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ON MEASURING THE REAL VALUE OF PRODUCTION. REFLECTIONS ON THE ECONOMIC ORDER OF THE REAL WORLD ON OCCASION OF THE FINANCIAL CRISIS[1]

Abstract: The article provides an answer in a new dimension to the very old question about the real value of production which has become up to date again after the financial crisis with its immense losses of securities and stocks. The answer includes the knowledge from the latest research on the existence of the economic order in the real equal natural world with energy as the means of payment. The results of a microeconomic approach within this natural order, based on observations and characteristics of marginal quantities within production processes, are described.

Keywords: financial crisis, value theory, ecological, bio-physical, and philosophy of economics.

1. Preliminary remarks

This article, stimulated by the present banking and financial crisis, is a response coming from science in order to promote a necessary change in the economic thinking of politicians and bankers. Let us remember – this banking and financial crisis was initiated by the long lasting unsecured mortgage loans of banks in the mid-

[1] Within European Erasmus program and due to invitation of Professor Julio Sanchez-Choliz, Department Economic Analysis, in March 2009 Professor H. Maier from Berlin School of Economics and Law, and Leontief-Institute for Economic Analysis/Germany stayed some weeks as visiting professor at University of Zaragoza/Spain to present lectures, discuss scientific problems and exchange ideas not only but also on the economic and financial order acting in the real world. A draft of this article was interim result of discussions about impacts of financial crisis between Julio Sanchez-Choliz, Dr. Jorge Bielsa-Callau, and Helmut Maier; as well it is impact of previous discussions about this item between Professor Zhao Yanyun of Centre of Applied Statistics of Renmin University of China in Beijing and Professor Maier during October 2008. On occasion of further visits of Professor Maier at Department of Economic Analysis of University of Zaragoza in September 2011 and at School of Statistics of Renmin University in Beijing in March/April 2012 this draft was overworked up to this final form. The author is most grateful to these persons as well as the support by German DAAD and Chinese Ministry for Education.

west of the United States of America. It was favored by a change of the global banking system since the 1980s with new financial products, steadily increasing expectations for income returns, and the unreserved monetary policy of central banks throughout the world which allowed banks to sell and spread the risk of unsecured loans bundled and sold as profitable investment projects in a legal way all over the world[2]. High and accelerated growth rates and contributions of the banking sector to the Gross Domestic and National Product turned out to be artificial. With the unavoidable collapse of stock market prices and even as the impact of missing real assets and other real equivalents to these expected and virtual profits, and in consequence the issued glut of money, the confidence and belief in the security of market economy have been damaged significantly. Hence the final demand for its products decreases, which according to John M. Keynes (1883–1946) is a decisive parameter for employment. It was unbelievable that decades ago even the United States of America – the guarantor of the free market economy (in contrast to the state economy of former socialistic countries) – forced state intervention to maintain employment, but these public measures worth billions of dollars are now a fact under the new president Obama.

The subject of this article is the measurement of the real value of production, the urgent need for which is the outcome of a previous article about the real cause of this banking crisis [Maier 2009a, pp. 141–153]. Insofar as the present article belongs to the field of value theory which has a long history in economic thinking, its milestone being the value theory of Karl Marx (1818–1883). It is not intended to recall this discussion or to explain the different terms and measures of value theory in detail, but it is mentioned. It seems impossible to measure the so-called absolute value of a certain economic good by itself that is independent from different goods and aspects[3]. The aim of this article is to introduce and substantiate a measuring concept of the real value of a product and service, respectively, by reflecting its production in neoclassic theory as well as in the economic and financial order of the real world which equals the natural world. Again it is not intended to introduce all the details of the latter order, however it is necessary to mention that within this order we center on the natural system instead of human society, and we consider the biological production of creatures as an economic production process. In other words, we look at this biological process of creation of life by creatures through the eyes of an economist in order to get inside the concept of philosopher Georg Friedrich Wilhelm Hegel's (1770–1831) so-called consistent overall picture of material and biological production which must exist. We learn that in the real world means of payment (and absolute reference to measuring and evaluating economic activities and assets) is energy,

[2] Taken and translated from [Eigendorf 2008].

[3] See Wikipedia (2009), Freie Enzyklopädie, Stichwort "Wert (Wirtschaft)", Cite: „Welchen absoluten Wert ein Wirtschaftsgut oder eine Ware aus sich selbst heraus hat, unabhängig von anderen, wird heute für unmöglich auszudrücken oder zu bemessen gehalten (zum Verhältnis von Wert zu Gebrauchswert siehe auch: Wertparadox)", http://www.Wikipedia.de (accessed 14 March 2009).

markets have a dual face with participants appearing as sellers in one and as buyers in the second, and any creature in one and the same subject equally is producer, final user, and final product, the latter is its "own living biomass and body able to provide services" (short notation "life"). This seems to be impossible but it is not. The paradox of how creatures can finance the production of their own life which they use by themselves could be solved[4].

Moreover, for the better understanding of the subject and the aim of this article, readers who do not know the previous article about the present banking and financial crisis (see footnote 3) are referred to read it, too, because it includes more details about this banking crisis; in addition more remarks on the financial order of the real world, remarks on the fundamental link between human and real financial order (represented by energy as indispensable for production in both orders), and on this basis it reflects the real cause of this banking crisis within the real world (the missing coverage in the absolute money and/or reference energy) as well as an evaluation of the present political measures to overcome this crisis (an elastic behavior of governments to delay and smooth negative impacts by broadening the base of responsibility and shifting burdens to future generations). This previous article ends with the conclusion: "A final solution (Remark: Of the financial crisis) if wanted at all must consider the rules and constraints of this natural economic and financial order the knowledge of which is to be enlarged urgently. A priority need is the development of a consistent statistical concept of how to measure the real prices of goods and services in energy values; a mere conversion into the measure 'barrels of crude oil' or 'units of coal' one can buy for a dollar or a unit of a different currency is too superficial and even wrong." [Maier 2009a]. The present article explains how to measure the real value of production within the economic order of the real world, and it is a necessary step in this direction.

