of this indicator in particular countries involved in the analysis. Polynomial trends of a difference indicator of the rate of investments and the rate of savings in Central European countries. Group in the monitored period refer to similar developmental tendencies characterized at the beginning of the reference period by increasing the imbalance of the rate of investments and the rate of savings (on average roughly until 2003) and then follow-up tendencies towards the gradual return to the balance.

In addition, the paper presents the different development of the given difference indicator in Central European countries in total, new member countries and "old" member countries. As for new member countries, Cyprus is not included because since 2000, it does not publish data necessary to calculate this indicator on EUROSTAT. Therefore, the number of new member countries is limited to 11 and EU11 is used for indication. In EU15 countries as a whole, a difference between the rate of investments and the rate of savings fluctuated around zero ($\pm 1\%$). A mean value of this indicator amounted to -0.11% for the period 1995–2009. Thus, the rate of investments roughly corresponded to the rate of savings on a long-term basis.

For the purpose of a more profound analysis, rates of investments and rates of savings, calculated on the basis of data available from EUROSTAT in monitored countries, are used again. A reference period for an analysis trying to prove statistically the existence of a correlation between the rate of investments and the rate of savings is the period 1995–2009. If necessary, other variables can be added to the model. For example, Brada et al. included also the variable of a gross domestic product per capita into the analysis of relationships between investments and savings. However, this variable appeared to be statistically insignificant. Therefore, I decided not to include this variable into the actual analysis. To determine parameters of a regression function, methods of regression and correlation analysis (including testing the statistical significance) described in detail in Methods were used. Parameters of linear, quadratic and cubic regression functions in the given reference period mentioned in the paper point to the existence of correlation between the rate of investments and the rate of savings. Indices of correlation were calculated for particular countries and types of regression. For the Czech Republic, results appear to be statistically highly significant at the use of all three types of a regression function. In Poland and similarly in Slovakia, the use of a polynomial of the second and third degrees appears to be statistically significant. In Hungary, the use of the first degree polynomial gives statistically significant results and using the third degree polynomial gives highly significant results. The intertemporal analysis of investments and savings presented in this paper can be further used and developed as part of problems of the intertemporal approach to the balance of payments.

SOUHRN

Vyhodnocení vztahu investic a úspor v zemích střední Evropy

Po pádu totalitních režimů v zemích střední a východní Evropy v devadesátých letech došlo k zásadním změnám, které ovlivnily jejich další ekonomický vývoj. Trendy ve vývoji ukazatelů úspor a investic v nových členských zemích Evropské unie se značně odlišují od vývoje v jejích původních členských zemích. Cílem příspěvku je vyhodnocení vztahu míry investic a míry úspor ve vybraných zemích střední Evropy s použitím kvantitativních metod včetně testování statistické významnosti. Výchozí bod příspěvku představuje studium domácí i zahraniční odborné literatury, kdy vztahem míry úspor a míry investic se ve vybraných zemích OECD zabývali např. Feldstein, Horioka (1980), Obstfeld, Rogoff (1994) a Brada a kol. (2008). Základním zdrojem dat je Evropský statistický úřad (Eurostat), příp. též Český statistický úřad. V analýze jsou zahrnuty čtyři země střední Evropy: Česká republika, Polsko, Maďarsko a Slovensko. Pro srovnání vývoje sledovaných ukazatelů je navíc přidán i průměr nových nebo starých členských zemí Evropské unie. Po seznámení se s charakterem dat následovalo rozhodnutí o použití metod vhodných pro vyhodnocení závislosti mezi vývojem míry investic a míry úspor. Vyhodnocení vztahu míry investic a míry úspor v zemích střední

Evropy je provedeno s použitím metod regresní a korelační analýzy, včetně testování statistické významnosti. Model uvedený Feldsteinem může být použit pro potřeby tohoto příspěvku, případně by jej bylo možné doplnit o další proměnné. Referenční období pro danou analýzu je (nejen) vzhledem k dostupnosti dat zvoleno na období let 1995–2009. Stejně dlouhé referenční období použili i Feldstein s Horiokou. Pro výpočty a vyjádření výsledků jsem použil statistický software UNISTAT 5.11 pro Windows případně statistické funkce programu Microsoft Excel 2002.

