Chapter 5

The comparative analysis for gross domestic product of China and ASEAN member states

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In spite of the fact that China's economy currently is the world's second-largest economy, it also decelerated in the year 2008 when the global financial crisis began. The gross domestic product (GDP) growth slowed down primarily as a result of the reduction in trade surplus – the contribution of net exports to GDP growth significantly decreased and thereafter remained at zero or negative level. In order to maintain the target GDP growth, the Chinese government responded to the global financial crisis by implementing a wide and expensive economic package[1] that provided various incentives for domestic demand.[2] Since that time, the Chinese economic growth was mainly caused by investment rather than exports – the contribution of gross capital formation to GDP growth rapidly increased in the year 2009 to above 85%.[3] The average growth rate of real GDP in China declined from 14.2% in 2007 to 9.6% in 2008 and next, to 9.2% in 2009. After the implementation of economic package counteracting the distortions due to the global financial crisis,

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1 The implementation of a massive stimulus program as a response to the global financial crisis, aimed at an increase in investments that were to be financed by bank loans and credits resulted in a very high level of post-crisis credit to *GDP* ratio. See: World Bank [2017], *China – Systematic Country Diagnosis: towards a more inclusive and sustainable development*, World Bank Group, Washington, D.C., p. 5.

2 W.M. Morrison [2014], *China's economic rise: history, trends, challenges and implications for the United States*, Congressional Research Service, Washington, D.C., p. 3.

3 C. Fang [2016], *China's economic growth prospects from demographic dividend to reform dividend*, E. Elgar Publishing, Cheltenham (UK), Northampton (MA, USA), pp. 129, 131.

China's economic growth in 2009 was lower than in the previous years but this fall was not as sharp as in 2008. In 2010 the growth rate of real GDP rose to 10.4% and in 2011 it fell back to 9.2%[4] so therefore, the average real GDP growth in China in the period 2009–2011 was equal to 9.6%. Unfortunately, in 2012 and 2013 the growth rate of real GDP dropped to 7.7%, suggesting that China's economy started slowing down again.[5] After the year 2011 the contribution of final consumption, which included both household and government consumption to real GDP growth decreased – the contribution to real GDP growth of government consumption was relatively steady but of the household consumption declined.[6] The reason for weak private consumption in China was the lack of adequate social safety net comprising the system of pensions, health care and education as well as unemployment insurance that should be financed by the government expenditure to reduce households' propensity to save.[7] In 2015 the growth rate of real government consumption increased from 4.1% in 2014 to 9.9% and the contribution of household consumption to real GDP growth[8] exceeded the contribution of capital fixed formation.[9]

The essential aim of this chapter is to assess the efficiency of government consumption expenditure in the creation of gross domestic product (GDP) in China. In order to attain this objective the comparative empirical research of China and ASEAN member states, which run broad cooperation in the political and security, economic and socio-cultural area,[10] was conducted. The comparison between countries qualified for the research sample was carried out in the period of ten years from the beginning of global financial crisis. The input-output analysis relied on data from the World Bank data base applied the input-oriented model with constant returns to scale (CCR), which is the basic model in the method of data envelopment analysis (DEA).

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4 The demographic transition connected with the disappearance of a demographic dividend i.e. the decrease of working age population, which began after 2011, caused a gradual decline in the savings rate leading to a lower investment rate – the contribution of gross capital formation to real *GDP* started to weaken. Compare: C. Fang [2016], *op. cit*., p. 66; World Bank [2017], *op. cit*., p. 2.

5 W.M. Morrison [2014], *op. cit.*, p. 4.

6 C. Fang [2016], *op. cit.*, p. 130; W.M. Morrison [2014], *op. cit.*, p. 29.

7 W.M. Morrison [2014], *op. cit.*, pp. 27, 32.

8 The changes of economic growth pattern from investment-led growth to final consumption-led growth was one of several objectives, which were established to transform China's economy towards slower but more equitable and sustainable development. Compare: C. Fang [2016], *op. cit.*, p. 131; W.M. Morrison [2014], *op. cit.*, p. 32; World Bank [2017], *op. cit.*, p. 1.

9 World Bank [October 2017], *Balancing Act. East Asia and Pacific Economic Update*, World Bank Group, Washington, D.C., p. 113.

10 ASEAN Secretariat [April 2017], *Overview of ASEAN China Relations*, https://web.archive.org/web/20180825002517; https://asean.org/storage/2016/01/Overview-of-ASEAN-China-Relations-April-2017.pdf, pp. 1–7 (accessed: 12.10.2019).

5.1. Impact of government expenditure on economic growth – literature review

The link between government expenditure and economic growth has been an issue of sustained interest of researchers conducting studies in the field of public finance both at theoretical and empirical levels for decades. Generally, the empirical research on effects of government expenditure on economic growth, usually measured by the gross domestic product (GDP) growth, were focused on the verification of Keynesian hypothesis stating that the expansion of government expenditure accelerates the economic growth and/or Wagner's law suggesting that the government expenditure increases because of the economic growth.

Barro,[11] while conducting empirical research on the basis of the cross-section data of 98 economies for the years 1960–1985, considered 14 various regression specifications for the economic growth. The findings of his studies indicated that the association between ratio of real government consumption expenditure to real GDP and growth rate of real GDP per capita was significantly negative. What was more, the relationship between government consumption expenditure and private investment, which was also significantly negative, implied that the decrease in private investment, being the result of distortions introduced by government consumption expenditure, was one route of the decline in economic growth. On the other hand, Barro found that the real government investment expenditure, measured by the ratio to real GDP was positively related to the growth rate of real GDP per capita but this association was statistically insignificant.

Relied on the decade-average data of 36 countries for the 1960s, 108 countries for the 1970s and 119 countries for the 1980s, Easterly and Rebelo[12] estimated parameters in three versions of the regression function for economic growth, which included the government investment expenditure by sector and level of government. The main result of their empirical research was that, regardless of the analysed version of regression function for economic growth, government investment expenditure on transport and communication sector as well as investment expenditure by general government, both expressed as the share in real GDP were positively correlated with the growth rate of real GDP per capita. The transport and communication investment was not related to private investment, which suggested that it increased the economic growth by rising social return to private investment but not by rising private investment itself. The relationship between general government investment expenditure and private investment was positive.

11 R.J. Barro [1991], *Economic Growth in a Cross Section of Countries*, "Quarterly Journal of Economics", vol. CVI (425), pp. 407–443.

12 W. Easterly, S. Rebelo [1993], *Fiscal policy and economic growthAn empirical investigation*, "Journal of Monetary Economics", vol. 32 (3), pp. 417–458.

Ghura,[13] taking into account findings of his empirical studies carried out among different in terms of the development level 33 countries in sub-Saharan Africa during the period 1970–1990, could not reject the research hypothesis about the adverse effect of government consumption expenditure on economic growth. The estimated coefficient on real government consumption expenditure in the form of percentage of real GDP in the regression equation for economic growth, which was measured by the growth rate of real GDP per capita, was negative and significant at 0.01 level.