The approach is multi and interdisciplinary but dominated by economics, it combines theoretical and empirical elements. According to the concept of Carl Menger (1840–1921) and neoclassical tools, the analysis considers a marginal quantity of production. Step by step we observe and describe, exemplarily, the process of its realization and production in the natural world in physical terms. Parallel to it we enrich and enhance the physical description by the decisive economic description and interpretation, bridge and interface is the identification of energy and money. Insofar as this approach is a hybrid – besides economics it uses knowledge of theory of potentials of mathematical physics. According to Hegel, we consider this marginal production quantity as an output of the production of an enterprise as well as an input into the production of another enterprise, and we look for its consistent overall picture. In the end we get a measure for the real value of a product in energy units. The consideration is extended to the pricing, especially in the case of

[4] For details of this order see [Maier 2007], especially for the solution of this paradox see pp. 39–48, or [Maier 2009b].

market equilibrium, and it is enhanced by a visualization of the macroeconomic outcome of this measuring concept for the real value of total production (of all species and creatures) on earth. In order to reach the recipients who are primarily economists, for easier understanding and to promote discussion of this issue, the analysis is executed and reported in words, and the related symbols, identities and equations are shifted to an appendix without the intention to present a closed model.

As for citing names, readers who are used to look at the actuality and scope of the included reference and bibliography, respectively, in order to evaluate the quality of the article may be surprised at the first reading because this style or "type of marketing" is not used by the author, and it is not decisive for an innovative issue, either. As a philosophical consideration, this article refers to the basic thoughts and principles of natural science and economics included in any good textbook of physic and economic discipline, and noticeably they do not change so quickly[5]. Instead, they are related to extraordinary scientists in history; hence citing their name is only fair and replaces to a certain extent the citing of these thoughts and applications in the latest issue of a book of a different author without depreciating the author's work. The author refers to Gerthsen [1960] for physics and to Henderson/Quandt [1973] for microeconomics. For a useful description of the history of economic thought in the German language, see [Söllner 1999]. Moreover, working on a special subject it is convenient to cite neighboring scientific approaches and solutions. John Tschirhart's [2002] work entitled "Ecological transfers replace economic markets in a general equilibrium ecosystem model" is mentioned. Although Tschirhart models ecological transfers using energy as means of payment, too, contrary to the author of this article, his opinion is – being not aware of the dual structure of natural markets – that classical tools of economic markets are not suitable to describe the behavior of these transfers, hence he models transfers of biomasses by risk management and related methods to optimize the use of scarce energy.

2. Explaining the measure for the real value of a product

2.1. First step: Remarks on the potential energy

We start the considerations in the real world and natural world, respectively. Imagine energy being in physics a potential distributed all over the world, invisible, and bound to mass. How can we imagine this potential? There are different possibilities. Think of a geographical map of the surface of a continent or a country of the earth showing its mineral resources as you may have seen during secondary education at school, for instance: regions with special mineral resources are marked by a special color, for coal, crude oil, etc.; the title of this map may have been "Natural resources" or even "Energy reserves." In fact these regions represent energy reserves, hence

[5] Examples are mentioned in: [Gerthsen 1960; Henderson, Quandt 1973].

mass points including a high concentration of useful energy. Or think of a bird, an eagle for instance, flying at a high altitude over the surface of the earth looking for prey which it usually detects when it moves. This prey (and the eagle) represent useful energy as well, again bound to a mass which is the body of this animal. In contrast to the first image which refers to the distribution of energy within dead masses, the second refers to the bio-energy of living creatures. You may find further images, moving leaves of trees which indicate wind energy, waterfalls which indicate kinetic energy, lights in the night of human infrastructure which represent electric energy, moving cars which represent again kinetic energy, etc. The decisive message is that at each point of the earth and depending on time, there is a certain amount of energy. In addition we note that in physics energy is a potential, in mathematics it is a function depending on the location of a mass during time, in statistics it is a random variable; viewing the time dependence it is even a stochastic variable, and the examples given above illuminate the distribution of this random and stochastic variable, respectively, throughout the world. We ask what role is played by this potential energy within the real and natural world? Referring to the economic and financial order of the real world, after several empirical and analytical tests the confirmed answer and hypothesis is - energy is the accepted means of payment between all creatures and absolute reference to measure and evaluate, respectively, economic activities and assets [Maier 2007, pp. 56–58]. Nothing runs in real world without energy, this is an accepted fact.

2.2. Second step: Remarks on the potential money

We extend the consideration; we switch to human species and society, respectively, and we ask what equivalent measurement, instead of energy, is in use within human economics? The answer is simply "human" money because energy is viewed as a product like any other we can buy for money, which is a fatal error in the opinion of the author and already stated in 1926 by Frederick Soddy (1877–1956) in his book *Wealth, Virtual Wealth and Debt*[6]. Broadly speaking, we can substantiate this by the well- known fact that nothing runs in human economics without money and this money is by human law the accepted means of payment between humans. However, there is a decisive difference concerning the quality of these two measurements. Human money and energy are not isomorphic measurements, rather human money is a homomorphous map of energy, like a copy it does not represent all the properties of the original which is energy; especially it does not represent a real value[7]. Insofar

[6] After [Swank, Gere 2009]. Soddy, Nobel Prize winner of chemistry in 1921, criticized money policy because it ignores the fact that "real wealth" is derived from using energy to transform physical objects, energy should lie in the heart of economics, and not supply-demand curves; reference to his book is taken from: http://wikipedia.org/wiki/ Frederick_Soddy.

[7] The marginal real value of a coin or banknote within the natural world can be neglected because it is far below the assigned value within human economics.

as human money needs confidence[8] when used on human markets and within transactions, and it cannot be used as means of payment between humans and other creatures. Imagine now human money being in human economics a potential well distributed all over the world, but visible in banknotes and coins, and bound to human beings. How can we imagine this potential? Again there are different possibilities. Think of a geographical map of the surface of a continent or a country of the world showing the income distribution of people living in a special district where districts with different levels of income are marked with different colors. Such maps, called “Income profile” exist for detailed local regions of Germany. Or think of a geographical map showing the public and private infrastructure of humans with buildings, streets, railways, a big concentration of this infrastructure may represent a higher amount of money as well. The decisive message is that at each point of the world and depending on time, there is a certain amount of human money. This human money is a reference for measuring human economic activities in human societies. Again we note that by the identification of (the roles of) energy and human money, according to Hegel’s philosophy the latter in physics can be treated as a potential, in mathematics as a function depending on the location of a human during time, in statistics as a random variable, viewing the time dependence even as a stochastic variable, and the examples given above illuminate the distribution of this random and stochastic variable, respectively, throughout the world. This means that we can apply methods of physics and mathematics to human money with an economic interpretation and result.

