

ECONOMETRIC MODELS OF PROPENSITIES

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Abstract

Human being is one of the most important sources of causative forces of events that assemble economical processes. Working out the effective tools that enable measurement of the impact of people on socio-economic processes is necessary in analyzing, troubleshooting and forecasting. In the article the issues of calculating propensities by means of properly specified econometrics models were presented. The definition of propensity was introduced. Questions connected with topic of propensities were presented in context of concepts promoted by Szczecin school of econometrics (pentagon of sources of causative forces, types of relationships in economics, geometric interpretation of personality, broom of events). Econometric models, useful in analyzing propensities, were classified on primary models, econometrics models of average propensities and econometrics models of marginal propensities. Connections between the models were described. Settlement of analytical shapes of characterized models was mentioned. In an empirical example the presented methods were used to analyze average and marginal propensity to consumption of alcoholic beverages and tobacco in the households of employees in manual labour positions in Poland in years 1993–2005.

Keywords: econometric models, propensities, marginal propensity, average propensity, propensity to consumption.

JEL classification: C01, C10, C51.

Philosophy of analysis of propensities

Propensities should be treated as an important economic category that allows for the analysis of impact of human behaviour on economical processes. In economic literature, since John M. Keynes, mainly marginal propensities have been considered, primarily a marginal propensity to consume or a marginal propensity to save. That kind of attitude does not seem to be sufficient in the context of analysis of economical occurrences, especially when a human factor is taken into account.

In a broad sense, the issues related to propensities were presented in Carl Popper's book "World of Propensities" and Albert Hirschman's "Passions and Interests". Passions, emotions and attitudes have determined philosophical debates since ancient times¹. Conflict between passions and intelligence was a subject of many dissertations conducted by such philosophers like Socrates, Plato, Aristotle or Epicurus. About affects, attitudes, passions and their impact on human behaviour Spinoza, Hume, Kant and Schopenhauer also have written.

Concepts conceived by Sigmund Freud, the founder of psychoanalysis, should be treated with special attention. Identification of three components of human psyche: id, ego and superego provided a possibility of a more astute analysis of factors determining human behaviour. It is worth mentioning that to these concepts many economists (L. von Mises, H. Leibenstein) later referred.

In opposition to many thinkers who mostly emphasized negative aspects of propensities, such philosophers as Giambattista Vico, Bernard Mandeville or Montesquieu thought that proceedings coherent with propensities had many positive aspects for the society². It happens when passions are properly directed (subjugated) or when positive propensities are set against negative propensities and they are linked with, for example, achieving material benefits. Adam Smith continued this way of thinking and identified passions with interests (benefits). According to Adam Smith, behaviour consistent with egoistic interests is good for the society because resources are then allocated efficiently.

Propensities were also very important in economic system of John M. Keynes. According to Keynes, economic decisions are influenced by many different psychological and sociological factors. Among them very important are propensities that determine 'psyche' of the society³.

The concept of propensities is consistent with views presented by H. Leibenstein who thought that selective rationality was more plausible than generally accepted assumption about maximization of utility. In accordance with Leibenstein's theory, propensities and tastes

make that calculation subjective and not rigorous so people are being pushed out of *homo oeconomicus* scheme. Propensities affect also something that Leibenstein called *efficiency X*. *Efficiency X* depends on the effort level that consist of pace, quality and time of action. However, the efficiency level depends on human propensities⁴.

Propensity could be defined as a slope of posture of somebody or something to somebody or something that makes probability of a certain event higher⁵. Propensities could be analyzed in context of such concepts like the pentagon of sources of causative forces, purposeful relations in economy, a broom of events or geometric interpretation of personality.

The pentagon of sources of causative forces identifies factors under which events (facts) take place. In accordance with this theory, events (facts) depend on time, place, human beings, other events and fortune: *Tempus locus homo casus et fortuna regit factum* (Figure 1). The analysis of propensities that determine human behaviour provides the possibility to take into account a human role in economical issues.