Razzolini and Shughart,[14] based on the data set comprising 50 states of the USA plus the District of Columbia for the years 1967 through 1992, explored the impact of a relative size of the state government on state income growth. Estimating several versions of regression function for the state income growth with the use of both ordinary last squares (OLS) and panel data techniques, they received the empirical evidence of negative dependence between the ratio of total direct general expenditure to total state personal income and the growth rate in state income per capita, which was significant at 0.05 level. Besides, the income growth was lower in these states where the government size was larger, the high level of government expenditure financed by the increase in taxes to balance state budget appeared to be a worse way of fostering the income growth than the low level of government expenditure financed partly by off-budget borrowing. Additionally, Razzolini and Shughart did not confirm the research hypothesis that the reduction in state income growth caused some changes in the level of government expenditure.

Fölster and Henrekson,[15] who conducted an econometric panel study on a sample of rich countries covering the period 1970–1995, pointed at a robust negative relationship between the government size and the economic growth. Solving a number of econometric issues in regression specifications to make the estimation of coefficients more reliable, they discovered that an increase in the share of government expenditure in GDP by 10 percentage points led to a decrease in the average growth rate of real GDP per capita on the order of 0.7–0.8 percentage points.

Loizides and Vamvoukas,[16] using the time series data from the UK, Ireland and Greece over the period from early 1950s to mid-1990s estimated parameters in three various regression equations for economic growth. The results of their empirical studies revealed that the link between the ratio of government expenditure to gross national product (GNP) and the growth rate of real GNP per capita was

13 D. Ghura [1995], *Macro Policies, External Forces, and Economic Growth in Sub-Saharan Africa*, "Economic Development and Cultural Change", vol. 43 (4), pp. 759–778.

14 L. Razzolini, W.F. Shughart II [1997], *On the (Relative) Unimportance of a Balanced Budget*, "Public Choice", vol. 90 (1/4), pp. 215–233.

15 S. Fölster, M. Henrekson [2001], *Growth Effects of Government Expenditure and Taxation in Rich Countries*, "European Economic Review", vol. 45 (8), pp. 1501–1520.

16 J. Loizides, G. Vamvoukas [2005], *Government expenditure andeconomic growth: evidence from trivariate causality testing*, "Journal of Applied Economics", vol. 8 (1), pp. 125–152.

positive and statistically significant in the short run for all investigated countries, and in the long run for Ireland and the UK. Moreover, in Greece not only the rise in government expenditure increased GNP but also the rise in GNP increased the government expenditure, which meant that the causality between considered variables was bi-directional. The causality from GNP to government expenditure in Greece was demonstrated by the bivariate test as well as by both trivariate systems i.e. the system with unemployment rate and the system with inflation rate. The same causality in this research was proved in case of the UK, when the trivariate model with inflation rate was adopted.

Ghosh and Gregoriou[17] carried out empirical studies on a sample of 15 developing countries during a period of 28 years to examine the influence of various components of government expenditure on economic growth. The findings of their research showed the positive and statistically significant association between the ratio of current expenditure to total government expenditure and the growth rate of real GDP per capita for OLS fixed effects model as well as the general method of moments (GMM) single-equation model and the GMM system. At the same time, in all three applied methodologies, the statistically significant coefficient on capital expenditure also measured by the ratio to total government expenditure, informed that this component of government expenditure was negatively correlated with the growth rate of real GDP per capita.

On the basis of the cross section data of 71 economies at the different level of development spanning from 1996 to 2003, Cooray[18] estimated parameters of the neoclassical production function that apart from other variables comprised the size and quality of government to account for their role in the economic growth. The OLS estimation of coefficients in transition model provided the empirical evidence that the relationship between the size and quality of government, expressed respectively by the share of government expenditure to GDP and four governance dummy variables describing the level of governance from very high to very low, and the change of GDP per capita between 2003–1996 was significantly positive. Referring to the effect of government expenditure on economic growth across countries distinguished in terms of governance level, Cooray found out that only in the group of countries with very high governance, the government expenditure was used more effectively leading to a greater economic growth. What was more, the results for the disaggregated model by income distribution, in which government expenditure was divided into investment and consumption expenditure as well as into education, health and military expenditure indicated the significantly positive influence

17 A. Gregoriou, S. Ghosh [2006], *On the Composition of Government Spending, Optimal Fiscal Policy, and Endogenous Growth: Theory and Evidence*, https://www.brunel.ac.uk/__data/assets/pdf_file/0010/84475/0619.pdf, pp. 1–28 (accessed: 12.09.2019).

18 A.V. Cooray [2009], *Government expenditure, governance and economic growth*, "Comparative Economic Studies", vol. 51 (3), pp. 401–418.

of investment as well as education and health expenditure on economic growth in all analysed countries, no matter the level of their development.

Rehman, Iqbal and Siddiqi,[19] while conducting empirical studies of Pakistan's economy for the years from 1971 to 2006, explained the causality between the economic growth and the government expenditure along with its various components such as debt services and defence, administrative and development expenditure. Relied on the cointegrated level and Toda-Yamamoto augmented Granger causality test, they rejected the research hypothesis that the real government expenditure amplified the real GDP at both aggregate and disaggregate levels. On the other hand, at bivariate level the rise in real GDP increased the real government expenditure and at multivariate level it increased only the administrative government expenditure.

Jiranyakul,[20] using quarterly data during 1993–2004 investigated the association between real government expenditure and growth rate of real GDP in Thailand. The findings of standard Granger causality test at the 1% level of significance allowed him to reject the research hypothesis that government expenditure did not cause economic growth and to confirm the one that postulated the lack of existence of the causality from economic growth to government expenditure. After the OLS estimation of regression equation for economic growth, he also discovered that real government expenditure and its one-period lag variable had highly significant effect on the growth rate of real GDP.

In the context of data for nine countries from different Asian regions and at the different development level comprising the period from 1970 to 2013, Lahirushan and Gunasekara[21] described the link between government expenditure and GDP, both given in absolute constant values in USD. Having applied the econometrical techniques of cointegration, panel fixed effects model and Granger causality test, they found out that the impact of government expenditure on GDP was significantly positive as well as the causality ran from government expenditure to GDP and vice versa.

Hasnul,[22] based on time series data during the period 1970–2014, employed OLS technique to identify whether in Malaysian economy there was a fixed effect

19 J. Rehman, A. Iqbal, M.W. Siddiqi [2010], *Cointegration-Causality Analysis between Public Expenditures and Economic Growth in Pakistan*, "European Journal of Social Sciences", vol. 13 (4), pp. 556–565.

