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Expanding Human Capabilities: Lange's 'Observations' Updated for the 21st Century¹

Jorge Buzaglo, Independent economist, Stockholm
j.buzaglo@telia.com

Abstract

Poland has produced two of the greatest economists of the past century, namely Michał Kalecki and Oskar Lange. Both worked with a wide and penetrating view of the economy and society, more typical of the great classical economists than of those of their own time. During the post-World War II 'Golden Age of Growth', while Keynes was the patron saint of economic theory and policy in the industrialised capitalist countries, Kalecki and Lange had a similar influence and role among the developing nations and – perhaps to a lesser extent – in socialist countries. Kalecki's 'The problem of financing of economic development' (Kalecki, 1954), and Lange's 'Some observations on input-output analysis' (Lange, 1957), in particular, deeply influenced the approach to economic and social development of a whole strand of structural economics, both in terms of economic analysis and practical policy. With the end of the Golden Age and the momentous neoliberal reaction then started, they became almost forgotten. The economics of Kalecki, however, has inspired in the last few decades the renaissance of a genuine – albeit still marginal(ised) – form of Keynesianism, the so called 'post-Keynesianism' ('bastard Keynesianism', as Joan Robinson called it, being the dominant, mainstream form of Keynesianism). Oskar Lange, on the other hand, does not yet seem to have been re-discovered to inspire a similar renaissance of advanced analysis and planning of policies for modern structural change and development. This paper proposes such a re-discovery. The main concern of Lange's 'Observations' is the appropriate intersectoral allocation of investment for efficient output growth. While output growth is still one of the main objectives in most societies, the growth of human capabilities should be an increasingly relevant concern, both in its own right, and in view of the existing ecological constraints. Buzaglo (2014a; b) postulated the existence of an \aleph (aleph) matrix, describing the proportions of the different capabilities necessary for the achievement of every particular capability. The present paper is about introducing capabilities within Lange's framework of analysis. A Lange-inspired analysis investigates the appropriate structures and properties of capability-enhancing growth paths.

Keywords: capabilities, economic planning, investment policy simulation model, human development

1. Introduction

In recent times, many respected voices have been raised to point out that humanity today confronts a combination of several grievous, potentially catastrophic crises – economic, ecological, political, moral, social and cultural. It would seem as if the whole present system of convictions and behaviours is not viable and sustainable any more. A new paradigm of

¹ A previous version of this paper was presented at the Conference on *Redefining Economics: Beyond the Neoclassical Approach* (Kalecki Foundation, May 2016, Warsaw, Poland). I would like to thank the organisers of and participants at the conference.

hopeful and inspiring ideas should be necessary for a renaissance and a new period of positive development.

Economics is the central, ideological constituent of the presently dominating paradigm. Mainstream economics is the model ideology of the avid, egotistic, myopic, insatiable material consumer. Mainstream economics is the proclamation and advertisement of an unsustainable and unviable paradigm. A new, more hopeful paradigm, I think, should shift attention and energies from the growth of material production and consumption to a different type of growth – namely human growth. Human growth should be understood as the process of ‘all-round development of individuals’ (Marx/Engels) in which individuals are enriched by an all-round process of increasing aptitude in a growing domain of different exertions. Or, in the language of *capabilities* introduced by Amartya Sen, human development is the process of increasing the domain of human capabilities/liberties.

Oskar Lange’s ‘Observations’ (Lange, 1957) were one of the most powerful presentations of the detailed intersectoral characteristics of the process of growth of material production. They were useful to a whole generation of structuralist economists for their description of the process of economic growth and development. They were an important source of inspiration in policy modelling and planning.

Lange’s focus on investment planning for the growth of material production was the relevant focus for a time of material penury and high aspirations of material welfare in most countries.² The times are perhaps mature now for new aspirations and new paradigms, which would shift the focus towards the all-round development and flourishing of individuals and societies.

