DOI: 10.20472/BMC.2016.004.008

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CAUSALITY AS A TOOL FOR EMPIRICAL ANALYSIS IN ECONOMICS

Abstract:

This paper deals with the causal determination of phenomena (briefly causality) as a tool for empirical analysis in economics. Although is the causality difficult to grasp, they are built on the basis of many scientific theories, including economic theory. Causality is very hot topic today, both in philosophy and economics. The causality is used in many multi-sectorial disciplines and the concept of causality is different in various disciplines. In economics, we encounter many assertions that connect cause and effect, but causal relationships are not clearly expressed. At first glance, there may be confusion between cause and effect and the phenomena studied can then be viewed in terms of causality and vice versa. The causality plays very important role in econometric and economics. The paper focused on using of causality in economics and econometric studies. The paper begins with a brief overview of theoretical definition of the causality. Then, the empirical approaches to causality in economics and econometric and selected tools of causality are presented and discussed and the case study of possible using of Granger Causality Test is shown. At the end of the paper we discuss the significance of the Grander Causality Test in economics. The aims of this paper are following: to define the different approaches to causality and describe a short history of this term, to analyse selected econometric methods in interaction with causality and to show on the example of Granger Causality Test using of causality in empirical analysis in economics.

Keywords:

Causality; Economics; Econometric; Empirical Analysis; Granger; Granger Causality Test

JEL Classification: B16, B23, C10

1. INTRODUCTION

The mere questioning "why" indicates that people want to get to the cause and the desire for a deeper explanation of the phenomenon or event, or want to find out what a given phenomenon before. Discussions on the issue of causation are very large and causality is a very extensive topic. There are many relevant and available literature sources in this area; on the other hand, it is almost impossible to capture the fullness of all aspects of the discussions on this topic. According Klimes (1998) causality is a philosophical category denoting the inevitability of genetic relationships of phenomena, one of which (the cause) makes the second (result); it means continuity and succession by cause: causality.

Causality is inseparably connected with human existence, the human way of thinking, to explore the outside world. The causality can also be seen in ontology, in which the causal relations used for example in defining the irreversibility of time. Furthermore, the causality thus engaged not only in philosophy but also other disciplines such as physics, linguistics, psychology, sociology, economics, history, theology, biology and many others.

If we are trying to find causal relationship phenomena in the real world, then we mostly rely on that context, the occurrence of phenomena we observe and then analyse the results of observations. This procedure is usually performed until it is possible to get the impression that we understand these patterns of connections. Then you can use the comparison and analysis reveal a causal relationship in which we can assume that it is valid until it is undermined by the new knowledge. This procedure is long and it is actually never-ending.

The law of causality is the essence of all natural laws, and is also known as the law of cause and effect or the law of action and reaction. Frank (1961) argues that the law of causality, which is the foundation of every theoretical framework, cannot be empirically confirmed nor refuted. Not so since it would be the law of causality taken a priori as a universally known truth, but because it is a purely conventional definition. His argument rests on the assertion that it is possible to define all clear (clear / known) features a closed system in time T_0, and call these qualities "and that". Then it is possible to define a set of other properties of the system at time T_1, and is called a "condition B". Repeated observations of the state B, which is followed the state A and is usually seen as proof operation of the law of causality in relation from the state A to state B. However, if observed at T_1 "state C" (consisting of other observed characteristics than the state B), not we still believe that there has to refute the existence of the law of causality, but we should be seen more as proof of the existence of other "state variables". So that in the state A, which precedes the state C, must be included in some other state properties than those observed characteristics that seemed to be the same state and condition, followed by B. Thus, if the law of causality is not valid according to a state definition, will redefine the status of such way that the law of causality applied. Thus the law of causality becomes the definition of "state". These considerations lead to the fact that the law of causality is only the foundation (creator) means of creating terminology.