20 K. Jiranyakul [2013], *The relation between government expenditures and economic growth in Thailand*, "MPRA Paper", vol. 46070, pp. 1–7, https://mpra.ub.uni-muenchen.de/46070/ (accessed: 12.09.2019).

21 K.P.K.S. Lahirushan, W.G.V. Gunasekara [2015], *The Impact of Government Expenditure on Economic Growth: A Study of Asian Countries*, "International Journal of Humanities and Social Sciences", vol. 9 (9), pp. 3152–3160.

22 A.G. Hasnul [2016], *The effects of government expenditure on economic growth: the case of Malaysia*, "MPRA Paper", vol. 71254, pp. 1–16, https://mpra.ub.uni-muenchen.de/71254/ (accessed: 12.09.2019).

of government expenditure split into various categories and types on economic growth, in which explored variables were respectively measured by the percentage of GDP and the growth rate of real GDP. The findings of his empirical studies indicated that the relationship between total government expenditure and economic growth was negative and significant at 5% level. Considering operating and development expenditure as well as education, health, defence and housing expenditure, he discovered that only development and housing expenditure significantly affected the growth rate of real GDP.

Gupta,[23] who carried out the analysis of the data for the period of 2002/2003–2015/2016 estimating parameters of the regression model, determined which components of government expenditure supported the economic growth in Nepal. The results of his empirical research showed that at the 5% level of significance, government expenditure on agriculture, non-agriculture, industry and service sector were positively related to the economic growth while capital and current expenditure was related negatively.

The empirical studies on the impact of government expenditure on economic growth generated a lot of controversies, for the simple reason that their results differed significantly in accordance with the analysed countries and periods as well as applied research methods and techniques.

5.2. Research Methodology

The gross domestic product (GDP) is a standard monetary measure of economic activities of a given country in a specified time period as well as the single most frequently used indicator although it is widely criticised not only by economists.[24] GDP is determined in the system of national accounts in three equivalent approaches:[25]

- an output approach — the sum of gross value added (output less intermediate consumption) of households, non-profit institutions, government and enterprises increased by taxes net of subsidies of products;

23 R. Gupta [2018], *The impact of government expenditure on economic growth in Nepal*, pp. 1–6, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3099218 (accessed: 12.09.2019).

24 GDP as a measure of costs rather than benefits of economic activities does not capture all social costs as well as GDP per capita identified with the social welfare indicator presents only the average income in the economy not the income distribution. See: J.C.J.M. van den Bergh [2009], *The GDP paradox*, "Journal of Economic Psychology", vol. 30, pp. 117–135.

25 OECD [2014], *National Accounts at a Glance 2014*, OECD Publishing, Paris, p. 36; F. Lequiller, D. Blades [2014], *Understanding National Accounts: Second Edition*, OECD Publishing, Paris, p. 20; *System of National Accounts 2008* [2009], EC, IMF, OECD, UN, WB, New York, pp. 104–105.

- an income approach — the sum of employee compensation, gross operating surplus of enterprises and government, gross mixed incomes of unincorporated enterprises and net taxes on production and imports;
- a final demand approach — the sum of final consumption expenditure of households, non-profit institutions and government, gross capital formation and exports less imports.

Bearing in mind the essential aim of this chapter, the basis of the empirical research on the efficiency of final consumption expenditure by general government in the creation of GDP in China is the GDP measure from the final demand side. GDP as the expenditure on final goods and services minus imports is calculated by the following formula:[26]

$$GDP = C + GCF + NE$$

where:
GDP – gross domestic product,
C – final consumption expenditure,
GCF – gross capital formation,
NE – net export.

The final consumption expenditure (total consumption) consists of household final consumption expenditure with expenditure of non-profit institutions serving households (NPISHs)[27] and general government final consumption expenditure,[28] which can be divided into the individual[29] and collective[30] consumption expenditure. The final consumption expenditure of households (private consumption) includes purchases of goods and services used by households to meet their everyday needs,[31] partial payments for goods and services provided by general government and payments to general government for different types of licences/ permits as well as some imputed expenditures.[32] The final

26 World Bank [1960–2018], *Data – GDP (current USD)*, https://data.worldbank.org/indicator/ny.gdp.mktp.cd (accessed: 12.10.2019).

27 The World Bank treats the household final consumption expenditure and final consumption expenditure of *NPISHs* together, even when they are reported separately in the national statistics of a given country.

28 Compare: F. Lequiller, D. Blades, *op. cit.*, p. 140.

29 The general government expenditure for individual consumption reflects the expenditure by general government incurred on behalf of an individual household, for example expenditure on health care system or education system.

30 The general government expenditure for collective consumption relates the expenditure by general government which benefit the whole society or its large part, for example expenditure on national defence system or justice system.

31 The expenditure of households on final goods and services which meet their everyday needs includes purchases of durable products but excludes purchases of dwellings.

32 The imputed expenditure covers for example rent for owner-occupied dwellings as well as value of goods and services received by employees as a part of their wages.

consumption expenditure by general government (public consumption) is the sum of its following costs:[33] compensation of employees of the government, purchases of materials and other intermediate consumption items by the government, consumption of government fixed capital, purchases of goods and services by the government for the benefit of households and other taxes on production paid without the costs of both partial payments of households and enterprises for goods and services provided by the government and own account production of gross fixed capital formation. The gross capital formation (gross domestic investment) consists of outlays on fixed assets of the economy (private and public investment – gross fixed domestic formation),[34] net changes of inventories and net acquisitions of valuables. The net exports is a difference between exports and imports of goods and services.

The empirical studies, comparing the efficiency of general government final consumption expenditure in the creation of GDP in China to the efficiency of this expenditure in nine ASEAN member states[35] in the years between 2008–2017 were conducted applying the method of data envelopment analysis (DEA). The DEA method[36] measures the relative technical efficiency[37] of decision making units (DMUs) based on the estimation of the relation between multiple inputs and multiple outputs. The efficiency of a given decision making unit (DMU) measured by the DEA method is described as a quotient of the weighted sum of outputs to the weighted sum of inputs, which looks as follows:[38]

$$e_i(u,v) = \frac{\sum_{r=1}^{p} u_{ri} y_{ri}}{\sum_{t=1}^{s} v_{ti} y_{ti}}$$

33 See: OECD, *op. cit.*, p. 42; F. Lequiller, D. Blades, *op. cit.*, pp. 139–140.

34 The gross fixed domestic formation of households and general government includes for example the purchase of dwellings and expenditure on transport infrastructure, military defence system, office buildings, hospitals and schools, respectively.

35 Myanmar as the member state of ASEAN was not taken into account in comparative empirical studies because the data about general government final consumption expenditure which was available in the World Bank database covered only for the period from 2010 to 2016.

36 The DEA method derives from the concept of microeconomic productivity function. The productivity measure is described as the ratio of a single output to a single input. See: G. Debreu [1951], *The Coefficient of Recourse Utilization,* "Econometrica", vol. 19 (3), pp. 273–292; M.J. Farell [1957], *The Measurement of Productive Efficiency,* "Journal of the Royal Statistical Society", series A, vol. 120 (3), pp. 253–290.