The analysis presented here departs from Lange’s approach in the ‘Observations’ about the conditions for the expanded reproduction of the production system. In the second section, the system of production is linked with the system of capabilities through a matrix connecting investments in expanding capabilities with investments in the producing sectors. A short final section speculates about the possible characteristics of a system in which capabilities alone are relevant.

2. Lange’s Approach to Investment and Growth in an Input-Output Framework

For Lange, input-output analysis can be conceived as a development and generalisation of the relations taking place in the process of reproduction of the national product, as studied by Marx in the reproduction schemes of Volume II of *Capital*.

Lange describes the process of *extended reproduction*, when part of the social product is invested as means of production, and as a result, total output is growing:

‘The part of the net outputs of the various sectors invested in production is added to the means of production available in the next period. This makes

² After World War II there was general agreement on the necessity for the government to ‘tak[e] an ever greater responsibility for directly organising investment’ (Keynes, 1936, p.164). During the post-WWII ‘Golden Age of Growth’ investment planning was commonplace: ‘[I]n all important states, the directing of investments and the regulation of the rate of saving have become government tasks’ (Polanyi, 1944, p. 252). Central to Keynes thinking in *The General Theory* is the crucial role of investment activity in capitalism; too important an activity (in determining employment and income levels) to be allowed to become ‘the bubble on a whirlpool of speculation. When the capital development of a country becomes the by-product of the activities of a casino, the job is likely to be ill-done’ (Keynes, 1936, p. 159). Karl Polanyi, in particular, was very emphatic about the serious risks involved in not being able to ‘re-embed’ the economy: ‘[T]he victory of fascism was made practically unavoidable by the liberals’ obstruction of any reform involving planning, regulation, or control’ (Polanyi, 1944, p. 257).

possible in the next period an increase in the output of the various sectors of the national economy. The investment done in one period adds to the amount of means of production in operation in the next period. In consequence, a larger output is obtained in the next period. The outputs of successive periods (years, for instance) are linked up in a chain through the investments undertaken in each period. Thus, productive investment generates a process of growth of output' (Lange, 1957, p. 210; page numbers from Nove's 1964 edition of the work).

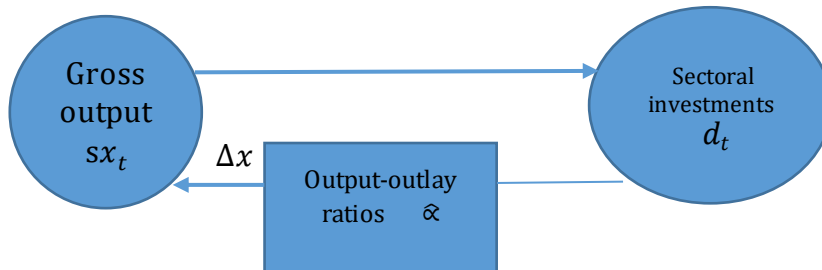
This sentence may be given a formal expression:

$$x_{t+1} = x_t + \hat{\alpha} d_t \quad (1)$$

In this equation, x is a dated $(n \times 1)$ vector of gross outputs³, $\hat{\alpha}$ is an $(n \times n)$ diagonal matrix of sectoral output-outlay ratios, indicating the effect of sectoral investment on output growth in the various sectors, and d_t is an $(n \times 1)$ vector of sectoral investments (i.e., investment by sector of destination). That is, x_{t+1} , the outputs of the next period, are equal to the outputs in the current period, x_t , plus the increase in the output of the various sectors made possible by the investments d_t done in the current period. The increase in output is proportional to $\hat{\alpha}$, Lange's *output-outlay ratios*, more commonly known as incremental output-capital ratios. Lange (1957, p. 217) shows that in aggregate terms, 'the rate of increase of gross national product is the product of the overall rate of investment and of the average output-outlay ratio'.⁴

The simple causal structure of the model of equation (1) can be visualised in Figure 1.