There are many empirical studies that use causality as one of many tools of analysis in the researches. Based on the observed relationships between observed variables are generalized findings and conclusions are drawn. Through analysis sessions, it is possible to predict the evolution of the dependent variables. The economy is no different and roughly 30th years of the last century a field called econometrics. In 1930 it founded Econometric Society, and in 1933 began publishing the journal Econometrica published today. In the 60th years of last century, econometrics enjoyed great prosperity, today, when the econometric software available to almost everyone, is no different. Recently, we can meet the mechanical application of statistical methods without a deeper understanding of the model and without proper interpretation of the results. It is important to note, therefore, if the rules are observed using statistical and mathematical / econometric methods and are aware of their possible usage limits, it is possible to use the principle of causality as an analysis tool.

2. THEORETICAL DEFINITION OF CAUSALITY

Discussions of the issue of causality are very large, such as a detailed bibliography regarding causality published Porro and Schmutz (2002), however Machula (2005) in his study argues that despite their rather extensive publication (includes 634 items) is far from complete, and suggests the existence of two basic patterns of thought regarding causality; these schemes are (i) the Aristotelian scheme and (ii) the Hume scheme.

Access Aristotle and the subsequent medieval thinkers on the issue of causality are sometimes considered exhaustive and still unbeaten. Predecessor Aristotle, Plato argued that everything that arises due to some cause. Aristotle defined four kinds of causes and the cause of the material, formal, efficient and purposeful. These four kinds of causes can also be viewed as four aspects or four conditions of a single causal relationship. His concept of causality allows a single phenomenon was due to multiple causes, also admits mutual causal links. Aristotle further distinguished two types of causation: regular and random. Augustine even says that nothing comes even extinguished without reason. Kant then pointed out that all the changes are happening under the Act links between cause and effect, and understood causality as an a priori and necessary method of synthesis of reason (Machula, 2005).

Very important role in issue of causality plays Smith (1776) and his great work “An Inquiry into the Nature and Causes of the Wealth of Nation”, which illustrates the centrality of causality to economics. Other interesting explanation of causality we can find in works which solve material and formal causes are among the concerns of economic ontology, a subject addressed by philosophers of economics - for more see Mäki (2001); theological explanation Cohen (1978); for a general discussion - see Kincaid (1996). But for the most part, taking physical sciences as a model, causal modeling in economics deals with efficient causes: What is it that makes things happen? What explains change? (Bunge, 1963)

In modern age we can meet with the questioning of the relationship of cause and effect is the case for example with Bacon et al. (2000), which considered the causality for the relationship coherent to observed facts, see quote from the study the “New Organon”: “Human thinking implies a higher degree of order and connections between things than what actually exists." Another important philosopher Hume, although not directly deny the existence of cause and effect, but sees causality only regular succession of phenomena and adds that assurance as to the veracity of their claims and beliefs about the necessity of causality only draw inspiration from our experience . Hume (1996) does not conceive causality as an objective relationship, but rather a subjective idea. Our experience leads us to the fact that in the future we expect a similar sequence of events, what has already happened in the past. When there is one event followed another phenomenon, and if the second occurrence of the phenomenon after the first regular phenomenon many times verified, the implications for the human mind in this connection certain regularity. The phenomenon first then fulfills the role of the cause, the other the result of a phenomenon. The first phenomenon is by Huma labeled as the cause, and the second resulted in only after the multiple observing their succession. Or necessary connection based on our experience and you cannot discover what is, see quote from his book The Exploration of human reason: "It seems that all events are quite free and independent. One event follows another, but never among them cannot observe any bond. It seems to us concurrence, but never touch."

Most apparently conflicting theories of causation but connect the two main arguments: (i) a causal relationship is not symmetric relation and (ii) cause precedes its effect in time. In other words, the first contention means that if event A causes event B, the event B does not cause the phenomenon A, speaks thus called "causal asymmetry of causal relationship". The second argument goes, if event A causes event B, then A phenomenon predates the event B, it is called "temporal asymmetry of causal relationship". Asymmetry, together with transitivity makes it possible to produce more complex causal chains. To ensure the possibility of causal chains sufficient alone transitivity, asymmetry ensures that the chain is linear and unidirectional. This means that it will not be possible to move the chain of causes and effects in the opposite direction.