37 The relative technical efficiency is understood as the relation between productivity of a given *DMU* to the productivity of efficient *DMU*. See: A. Domagała [2007], *Metoda Data Envelopment Analysis jako narzędzie badania względnej efektywności technicznej*, "Operations Research and Decisions", vol. 3–4, p. 23.

38 A. Kucharski [2014], *Metoda DEA w ocenie efektywności gospodarczej*, Wydawnictwo Uniwersytetu Łódzkiego, Łódź, p. 11.

where:
$e_i(u,v)$ – efficiency measure for *i-th DMU*,
i – index denoting a given *DMU*, $i = 1, \ldots, n$,
p – number of outputs, $(r = 1, \ldots, p)$,
s – number of inputs, $(t = 1, \ldots, s)$,
u_{ri} – weight of *r-th* output for *i-th DMU*,
v_{ti} – weight of *t-th* input for *i-th DMU*,
y_{ri} – *r-th* output of *i-th DMU*,
x_{ti} – *t-th* input of *i-th DMU*.

The estimation of a efficiency measure with the DEA method can be made in the framework of four different models in terms of their assumptions:

- a model with constant returns to scale (CRS);[39]
- a model with variable returns to scale (VRS);[40]
- a model with non-increasing returns to scale (NIRS);[41]
- a model with non-decreasing returns to scale (NDRS).[42]

Moreover, the DEA method allows to estimate the efficiency measure in three various forms:[43]

- input-oriented efficiency – minimizing inputs while unchanged outputs;
- output-oriented efficiency – maximizing outputs while unchanged inputs;
- efficiency without the orientation.

The unquestionable advantage of the DEA method[44] is that many heterogeneous inputs and outputs[45] can be taken into consideration without the need to

39 This model in the economic literature is marked from the names of its authors (A. Charnes, W.W. Cooper and A. Rhodes) as *CCR*. See: A. Charnes, W.W. Cooper, B. Golany, L.M. Seiford, J. Stutz [1985], *Fundations of DEA for Pareto-Koopmans Efficient Empirical Production Function*, "Journal of Economics", vol. 30 (1–2), pp. 91–107.

40 This model in the economic literature is marked from the names of its authors (R.D. Banker, A. Charnes and W.W. Cooper) as *BCC*. See: R.D. Banker, A. Charnes, W.W. Cooper [1984], *Some Models for Estimating Technical and Scale Inefficiencies in Data Envelopment Analysis*, "Management Science", vol. 30 (9), pp. 1078–1092.

41 See: R. Fäare, S. Grosskopf, C.A. K. Lovell [1985], *The Measurement of Efficiency of Production*, Kluwer Academic Publishers, Boston.

42 See: S. Ylvinger [2000], *Essays on Production Performance Assessment*, "Umeå Economic Studies", vol. 531.

43 The *DEA* efficiency is also Pareto efficiency which means that a given *DMU* is fully efficient if and only if it is not possible to make any inputs or outputs better off (decrease of inputs or increase of outputs) without making the others worst off (increase of inputs or decrease of outputs). See: A. Charnes, W.W. Cooper, E. Rhodes [1978], *Measuring the efficiency of decision making units*, "European Journal of Operational Research", vol. 2 (6), p. 433.

44 Compare: A. Sajnóg [2015], *Comparative Analysis of Economic Efficiency of Polish and German Listed Companies*, "Oeconomia Copernicana", vol. 6 (2), p. 71.

45 Inputs and outputs can be expressed in diverse units, even not monetary ones but their values cannot be negative as well as at least one input and at least one output for each *DMU* must be different from zero.

determine their weights[46] and functional relationship,[47] which causes that it is widely implemented in the efficiency assessment of DMUs.[48]

The efficiency measure in DEA method takes values between 0 and 1, but the value equal to 1 reflects the full efficiency of a given DMU. In the case of the input-oriented CCR model, treated as a basic model in the DEA method, the efficiency measure amounting to 1 indicates that optimal inputs to achieve given outputs are the same as real inputs.[49] On the other hand, measure of DEA efficiency lower than 1 signals that optimal inputs to obtain given outputs are not highest than real inputs.[50]

The comparative analysis of the efficiency of general government final consumption expenditure in the creation of GDP in China and nine ASEAN member states using the DEA method was conducted on the basis of the input-oriented model with constant returns to scale (CCR), where the final consumption expenditure by general government was assumed for the input and the size of GDP for the output[51] – both variables over ten-year research period for each examined country, which was treated in the comparative analysis as DMU were expressed in current

46 Weights of inputs and weights of outputs, which define their importance and maximize the efficiency of each *DMU* are generated during the estimation of *DEA* efficiency measures.

47 The *DEA* method as a non-parametric technique does not require to define the production function to present the functional dependence between inputs and outputs.

48 Y.J. Feng, H. Lu, K. Bi [2004], *An AHP/DEA method for measurement of the efficiency of R&D management activities in universities*, "International Transactions in Operational Research", vol. 11 (2), pp. 181–191; A. Feruś [2006], *Zastosowanie metody DEA do określania poziomu ryzyka kredytowego przedsiębiorstw,* "Bank & Credit", vol. 7, pp. 44–59; M. Helta [2009], *Zastosowanie metody DEA do opracowania rankingu efektywności spółek Agencji Nieruchomości Rolnych w 2006 roku*, "Annals of Agricultural Sciences", series G, vol. 96 (3), pp. 107–111; R. Jacobs [2001], *Alternative methods to examine hospital efficiency: data envelopment analysis and stochastic frontier analysis*, "Health Care Management Science", vol. 4 (2), pp. 103–115; A. Sajnóg, T. Sosnowski [2015], *Efektywność realizacji procesów dezinwestycji funduszy private equity na GPW w Warszawie*, "Studies and Works College of Management and Finance", vol. 143, pp. 55–76; T. Sueyoshi, M. Goto [2012], *Data envelopment analysis for environmental assessment: Comparison between public and private ownership in petroleum industry*, "European Journal of Operational Research", vol. 216 (3), pp. 668–678; W.-H. Tsai, H.-L. Lee, C.-H. Yang, C.-C. Huang [2016], *Input-Output Analysis for Sustainability by Using DEA Method: A Comparison Study between European and Asian Countries*, "Sustainability", vol. 8 (12), pp. 1–17, https://www.mdpi.com/2071-1050/8/12/1230 (accessed: 04.09.2019).

49 The efficient *DMU* sets the border of efficiency, which being also the border of production possibilities for the whole examined group of entities may be used by inefficient *DMUs* in searching for the optimal level of inputs. See: A. Domagała, *op. cit.*, p. 25.

