SUITABILITY OF PORTER'S SD MODEL AND THE 9F MODEL FOR EVALUATION OF NATIONAL COMPETITIVENESS OF VISEGRAD GROUP COUNTRIES AND GERMANY

Marta Nečadová

Abstract

The competitiveness rankings are a widely used method of international comparison of countries' position in global economy. A change of country's position in these rankings can be seen as a signal of future economic potential and opportunities for further development and growth. The reliability of this prediction, however, depends on the quality of the model applied for the international comparison. In every composite indicator analysis, the final index is the outcome of a number of choices: the framework (usually driven by theoretical models and experts' opinions), the indicators to be included, their normalization, the weights assigned to each indicator, and the aggregation method. The discussion about one clear definition of the term national competitiveness is not closed and has not one unambiguous generally accepted result. Different institutions stress different aspects of the competitiveness phenomenon and use different groups of indicators, different methods of normalization, and different aggregation methods. It is clear that countries' results are influenced by the aforementioned steps of construction of composite indicators. Taking into account the essence and the methodology of the Porter's Diamond model (SD model) and the Nine-factor model (9F model), we construct our own simple models. The main aim of this paper is to identify the similarities and differences between these two models and to discuss the suitability of these models for countries with different economic characteristics. Our discussion is based on the evaluation of the results of the Visegrad group countries (V4), which are then compared to the results of Germany.

Key words: composite indicators, national competitiveness, 9F model, SD model, V4 comparison

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Introduction

Being competitive in the global context is a major economic objective frequently invoked by economic policy-makers worldwide. The term competitiveness is used in wide variety of ways, both in economic policies and academic researches. It is generally connected with the ability to achieve certain overall outcomes, such as high standard of living and economic growth. However, some definitions concentrate on the ability to achieve specific economic outcomes, such as job creation, exports, or FDI, while other underline the importance of specific local conditions (e.g. low wages, stable unit labour costs, a balanced budget, a competitive exchange rate) as prerequisites for success in global competition. Most analysts use a broader definition of competitiveness and focus on the structural factors, which influence medium to long-term economic performance: investment, productivity, skills, innovation, clusters, information, competitiveness policy etc. (Fagerberg, 1996, Lall, 2001)

Fagerberg, Srholec, Knell (2007) outline a synthetic framework, based on Schumpeterian logic, for analysing national competitiveness. They take into account four different aspects of competitiveness: technology, capacity, demand, and price/cost. Authors highlight the first three aspects, which often tend to get lost due to measurement problems. According to Lall (2001) and Fagerberg et al (2007), deteriorating technology and capacity competitiveness are, together with an unfavourable export structure, the main factors hampering many developing countries in exploiting the potential to catch-up in technology and income.

Delgado et al (2012), Cho, Moon (2013) and others emphasise the fact that the different concepts of competitiveness confuse the public and scholar dialogue and as a result complicate the explanation of the causes of cross-country differences in the economic performance. Lall (2001), Cho, Moon (2013) and others criticise the methodology used by famous international institutions for national competitiveness assessment. According to Lall (2001), the WEF composite index has two problems. The first problem is its underlying assumption that markets are efficient and that policy intervention, where necessary, must be “market friendly“. As Lall emphasises, this assumption removes from consideration the conditions in developing countries, where market failures call for selective responses. The second problem is connected to the unclear definition of national competitiveness. According to Lall, the broad definition of this term diverts the focus from its original purpose - to compare the countries in direct competition - and takes it into areas, where competitiveness analysis is both unwarranted and has little analytical advantage (Lall, 2001).

The critics of the WEF methodology usually draw the policy-makers' attention to problems with the model specification, the choice of variables (wide using of soft data obtained by questionnaire responses), the identification of casual relations, the use of data, and the method of aggregation. Pérez-Moreno et al (2016) pronounce total substitutability between the twelve pillars in the WEF composite index and propose the following improvements of the computation of the GCI: double reference point scheme in the normalization and an aggregation function, which deals with the problem of substitutability between pillars. Expert discussion about the relevance of results of national competitiveness rankings shows that the most reputable reports (the World Competitiveness Yearbook published by the IMD and the Global Competitiveness Report published by WEF) are more successful in evaluating developed countries, because they underline the size of the domestic market (in the WEF methodology, the indicator of the domestic market size has the greatest weight in the composite index) as well as the stage of the country's development.