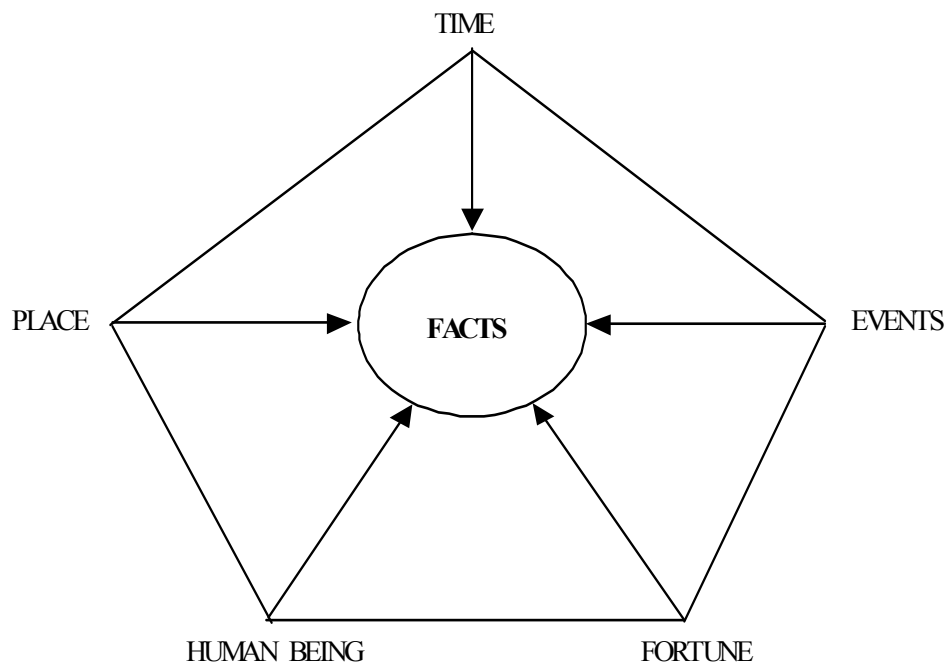


Fig. 1. A universal pentagon of sources of causative forces
Source: Hozer (2003).

The occurrence of a certain event could be treated as a result of influence of circumstances, time, place, fortune and intrinsic, depending on propensities, imperatives of a given person. Propensities strongly determine human actions and behaviour, which is important because people constitute one of the most valid causative sources. Propensities

affect undertaken decisions and essentially shape statistical regularities and economical processes.

Propensities could be treated as attributes of personality that influence actions, among them purposeful actions. The existence of purposeful relations makes the meaning of propensities in economization processes even more significant. Correct identification of relations types in economy is necessary to understand a human role in fact creation. There are three types of relationships in economy: causative, purposeful and coexistence relationships (see Table 1).

Table 1. Types of relationships in economy

Lp.	Types	Dependent variable	Explaining variable	Sort of question	Sort of answer
1	Causative	y_t	$x_{t-\tau}$	Why y_t ?	Because $x_{t-\tau}$
2	Purposeful	$y_{t+\tau}$	x_t	What for x_t ?	For $y_{t+\tau}$
3	Coexistence	y_t	x_t	What with?	y_t with x_t

Source: Hozer (2003).

In case of causative relations, passive person's attitudes are dominating. An event happens because another event took place before. This is an *ex post* relation that seems to be unavoidable. These kinds of relations are most probable when propensities that determine human behaviour are generally unconscious⁶. If analysed occurrences influence each other in the same time, coexistence relation subsists. Purposeful relations constitute *ex ante* dependencies. Events take place to increase the probability that another desired event will happen. Facts are created consciously when people act in a purposeful way. The frequency of creation of certain facts depends on the propensities that characterize given person or collectiveness⁷. A purposeful activity that depends on propensities disturbs statistical regularities or generates other regularities. Planning or forecasting economical processes could give better results after a degree of entropy that depends on propensities distinctive for analyzed collectiveness (or person) is taken into account⁸.

In a context of geometric interpretation of personality, humans are generally realizing, with different intensity, three kinds of goals that could be classified as intellectual, material and biological (see Figure 2)⁹. Propensities determine which of these aims will be realized with higher frequency.