Figure 1



³ There are many different conceivable disaggregations of GDP in output-producing sectors, depending on the aims of the research. Since 1948, the most widely used classification in practical applications is the International Standard Industrial Classification of All Economic Activities, or ISIC (see United Nations, 2008). This classification specifies sectors producing both goods (e.g., agriculture, manufacturing) and services (e.g., finance, education, arts and entertainment). In an evolving economy, new activities or even whole sectors may emerge (or disappear). It is almost impossible to predict that evolution, but it can, over time, be incorporated (as new activities or sectors of updated x -vectors) in the type of simulation approach proposed by Lange. In the following analysis, the same applies to parameters, which are supposed to be given, fixed and constant. That is, parameters may be updated over time as new information is being produced (this approach is sometimes called 'rolling planning'). Also, they can be assumed to be time-varying according to some law, if such a law may plausibly be proposed.

⁴ This classical idea has been re-discovered, and (in its aggregate form) baptised 'AK endogenous growth model'.

Lange shows also that, departing from equation (1), ‘we can calculate the effect of a given investment programme upon gross national income after a number of unit periods of time’ (Lange, 1957, p. 217). In effect, starting in the initial unit period in which outputs are known, and given the overall rates of investment, and the fractions of the total investment outlay allocated to the various sectors of the economy, we can, from equation (1), calculate the trajectory of gross outputs over subsequent future periods. That is, given initial gross outputs x_0 and a time-sequence of sectoral investments $\{\bar{d}_t\}$, equation (1) can be recursively solved forward in time, for known output-outlay parameters \mathfrak{A} . In this way we determine the time-sequence $\{x_t\}$ of future gross outputs resulting from investment programme $\{\bar{d}_t\}$. (Nowadays, this type of solution is called a *simulation*.)

When ‘Observations’ was written there were very limited computing capabilities available, even in the most advanced economies, so the possibilities for these types of calculations were, in general, very limited. In a later work, based on his lectures at Warsaw University, Lange describes in certain detail the design of hydraulic or electrical models, or analogical computers, in order to study the solution of these potentially very complex numerical problems (Lange, 1969, Appendix 1). He recognises however that ‘...now that electronic computers are applied to numerical calculations, the possibilities of solving numerically complex economic problems are infinitely greater’ (Lange, 1969, p. 132). Since then, the development of powerful programming and modelling systems such as GAMS or *Mathematica* has radically facilitated the implementation and solution of these types of problems.

The investments in the model of equation (1) must of course be consistent with the general structure of the economy, in particular with incomes generated in production, and with existent consumption and saving behaviours. In Lange’s model, largely describing the functioning of an ideal planned economy, the overall rates of consumption and investment are determined by the planning authorities, and the consumption of the different categories of output is determined by behavioural (statistical) consumption parameters. In a capitalist market economy, or in a mixed economy, however, it may be relevant to incorporate a detailed description of the distribution of incomes among different size- or class-income groups (and the government), because different income groups have different savings and consumption behaviours. It may also be relevant for economic policy and investment strategy to have a detailed knowledge base for the design of appropriate redistribution policies for growth and equity.

A most convenient form for an operational income distribution function is a linear form:

$$y_t = V x_t \quad (2)$$

in which incomes by income group y_t (a column vector with k files/groups), linearly depend on outputs x_t , according to proportionality coefficients given by the $(k \times n)$ matrix V . Matrix V can be understood as a constant matrix in the case of distributional *status quo*, or it can vary according to planned or expected changes in income distribution – in this case we may have a time-sequence $\{V_t\}$ of income distribution matrices.

As said, a mixed economy version of Lange’s model would include an endogenous determination of consumption and savings according to behavioural parameters, at least for the private sector. The public sector may still influence the volume of overall savings available for investment through its influence on income distribution matrix V – expanding/contracting public income and expenditures.

Consumption by type of output c_t can be then described by a simplified linear expenditure system:

$$c_t = \Gamma y_t \quad (3)$$

where Γ is an $(n \times k)$ matrix of consumption coefficients by income group and type of output.

