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New Anti-Crisis Instruments For Market Economy

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ABSTRACT

It is shown that processes prevailing in existing market economy because of the influence on it of the human factor are described by systems of the parametrical differential equations, which have solutions in the form of random functions of time. This is why, such economy is essentially unpredictable and economic crises are inevitable. For creation of anti-recessionary protection of existing economy it is necessary to use new economic tools which will allow minimizing the influence of the human factor. Such new economic tools are suggested. In order to minimize the negative influence of the internal human factor on economy it is recommended to use the so-called business interfaces. To minimize the negative influence on it of the external human factor we suggest the use of business-oriented services of new global information network PC•net, which is free from all shortcomings of the Internet. The economy reformed as suggested above will have the adequate mathematical description in the form of systems of mainly linear differential equations which will allow regulating it successfully. Economics will become an exact science. Eventually, precise computer-aided design and simulation of complex economic systems will become possible. The global economy itself will become crisis-proof.

Key words: *Economic crisis, economic reform, crisis-proof economy, the "goods-money-goods" process, human factor*

1. INTRODUCTION

Despite the existence of numerous economic theories developed by Adam Smith, Thomas Robert Maltus, Jean Baptiste Say, David Ricardo, Jean-Charles Leonard Sismonde de Sismondi, John Stuart Mill, Karl Heinrich Marx, Alfred Marshall, John Bates Clark, Vilfredo Pareto, Ludwig Heinrich Elder von Mises, Joseph Alois Schumpeter, John Maynard Keynes, Nikolai Dmitriewitsch Kondratieff, Friedrich August von Hayek, Simon Smith Kuznets, Wassily Wassilevich Leontief, Milton Friedman, Walt Withman Rostow, Christopher Freeman and many other prominent scientists [1], [2], both local and global economic crises still happen, moreover, they are inevitable and unpredictable.

2. NECESSITY OF THE ADEQUATE MATHEMATICAL DESCRIPTION OF EXISTING MARKET ECONOMY

However, this situation gives no reasons to assert that economic science is less exact, than, for example, electronics, physics or computer sciences due to the fact that the latter have more revealed and mathematically described laws. Quite the opposite, the existing state of affairs testifies to the fact that processes taking place in economics are much more difficult to understand than those in exact sciences, at least because they a priori are essentially more multiple-factor while the laws revealed in the exact sciences, with a rare exception (e.g. Kepler's third law with Newton's amendments), are almost always described by functions of no more than three variables.

Taking this into account, we can state that the economy remains in many respects yet unknown. In exact sciences, this situation is described with the term "the black box", suggested by William Ross Ashby (1903 – 1972). The black box refers to an object under investigation whose mechanism of functioning is unknown, but the result of its operation is known. And this result is unpredictable and not giving in to the mathematical description.

Thus, any regulatory activities of governments and top managers of the economy turn out to be inefficient. Indeed, in order to control the subject of regulation, it is necessary to be able to extrapolate its behavior. And for this purpose it is necessary to have the possibility to transform "the black box" into "the white box", whose mechanism of functioning, according to the definition suggested by Norbert Wiener (1894 – 1964), is known, and which eventually yields the same results as "the black box". In other words, it is necessary to have a relevant mathematical description of processes taking place in the economy. Therefore it is necessary:

- to choose the appropriate mathematical tools;
- using these mathematical tools, to describe a certain algorithm of operation of the economy, and

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- to define the parameters of the algorithm relevant to a particular economic situation.

None of the above is fulfilled.

Moreover, mathematical analysis of different situations using the supply and demand curves allows defining only a state, but not a process. Indeed, the intersections of the supply and demand curves in terms of mathematics are graphic solutions of algebraic equations. Besides, neither the supply and demand curves, nor the corresponding algebraic equations are derived analytically; this is why the supply and demand curves are plotted on the basis of some intuitive considerations. Consequently, they give not even a quantitative, but only a qualitative evaluation of the state of economy under investigation. Certainly, the results obtained using the supply and demand curves are useful; nevertheless, they do nothing to facilitate the understanding of processes taking place inside the 'black box' of global economy.