50 The degree of inefficiency in a given *DMU* is described by the difference between 1 and calculated measure of *DEA* efficiency $e_j(u,v)$. See: A. Kucharski, *op. cit.*, p. 10.

51 The terms "inputs" and "outputs" have a certain conventional character. As far as connection of the term "output" with returns is justified in this study, the term "inputs", which usually refers to costs, is used only to perform the role of customary terminology used in the terminology of *DEA* method.

USD.[52] In order to investigate the role and significance of general government expenditure on final consumption in the creation of GDP in China and nine ASEAN member states, the empirical studies included additionally the evaluation of a percentage share of general government final consumption expenditure in GDP[53] and the analysis of a correlation dependence between examined variables.

Identifying the correlation dependence[54] between GDP and general government final consumption expenditure and defining its direction and strength the Spearman's rank correlation coefficient (Spearman's *rho*) was applied.[55] The Spearman's *rho*,[56] which requires assigning the ranks[57] to the values of investigated variables x and y[58] and to determine the variable d_i, which is the difference between the ranks of i-th values of each variable, is calculated in the following way:

$$r_s = 1 - \frac{6\sum_{i=1}^{n} d_i^2}{n(n^2-1)}$$

where:

r_s – Spearman's rank correlation coefficient,
n – number of observations,
$d_i = Rx_i - Ry_i$,
Rx_i – rank of i-th observation of variable x,
Ry_i – rank of i-th observation of variable y.

52 The variables expressed in constant or current international $ could not be used because the data about general government final consumption expenditure in this currency are not available in the World Bank database for any country. The variables expressed in constant US$ could not also be used due to the lack of data about general government final consumption expenditure in constant currencies for China.

53 The evaluation of percentage share of general government final consumption expenditure in *GDP* was based on the descriptive statistic.

54 The correlation association is a special case of a stochastic relationship, which consists in the fact that with the change of one variable, the probability distribution of the other variable changes. See: C. Domański [2001], *Analiza korelacji i regresji*, in: C. Domański (ed.), *Metody statystyczne. Teoria i zadania*, Wydawnictwo Uniwersytetu Łódzkiego, Łódź, p. 170.

55 In the study of correlation dependence, the Pearson's linear correlation coefficient is most commonly used, but if a number of variants of measurable variables is small and their distributions are not normal to examine the direction and strength of the association between variables, the Spearman's rank correlation coefficient is a more appropriate measure. See: M. Sobczyk [2010], *Statystyka opisowa*, C. H. Beck, Warszawa, p. 117.

56 The Spearman's *rho* is a nonparametric measure defined as the Pearson's linear correlation coefficient between the ranked variables. See: J.L. Myers, A.D. Well [2003], *Research Design and Statistical Analysis (2nd ed.)*, Lawrence Erlbaum Associates Publishers, New Jersey–London, p. 508.

57 The advantage of ranks correlation is that it is not sensitive to outliers (unusual).

58 The assignment of the rank Rx_i to i-th observation of variable x and the rank Ry_i to i-th observation of variable y means giving to the values of variables x and y consecutive numbers from 1 to n in ascending or descending order, but the same order for both variables.

Table 5.1. Classification for values of the Spearman's rank correlation coefficient in terms of the strength of the correlation dependence

Value of the Spearman's *rho*	Strength of the correlation dependence
(0 – ±0.2>	very weak
(±0.2 – ±0.4>	weak
(±0.4 – ±0.6>	moderate
(±0.6 – ±0.8>	strong
(±0.8 – ±1.0>	very strong

Source: own elaboration based on: M. Sobczak [2010], *op. cit.*, pp. 111, 118

The Spearman's *rho* takes values in the range <–1; 1>. The sign of the correlation coefficient shows the direction of correlation dependence, and the absolute value reflects its strength. A correlation coefficient of 0 means that the examined variables are not correlated and thus indicates a lack of correlation dependence between them. If the correlation coefficient is equal to 1, then there is a full compliance of ranks of the examined variables (perfect positive association of ranks), and if it is equal to –1, then there is a full non-compliance of ranks (perfect negative association of ranks). In order to characterise the strength of the correlation dependence between the investigated variables, the following classification for values of the Spearman's *rho* was defined (table 5.1). Assessing the statistical significance of the Spearman's *rho*, there was used the critical level of significance *p-value*,[59] which should be interpreted as the lowest level of statistical significance α allowing to reject the null hypothesis, stating that Spearman's *rho* equals to zero in favour of the alternative hypothesis, stating that it is significantly different from zero.[60]

59 Using the critical level of significance *p-value* in the course of assessing statistical significance as opposed to *t*-statistics, which has a Student's *t*-distribution with *n*–2 degrees of freedom, allows to know the results of a statistical test for a given hypothesis at all levels of statistical significance α.

60 The critical level of significance – *p-value* is the level of statistical significance α at which the critical value of Student's *t*-test – t_α is equal to its value calculated from the sample – $-t = r_s\sqrt{\frac{n-2}{1-r_s^2}}$. Compare: J. Jóźwiak, J. Podgórski [2009], *Statystyka od podstaw*, PWE, Warszawa, pp. 242–245.

5.3. Efficiency of general government final consumption expenditure in the creation of GDP – results of empirical research

The empirical research on the differentiation of China's and nine ASEAN member states' economic efficiency in terms of gross domestic product (GDP) while minimizing general government expenditure on final consumption, in addition to assessing the efficiency measures estimated in the basic model of data envelopment analysis (DEA), included the evaluation of a percentage share of general government final consumption expenditure in GDP and the analysis of a correlation dependence between these variables.

The mean share of general government expenditure on final consumption in GDP for the examined group of countries in the years 2008–2017 fluctuated, increasing in 2009, 2012 and 2013 as well as in 2015. The mean share of final consumption expenditure by general government in GDP ranged from 10.26% in 2008 to 12.71% in 2015, with the above-average mean share observed in 2009 and in the period after the year 2013. The standard deviation of a share of general government final consumption expenditure in GDP after the year 2011 systematically increased, thus indicating the rising differentiation of investigated countries in terms of the importance of general government final consumption expenditure for creating the demand on final goods and services. The share of general government expenditure on final consumption in GDP after the year 2008 in every second analysed country was higher than 11.43%.

The lowest share of general government final consumption expenditure in GDP in the period to 2011 took place in Vietnam, and since 2012 in Cambodia. The mid-term share of general government expenditure on final consumption in GDP in both these countries was lower than the average share for the examined group of countries. Brunei Darussalam where the highest share of final consumption expenditure by general government in GDP appeared in each year of the adopted ten-year research period, was characterized by the highest average annual share among investigated countries. The above-average mid-term share of general government final consumption expenditure in GDP beyond Brunei Darussalam was noted in China, Malaysia, Thailand and Laos (table 5.2.).