2.3. Third step: Remarks on a marginal quantity of production

Now we apply the microeconomic concept of Carl Menger and neoclassical theory and focus on a marginal quantity of production output defined as the “virtual production of an additional single good (and service if so) on a fixed level of production along an isoquant”. We recall that an isoquant is the geometric locus of all combinations of quantities of input factors with the same level of production output; it expresses the possibility of substituting a quantity of a special input factor (think of a capital good) by a different quantity of a different input factor (think of labor). If we consider two input factors and different levels of production we get a set of isoquants represented by a set of rectangular hyperbolas in the first quadrant of a co-ordinate system, the more these curves move away from the origin zero of this co-ordinate system the higher the level of production is. Why do we stress the characteristic “virtual”? The answer is that when moving along an isoquant the total change of production, mathematically expressed by the total differential of the production function (depending on its input variables) is null, which means that this

[8] Note, in the seventh step this confidence will turn out as confidence to re-convert money into energy.

marginal quantity does not reflect in the production output, hence it is virtual! The essential question is why do we focus on just a marginal quantity of production? The answer is that on each level of production output and for any two input variables, via marginal productivities (MPs) these marginal quantities are reflected in the rate of technical substitution (RTS); and via marginal costs (MCs) they are reflected in the ratio of prices (for a unit), the latter under the assumption that an enterprise works on a maximum level of production output with restricted cost budget for factor inputs. More exactly, the RTS equals the ratio of the MPs of these two input variables, and equals the ratio of MCs as well as the ratio of the prices (for a unit) of these two input variables; this is the essential result of the neoclassical theory of enterprises [Henderson, Quandt 1973, pp. 48–62]. By choosing a marginal quantity of production, we hope to find access to a measure of the real value of a product via marginal productivities, marginal costs and related prices, this is an elaboration of his idea. We recall that viewing a special input variable, the attributed MP denotes the marginal quantity of production (output) influenced or gained by a marginal quantity of one input variable during production in the case of fixed levels for other input variables, the latter – since Marshall (1842–1924) – is known as *ceteris paribus* condition (*cp*); mathematically MP equals the partial derivative of the production function (describing the output quantity of production depending on the input variables equal quantities for input factors) after this one input variable. RTS, given the case of two input factors view as variable and the other fixed (*cp*), denotes the negative slope of the tangent in a special point of an isoquant, the latter point marks a special choice of quantities of these two input variables for the allocation of the production by an enterprise. Finally MC, given a restricted cost budget and a linear cost function (including fixed cost and variable cost for variable quantities of input factors), denotes the additional cost caused by a marginal quantity of one input variable in addition and the others fixed (*cp*); mathematically MC equals the partial derivative of the cost function after this input variable. Now we ask how we can imagine such a marginal quantity of production in the real world? And we answer: think of “a car driven by a human and riding from a town on a plain (like Zaragoza) to a village in the mountains (like the Pyrenees)”; this observable phenomenon within the real world we shall choose as an example for this analysis. We expand it by using economic features. Imagine the driver is an employee of an enterprise producing washing machines, and his task is to deliver one just produced additional washing machine from the enterprise in Zaragoza to a laundry in this village to replace a damaged one urgently; by this the phenomenon of the driving car in the eyes of economists, together with the just produced washing machine, it turns into a marginal quantity of production unit being in this case this just produced washing machine in addition including a service (equal marginal service). It is a “virtual” marginal quantity of production because this is only us imagining the driving car; the exact reason of this drive in reality is not known, In addition, we analyze it in isolation and keep all other features not noted, hence we imagine them unchanged which meets *ceteris paribus* condition. For the purpose of simplification and in the absence of knowledge about the detailed technical production process of this washing machine within this enterprise (which is not decisive for the conclusions), we restrict the detailed analysis to this marginal service and part of this marginal quantity of production, but in the end we extend the result to the entire marginal quantity of production (including the production of the one washing machine). In doing this we use the strongest tool of statistics which is observation. We observe that driving the car continuously uses up gasoline and energy, respectively, from its tank, and gains force from the engine of the car, and from this force moves it, the latter by joining the engine to the wheels. The physical background according to Isaac Newton (1642–1726) et al. is, on the one hand, that a force is a derivative of the potential energy, to be more precise. A force is the negative gradient of the potential energy which means the car gets force by extracting energy from gasoline, which means there is a balance between the gained force and the lost potential energy[9]. The physical background is, on the other hand, a force – again according to Isaac Newton – which is equal to the mathematical product of mass and acceleration, which means forces cause masses to move and the car with or without driver and cargo represents a mass. By this movement the car, including driver and the washing machine, step by step is able to ride from one place to another. It is noted that the physical formulas of transforming a potential to a force and to convert a force into a movement via an acceleration of a mass, describe mere balances, they do not include information about how the transformation process itself is executed. But the latter we can observe in reality, through a pipe the gasoline is drawn into the engine which is some kind of a body able to convert this gasoline using air in addition to force, and by joining the engine to the wheels the force provided by this engine is transmitted into the movement of the wheels – thus the car drives. We enrich this description by an economic interpretation: imagine this potential is not energy but human money, and it is not drawn from the tank of a car but issued by a bank to an economic body (let us say an enterprise). Then, by using this money we equally get a force called "economic force" which is used to execute this service. In other words, the enterprise which pays money for the driver and gasoline[10] "loses" money (which we identify with "spending money"), gains economic force, and from it this service, because "moving something" in the eyes of economists' is indeed a service. Notably, the "economic force" gained from transforming human money is converted into "physical force", without this conversion this marginal service (and the marginal quantity of production) could not be executed in the real world.

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[9] It is noted that this balance refers to conservative forces, and not all forces are conservative forces, but this is subordinate in this consideration.