Hodnoty ukazatelů míry investic a míry úspor vycházejí z dat Eurostatu. Míra úspor je vyjádřena pomocí ukazatele hrubé úspory jako procento HDP. Pro míru investic je použit ukazatel hrubá tvorba kapitálu jako procento HDP. Jako první je možné se v příspěvku seznámit s vývojem ukazatele, který byl vypočten jako rozdíl mezi mírou investic a mírou úspor ve zvolených zemích. Z hodnot tohoto ukazatele je zřejmé, že v zemích střední Evropy míra investic ve sledovaném období trvale převyšovala míru úspor. Z celkem šedesáti vypočtených rozdílů míry investic a míry úspor v těchto čtyřech nových členských zemích Evropské unie dosáhly jen dva údaje záporných hodnot, a to v Polsku a na Slovensku v roce 1995, tedy na samém počátku sledovaného období. Po zbytek referenčního období se rozdílové hodnoty míry investic a úspor pohybovaly v kladných číslech. Proložení vývojové řady ukazatele vypočteného jako rozdíl míry investic a míry úspor ve sledovaných státech polynomem druhého stupně bylo možné porovnat trendy tohoto ukazatele v jednotlivých zemích zahrnutých v analýze. Polynomické trendy rozdílového ukazatele míry investic a míry úspor v zemích střední Evropy ve sledovaném období poukazují na podobné vývojové tendence charakteristické zpočátku referenčního období prohlubováním nerovnováhy míry investic a míry úspor (v průměru přibližně do roku 2003) a poté opětovnými tendencemi k postupnému návratu k rovnovážnému stavu.

Dále je v příspěvku prezentován rozdílný vývoj daného rozdílového ukazatele v zemích střední Evropy celkem, nových členských zemích a tzv. starých členských zemích. Z nových členských zemí není v analýze zahrnut Kypr, protože od roku 2000 na Eurostatu nezveřejňuje údaje potřebné pro výpočet tohoto ukazatele. Proto je počet nových členských zemí omezen na 11 a je užito označení EU11. V zemích EU15 jako celku se rozdíl mezi mírou investic a mírou úspor pohyboval okolo nuly ($\pm 1\%$). Průměrná hodnota tohoto ukazatele za období let 1995–2009 činila $-0,11\%$. Míra investic tedy dlouhodobě přibližně odpovídala míře úspor.

Pro potřeby hlubší analýzy jsou opět využity míry investic a míry úspor vypočtené na základě údajů dostupných z Eurostatu ve sledovaných zemích. Referenčním obdobím pro analýzu, která se pokouší statisticky prokázat existenci korelace mezi mírou investic a mírou úspor, je časový úsek 1995–2009. Do modelu mohou případně být přidány i další proměnné. Např. Brada a kol. do analýzy vztahu investic a úspor začlenili i proměnnou hrubý domácí produkt per capita, která se ovšem ukázala jako statisticky nevýznamná, proto jsem se rozhodl tuto proměnnou do vlastní analýzy nezačlenit. Ke stanovení parametrů regresní funkce jsou použity metody regresní a korelační analýzy (včetně testování statistické významnosti) popsané podrobněji v metodické části. Parametry lineárních, kvadratických a kubických regresních funkcí v daném referenčním období uvedené v příspěvku poukazují na existenci korelace mezi mírou investic a mírou úspor. Byly vypočteny indexy korelace pro jednotlivé země a typy regresní funkce, kdy pro Českou republiku se výsledky jeví jako statisticky vysoce významné při použití všech tří typů regresní funkce. V Polsku se jako statisticky významné jeví použití polynomu druhého a třetího stupně, obdobně je tomu na Slovensku. V Maďarsku již použití polynomu prvního stupně vede ke statisticky významnému výsledku, při užití třetího stupně se jedná o výsledek statisticky vysoce významný. Intertemporální analýza investic a úspor prezentovaná v tomto příspěvku může být dále využita a rozvinuta jako součást problematiky intertemporálního přístupu k platební bilanci.

míra investic, míra úspor, korelace, země střední Evropy

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