If we can identify the direction of the causal impact through chronology, it does not mean that a causal relationship is reduced to mere temporal sequence. The mere temporal succession of events so far does not mean that researched events causally related. Identifying the direction of the causal impact and direction of time is entered directly into the definition of a causal relationship. The chronology is possible to imagine such a form, an integral part of the causal relationship. While its contents constitute interaction, conditionality events, when one causes the other, a dynamic, creative force causes (causal power). Flanders (2014) mentions the possibility of simultaneous action of cause and effect. According to him, it is a condition which causes a time so close to the action that we are not able to this time interval (in the limit approaching zero) to observe. However, it still cause precedes effect.

3. EMPIRICAL APPROACHES AND CAUSALITY

The causality law should be the basis of any theoretical framework (and really is). The concept of causality has different concepts in various disciplines. In economics, we encounter many assertions that connect cause and effect, but causal relationships are not clearly expressed. So at first glance, there may be confusion between cause and effect and the phenomena studied can then be viewed in terms of causality and vice versa.

At the theoretical level may cause problems or confusion in defining the direction of dependence between variables. In economics, the main problem is the complexity assessment of economic systems. Normally it is possible to find several causes for one result, or conversely one causes multiple consequences, which are not contrary to the law of causality; see more Reichenbach (1956), but it was hard then, these causal relationships monitor and describe.

Another factor that complains observation of relationships between variables, it is the length of the time delay between cause and effect. Hicks (1979) finds useful to apply the causality in economics, also introduces three concepts: static, current, subsequent causality. Korda (2007) states that the introduction of the current causality is to deny Hume's assertion that the cause precedes consequence, and at first glance it might seem that in terms of the object of investigation of economics, this is not important, but in some of its areas (for example in the financial economics) may be temporal distance between cause and effect quite small (although final). Allow me to disagree with the assertion of the author, specifically the second part, because if they exist, even if only a very small periods of time, cause and effect cannot be a negation of Hume's argument. In addition, some authors criticize Hicks concept of simultaneous causality (for more see Termini, 1989).

Although lead the debate among experts regarding causality and its applicability, whether in terms of economic theorizing or directly within the application empirical analyzes, it is still relatively widely used tool analyzes. Hausman (2013) ranks problems with the use of causality in economics and econometrics as one of six central methodological issues of economics. It would be worth some problems encountered during any empirical work often come across mention. It is a dichotomy between theoretical concepts and their empirical counterparts; the problem is at the very defining variables, choosing the appropriate variable and its unit of measurement, the problem of transition from theory to empirical formulation. Very simply put, getting inaccurate estimates already on inaccurate measurements. The actual construction of the econometric model is no less complicated, scientists themselves are aware of this. How mentioned Box (1989): "... all models are wrong, but some of them can be useful."

4. SELECTED ECONOMETRIC METHODS AND CAUSALITY

The empirical definition of causality in economics is usually solved by using mathematical and statistical methods in the context of econometric testing. Difficulty explanation of causality in theoretical background is transmitted to the area of econometric.Therefore, sometimes statisticians and econometricians mention the philosophical underpinnings of causality. Statisticians themselves have in their field with causality considerable problems. In statistics, the concept of causality has not previously paid attention to statistics and therefore had to return to causality (Hebák, 2003).

The goal of most empirical studies in economics and other social sciences is to determine whether a change in one variable x causes a change in the variable y.

The following text describes some methods that are used in the analysis of causal relations in econometrics. The main of them are following:

- control variables,
- instrumental variables,
- Granger causality.