[10] It is noted that within the marginal analysis of this service fix cost positions for the car like investment cost measured via cost of depreciation and cost of periodical care are out of consideration, hence the variable cost position "gasoline" is included, only.

2.4. Fourth step: Remarks on physical and economic labor

Now we introduce the physical as well as economic term of labor. We consider the impact of this force gained by transformation of the potential (either energy or money) on a mass along a certain way. Imagine the driver joins the engine to the wheels and drives this car from the enterprise in Zaragoza on the plains (the starting point) to the village in the mountains of the Pyrenees (the target point). In physical terms, the moving car including cargo and driver executes labor; this labor is measured, roughly speaking, more exactly by the mathematical product of force and way. By the integral over the scalar product of this force and all marginal pieces of the way, from the starting point up to the target point. Physical labor is measured in energy units called "erg" or "dyn×cm". In the eyes of economists' this moving car including cargo and driver represents labor, too, but the labor of the driver. Hence it is a primary input into this production process, measured in time units (hours) and paid for in money units per time unit (think of euro/hour) the movement of the car itself including cargo is not counted as (human) labor, its costs (in money units) are included in different cost positions of the production process. Independently from this, a different use of the same term "labor" in physical and economic sciences, in both economies of human and real world, the driving car including cargo and driver represents a service and hence an economic product.

2.5. Fifth step: Remarks on the return of a marginal quantity of production

Imagine now that the car with driver and cargo has reached its target point in the village in the Pyrenees, the washing machine is unloaded and replaces the damaged one in the laundry; the marginal quantity of production (production and delivering of one washing machine in addition to a certain level of production) is done. Gasoline and energy, respectively, is used and finished; the labor (either considered physically or economically) is done and taken away as well as the washing machine; and all is paid for by the laundry in money units of the human world. We ask – what do we get instead of or besides this return in money units of human society, as a return within the real and natural world? In other words: what is the positive effect and return, respectively, of this marginal quantity of production output in the real world? This is the decisive question after the real value of this marginal quantity of production. Referring to Hegel, we shift this question to the theory of potential, from where we get the answer that we regain a different potential of energy! But how much energy do we regain? Does the regained level of energy cover the energy expenses, not only of the car and driver during this move and service, but also for the production of this one washing machine? Or is it less or even more? These questions are decisive, because this energy we get as a return for this marginal quantity of production represents a real value, and hence, it is a (real) measure for the real value of this marginal quantity of production. The precise answer of potential theory is that the lost and invested, respectively, physical labor, mathematically denoted by a minus sign, during this move from the starting point up to the target point (which means the labor is done), is replaced by a different potential at the target point. From a natural science perspective we may explain this by the natural laws of *action and reaction* and the *law of conservation of energy*. We ask if these laws will also hold when we consider transactions from the (economic) potential money to the (physical) potential energy and vice versa? The answer is that we are not sure. Hence we look for an independent economic substantiation! We note that in the theory of potentials there exist three possibilities: either the amount of recoverable energy at the target point (during the time from now on) is bigger, equal, or lower than the amount of energy of this marginal quantity of production (output) at the target point, reduced by the stock at its starting point (which is the beginning of production in Zaragoza). Translated into economics, this means in real terms that either this marginal quantity of production is profitable, just breaks even, or is not profitable measured in energy units. If we apply this result to the potential money of human economics, this means that either this marginal quantity of production (output) is profitable, just breaks even, or is not profitable measured in money units. How can we imagine this regained or recoverable potential of energy? The answer is that with the car, for instance, at the higher geographical level in this village in the Pyrenees a higher amount of so-called "potential energy" is assigned, a special type of energy depending on geographical location. Or with the driver, for instance, if he buys and eats something at the target point when the work is done (from the money he earned by doing this service) he regains energy which he lost driving. But the decisive economic source of recoverable energy is the new location of this washing machine within the laundry at the target point: The real value of this (just produced and delivered) washing machine being now in this laundry, connected and ready for use, is a higher one than at the starting point in the enterprise. Why is this so? The economic answer is that because within the laundry it can produce a return and it could not produce a return in the enterprise where it was produced. This return we can measure by the amount of energy which is saved within this laundry when this washing machine is used as an input factor for washing instead of a different input factor, for instance for human labor. At this point of analysis we can observe that the role of the marginal quantity of production is changing from an output to an input variable – up to now we have considered it as an output of the enterprise producing (and delivering washing machines), from now on and due to Hegel's idea, we look at it as a factor input into the laundry. This possible return (within the laundry) we may call the surplus value of energy gained by this marginal production and service unit, this is in line with the surplus value of (human) labor of Karl Marx. It is in line with the profit of neoclassical theory of enterprises, too. Balancing this regained potential of energy equals the profit with the lost potential equals expenses for this (virtual) marginal production and service unit (either in energy or money units), it is mathematically viable that this balance can be positive, null, or negative. However, visibly these values – null or negative – occur in the real world, an example from material production in this case is that this single washing machine turns out to have been broken during transport; an example from biological production is a still-born child or a different creature. What might be the reason? An answer is that up to now we considered a "virtual" quantity of production only under the condition of *ceteris paribus*, which means we keep all the other features unchanged except for one input factor and variable, respectively. Surely, for this (Marshall's) condition it is necessary to apply the mathematical calculus of partial derivatives and it is useful for getting estimates for MPs, MCs, and the RTS. However, considered in isolation, it does not capture the full reality, because when moving along an isoquant it is assumed that we do not produce a product any more but only the same amount under different combinations of quantities for two of all input factors. Hence, the real effect of this virtual marginal quantity on the amount of total production output is null, in neoclassical theory as well as in the real world. Moreover, this construction suffers because we cannot turn back the time and produce the same marginal quantity a second time under changed conditions! At this interim point we break off the discussion of this (single) marginal quantity of production.