Economics also uses statistical methods to forecast economic macro and micro processes. However, statistical estimates of multi-factor economic processes, once again, correspond only to states, and are, therefore, unsuitable to describe processes. Moreover, these low-factor estimates of multi-factor processes are not informative (this is why it would not occur to a doctor to treat the patients using their average temperature).

The fact that such mathematical tools do not correspond to processes taking place in the economy in the end of last century was pointed to by physicists, who created a new science – econophysics (from economics and physics). They said that the processes taking place in the economy have a lot in common with some processes in physics and, therefore, require new mathematical tools to be used [3] – [6] . The new mathematical tools of econophysics are mainly statistical methods borrowed from statistical physics. In particular, such nonconventional for economics mathematical tools, as the theory of the self-organized criticality, the fractal analysis, the theory of phase transitions, and the percolation theory are widely used. But these new mathematical tools also allow defining only a state, and not a process.

The present article discusses another new mathematical tool which, however, differs from those suggested in econophysics. This mathematical tool is differential equations, since it is these equations that describe processes. It is noteworthy that attempts to use differential equations (non-linear differential equations, to be more precise) in economics have already been made [7]. However, their use did not facilitate understanding 'the black box' of the economy, since real economy turned out to be described with differential equations of a different kind.

3. LINEAR DIFFERENTIAL EQUATION OF THE 'GOODS-MONEY-GOODS' PROCESS

A recent publication [8] describes the basic economic process 'goods-money-goods' with a linear differential equation. It demonstrates that the behaviour of a generalized aggregate vendor (who is also a manufacturer) in the market is described with formula

$$P_V(t) = \frac{1}{Q_V(t)T_V}\int_0^t M_V(t)dt \qquad (1a)$$

or an equivalent formula

$$M_V(t) = T_V \frac{d[Q_V(t)P_V(t)]}{dt} \qquad (1b)$$

where

$P_V(t)$ Is the current wholesale market price of The goods;
$Q_V(t)$ is the current quantity of goods Manufactured by the vendor;
$P_V(t)Q_V(t)$ is the flow of the vendor's Circulating assets;
$M_V(t)$ is the current revenue of the vendor (The amount of current assets) covering the cost of production and generating profit;
T_V is the duration of the goods production process.

Consequently, the price of goods, in accordance with formula (1a), is the accrued expenses of the vendor subject to planned revenue, divided by the quantity of manufactured goods.

Similarly, the behaviour of a generalized aggregate buyer in the market is described with formula

$$M_B(t) = \frac{1}{T_B}\int_0^t Q_B(t)P_B(t)dt \qquad (2a)$$

or an equivalent formula

$$Q_B(t)P_B(t) = T_B \frac{dM_B(t)}{dt} \qquad (2b)$$

where

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$M_B(t)$ is the current expenses (the amount of current assets) of the buyer;
$P_B(t)$ is the current retail price of goods purchased by the buyer;
$Q_B(t)$ is the current quantity of goods purchased by the buyer;
$P_V(t)Q_V(t)$ is the flow of circulating assets of the buyer;
$M_B(t)$ is the current expenses (the amount of current assets) of the buyer;
T_B is the useful life of goods purchased by the buyer.

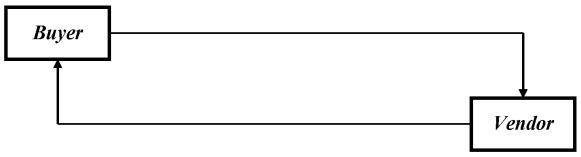

Figure 1: Idealized functional scheme of the simplest link of the commodities market

Consequently, the expenses of the buyer equal to accrued expenses (the amount of current assets) for the purchase of necessary amount of goods taking into account the purchase dynamics.

Thus, both the vendor and the buyer use their averaged estimates when making a transaction in accordance with formulae (2) and (3). In other words, they suggest their bid and ask prices only after analysing the market situation.