Control variables play in economic theory and econometric analysis key role. In economics, it is generally known and widely used term ceteris paribus. Simple finding that the two variables are correlated with each other, rarely leads to the conclusion that a change in one variable causes a change in the other. This conclusion cannot afford it and also because of the nature of economic data. Rarely can the economy to run a controlled experiment that allows the simple correlation analysis reveal a causal connection between variables. When we want to know the mean or expected value of the variable y, ceteris paribus condition is entered in the estimate E (y | x, c) the expected value of y they are conditioned x c. the vector c refers to a file called “control variables” that we want to maintain constant monitor the impact of the expected values of x and y. The reason why we introduce control variables, it is possible to assume that x is in relation with other factors that may also affect the variable y. If x is continuous, our interest focuses on δE (y | x c) / Dx, and is referred to as partial effect of x to E (y | x, c). If x discreet, talking about the impact on E (y | x, c) for different values of x. If we were able to observe all the control variables c, then estimate the impact on E x (y | x, c) would be relatively trivial. The decision, which will include a control variable into the vector c is not always easy, and the use of different control variables may lead to different conclusions about a causal relation between x and y. Unfortunately, economics and other social sciences, a large number of variables “c” are for estimating econometric model included as a control variable, it prevents their simple quantification and our (in) ability of their observations.

Another way to control the relationships between variables in our econometric model is the use of so-called “instrumental (auxiliary)” variables. For instrumental variables are searched such variables which show correlation with x and are not correlated with the response variable y. Implicitly assumes that the value of x correlate with the random component, so there is unexplained variability caused by variable c, and fulfills a necessary condition to carry out an econometric estimation using instrumental variables. According Hušek (2007) selection of appropriate auxiliary variables is not clear in practice, so that it can arrive at several different estimates of the model parameters depending on which of the variables under consideration was used. It is virtually impossible to verify the assumption of independence auxiliary variables selected on a random component to the model and measurement errors. Therefore, to find such a variable and the explanatory variables, it is sometimes not easy.

Granger arrives in the 60th years of the last century quite a daring idea, proposing to generalize the notion of causality contrast, as was previously used; for more see Granger (1969), Granger (1980) or Grander (1988). According to Mlčoch (2013) for interest here very useful quote Jacob Bronowskiho (1952), when describing the development of econometric analysis and use of Granger causality.) Who has innovated almost 20 years ago Granger innovative concept of causality said: "The idea that gave science, new momentum is greater than the mechanistic approach: cause → effect. He defines no specific mechanism between the present and the future. It is able to predict the future without having to insist that the calculation must proceed according to the law of causality. However, it requires more courage to application than we had yet to prove that we were faced with a (scientific) problem." The concept of Granger causality is based on the idea that when the time series and contribute to improving forecast time series B can be considered time series B causally dependent on the time series A. Granger causality in econometrics used for more than 50 years, but certainly not perceived as equivalent philosophical concept of causality (which the author himself was conscious). Arlt (1999) and Hušek (2007), this fact in its publications also mentioned.

5. EXAMPLE OF GRANGER CAUSALITY TEST APPLICATION IN ECONOMICS

There was chosen the example for using of Granger Causality Test the topic of national healthcare system evaluation with using of WHO indicators.

The following data were used from the paper Hejduková, Kureková (2016). There were chosen four indicators for evaluation of healthcare performance. These indicators are: (i) Life expectancy at birth ("LE"), (ii) Potential years of life lost ("PYLL"), (iii) Disability-adjusted life expectancy ("DALE") and (iv) Health care expenditure („EXP“). These indicators were used to compare and to describe their developments over time and within these European countries: Belgium, Czech Republic, Estonia, France, Luxembourg, Germany, Nederland, Poland, Slovakia and Slovenia. Then it was examined the statistical hypothesis test for determining whether health care expenditure is useful in forecasting two indicators: „LE“ and „PYLL“. The Granger causality test is used for this examination.