2.6. Sixth step: Remarks on the resulting measure of the real value of a real product

Now we shift to the consideration of the total amount of production output of this enterprise which we assume produces and delivers washing machines. To avoid the disadvantage of a single virtual marginal quantity (caused by the *cp* condition) we consider in this step the non-virtual but real production of one single good and service (producing and delivering one washing machine). The (infinitesimal) change of quantity of production output is mapped by the total differential of the production function. We consider the case that this (infinitesimal) change is just one product that is the smallest unit of production output, in doing this, we move away from a given point of any isoquant and get more distance from the origins, which means the production is raised by one product in reality. We note that this total infinitesimal change includes and refers to all (virtual) marginal quantities of production output of all input factors which means that we focus on the sum or bottom line of all marginal quantities of production of this one product during the process of production. Applying the theory of enterprises, we conclude that the bottom line of all these single balances between the regained or recoverable potential of energy (or money) at the target point, reduced by the stock of the potential of energy (or money) at the starting point of production must be positive, otherwise this production as well as this enterprise (either in the natural world or in the human world) could not exist economically because it makes no profit (neither in energy nor in money units), hence we could not observe it in the real world. But we observe it, hence the profit must exist! This profit of the enterprise we may as well identify as the surplus value of labor as in the theory of Karl Marx. It follows the bottom line of all energy balances of the corresponding economic activities, services or pre-products, to produce one single product, in this example "producing and delivering one washing machine" – focusing the production in the natural world this product is "one creature" or "life of one creature"[11] – must be positive as well. The result is that *The positive bottom line of all energy balances during the production process of a product is a natural measure for the real value of this product. In other words, this measure of the real value of a product is nothing different than the positive balance between accumulation and degradation of energy during its production process; it represents the gross added value in energy units gained by producing this product.*

2.7. Seventh step: Remarks on pricing of products

In order to get an image of the market price of this marginal quantity of production and service unit (production and transport of one washing machine to a laundry) in real terms, equal energy units, we switch back to and continue the consideration of the marginal quantity of production. To check the opinion that any price for a product can be set early on, it is noted that all prices result from the market where supply and demand of quantities come together due to different strategies of producers and users. If prices are set and fixed unrealistically without considering the laws of the market, this setting counts for nothing, this market cannot work and we cannot observe it. In order to learn which microeconomic strategies of demand and supply are to be focused on with this exemplary production, there is a need to clarify the type of this market[12]. The result is that this marginal quantity of production output of the enterprise producing and delivering washing machines belongs to a factor market. Why is this so? Because this washing machine is used for production in the laundry, it is an intermediate input into this laundry, and the laundry uses washing machines to provide the service of "washing clothes" for further intermediate or final use. At this point the strategies of maximizing utility (of final users) under special budget constraints are out of consideration [Henderson, Quandt 1973, pp. 11–16 and 56–62], we have to focus on the strategies of the laundry enterprise which are either maximizing its output (in physical or money units), return or profit (both in money units), or which are minimizing its cost (in money units) under special conditions; both optimizing the strategies executed in real values of energy and not in human money. In this remark we consider the strategy of maximizing the output in physical units from this marginal quantity of production (and service) under the condition of a fixed cost budget of the laundry enterprise, only. Applying this strategy, we learn that, considering a fixed budget for purchases on the (input) factor markets, this

[11] For a detailed substantiation in a macroeconomic context with creatures see [Maier 2007, p. 45].

[12] For the different strategies of demand and supply see for instance [Henderson, Quandt 1973, pp. 11–16 and 56–62].

laundry works at the maximum level of output in physical units if and only if the ratio between the prices (in energy) for each two input factors (for instance washing machines and labor) firstly equals the ratio of the marginal productivities MPs within this laundry (in energy) from these two input factors, and secondly equals the ratio between the marginal costs MCs within this laundry (in energy) of these two input factors. We conclude that in the case of market equilibrium on this factor market, the market price in energy units of one washing machine, viewed as an input factor for the laundry, must reflect and satisfy, respectively, these conditions. We ask: *could the real value of this washing machine, measured by the gross added value in energy units during its production and delivery, be its market price*? What a question – the market price is set by the market and not by a scientific consideration! Having in mind this objection, nevertheless we discuss this question. For this we assume the laundry, as well as the enterprise producing this washing machine, on this factor market work under balanced market conditions of supply and demand, and the resulting quantity (for demand and supply of washing machines), and the resulting (market) price (for a washing machine) reflect market conditions of equilibrium. The laundry follows the strategy of maximizing its physical output with a fixed budget for purchases (in energy units), and it works at the maximum level of physical output. In addition we assume a washing machine is a homogenous good and market participants have complete information[13], these are the usual premise for a perfect market. We conclude that this gross added value in energy units of a washing machine is an estimation of its market price when and only when it satisfies the above listed two conditions. This means that the ratio between the gross added value (in energy units) of this washing machine and the market price (in energy units) for any different input factor of this laundry firstly must equal the ratio between the marginal productivity MP (in energy units) from this washing machine and the marginal productivity MP (in energy units) from the same different input factor, and secondly must equal the ratio between the marginal cost MC (in energy units) of a washing machine and the marginal cost MC (in energy units) of the same different input factor. At this point we end the microeconomic consideration. We learn that the results of microeconomic approaches may hold also when we replace human money by energy. The gross added value of a washing machine (in energy units) gained during producing and delivering it might serve as the balanced market price on the factor market. But we have no ultimate certainty; we are not able to check whether these conditions are satisfied because we do not know the different input factors of the laundry. We ask "why?" The answer is that, as opposed to macroeconomics where we look at a closed cycle of economic activities (think of an input/output-table), microeconomic theory of enterprises suffers from the lack of a closed cycle between the two focused (or more) enterprises which links the outputs of the one to

[13] Note, in the economic and financial order of the real world complete information of market participants is not given, see [Maier 2007, pp. 21–22].