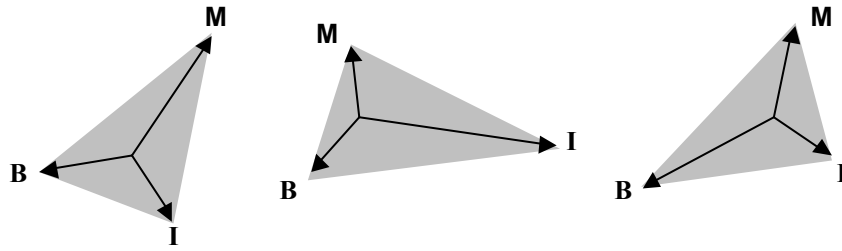


Fig. 2. Exemplary diagrams of geometric interpretation of human personality: a manager's type (M), a professor's type (I) and a type X (B)

Source: Hozer (2003).

Intensity of realization of biological, material and intellectual aims depends on human propensities that characterizes given person or collectiveness. A person with intellectual interests will be focused on that kind of goals; a materialist will spend their time and income to achieve material aims, etc.

A broom of events presents conversion process of indefinite number of possibilities in one historical fact (see Figure 3). The frequency of certain fact creation depends on propensities.

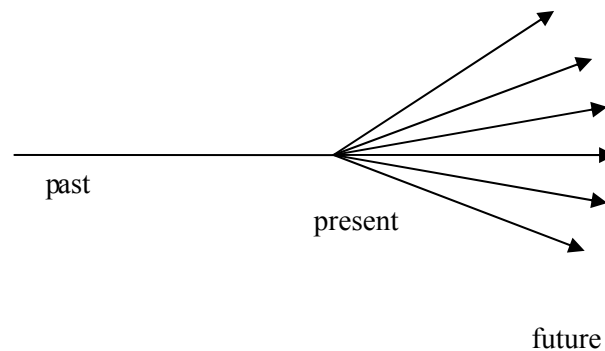


Fig. 3. A broom of events

Source: Hozer, Doszyń (2004a).

Propensities, preferences and tastes are factors that designate, to a given degree, future choices. They also reduce entropy (indefinableness) of actions. Propensities also qualify which possibilities will be preferred and what kind of events will occur with higher frequency.

1. Methodology of propensities' analysis

According to Carl Popper¹⁰, propensities should be treated as forces that make statistical regularities stable. In the article by Hozer and Doszyń¹¹ a hypothesis that propensities make parameters of distributions stable was verified. This statement seems to be true also in the context of the remaining types of statistical regularities. It can be assumed that propensities also make coexistence relations stable so propensities could be analysed by means of properly specified econometric models.

Propensities could be measured by means of frequency and trigonometric methods¹². In pursuance of a frequency method, propensity could be obtained as:

$$s_t = \frac{y_t}{x_t}, \quad (1)$$

where:

s_t – analyzed propensity in period t ,

y_t – number of certain events in period t ,

x_t – number of all possible events in period t .

The relationship (1) could be transformed hereby that dependent variable will symbolize number of certain events in period t . After that kind of conversion the formula (1) could be written such as:

$$y_t = f(x_t, u_t), \quad (2)$$

where u_t represents a random component.

On the basis of the relationship (2) econometric models with different analytical forms could be obtained. It is possible to undertake that the propensity s_t makes the relation between variables y_t and x_t stable (if variables are properly defined). In the formula (2) it is assumed that variables were corrected due to impact of other important factors (which could be done, for example, by means of Frisch-Waugh theorem).

On the basis of the formula (2) different kinds of econometric models of propensities could be obtained, too. Models like (2) that give an opportunity to acquire econometric models of average and marginal propensities will be called primary econometric models.

Propensities could be analyzed by means of three kinds of econometric models: primary econometric models, econometric models of average propensity and econometric models of marginal propensity (see Figure 4).