In this particular simplest case, when there is only one vendor and only one buyer, $Q_V(t) = Q_B(t) = Q(t)$, $P_V(t) = P_B(t) = P(t)$. Then, with regard to the scheme of the simplest link of the commodities market, which is assumed to be isolated, the sum of circulating assets of the vendor and the buyer $M_V(t) + M_B(t) = M = const$ is invariable. In this case, it follows from (1b) and (2a) that

$$T_V \frac{dQ(t)P(t)}{dt} + \frac{1}{T_B}\int_0^t Q(t)P(t)dt = M \quad (3a)$$

Differentiating the expression (3a), we get

$$T_V T_B \frac{d^2[Q(t)P(t)]}{dt^2} + Q(t)P(t) = 0 \quad (3b)$$

If we additionally take into account that other market participants are also involved in the "goods-money-goods" process, including banks, tax administration, etc., we will have to complicate the scheme of the simplest link of the commodities market (see Fig. 2). Then the differential equation of the "goods-money-goods" process takes the form

$$T_V T_B \frac{d^2[Q(t)P(t)]}{dt^2} + T_B(k_{TS} + k_B)\frac{d[Q(t)P(t)]}{dt} + Q(t)P(t) = 0 \quad (4)$$

where

k_{TS} is the current relative value of tax payments;
k_B is the current relative value of payments to a bank for processing the payments of the buyer to the vendor.

The equation obtained takes into account that the specified additional market participants do not have a direct influence on the price formation process on the part of the buyer and the vendor; their influence is rather dissipating, i.e., they withdraw a certain amount of circulating assets.

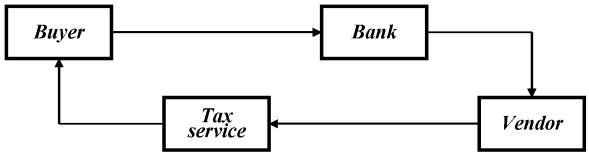

Fig 2: Another idealized functional scheme of the simplest link of the commodities market

The equation obtained above can be even more complicated if additional factors are to be taken into account – delayed positive feedback corresponding to extended reproduction; external influence of processes taking place in real multi-linked economy; presence of different non-linear elements (e.g., peculiarities of any real taxation system), etc.

All these circumstances are omitted for simplicity in the present research, since its objective is to reveal only the major peculiarities of the real market process, which will allow developing though simplified, yet appropriate mathematical description of it.

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4. NEW OSCILLATION PROCESSES IN THE MARKET ECONOMY

The solution of linear differential equations (3b) and (4) is an oscillation process. However, this oscillation process has nothing to do either with the Elliott waves [9] or with the seasonal oscillations of business activity (e.g., in agriculture), or with the economic cycles of Joseph Kitchin (1861-1932), Clément Juglar (1819-1905), Simon Kuznets (1901-1985) or Nikolai Kondratiev (1892-1938) [10] and is not related to economic crises.

Moreover, this oscillation process in economics is still unknown, since the conditions for its implementation are not fulfilled (and cannot be fulfilled at random – see below). However, as shown in [11], oscillation processes of this type are quite beneficial and will become widespread in the economy of the future (just like they have already become widespread in engineering).

Since the simplest links of the commodities market presented in Fig. 1 and Fig. 2 are idealized, they are only potentially oscillating.

5. PARAMETRIC DIFFERENTIAL EQUATION OF THE 'GOODS-MONEY-GOODS' PROCESS

In engineering (e.g., in radio-electronics), if there is an oscillation link the components of which are connected in accordance with the drawing, oscillations definitely exist. It is not so in economics. In economics, even if the buyer and the vendor negotiate and eventually reach an agreement, the process of exchanging goods for money may not take place or go on in a different way. In other words, the 'goods-money-goods' oscillation process may exist, and may not exist. In economics, the human factor must also be taken into account, because the buyer or the vendor may change their mind, may delay payments or

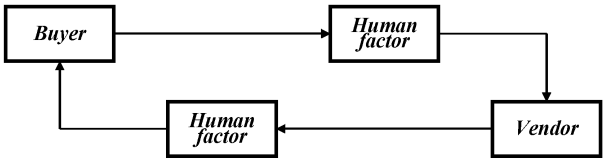

Figure 3: The realistic functional scheme of the simplest link of the commodities market

Delivery of goods, unforeseen circumstances may influence the behaviour of the buyer or the vendor, and so on. Sir Isaac Newton (1642 – 1727) wrote [5] that modelling the behaviour of people is more difficult than modelling the motion of planets.