Because we adhere to the criticism of the WEF methodology (too many indicators, excessive usage of soft data, the weighting system and the aggregation method), we decided to respect Porter's logic and construct a simple composite index based on the Porter‘s Diamond model (SD model). The obtained result will be compared to the second simple composite index, which will be based on the Nine-factor model (9F model). The main aim of this paper is to identify the similarities and differences between these two models and to discuss the suitability of these models for countries with different economic characteristics. Our discussion arises from the evaluation of the results of the Visegrad group countries (V4), which are then compared to the results of Germany. Our analysis, due to the general critical view of the excessive usage of soft data in the WEF's methodology, used mainly hard (statistical) data. Data selection and the calculation method of the composite index is inspired by two experiments with the modified SD model and the modified 9F model (Cho and Moon, 2013; Balcarova, 2014).

In order to construct reliable composite indicators, several steps need to be taken and corresponding methods have to be chosen. The basic steps are following: selection of sub-indicators, data selection, data editing, data normalization, weighting scheme, weights' values, and composite indicator formula. Saisana, M. et al (2005) point out three types of disputable issues: normalization methods for the values of sub-indicators, weighting approaches, and uncertainty in the weight, which should be attributed to the sub-indicators.

In our text, we choose – similarly as Cho and Moon (2013) and Balcarova (2014) - a statistically simple procedure, which is described in subchapter 1.3. Data normalization is based on the comparison of each selected country with the best country in the relevant indicator (the country value is 100). Equal weight is assigned to all indicators (i.e. we calculate the arithmetic average of the normalized values) within their respective sub-groups, which in turn play equal part in the computation of the final composite index.

Our attitude to computation of the final composite index is the same - i.e. the individual sub-groups of indicators have equal weights.

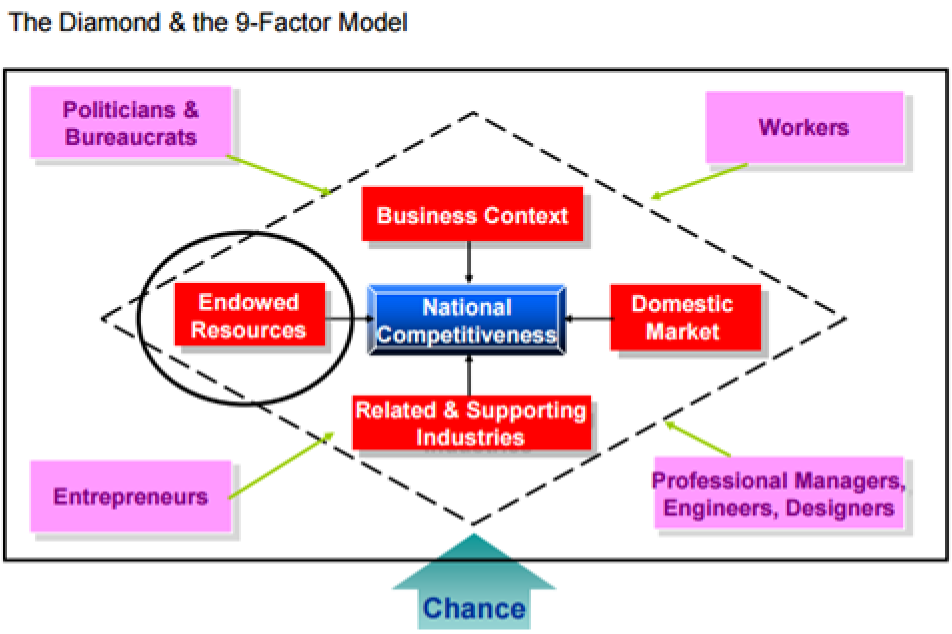
1 Single composite indices based on Porter's diamond model and the 9-factor Model

1.1 Brief description of models

Porter (1990) refocused the competitiveness debate towards the notion that competitiveness is the foundation of the creation of wealth and economic performance. Porter's model is considered to be the first comprehensive and dynamic model of competitiveness. The traditional classical theory of international trade and Porter's approach differ in classification of determinants of competitiveness. According to Porter, national competitiveness does not grow out of resource endowments or currency value, as traditional models assumed, but can be created by a combination of strategic choices along the four determinants of the Diamond model. These determinants consists of four groups of interacting endogenous factors (factor conditions, demand conditions, related and supporting industries and business structure, strategy and rivalry) and two exogenous factors (government intervention and coincidence, and chance). The model specifies the conditions that enable national companies (sector) to realise a competitive advantage; the competitiveness of companies in the international comparison is seen as a prerequisite for the competitiveness of the national economy. For the aforementioned reasons, national competitiveness is a dependent variable in the SD model. Porter's evaluation of the national competitiveness is based on the national productivity, the appropriate proxy variables are FDI and country's export.