the inputs of the other, and vice versa. Hence we may assume that the enterprise producing washing machines cannot exist for a longer time if it gets back less return (in energy units) from the laundry than it provides by the gross added value (in energy units), this is compatible with the natural law of conservation of energy. We may suppose the laundry will get into difficulties on the market with its customers if it pays a price (in energy units) for its input which is over this gross added value (in energy units) and may vanish from the market in future, but this is all. Therefore we continue the consideration within the natural economic and financial order, where this missing link exists and is represented by the dual structure of all markets[14]. Remembering that markets have dual faces within this order, we ask for the dual market of this factor market on which the roles of supply and demand are transposed. The result is that this dual market is a "money market", supply is represented by the laundry, and demand is represented by the enterprise producing washing machines. We learn that the enterprise producing washing machines does not produce them because the laundry has a need, rather it produces washing machines because it wants to make money! By introducing human money, the original dual markets where both market participants exchange goods and services using energy as means of payment are dispersed, the dual market is replaced by a money market. On the dual market, the enterprise producing washing machines pays for the good "money" it demands and gets (in money units) from the laundry observably with the gross added value (in energy units) of this washing machine. And on the other market (factor market), the laundry pays (in energy units) for the good "washing machine" it demands and gets from the enterprise producing washing machines observably with money (in money units). Applying the result of the microeconomic analysis within the natural order which looks at both dual markets as a coupled and closed system, we conclude that both dual markets work in equilibrium, if and only if, for both participants the returns (on the one market) cover the cost (on the other market) and vice versa. Otherwise both market participants could not exist economically, they would vanish from the market and we could not observe this market. Hence the returns (in money units) of the enterprise producing washing machines on the factor market in the case of market equilibrium must cover its cost (in energy units) of producing washing machines on the dual money market, the latter equals the gross added value (in energy units). The returns (in energy units) of the laundry providing money on the dual money market in the case of market equilibrium must cover its cost on the factor market (in money units). *This means human money must be re-convertible into equivalent units of energy! In other words, human money must be covered by an equivalent amount of energy; then and only then within this model of coupled and closed dual markets – in the case of market balance the gross added and*

[14] The following explanations apply the microeconomic results of coupling and closing dual markets within the natural order, see [Maier 2007, pp. 26–27 (Example: Buying potatoes on a food market), and pp. 29–38 (1.5 Analytic substantiation)].

real value (in energy units), respectively, of a product (here a washing machine produced and delivered) – represents its market price (either in energy units or in money units) in the real world. Viewing this essential result it is understandable why human markets need the feature which is called "confidence in the market". This feature is not necessary on natural dual markets, where goods and services are exchanged using energy as means of payment, and equivalent amounts of energy are subject to the natural law of *conservation of energy*. This feature replaces the physical impossibility to re-convert a certain amount of human money within the natural world (without humans) into this amount of energy which was necessary to earn this amount of human money in human economics. In order not to be misunderstood, this physical impossibility is demonstrated with two examples. Firstly, imagine you have a hard-earned certain amount of money, let us say 5 thousand euro. You take this money, let us say 10 500 euro notes and bury it – like treasure – in the ground. By doing this you recycle it within the natural world. Will it bring back the energy you needed to earn this money? Never – because the (chemical) energy included in these 10 banknotes is not equivalent to the energy you lost by earning this money. The energy to produce these 10 banknotes (by order of a central bank) is not equivalent to this energy you lost by earning this money, either. Secondly, think of the present financial crisis which is the origin of this elaboration. Notably this impossibility appears as a "misuse of this confidence" by legal financial transactions; it hides behind instruments of risk management. Insofar as this crisis proves empirically the re-conversion of human money into an equivalent amount of energy which is necessary to earn or to get this money as profit, it is not self-evident. There are losers and winners, in other words, the dual markets within a chain of markets are out of balance, at least temporarily[15]. We note that *political measures to overcome the financial crisis which do not reflect this condition of re-convertibility of human money into energy will not have a lasting effect and will not restitute the damaged confidence in human financial markets.* In order to enhance this essential result, we reconsider both dual markets between producers of washing machines and laundries, but we assume now that mutual products are paid for in energy units by each partner and human money is out of the economic cycle. Surely this is an artificial consideration, we cannot pull money out of human economics as it will not work in isolation, but this method, called "Hypothetical Extraction Method" HEM, is in use and still provides useful information[16]. In executing this project, we assume that the laundry pays for one washing machine on the factor market, the equilibrium price which is its gross added value in energy units with an equivalent gross added value

[15] An example for such a chain of markets where the dual markets were out of balance is given within a reflection of the bird virus infection, the intermediate losers are the birds who die because of this infection, intermediate winners are viruses of type H5N1, see [Maier 2006].

[16] An example the reader may find with: [Duarte et al. 2002]. The resource which is extracted hypothetical of the production process is water. This is made to demonstrate its role within the production process.

gained by washing clothes from different clients. Who are they? In the case of the closed and coupled dual markets these clients are only the producers of washing machines. Hence we must assume the producers of washing machines need the service washing of clothes (for its employees for instance) as the only input, and vice versa the producers of service washing need the product washing machine as the only input. Surely, this model looks like a bed of Procrustes, we have this objection in mind, but it recalls Piero Sraffa's (1889–1983) view that goods are produced out of other goods, and we are curious about its impact. In the case of equilibrium, the cost of producing one washing machine (by the producers of washing machines) which is its gross added value in energy units, must be balanced and paid for by an equivalent amount of gross added value gained by this laundry on the dual market through washing a certain set of clothes. Let us assume in the case of market balance (on both dual markets) that the gross added value of one washing machine is just one energy unit. Then the laundry has to pay this one energy unit by its own gross added value gained by washing clothes. Let us assume this laundry has to wash 3 tons of clothes to gain this one energy unit as gross added value by washing, then the exchange ratio is "1 washing machine for 3 tons washed clothes". This relation is known as the exchange ratio of Karl Marx! Its meaning within the economic order of the real world is that the energy the enterprise (producing washing machines) needs to produce 1 washing machine is equal to the energy the laundry (producing service washing) needs to produce 3 tons of washed clothes. In spite of our rough model, this is a remarkable result. It allows and substantiates the hypothesis: *The exchange ratio of products and services on markets in the case of equilibrium expresses that the gross added energy values and the real values in energy, respectively, of both parts of this relation are equal*. This hypothesis is confirmed empirically because it reflects the natural law of *conservation of energy* within transactions on economic markets.