This is why, in reality, the simplest link of the commodities market has the form shown in Fig. 3, and processes in it are described with a parametric differential equation

$$H_V(t)T_V T_B \frac{d^2[Q(t)P(t)]}{dt^2} + H_B(t)Q(t)P(t) = 0 \quad (5)$$

where

$H_B(t)$ is the human factor taking into account the behaviour of the buyer;

$H_V(t)$ is the human factor taking into account the behaviour of the vendor.

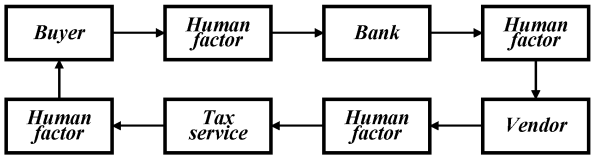

Figure 4: Another realistic functional scheme of the simplest link of the commodities market

A bit more complicated implementation of the simplest link of the commodities market has the form shown in Fig. 4.

Processes in it are described with parametric differential equation

$$H_V T_V T_B \frac{d^2[Q(t)P(t)]}{dt^2} + H_A T_B (k_{TS} + k_B) \frac{d[Q(t)P(t)]}{dt} + H_B Q(t)P(t) = 0 \quad (6)$$

where

$H_A(t)$ is the human factor taking into account the behaviour of other participants of the goods-money-goods' process.

However, since the factors $H_V(t)$, $H_A(t)$ and $H_B(t)$ are various random functions of time, the solution $P(t)Q(t)$ of parametric differential equations (5) and (6), as well as the dependent values $M_V(t)$ and $M_B(t)$ are random functions of time.

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Consequently, the whole global economy described with a system of parametric differential equations of the type (6), is unpredictable and uncontrollable.

Thus, the above mathematical description of current market economy processes does not allow combating economic crises. But it explains why the attempts to combat economic crises have failed so far.

6. NEW ECONOMIC TOOLS FOR REFORMING MARKET ECONOMY

It follows from the above that in order for the market economy to become predictable and controllable, it has to be reformed in such a way as to minimize the influence of the human factor.

To this end, it is necessary to create the conditions which will provide $\lim H_V(t) \to const$, $\lim H_A(t) \to const$ and $\lim H_B(t) \to const$. However, it is necessary to have new economic tools which have to neutralize the influence of human factors on economic processes. There are two types of human factors which have to be neutralized – the internal and the external. The internal human factor is understood as the unpredictability of behaviour of market participants, i.e., buyers and vendors. The external human factor is understood as the unpredictable external influence on market participants on the part of other individuals and entities, such as criminal organizations, administrative institutions, and so on.

6.1 Business-interfaces

In order to neutralize the internal human factor, new economic tools in the form of business-interfaces described in [11], [12] can be used. They are named after interfaces in computer engineering, where they are understood as the hardware and software means of connecting different devices. If, for instance, joints of these devices are connected with inappropriate plugs which do not match the interface, the devices will not be connected. If the plugs are correct, but a wrong signal which does not match the interface is fed to at least one pin of the plug, the connected devices will not operate.

This is why we shall refer to business-interfaces as the commodity-money means of connecting market participants, i.e., the documents governing their activities to such a detail that the human factor will be fully eliminated. Consequently, the corresponding documents must strictly specify all the terms and conditions of a transaction, and their breach must be fraught with strict penalties. First of all, schedule of delivery of goods and services, as well as schedule of corresponding payments must be as detailed as possible. Besides, as mentioned above, oscillation processes will be widely used in the new economy, therefore, the schedule of deliveries and payments shall contain (but not necessarily) a sinusoidal component, the parameters of which are optimal for a particular transaction (which will allow, for instance, making the process a resonant one). For implementation of more complicated processes, e.g., in systems with a switched structure [13], a different schedule described with a corresponding function of time will be used.

The above restrictions, however, do not abolish the basic principles of market economy – competition and freedom of choice, which will be fully applicable until the moment the decision on purchase/sale is made and the corresponding contracts are signed, giving strict governance of business-interfaces chosen by buyers and vendors for a particular transaction. However, once the decision on purchase/sale is made, the freedom of choice will be substituted by strict obligations to meet the terms and conditions of the contract. This is the price of crisis-proof economy.