The non-consumed part of total income is available for investment in the various sectors of the economy. That is, the volume of total savings, or investable funds in the economy, equals income minus consumption. We write first savings by income class:

$$s_t = y_t - c_t^* \quad (4)$$

where vector c_t^* , like y_t , is a column k -vector, obtained from equation (3) of consumption by output category (an n -vector), by transposing, vertically summing, and diagonalising matrix Γ :

$$c_t^* = \hat{\iota}' \Gamma y_t \quad (5)$$

in which ι is a summing vector $(1, 1, \dots, 1)$ of appropriate dimension, the apostrophe $'$ denotes transposition and the hat $\hat{}$ denotes diagonalisation.

Now saving by income class can be written as:

$$s_t = y_t - \hat{\iota}' \Gamma y_t = (I - \hat{\iota}' \Gamma) y_t$$

And, taking account of equation (2),

$$s_t = (I - \hat{\iota}' \Gamma) V x_t. \quad (6)$$

Now, total savings in the economy is simply the sum ιs_t of the savings of all income classes that is, the vertical sum of s_t . The total available saving/investment fund ιs_t can be assumed to be centrally organised, as in Keynes (1936, p. 164), 'on long views and on the basis of the general social advantage'. This can be interpreted as a central, direct allocation of sectoral investments, or as a mixed system, in which the state allocates part of total investments (public investment in infrastructure, mixed enterprises, subsidised private investments, etc.), and the private sector allocates another part.⁵

In the simpler case of direct central allocation of investments, it is useful to think in terms of proportions of the common investment fund to be allocated to the different production sectors. We can define a distribution n -vector z_t , summing up to one, of proportions of the public investment fund allocated to the various sectors.

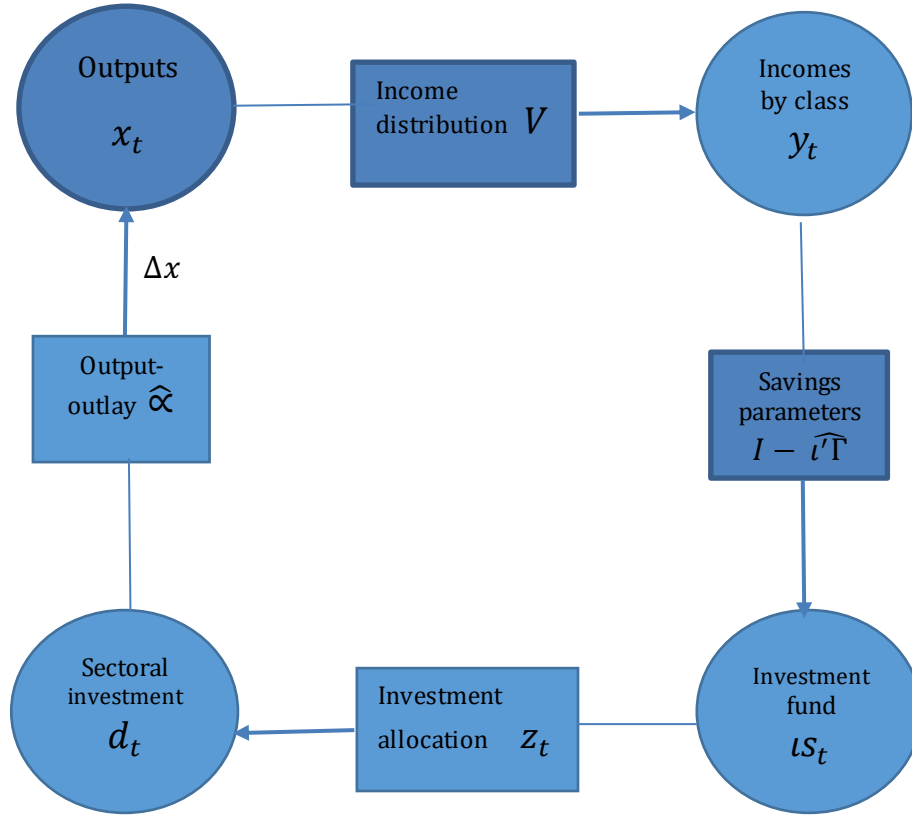
Sectoral investments in each period are then equal to the proportion corresponding to each sector times the total saving/investment fund:

$$d_t = z_t \iota s_t \quad (7)$$

The dynamic loop is then closed with the increment in output produced by sectoral investment, according to the sector's respective output-outlay parameter (equation (1)). A visual description of the process in Figure 2 may give a more intuitive picture of the process.