The share of general government expenditure on final consumption in GDP in China during the considered research period showed a slow upward trend, decreasing only in 2010 and 2014 – this share was within the range from 13.20% in 2008 to 14.59% in 2017. In ASEAN countries without Myanmar (ASEAN – 9), the average share of final consumption expenditure by general government in GDP in 2017 was higher than in 2008, however, the largest average share of 12.56% was recorded in the year 2015. It is worth highlighting that compared to the share of general government

Table 5.2. General government final consumption expenditure in China and nine ASEAN member states in the years 2008–2017 – share in GDP (%)

Country		Code	Year										Arithmetic mean
			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	
China		*CHN*	13.20	13.22	12.85	13.22	13.48	13.59	13.38	14.04	14.39	14.52	13.59
ASEAN – 9	Malaysia	*MYS*	11.50	13.05	12.58	13.27	13.84	13.72	13.33	13.15	12.58	12.17	12.92
	Philippines	*PHL*	8.83	9.86	9.72	9.70	10.84	10.84	10.56	10.93	11.19	11.24	10.37
	Thailand	*THA*	14.34	15.98	15.80	16.14	16.35	16.36	16.92	17.12	16.94	16.37	16.23
	Singapore	*SGP*	10.11	9.93	9.69	9.24	8.86	9.74	9.63	10.19	10.34	10.43	9.82
	Indonesia	*IDN*	8.42	9.59	9.01	9.06	9.25	9.52	9.43	9.75	9.53	9.09	9.26
	Brunei Darussalam	*BRN*	17.14	23.29	22.15	18.73	18.44	20.16	21.42	25.06	26.22	26.48	21.91
	Vietnam	*VNM*	5.63	5.78	5.99	5.91	5.93	6.16	6.27	6.33	6.51	6.51	6.10
	Lao PDR	*LAO*	7.77	13.38	11.90	11.56	13.42	17.07	15.18	15.11	13.97	12.90	13.23
	Cambodia	*KHM*	5.63	6.16	6.34	6.02	5.78	5.61	5.49	5.40	5.21	5.12	5.68
Descriptive statistics	Number of countries		10	10	10	10	10	10	10	10	10	10	10
	Arithmetic mean		10.26	12.02	11.60	11.28	11.62	12.28	12.16	12.71	12.69	12.48	11.91
	Standard deviation		3.78	5.11	4.77	4.15	4.23	4.76	4.90	5.70	5.94	5.99	4.93
	Minimum		5.63	5.78	5.99	5.91	5.78	5.61	5.49	5.40	5.21	5.12	5.59
	Maximum		17.14	23.29	22.15	18.73	18.44	20.16	21.42	25.06	26.22	26.48	21.91
	First quartile		7.94	9.66	9.18	9.10	8.96	9.57	9.48	9.86	9.73	9.42	9.29
	Median		9.47	11.49	10.81	10.63	12.13	12.21	11.94	12.04	11.88	11.70	11.43
	Third quartile		12.77	13.34	12.78	13.26	13.75	15.70	14.73	14.84	14.28	14.12	13.96

Source: own elaboration based on data of the World Bank

final consumption expenditure in GDP in China, the average share in nine ASEAN countries not only revealed greater variability, but was also lower throughout the entire ten-year research period (figure 5.1.).

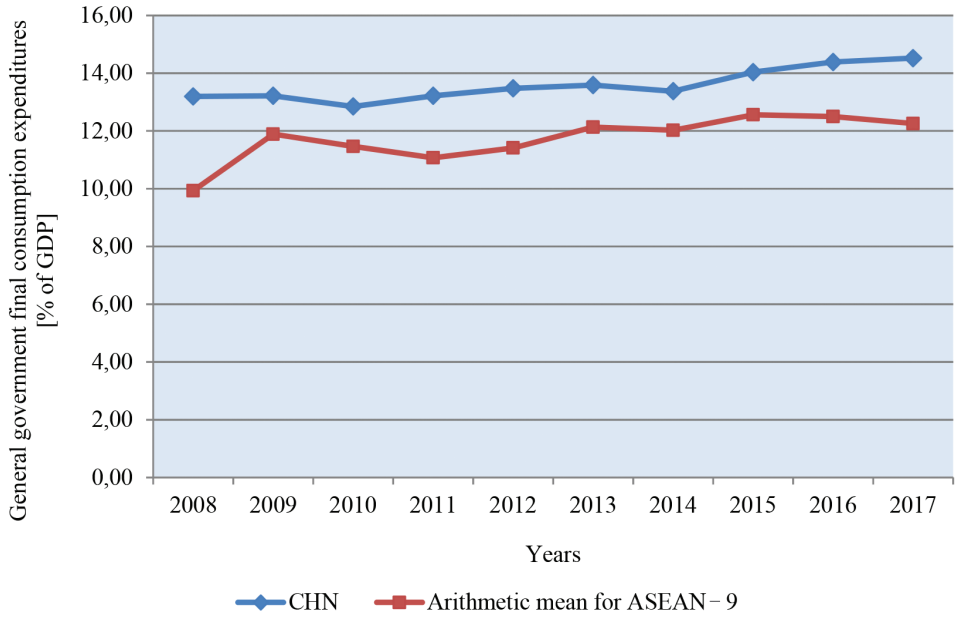

Figure 5.1. General government final consumption expenditure in China and nine ASEAN member states in the years 2008–2017 (% of GDP)
Source: own elaboration based on table 5.2.

In each investigated country, the Spearman's rank correlation coefficient (Spearman's *rho*) was positive and statistically significant at the significance level $\alpha = 0.05$. This means, therefore, that in the years 2008–2017 in particular countries, the increase in general government expenditure on final consumption was accompanied by the increase in GDP. The correlation dependence between general government final consumption expenditure and GDP in Brunei Darussalam was strong and in other countries it was very strong, with the Spearman's *rho* for China, Vietnam and Cambodia amounted to 1 (table 5.3.).

The mean measure of DEA efficiency for the examined group of countries in the years 2008–2017, gradually decreasing during 2012–2016, ranged from 0.6218 in 2008 to 0.4972 in 2016. The standard deviation of a DEA efficiency measure fluctuated, declining in 2010, 2014 as well as in 2016 and 2017. The highest differentiation of investigated countries in terms of the estimated DEA efficiency measures took place in the year 2014, when the standard deviation amounted to 0.2447 (table 5.4.).