The period from 2000 to 2013 was selected as a reference period for further analysis, but unfortunately not all data were complete, that is why we had to reduce examined period for Granger causality test. So the period for testing Granger causality contains years from 2005 to 2010. As a data source were used European Health for All Database (European Health for All Database, 2016), OECD Health statistics (OECD, 2016) and Eurostat database (Eurostat, 2016).

For creating a balanced panel data set was chosen period from 2005 to 2010, this data set contains 60 observations. It was necessary to find out whether the time series is stationary. It was used the augmented Dickey–Fuller test (ADF test), unfortunately at 5% significance level was not possible to reject the null hypothesis. It means that time series variables are non-stationary; hence it was necessary to adjust the time series to be stationary. For stationarizing time series variables were used first differences and then logarithmic transformation. This transformed time series were finally stationary and two tests of Granger causality were applied. Granger causality test helped us to find out whether expenditures on health care EXP explain the development of selected indicators (PYLL and LE). Two null hypotheses were tested: H0: Percentage change of EXP did not cause percentage change of PYLL and H0: Percentage change of EXP did not cause percentage change of LE.

Table 1. Results of Granger causality test

Equation	Exluced	F	df	df_r	Prob > F
LE	Exp	2.3684	2	43	0.1057
PYLL	Exp	0.67184	2	43	0.516

Source: Hejduková, Kureková (2016)

According results in Table 1, it is clear that the at the 5% significance level we are not able to reject both null hypothesis. Thus we are able to claim according these data that the percentage change in EXP did not cause percentage change in the indicators LE and PYLL.

There were chosen countries with health systems for which are typical the social health insurance. However these health systems represented by these indicators show quite huge differences in dynamic changes over time. From the perspective of the share of social insurance in the total health expenditure, the Czech Republic has the second highest the share of social insurance in total health expenditure in comparison with other analyzed countries. On the other hand, from the perspective of the health expenditure per habitant, the Czech Republic shows one of the greatest growths in years 2005 – 2010.

The growth of indicator “Life expectancy at birth” was quite small in the Czech Republic in comparison with other analyzed countries. The same results we can see for indicator “Potential years of life lost” which is declined over time and this decrease was also the one of the smallest.

There was set the question in the paper, if health care expenditure can cause the changes in the indicators PYLL and LE. Granger causality test helped us to find out whether expenditures on health care EXP explain the development of selected indicators (PYLL and LE). According results, we are able to claim that the percentage change in expenditure did not cause percentage change in the indicators LE and PYLL.

6. CONCLUSION

The issue of causality is very complex, not only in economics. Causality is inextricably linked to the way of human thinking and learning about the outside world. Inconsistencies mentioned in this essay between theoretical and empirical causality concept in economics is rather pointing out that the results of an empirical analysis must be treated in accordance with any possible shortcomings or limitations. In conclusion, We would like to mention a quotation Box (1976): "One important point is that science is a means to knowledge, which is not, achieved merely theoretical speculation on the one hand, nor piecemeal accumulation of practical experience on the other, but rather it is achieved through instigated iteration between theory and practice."

Econometrics is currently the primary applied methods in economics and many researchers extend their research with them. In relation of using the econometric methods, it is important to clearly define the link between a theoretical and an empirical formulations and it is important to distinguish between correlation and causation and whether a statistical relationship is actually causal at all.

There were chosen countries with health systems for which are typical the social health insurance for application of using the causality in economics. However these health systems represented by these indicators show quite huge differences in dynamic changes over time. From the perspective of the share of social insurance in the total health expenditure, the Czech Republic has the second highest the share of social insurance in total health expenditure in comparison with other analysed countries. On the other hand, from the perspective of the health expenditure per habitant, the Czech Republic shows one of the greatest growths in years 2005 – 2010.

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The correct explanation of causal relationship to the economy has significant consequences. Economics (and especially macroeconomics) is the basis for economic policy recommendations that could influence life of all people. The topic of causality is not clear, not only in philosophy but also in economics. Causality is one of the fundamental methodological issues of economics.

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