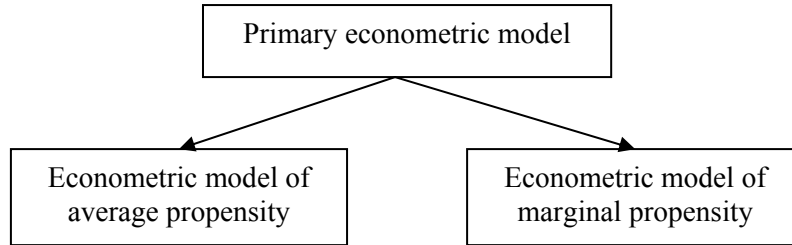


Fig. 4. Econometric models of propensities

Source: individual study.

A primary econometric model is a model like (2). In this kind of models a dependent variable expresses a generally defined number of certain events. The value of this variable depends on a strain of propensity and a number of possible occurrences.

An econometric model of average propensity is obtained by division of both sides of the primary econometric model:

$$s_t = f\left(\frac{1}{x_t}, v_t\right), \quad (3)$$

where $v_t = u_t / x_t$.

The econometric model of marginal propensity could be obtained after calculating a derivative of the primary econometric model with respect to variable x_t :

$$s_{kt} = f'(x_t, u_t). \quad (4)$$

This type of model should be used to analyse propensities depending on heteroscedasticity of the error term u_t . In most cases propensities should be analyzed on the basis of the primary econometric model. There is an exception when an error term in primary econometric model takes the form $u_t^2 = \sigma^2 x_t^2$, where σ^2 is a constant variation of a random component. In this case the estimation of econometric model of average propensity and the

estimation of the primary econometric model by means of the weighted least squares method are equivalent. Weights are calculated as inversed values of an independent variable x_t .

Analytical forms of the models (3) and (4) are connected with the analytical shape of the primary econometric models. The econometric models of average and marginal propensities obtained from the primary models of different analytical characters (linear, power, logarithmic and exponential) are presented in Table 2.

Table 2. The econometric models of average and marginal propensities obtained on the basis of the linear, power, exponential and logarithmic primary models

Lp.	Primary econometric models	Econometric models of average propensity	Econometric models of marginal propensity
1	$y_t = \alpha_0 + \alpha_1 x_t + u_{1t}$	$\hat{s}_t = \frac{\hat{\alpha}_0}{x_t} + \hat{\alpha}_1$	$\hat{s}_{kt} = \hat{\alpha}_1$
2	$y_t = \alpha_0 x_t^{\alpha_1} e^{u_{2t}}$	$\hat{s}_t = \hat{\alpha}_0 x_t^{\hat{\alpha}_1 - 1}$	$\hat{s}_{kt} = \hat{\alpha}_0 \hat{\alpha}_1 x_t^{\hat{\alpha}_1 - 1}$
3	$y_t = \alpha_0 \alpha_1^{x_t} e^{u_{3t}}$	$\hat{s}_t = \frac{\hat{\alpha}_0}{x_t} \hat{\alpha}_1^{x_t}$	$\hat{s}_{kt} = \hat{\alpha}_0 \ln(\hat{\alpha}_1) \hat{\alpha}_1^{x_t}$
4	$y_t = \alpha_0 + \alpha_1 \ln x_t + u_{4t}$	$\hat{s}_t = \frac{\hat{\alpha}_0}{x_t} + \hat{\alpha}_1 \frac{\ln x_t}{x_t}$	$\hat{s}_{kt} = \frac{\hat{\alpha}_1}{x_t}$

Source: individual study.

The econometric model of average propensity gained from the linear primary model has a hyperbolic form with a horizontal asymptote equal $\hat{\alpha}_1$. Analytical forms of econometric models of propensities obtained from power and exponential models are the same as analytical shapes of the primary econometric models. An analytical form of the econometric model of average propensity appointed upon logarithmic primary model is non-typical.

Marginal propensity obtained from linear model is constant and equal $\hat{\alpha}_1$. The econometric models of marginal propensities obtained upon a power and exponential model have the same analytical forms as the primary models. The econometric model of marginal propensity based on the logarithmic primary model has a hyperbolic form.

An analytical form of a model depends on the type of data generating process. In Table 3 the properties of processes and corresponding analytical forms of the econometric primary models are presented.