Table 5.3. Relationship between gross domestic product and general government final consumption expenditure in China and nine ASEAN member states in the years 2008–2017 – Spearman's rank correlation coefficient [–]

Country		Code	Valid *N*	Spearman's *rho* (r_s)*	*t-stat*	*p-value*
China		CHN	10	1.000000	x	x
ASEAN – 9	Malaysia	MYS	10	0.903030	5.945747	0.000344
	Philippines	PHL	10	0.987879	18.000339	0.000000
	Thailand	THA	10	0.951515	8.749268	0.000023
	Singapore	SGP	10	0.975758	12.610493	0.000001
	Indonesia	IDN	10	0.951515	8.749268	0.000023
	Brunei Darussalam	BRN	10	0.672727	2.571678	0.033041
	Vietnam	VNM	10	1.000000	x	x
	Lao PDR	LAO	10	0.951515	8.749268	0.000023
	Cambodia	KHM	10	1.000000	x	x

* With the Spearman's rho equal to 1, the value of Student's t-test from the sample – t cannot be calculated (the expression in the denominator of the formula for the value of Student's t-test from the sample – t is zero), and therefore the level of statistical significance α, at which the critical value of Student's t-test – t_α is equal to its value calculated from the sample – t, i.e. the critical level of significance – p-value cannot be determined

Source: own elaboration based on data of the World Bank with the Statistica 12 software

The most efficient year from the point of view of the achieved size of GDP while minimizing general government final consumption expenditure was the year 2008, when the estimated measure of DEA efficiency in every second analysed country was at least equal to 0.5966. The year 2016, when the estimated DEA efficiency measure in three out of four examined countries was at most equal to 0.5361, was the least efficient year. Refering to the mean measure of DEA efficiency for the whole ten-year research period, the period up to the year 2012 was above-average in terms of efficiency (compare: table 5.4., figure 5.2.).

The highest DEA efficiency measure of 1.00 occurred in Vietnam in the period to 2011 and in Cambodia since 2012. The above-average mid-term measure of DEA efficiency, except countries, where the efficiency in terms of the reached size of GDP while minimizing general government expenditure on final consumption was periodically full, was observed in Singapore and Indonesia. Brunei Darussalam, where the lowest DEA efficiency measure appeared in each year of the adopted ten-year research period, marked the lowest average annual efficiency measure among investigated countries (compare: table 5.4., figure 5.3.).

Table 5.4. Economic efficiency in terms of gross domestic product while minimizing general government final consumption expenditure in China and nine ASEAN member states in the years 2008–2017 – DEA efficiency measure [–]

Country		Code	Year										Arithmetic mean
			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	
China		*CHN*	0.4263	0.4372	0.4665	0.4472	0.4291	0.4130	0.4108	0.3846	0.3621	0.3528	0.4130
ASEAN – 9	Malaysia	MYS	0.4889	0.4428	0.4763	0.4454	0.4177	0.4092	0.4122	0.4105	0.4140	0.4211	0.4338
	Philippines	*PHL*	0.6369	0.5860	0.6164	0.6093	0.5333	0.5178	0.5202	0.4940	0.4658	0.4558	0.5435
	Thailand	*THA*	0.3922	0.3616	0.3793	0.3662	0.3536	0.3430	0.3248	0.3153	0.3076	0.3129	0.3456
	Singapore	*SGP*	0.5562	0.5819	0.6183	0.6400	0.6528	0.5760	0.5704	0.5297	0.5039	0.4914	0.5721
	Indonesia	*IDN*	0.6678	0.6026	0.6654	0.6525	0.6252	0.5897	0.5829	0.5537	0.5468	0.5639	0.6050
	Brunei Darussalam	*BRN*	0.3282	0.2481	0.2705	0.3156	0.3136	0.2784	0.2565	0.2154	0.1987	0.1935	0.2619
	Vietnam	*VNM*	1.0000	1.0000	1.0000	1.0000	0.9755	0.9118	0.8769	0.8523	0.8004	0.7872	0.9204
	Lao PDR	*LAO*	0.7237	0.4319	0.5037	0.5111	0.4310	0.3287	0.3619	0.3573	0.3729	0.3973	0.4420
	Cambodia	*KHM*	0.9983	0.9377	0.9445	0.9820	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9863
Descriptive statistics	Number of countries		10	10	10	10	10	10	10	10	10	10	10
	Arithmetic mean		0.6218	0.5630	0.5941	0.5969	0.5732	0.5368	0.5317	0.5113	0.4972	0.4976	0.5524
	Standard deviation		0.2349	0.2406	0.2316	0.2359	0.2439	0.2447	0.2401	0.2435	0.2389	0.2371	0.2391
	Minimum		0.3282	0.2481	0.2705	0.3156	0.3136	0.2784	0.2565	0.2154	0.1987	0.1935	0.2619
	Maximum		1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
	First quartile		0.4419	0.4332	0.4690	0.4459	0.4206	0.3596	0.3741	0.3641	0.3648	0.3639	0.4037
	Median		0.5966	0.5124	0.5600	0.5602	0.4821	0.4654	0.4662	0.4522	0.4399	0.4384	0.4974
	Third quartile		0.7097	0.5985	0.6537	0.6494	0.6459	0.5863	0.5798	0.5477	0.5361	0.5457	0.6053

Source: own elaboration based on data of the World Bank with the DEA Frontier software

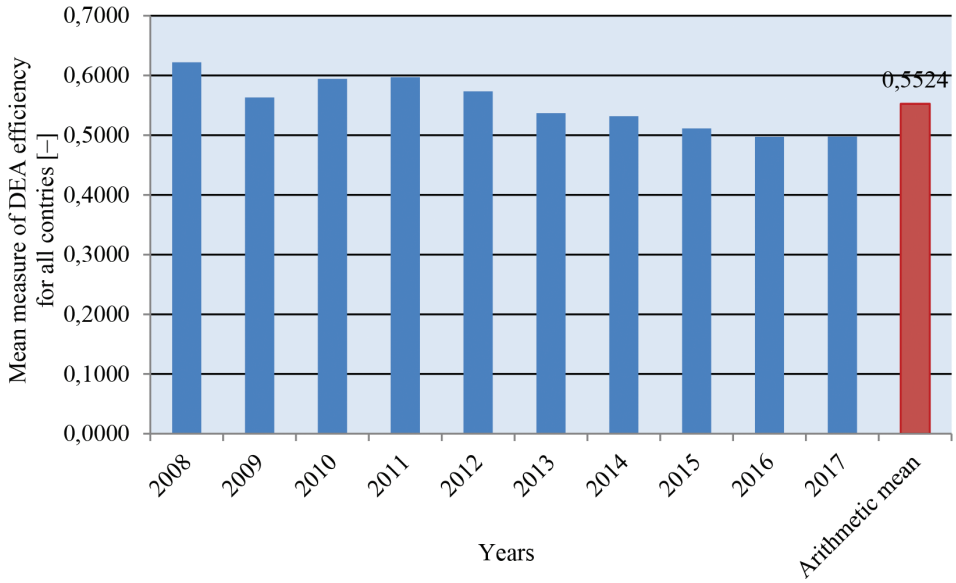

Figure 5.2. Mean measure of DEA efficiency for all countries in the years 2008–2017 [–]
Source: own elaboration based on table 5.4.