The 9F model was constructed by Dong-Sung Cho (2013) with the aim to highlight the role of human factors in the improvement of national competitiveness. This model is an extension of the Porter's SD model and includes wider spectrum of factors - nine groups of factors of competitive advantage, hence the name. Eight internal factors are grouped into two categories - physical factors and human factors - and the 9th factor, chance, remains external. Four groups of competitiveness indicators fall into the physical factors (endowed resources, domestic demand, business environment, related and supporting industries) and four groups into the human factors (workers, entrepreneurs, politicians and bureaucrats, professional managers and engineers) of competitive advantage. This model attributes greater importance to the impact made by human factors rather than to the result of the interaction of individual parts of the model as the SD model does, which constitutes the main difference between the two. This difference is visible on the Figure 1, which illustrates the most important interactions in both models.

Fig. 1: Construction of the Porter's Single Diamond model and the 9-factor Model



Source: Cho, D.S., Moon H. Ch.2016.: IPS national Competitiveness Research 2014-15. Created advantage as the source of competitiveness. PowerPoint presentation.
http://www.ips.or.kr/site/IPS_english/research/develop_04.aspx

1.2 Modified SD model and the 9F model - methodology of construction and chosen variables

The explanatory power of composite indicators is importantly swayed by the choices of the variables, the weighting scheme, and the aggregation method. Since our primary aim is to create simple meaningful models enabling the comparison of different results obtained by different attitudes to the measurement of national competitiveness, we chose only a few indicators in each category, the ones which according to us shape the models most significantly. All variables of the SD model and the 9F model are specified in Tables 1 and 2 (in brackets we show the data source and the last year recorded in the database). It is not possible to find all required data for the same time period, therefore we use the last available statistical data for all variables.

Tab. 1: Variables in the SD model

Factor conditions	Value added in industry (World Bank, 2015, % of GDP)
	Gross domestic expenditure on R&D (Eurostat, 2015, Euro per inhabitant)
	Researches in R&D (Eurostat, 2015, per million inhabitants)
Demand conditions	Final consumption expenditure (Eurostat, 2015, Real expenditure per capita (in PPS_EU28))
	Public expenditure on education (Eurostat, 2015, % of GDP)
	Tertiary graduates (Eurostat, 2014, per 1000 inhabitants, aged 20-29 years)
	Turnover from innovation (Eurostat, 2012, % of total turnover)
Related and supporting industries	Mobile cellular subscriptions (World Bank, 2015, per 100 inhabitants)
	Railway transport - length of tracks (World Bank,2014, km per million inhabitants)
	Length of motorways (Eurostat, 2014, km per million inhabitants)
Firm strategy, structure and rivalry	R&D expenditure (capital expenditure) in business sector (2014, % of GDP, Germany and Austria 2013)
	Global Innovation Index (2016)[1]
	Innovation expenditure of manufacturing firms (2014, % of turnover)

Source: Eurostat, World Bank, Cornell University, INSEAD, and WIPO, own processing

Even though some of the variables listed in Table 2 are similar to the variables included in the SD models, more attention is paid to the human factor and thus more detailed division of the indicators is applied. Endowed sources comprise the basic natural resources of economy: renewable water resources, land area, and crude oil and petroleum products. The second group of physical factors indicates the telecommunication level and the ease of doing business in the economy.

Public expenditure on education and turnover from innovation quantify the sophistication of domestic demand and the final consumption expenditure measures the size of domestic demand. The human factors of competitiveness are divided into four segments.

[1] The EU institutions deal with innovation performance in these three indices: the Innovation Union Scoreboard, the Regional Innovation Scoreboard, and the European Public Sector Innovation Scoreboard. At the Faculty of Business Administration, the EU-27 Innovation Index was constructed by Soukup (2016) et al.

The choice of indicators also takes into account the significance which the quality of workers holds for the national economy.