Table 3. The properties of processes and applicable analytical forms of the primary models

Lp.	Properties of processes	Analytical forms of primary models
1	$\frac{\Delta y_t}{\Delta x_t} = \text{const.}$	Linear form
2	$\frac{\Delta \ln y_t}{\Delta \ln x_t} = \text{const.}$	Power form
3	$\frac{\Delta \ln y_t}{\Delta x_t} = \text{const.}$	Exponential form
4	$\frac{\Delta y_t}{\Delta \ln x_t} = \text{const.}$	Logarithmic form

Source: individual study.

If quotients of absolute increases of dependent and independent variables oscillating around a constant level, a linear primary model should be chosen. Power form is adequate if relations between the increases of logarithms of dependent and independent variables are constant. The exponential model is suitable when quotients of the increases of logarithms of a dependent variable and absolute increases of an independent variable are constant. When relations between absolute increases of a dependent variable and absolute increases of logarithms of an independent variable are constant, a logarithmic form is applicable. Analytical forms of the econometric models of average and marginal propensities are based on analytical forms of the primary models.

3. Empirical example

Propensities to consumption of alcoholic beverages and tobacco in households of employees in manual labour positions in Poland in years 1993-2005 were estimated. The analyzed variables – the average expenditures on alcoholic beverages and tobacco (y_t) and the average disposable incomes (x_t) – were corrected with regard to inflation and expressed in 2005 prices. The data come from Statistical Yearbooks from the years of 1994-2006.

After inspecting scatter plots and analyses of properties of the processes, a linear form of the primary econometric model was assumed. Estimates of the primary econometric model are as follows (in brackets t -values are given):

$$\hat{y}_t = -31.241 + 0.089x_t, S_e = 0.896 \text{ zł}, \bar{R}^2 = 0.861. \quad (5)$$

$\begin{matrix} (-5.336) & (8.690) \end{matrix}$

Model (5) is well fitted to empirical observations. The corrected determination ratio (\bar{R}^2) equals 0.861 (standard error of estimation $S_e = 0.896 \text{ zł}$). Constant and independent variables were significant at the significance level 0.001. Marginal propensity to consumption of alcoholic beverages and tobacco was about 0.089. Jarque-Bera's test, White's test and Breusch-Godfrey's test were used to analyze the properties of residuals. On the significance level 0,01 there were no reasons to reject a hypothesis that assumed normality of distribution, homoscedasticity and the lack of the first and the second order residuals autocorrelation. In the considered model also the absolute values of residuals were not proportional to an independent variable so the primary model was used to compute average and marginal propensities.

The econometric model of average propensity obtained from model (5) has the following form:

$$\hat{s}_t = \frac{-31,241}{x_t} + 0,089. \quad (5)$$

Negative valuation of a constant in the primary model (5) indicates that average propensity to consumption of alcoholic beverages and tobacco in employees' households and the average disposable income are positively correlated.

Summary

The definition of propensities, methods of measurement, econometric primary models and econometric models of average and marginal propensities could be very important in the context of the analysis of propensities in economical processes. The meaning of propensities in theory and practice is obvious especially when such concepts as the pentagon of sources of causative forces (demonstrating the role of human beings in fact creation), purposeful relationships or the broom of events are taken into account. Such propensities as saving, diligence, benevolence, discipline, responsibility, veracity and creativity have significant impact on the recognition of a phenomenon in an economical realm. Propensities could be formed. The development of economical structures often depends crucially on a fact if propensities are formed properly. The article contains philosophical, economic and econometric conclusions.

Notes

- ¹ Hozer, Doszyń (2004a).
- ² Hirschman (1997).
- ³ Doszyń (2005).
- ⁴ Hozer, Doszyń (2004a).
- ⁵ Hozer (2002).
- ⁶ Doszyń (2005).
- ⁷ Hozer, Doszyń (2004a).
- ⁸ Doszyń (2002), Doszyń (2005).
- ⁹ Hozer (2003).
- ¹⁰ Popper (1996).
- ¹¹ Hozer, Doszyń (2004b).
- ¹² Hozer, Doszyń (2004a).

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