We can even say that the economy reformed as suggested above will become a market- directive economy: before entering into a transaction, market participants will operate in the market (capitalist) economy, and after the transaction is made they will find themselves in a directive (socialist) economy. That is, they will have to earn money operating under the constrained directive economy, and spend money in the free market economy. The time spent under this or that type of economy will depend only on market participants themselves.

It is possible even to assume that under such circumstances leftist doctrines and corresponding political movements will become less appealing.

As for social tension in the society, it can be released significantly by using another tool for introducing economic reforms in the society, which allows minimizing the external human factor restricting or even abolishing the principle of the freedom of choice.

6.2 New Global Information Network PC•net

In order to neutralize the external human factor, it would be appropriate to substitute the Internet with the new global information network PC•net described in [14] – [16], which at first can be implemented as a combination of numerous regional networks.

Contrary to the Internet, the new information network does not use packet-switched communication. This is why, due to the use of only single one-way broadband (e.g., television) communication lines (see Fig. 5) instead of dual communication lines (in-line and feedback) or single bidirectional communication lines (e.g., telephone), the new network provides for complete information security, i.e., guaranteed protection against hackers, worms, spam and other network threats. Absence of feedback lines in the PC•net makes it impossible to retrieve information from users' PCs (just like from their TV-sets). As for noise suppression during transmission of computer information to users, it will be provided for by the use of noise-proof encoding which has proven to be highly efficient in deep space communication. Thus, the PC•net will not only provide for complete information security, but reduce the information retrieval time to zero, because information is not searched for, it is received by subscribers immediately.

The new information network is very convenient for business purposes because, in addition, it offers its users numerous business-oriented services – trading, exchange, administrative, analytical, and so on, which will enable business people to successfully solve a variety of their practical tasks. Contrary to the Internet, where it takes a lot of time to search for the necessary information, or the information is simply not available, the PC•net will enable business people to receive the information they need very quickly by subscription. The new information network will enable business people to find business partners independently (without any third parties involved) and quickly, as well as to successfully avoid the influence of external human factors.

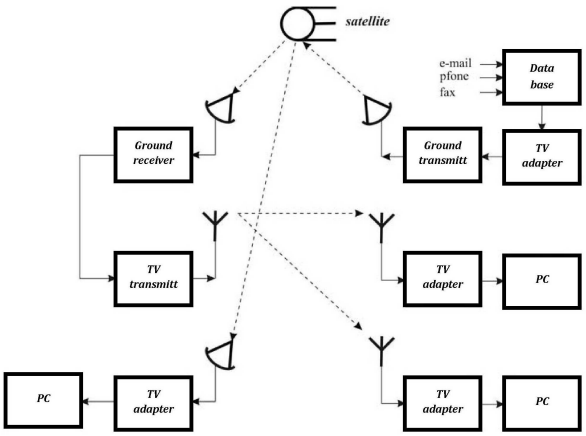

Figure 5: Simplest implementation of the PC•net

The PC•net information network operates as follows. Users of, for instance, the trading or the exchange service submit detailed information on the goods and services they offer to the Data base, where it is supplied with the corresponding descriptors and transmitted to all subscribers via one-way television (terrestrial, cable and/or satellite) or fibre-optic channels of the local or global implementation of the PC•net. In order to connect users' PCs and TV transmitters to the PC•net, television adapters similar to modems in the Internet are used. Users subscribe to the PC•net services just like to TV broadcasting programs, indicating the topics they are interested in, instead of TV channels. Computer information can be broadcast to the PC•net users 24 hours a day, including day-time background mode, and stored in the PC's personal memory. Users look through the information at their convenience, use the corresponding software to select the goods and/or services matching the specified criteria, and make purchases at fixed prices (with the help of the trading service) or in the auction mode (with the help of the exchange service).

Users of the analytical and the administrative services receive a different type of information. First of all, it includes all news on events in the business world, politics, science, including official reports and relevant publications. That is, this is the information generated up-to-date. Other information, including archive information, is also broadcast in special issues. All information, in accordance with the descriptors set by the users, is stored in the personal memory of their PCs, which enables the users to quickly create personal data bases. Analysis of their content will allow the users (with the help of supplementary software, e.g., for intellectual enforcement) revealing trends and regularities of certain situations, enabling them to make quick and accurate decisions.