Tab. 2: Variables in the 9F model

Endowed resources (3)	Renewable internal freshwater resources (World Bank, 2014, m^3 per inhabitant)
	Land area (World Bank, 2016, m^2 per inhabitant)
	Total petroleum products (Eurostat, 2015, tonne per million inhabitants)
Business environment (3)	Internet Users (World Bank, 2015, per 100 inhabitants)
	Time required to start a business (World Bank, 2016, days)
	Mobile cellular subscriptions (World Bank, 2015, per 100 inhabitants)
Domestic demand (3)	Public expenditure on education (Eurostat, 2015,% of GDP)
	Final consumption expenditure (Eurostat, 2015, Real expenditure per capita (in PPS_EU28))
	Innovation expenditure of manufacturing firms (2014, % of turnover)
Related and supporting industries (3)	Railway transport - length of tracks (Eurostat,2014, km per million inhabitants)
	Length of motorways (Eurostat, 2014, km per million inhabitants)
	Gross domestic expenditure on R&D (Eurostat, 2015, Euro per inhabitant)
Workers (3)	Employment rate (Eurostat, 2015,% of total population over 15 years old)
	Tertiary graduates (Eurostat, 2014, per 1000 inhabitants, aged 20-29 years, Germany and Austria 2015)
	GDP per hour worked (Eurostat,2015, percentage of EU28 total (based on million PPS), current prices)[2]
Politicians & bureaucrats (2)	Corruption perception index (Transparency International, 2016)
	Gini Index (World Bank, 2012, Germany 2011)
Entrepreneurs (1)	Self-employed persons (Eurostat, 2015, % of total employed)
Professional managers & engineers (1)	IT specialists (Eurostat, 2015, % of total employed)

Source: Cornell University, INSEAD, and WIPO, Eurostat, Transparency International, World Bank, own processing

[2] We chose only one from the generally used indicators of productivity - GDP per hour worked. The paper of Klecka, Camska (2016) works with productivity indicators based on the contemporary concept (economic costs and economic profit). Their paper deals with the total value productivity (for all inputs) and the main partial productivities in metallurgy, automotive, and chemical industry in the Czech Republic According to the authors, inputs having similar strong and persistent decline in productivity as revenues had demonstrated small flexibility in the enterprise.

1.3 Modified SD model and 9-F model - methodology of construction

We chose very simple method for the computation of composite indicators. We will demonstrate our attitude on an example of factor conditions, i.e. the first part of the SDS model[3]. Table 3 displays the data for the factor conditions.

Tab. 3: Factor conditions in the SD model: variables and data

	Czech Rep.	Germany	Hungary	Poland	Slovakia
Factor conditions (3)	Value added in industry (World Bank, 2015, % of GDP)				
	38,1	30,4	31,2	33,5	34,4
	Gross domestic expenditure on R&D (Eurostat, 2015, Euro per inhabitant)				
	429	904,5	221,8	171,8	231,0
	Researches in R&D (Eurostat, 2015, per million inhabitants)				
	6304,0	7558,6	3738,7	3245,5	3244,8

Source: Eurostat, World Bank, own processing

The maximum value of each indicator is 100. If some part of diamond is specified by more indicators, then maximum value of each of them is 100 divided by the number of indicators. Since factor conditions are represented by three variables, each of them has the weight of 1/3. If the country does not achieve the maximum value, we compute its percentage share of the maximum value. In case of the factor conditions of the competitiveness indices are follows:

$$\text{Czech Republic: } (1/3)\cdot 100 + (1/3)\cdot 47{,}2 + (1/3)\cdot 83{,}4 = 76{,}9 \quad (1)$$

$$\text{Germany: } (1/3)\cdot 79{,}9 + (1/3)\cdot 100 + (1/3)\cdot 100 = 93{,}3 \quad (2)$$

$$\text{Hungary: } (1/3)\cdot 81{,}8 + (1/3)\cdot 24{,}5 + (1/3)\cdot 49{,}5 = 51{,}9 \quad (3)$$

$$\text{Poland: } (1/3)\cdot 88{,}1 + (1/3)\cdot 19{,}0 + (1/3)\cdot 42{,}9 = 50 \quad (4)$$

$$\text{Slovakia: } (1/3)\cdot 90{,}3 + (1/3)\cdot 25{,}5 + (1/3)\cdot 42{,}9 = 52{,}9 \quad (5)$$

The overall competitiveness index for the SD model is calculated as the arithmetic mean of the four determinants, while the overall index for the 9F model is computed as the arithmetic mean of two indices - the index of the physical factors and the index of the human factors[4].

[3] Our explanation is based on the same variables as Balcarova attitude (Balcarova, 2014). This choice enables a comparison of changes in data during the time period.

[4] In the case of two indicators entering into the 9F model (Number of days required to start a business and the Gini index, which measures income inequality), the best evaluated country achieves the lowest value.