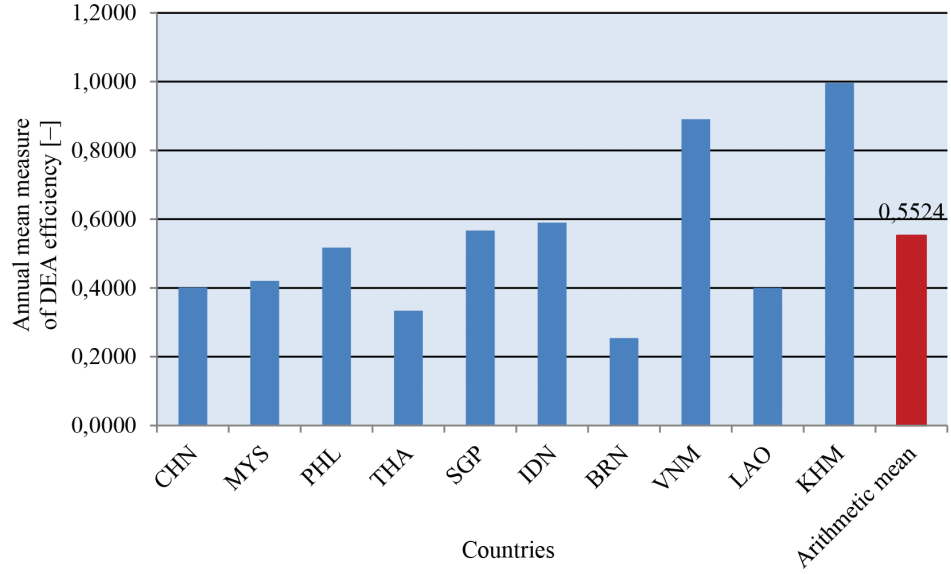

Figure 5.3. Annual mean measure of DEA efficiency in China and nine ASEAN member states [–]
Source: own elaboration based on table 5.4.

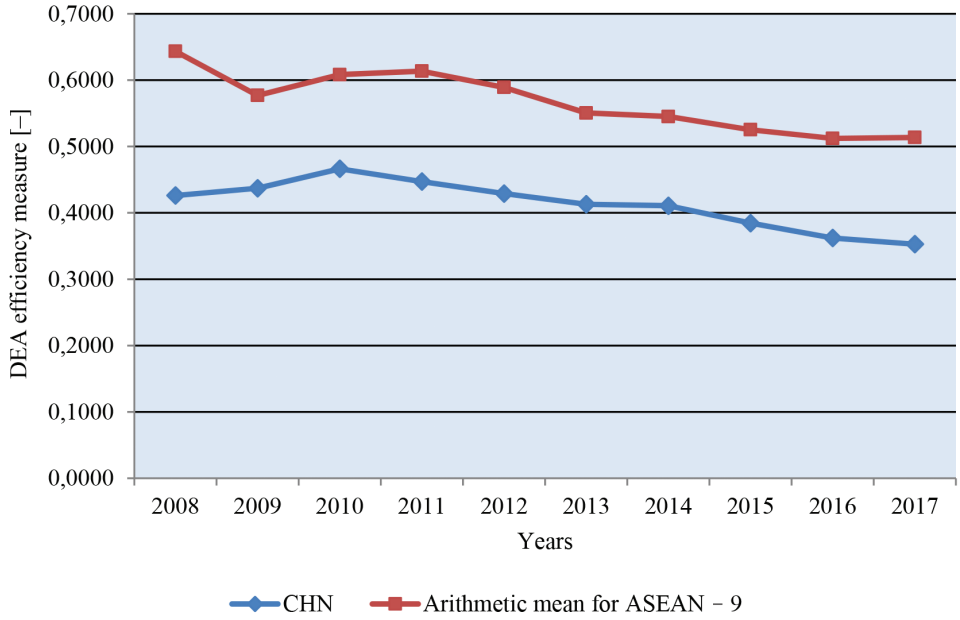

Figure 5.4. DEA efficiency measure in China and nine ASEAN member states in the years 2008–2017 [–]
Source: own elaboration based on table 5.4.

The estimated measure of DEA efficiency in China over the considered research period showed a slow downward trend, increasing only during 2009–2010 – this efficiency measure fell into the range from 0.3528 in 2017 to 0.4665 in 2010. In ASEAN countries without Myanmar (ASEAN – 9), the mean measure of DEA efficiency in 2017 was lower than in 2008, although the lowest average efficiency measure of 0.5122 was noticed in 2016. Similarly to the share of final consumption expenditure by general government in GDP, the average DEA efficiency measure in nine ASEAN countries was more volatile than the efficiency measure in China, but throughout the entire ten-year research period it was higher than China's efficiency measure (figure 5.4.).

Conclusions

On the basis of obtained empirical results the following broad conclusions emerged:

- the highest average share of general government final consumption expenditure in GDP for ASEAN member states without Myanmar (ASEAN – 9),

which appeared in 2015 (12.56%) was below the lowest share for China that occurred in 2010 (12.85%);
- the average annual share of final consumption expenditure by general government in GDP for Brunei Darussalam was the largest among the investigated countries, but the positive relationship between the analysed variables, which was significant at 0.05 level, albeit still strong, was weaker;
- in Vietnam and Cambodia, which were characterised by a very small average annual share of general government expenditure on final consumption in GDP, the positive relationship between the examined variables, just like for China, was perfect;
- countries with a relatively low share of general government final consumption expenditure in GDP had a relatively high average annual measure of DEA efficiency;
- the mid-term share of general government expenditure on final consumption in GDP for China (13.59%) was higher than the average mid-term share (11.91%), and the mid-term DEA efficiency measure (0.4130) was lower than the average mid-term measure (0.5524);
- the highest measure of DEA efficiency in China was observed in 2010 (0.4665) with the lowest share of final consumption expenditure by general government in GDP (12.85%) – the lowest measure of DEA efficiency was noted in 2017 (0.3528) with the highest share of final consumption expenditure by general government in GDP (14.52%);
- the highest DEA efficiency measure in China that appeared in 2010 (0.4665) was under the lowest average efficiency measure for ASEAN member states without Myanmar (ASEAN – 9) that occurred in 2015 (0.5122).

These empirical studies allowed to assess the efficiency of general government final consumption expenditure in the creation of GDP in China against the background of nine ASEAN countries in the adopted ten-year research period but they did not take into account the significance of individual components of general government expenditure on final consumption. Therefore, the future empirical research could be continued towards assessing the efficiency of particular kinds of final consumption expenditure by general government in the creation of GDP as well as it could be conducted in the comparison to other Asian countries than ASEAN member states or to the United States and members of European Union. Besides, the empirical studies on the efficiency of final consumption general government expenditure in the creation of GDP in China should be continued because this issue seems to be important in the scope of a significance of government expenditure in the transformation of economic growth pattern from investment-led growth to consumption-led growth – in the transformation, which supported by changes in monetary policy (chapter 6) can determine the development of strategic sectors (chapter 4).