7. THE FUTURE OF ECONOMICS

Since processes taking place in the economy reformed as suggested above will be described with systems of linear differential equations, economics will become an exact science, similar to, for instance, radio-electronics.

The current economy, if we continue its comparison with radio-electronics, is like a set of radio-electronic parts – resistors, chips, capacitors, etc. – connected and rearranged at random moments of time in a random fashion. Certainly, it is impossible to develop a more or less efficient economic system similar, for example, to complicated radio-electronic devices, e.g., an

automatic pilot, a computer, a navigator, a TV-set, and so on, based on these principles.

In terms of the new economy reformed as suggested above, it is quite possible to develop the theory of economic systems (similar, e.g., to the theory of radio-electronic systems) based on economic counterparts of the Ohm's laws, the first and the second Kirchhoff's laws, and so on. Moreover, to facilitate the development of certain sub-systems of the new economy and the economy as a whole, principles of variable-structure systems theory, principles of the automatic control theory and other exact sciences can be used, as well. Sub-systems of the new economy can be synthesized and simulated before their practical implementation, similar to the way it is done in other exact sciences. And crises will be soon forgotten.

8. CONCLUSION

Thus, the given appropriate mathematical description of the market economy, reformed as suggested above, with systems of linear differential equations, will allow successfully managing it. This will provide for guaranteed prevention of new economic crises. The suggested mathematical description of economic processes will also allow successfully solving optimization problems.

Validity of the suggested mathematical description of the economy can be confirmed or disproved only by the corresponding economic experiment. In this respect, it is appropriate to recollect a saying of a prominent scientist, developer of operational calculus Oliver Heaviside (1850 – 1925): "Mathematics is an experimental science" [17].

REFERENCES

[1] Bannock, G. and Baxter, R., 2009. The Palgrave Encyclopedia of World Economic History: Since 1750. Palgrave Macmillan, Basingstoke.

[2] Barber, W.J., 2009. A History of Economic Thought. Wesleyan University Press, Middletown, CT.

[3] Mantegna, R.N, and Stanley, H.E., 1999. An Introduction to Econophysics: Correlations and Complexity in Finance. Cambridge University Press, Cambridge.

[4] Maslov, V.P., 2005. Quantum economics. Nauka (Science), Moscow.

[5] Bouchaud, J.P., 2008. Economics needs a scientific revolution. Nat. 455, 1181

[6] Pokrovskii, V.N., 2011. Econodynamics. The Theory of Social Production. Springer, Berlin.

[7] Brock, W.A. and Malliaris A.G., 1989. Differential Equations, Stability and Chaos in Dynamic Economics. Elsevier-North Holland, New York.

[8] Antonov, A.A., 2010a. Differential equation for the 'goods-money-goods' process. Europ. J. Sci. Res. 40. 1: 27–42. http://www.eurojournals.com/ejsr_40_1_03.pdf

[9] Poser, S.W, 2003. Applying Elliott Wave Theo

[10] Zarnowitz, V., 1996. Business Cycles. Theory, History, Indicators, and Forecasting. University of Chicago Press.

[11] Antonov, A.A., 2010. Economic oscillating systems. Am. J. Sci. Ind. Res. 1. 2: 359–363.

[12] Antonov, A.A., 2011. Realization of Crisis-Free Economy. Int. J. Emerg. Sci. Special Issue: Selected Best Papers. 1. 3: 387–399.

[13] Emelyanov, S.V., 1995. Variable-Structure Control Systems Discrete and Digital. Warrior Books Inc, Malabar, FL.

[14] Antonov, A.A., 2009. Safe Global/Regional Informational Network. Europ. J. Sci. Res. 28. 1: 165–174.

[15] Antonov, A.A., 2011. From Artificial Intelligence to Human Super-Intelligence. Int. J. Comput. Inf. Syst. 2. 6: 1–11.

[16] Antonov, A.A., in press. New Business-Oriented Global/Regional Information Network. Int. J. Bus. Inf. Syst.

[17] Nahin, P.J., 2002. Oliver Heaviside: the life, Work and times of an electrical genius of the Victorian age. The Johns Hopkins University Press. Baltimore.