2 Results of modified models and their discussion

Due to the choice of variables, our results are not primarily influenced by the size of the economy, unlike the results of the original Porter's model and the WEF composite indicator. However, Germany is still the most competitive economy in both our modified models. Table 4 displays the results of our chosen countries according to modified SD model.

Tab. 4: Results of countries – the SD model

	Czech Rep.	Germany	Hungary	Poland	Slovakia
Factor conditions	76,9	93,3	51,9	50,0	52,9
Demand conditions	79,6	86,3	66,3	73,8	84,1
Related and supporting industries	75,9	71,1	89,7	59,4	66,6
Firm strategy, structure and rivalry	76,6	92,6	65,5	52,8	34,0
Competitiveness index	**77,3**	**85,8**	**68,3**	**59,0**	**59,4**

Source: Eurostat, World Bank, Cornell University, INSEAD, and WIPO, own processing

Germany has the best rating in five of the selected indicators - the gross domestic expenditure on R&D, the number of researchers, demand conditions (except for the share of innovative products in the total turnover of the companies, where Germany is on the 3rd place behind Slovakia and the Czech Republic), and firm strategy, structure and rivalry can be regarded as Germany's competitive advantage. The competitive advantage of the Czech Republic, the best of the V4 countries, consists in factor conditions, factors determining innovation activity (the 4th Porter's determinant), the share of gross value added in manufacturing in GDP and capital expenditure in the business sectors and innovative activities (Czech rank according to the Global innovation index). Table 5 shows the index of the physical factor, the index of the human factors and the overall competitiveness index in the modified 9F model.

Tab. 5: Results of countries – the 9F model

	Czech Rep.	Germany	Hungary	Poland	Slovakia
Endowed resources (3)	65,8	67,6	59,7	65,2	80,9
Business environment (3)	92,6	92,3	77,4	71,8	73,4
Domestic demand (3)	69,2	93,6	62,3	63,7	55,8

Comparability with other data is assured by the following modification of data: we take into account the absolute value of the difference between the relevant data and 100.

Related and supporting industries (3)	61,8	78,3	73,1	35,3	45,5
Physical factors	72,4	82,9	68,1	59,0	63,9
Workers (3)	77,5	87,5	65,5	79,0	75,3
Politicians & bureaucrats (2)	83,9	97,3	76,6	84,0	81,5
Entrepreneurs (1)	91,6	56,7	57,9	100,0	82,1
Professional managers & engineers (1)	100,0	100,0	97,3	70,3	75,7
Human factors	88,2	85,4	74,3	83,3	78,6
Competitiveness index	**80,31**	**84,15**	**71,22**	**71,16**	**71,27**

Source: Cornell University, INSEAD, and WIPO, Eurostat, Transparency International, World Bank, own processing

From the 9F model's point of view, all our chosen countries have their competitive advantage in human factors. The Czech Republic is the best-rated country mainly due to the relative high number of IT professionals and entrepreneurs, high employment rate, and relatively low income inequality. For the Czech Republic, the index of human factors is negatively influenced by the extent of corruption (evaluated by the Corruption perception index published annually by Transparency International). Weaknesses were found in the physical factors, however, their evaluation is positively influenced by the indicators mapping the business environment. Competitive disadvantage of Hungary was ascertained in physical factors, but also in the real final consumption expenditure per capita and the gross domestic expenditure on R&D per capita.

Conclusion

Our comparison of the results of the SD model and the 9F model shows that minor differences among countries are observed in the 9F model. This most probably indicates that the SD model underestimates some important aspects of national competitiveness (especially the human factors). The structure of Porter's original SD model works better for more developed economies with relatively large domestic market. The same conclusion was pronounced by Cho and Moon (2013), who investigated the suitability of Porter's model and its extended versions (i.e. the 9F model) for countries with different openness of economy and different dependency on human factors, and Balcarova (2014), who compared the results of the modified SD model and the modified 9F model for the Czech Republic, Hungary and Slovakia. The 9F model provides better results for less developed countries (V4 countries compared with Germany), especially for those which depend on the quality of human resources, such as Poland and Slovakia. Smaller differences among countries in the overall composite index prove the 9F model has better explanatory power than the SD model.

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Contact

Marta Nečadová
Department of Microeconomics, Faculty of Business Administration
University of Economics, Prague
W. Churchill Square 4
130 67 Prague 3
necadova@vse.cz