2.8. Eighth step: Remarks on the outcome of entire production on earth

Finally, we ask what is the outcome on a macroeconomic level for the entire production of all species including humans (and their material production of SNA) on Earth when the real value of a product is measured by its Gross Added Value in energy units, or what is the equivalent – the total production output less the production input for intermediate use both measured in energy units? The answer is that the outcome is an equivalent figure to the Gross Added Value in money, figures of SNA of human economics, for an entire economy a huge amount of energy, like a huge amount of money, whose huge amount usually suffers from the lack of a concrete imagination. But, looking at the final products of an economy, and excluding products for intermediate use, we can visualize this amount of energy indirectly by the traces of allocation of energy for production and by the traces of energy for consumption; in ecological economics these traces are known as (ecological) footprints. Examples are the absence of grass on a meadow during the grazing of deer for instance, from the viewpoint of the deer population is a trace of allocation of energy for the production of the deer, and from the viewpoint of the grass population on this meadow it is a trace of consumption of energy of grass population (in order to transport its seeds). Houses and streets represent traces of allocation of energy from the construction of these houses and infrastructure, people in houses and on the streets represent energy traces of using these houses and streets. By these traces or footprints the total environment changes, step by step. Hence the demand of the creatures for energy for life, and the supply of energy by the sun, together with the constraints and possibilities on the Earth, changes the environment day by day. What is the positive visualization of this invisible energy? The answer is the phenomenon of the creation of life by the creatures. Hence the creatures and their peripheral material production (with humans, their houses, streets, etc.) themselves represent and illuminate this amount of energy. What is the negative visualization of this invisible energy? The answer is that the phenomenon of destruction and pollution of environment which represents and illuminates this amount of energy as well. *Hence the creation of life by creatures on Earth as well as the parallel and unavoidable destruction and pollution of the environment on Earth illuminate the macroeconomic outcome of this huge amount of energy*.

3. Closing remarks

The main three results are described in the abstract: (1) the outcome for the measure of the real value of a product (step six), (2) the real price (in energy) of this product within the exchange of goods and services on markets including financial, political and legal requirements to restitute the damaged confidence in human markets (step seven), and (3) the clarification of macroeconomic outcome of total production on Earth of all species including Man by visualizing its positive and negative impact (step eight). Hence the aim of these closing remarks is to focus empiric tests and related aspects in the broader field of politics and economic theory.

Readers are referred to two empirical tests and applications, respectively, worked out in parallel to this elaboration. The subject of the first is the measure of the real price of nuclear power and real social impact on Germany on the occasion of the catastrophe in Fukushima in [Maier 2011a]. The subject of the second is the measure of the real value of two amounts of 500 and 750 billion euro of the European Union's emergency fund and its real social impact on donor states [Maier 2011b]. Looking at related social statistical data (of the result of the close election in Germany on 27th March 2011, and of the development of net reproduction rate in different countries, respectively), both tests give no reason to reject this measure.

As for the re-convertibility of (human) money into energy, which is a sine qua non condition and the result of this elaboration (step seven), in order to restore lost confidence in the markets, especially financial markets, it is obvious that financial policy making at present is not going in this direction. The proof of this is the European Commission's proposal to introduce Eurobonds as government bonds issued in euros together by the 17 euro zone countries in order to overcome the European sovereign debt crisis of November 2011. "Eurobonds are debt investments whereby an investor loans a certain amount of money, for a certain amount of time, with a certain interest rate, to a euro zone block as a whole, which then forwards the money to individual governments"[17]. A security in real terms of energy bound to national resources and potentials (like sun, water, energy reserves, flora, fauna, etc.) or social energy potentials (like population, education, etc.) is not addressed. The actual financial cut taken in Greece is empirical proof that the energy equivalents provided by the debtor is not replaced by a real equivalent[18]. Obviously, it will take time until politicians are open and willing to learn this result from science. To some extent this situation recalls chemist Frederick Soddy's ignored statement that economists should focus on energy as a source of "real wealth" instead of money, years before the financial crisis of 1929 (see footnote 6).

A corollary of this approach concerns the limits of microeconomics of neoclassic theory. Because it looks in one direction within the production process of enterprises, only in order to find optimal strategies for allocation of scarce money to the inputs, and it does not show a closed circle of enterprises, we were not able to test whether the conditions for pricing in real values (of energy) hold. This closed cycle is the subject of macroeconomics. Hence we used the dual structure of natural markets to determine the price of a product on the market as well as the exchange ratio in real equal energy units. As human markets are a part of natural markets, the conclusion is to enhance the neoclassical theory by this element. Viewing Hegel's overall picture of production, this subject is discussed by Maier [2011a] as well.

The estimation of the real value of a product impressively confirms the impossibility to measure it absolutely, but only within a context (footnote 3). If we could measure the real value of a single product (think of the one produced and delivered washing machine) without looking at its use (think of the laundry) – which represents its context – the estimation would be given by the balance of accumulation and degradation of energy between the target point (the location of the laundry in the Pyrenees) and starting point (the start of producing this washing machine at the location of the enterprise in Zaragoza) which observably only measures cost. But this product is not produced as an end in itself or out of some kind of narcissism – rather it is produced for the market that is on demand from other enterprises (the laundries or private households). Hence its real value depends also on the recoverable energy in other enterprises (or private households), otherwise it would not be produced and we could not observe it.

[17] Cite taken from Wikipedia, Freie Enzyklopaedie, Stichwort Eurobonds, http://en.wikipedia.org/wiki/Eurobonds (accessed 15 March 2012).

[18] Griechenland erkämpft Enteignung der Gläubiger, *Handelsblatt* 09.03.2012, http://www.handelsblatt.com/finanzen/boerse-maerkte/anleihen/schuldenschnitt-griechenland-erkaempft-enteignung-der-glaeubiger/6307208.htm (accessed 15 March 2012).

Finally, and referring to the last result that the phenomena *creation of life* and *destruction and pollution of environment* on Earth are inseparably joined and in the long term (billions of years) will exhaust the fundaments of life on it, the question arises where life might go on after ending on Earth. If the first aim of the economic and social order of the real equal natural world is really the *conservation of life*, we expect there is a solution. A speculative aim of research on the future based on the equation of Einstein (1879–1955) and the input/output concept of Leontief (1906–1999) may be found in [Maier 2011c].

Appendix

List of related symbols

E – energy in physics, a scalar,

Φ – potential in mathematical physics, a scalar function,

Φ_s – distribution function in statistics; index s used to avoid confusion with Φ, scalar function,

φ – distribution density in statistics,

X – random variable in statistics, a scalar,

X_t – stochastic variable in statistics, a scalar,

$\boldsymbol{x}$ – location of a mass in physics, a three dimensional vector (in bold),

t – time in physics, statistics and economics, explicitly or as index,

M – money in economics, a scalar,

L – Labor in physics, a scalar,

m – Mass in physics, a scalar,

$\boldsymbol{a}$ – acceleration in physics, a three dimensional vector (in bold),

$\boldsymbol{F}$ – Force in physics, a three dimensional vector (in bold),

grad – gradient operator of mathematics, producing a three dimensional vector from a scalar (in bold),

$\int$ – integral operator of mathematics

d – differential operator for total differential,

∂ – differential operator for partial differential presuming *ceteris paribus* (*cp*) condition,

. – point between two vectors denotes the scalar product of these vectors,

q – quantity of production (output) of a good, scalar,

$q(x_1, x_2, \ldots)$ – production function, a scalar function depending on the input quantities $x_1, x_2, \ldots$ of different input factors 1, 2, …,

C – cost of production, variable,

Co – restricted and fixed cost level for production in an enterprise, parameter,

$C(x_i, x_j)$ – linear cost function including fix cost and variable cost of quantities of input factors i, j,

$d\boldsymbol{x}$ – infinitesimal change (of location) x in physics, a three dimensional vector (x in bold),

dq – total infinitesimal change of production (output) equal total differential of production, function, a scalar variable

∂q – marginal quantity of production (output) q in respect to one input variable and the others viewed as fixed due to *cp* condition, a scalar,

x_i – variable quantity of input factor i, a scalar (not to confuse with bold printed co-ordinates of x),

dx_i – infinitesimal change of quantity of x_i of input factor i, a scalar variable,

∂x_i – marginal quantity of input variable x_i of input factor i under *cp* condition, a scalar variable,

r_i – price per quantity unit of input factor i, a scalar,

MP – marginal productivity of an input factor i, a partial derivative and scalar,

RTS – rate of technical substitution of an infinitesimal quantity of input factor i by an infinitesimal quantity of input factor j, a ratio and scalar,

MC – Marginal cost of one input factor (under cp condition), a partial derivative and scalar.

List of regarded identities and equations

$E = X$ identifies energy as a random variable with attributed functions Φ_s and φ,

$E(t) = X_t$ identifies energy (depending on time) as stochastic variable,

$M = X$ identifies money as a random variable with attributed functions Φ_s and φ,

$M(t) = X_t$ identifies money (depending on time) as stochastic variable,

$E = \Phi\ (x(t))$ identifies energy as a potential depending on the location of a mass at time t,

$M = \Phi\ (x(t))$ identifies money as a potential depending on the location of a (human) mass at time t,

$F = ma$ means that a physical force F provides mass m an acceleration a hence move,

$F = -\text{grad}\ \Phi$ means that a (conservative) force F is gained by degrading a potential Φ,

$L = \int F.dx(t) = \Phi(x(t_1)) - \Phi\ (x(t_0))$ defines physical labor L on the way from starting point $x(t_0)$ to goal point $x(t_1)$ denoted by an ascertained integral,

$-L = \int(\text{grad}\ \Phi).dx(t) = \Phi + \text{constant}$ means that the spent labor L during production creates a new and different potential denoted by an unascertained integral,

$dq = 0$ defines an isoquant equal the geometric locus of all combinations of two input variables with same level q of output of production, and the other input variables fixed due to *cp*,

$dq = 1$ denotes the infinitesimal change of total amount of production of one product,

$\text{RTS} = -dx_j/dx_i$ – rate of technical substitution of input factor i by input factor j equal negative slope of the tangent at any point of an isoquant,

$dq = (\partial q/\partial x_1)\ dx_1 + (\partial q/\partial\ x_2)dx_2 + \ldots$ – total differential of production function $q(x_1, x_2, \ldots)$,

MP = $(\partial q/\partial x_i)$ – marginal productivity of input factor *i* (assuming *cp* condition),

MC = $(\partial C/\partial r_i)$ – marginal cost of input factor *i* (assuming *cp* condition).

Condition of substitution of two input factors *i* and *j* along an isoquant (assuming *cp* condition):

RTS = $(-dx_j/dx_i) = (\partial q/\partial x_i)/(\partial q/\partial x_j)$ = ratio of marginal productivities MPs of factors *i*, *j*.

Condition for maximizing production output level under fixed cost (assuming *cp* condition):

RTS = $(-dx_j/dx_i) = (\partial C/\partial r_i)/(\partial C/\partial r_j) = r_i/r_j$.

Note the changing role and description of the same marginal quantity of production within the analysis: $\partial q = \partial x_i$. On the left side the marginal quantity is viewed as an output of production of an enterprise (assuming cp condition), and on right side it is viewed as an factor input for production (among others) in a different enterprise, that is we observe a change $\partial q \rightarrow \partial x_i$.

Note: Used symbols for continuous terms may be replaced by adequate discrete ($dq \rightarrow \Delta q$ etc.).

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O POMIARZE RZECZYWISTEJ WARTOŚCI PRODUKCJI. REFLEKSJE O PORZĄDKU EKONOMICZNYM ŚWIATA REALNEGO W DOBIE KRYZYSU FINANSOWEGO

Streszczenie: Artykuł jest nowoczesną odpowiedzią na wielokrotnie zadawane pytanie o rzeczywistą wartość produkcji. Pytanie to staje się ponownie istotne od czasu zaistnienia kryzysu finansowego, w trakcie którego obserwowane są ogromne straty papierów wartościowych i akcji. Odpowiedź na to pytanie zawiera wiedzę o najnowszych badaniach istnienia porządku ekonomicznego uwzględniającego rzeczywisty, równy świat naturalny z energią jako środkiem płatniczym. Opisano wyniki makroekonomicznej analizy uwzględniającej ten naturalny porządek oparty na obserwacji i charakterystyce marginalnych wartości w procesie produkcyjnym.

Słowa kluczowe: kryzys finansowy, teoria wartości, ekonomia ekologiczna, ekonomia biofizyczna, filozofia ekonomii.