⁵ Buzaglo (1984; 1991; 2015) utilises a mixed-economy investment allocation system, in which public investment follows goals such as (re)industrialisation or poverty reduction, while private investments are allocated according to an endogenous (accelerator) principle.

Figure 2: Flow diagram of the dynamic core



This model gives the pattern of sectoral gross outputs or supplies over time, but does not inform us about sectoral demands. That is, ‘material balances’ are not ensured in this description. In order to describe sectoral demand/supply balances we must be able to define intermediate demands, consumption demands and investment demands. The following expression describes sectoral balances between supplies and demands:

$$q_t = x_t - (Ax_t + c_t + Bd_t) \quad (8)$$

in which sectoral excess demand n -vector q_t equals total supplies x_t minus total demands $(Ax_t + c_t + Bd_t)$. A denotes the technical coefficients matrix, so that Ax_t is a column n -vector of intermediate demands. Consumption by type of output c_t was defined in equation (3) above. Given matrix B describing the sectoral composition (origin) of investments by destination d_t , Bd_t is a column n -vector of investment demands by sector of origin.

In an open economy in which world prices prevail and output is tradable, sectoral excess demands q_t may be assumed to be traded: net exports when positive, and net imports when negative. An investment strategy may consist in the time-sequence $\{\bar{z}_t\}$ of investment allocation coefficients approaching as much as possible a desired time-profile $\{q_t^*\}$ of exports and/or imports. This is the case when, for instance, the consequences of some particular import-substitution, export-promotion, or industrial policy are investigated. Also, it can show the limits to overall growth and development imposed by agricultural stagnation, in turn caused by structural conditions in agriculture – in particular, property relations – as analysed by the classic Kalecki (1954) article.

Lange introduces coefficients of labour requirements specific to every production sector, which implies that, generally, different growth patterns will result in different levels of employment.⁶ Lange shows that an investment strategy attempting to maximise employment may be less successful (in expanding employment) than a growth-maximising strategy after a number of time-periods. When it comes to the reduction of poverty, however, in some cases increasing employment as much as possible may be equivalent to minimising poverty.⁷

3. Extending Lange's Analysis to Human Capabilities

We try now to approach the world of human capabilities from an economic point of view. It is a less well known world than the purely material world of production, and observations and opinions on the subject are (even more) conjectural than observations and opinions about the usual material world of economics. For several decades, and particularly thanks to the work of Amartya Sen (see e.g. Sen, 1988; 1999), the concept of development in economics refers more and more to the idea of expanding the domain of human capabilities, and less and less to the idea of increasing the flow of commodities. Human development can be understood as increasing the number and scope of different capabilities (faculties, aptitudes, abilities, capacities) that every member of society is able to exert. The growth of human capabilities is an end in itself – in this view, *the* desired end of the socioeconomic process. The growth of capabilities is not a means to achieve some other end such as GDP growth or capital accumulation – that is, it does not refer to the growth of labour productivity or 'human capital'.

In principle, the space of human capabilities is a (potentially) infinite-dimensional space, which accounts for every conceivable dimension of human activity. In reality, however, we have relatively little knowledge of this potentially limitless space – although Nussbaum (2011) is an important contribution in this sense. In Buzaglo (2014), a tentative and conjectural effort is made to describe in some detail the possible structure and content of the capability space, including the possibility of constructing aggregate indexes over individuals and capabilities, thus suggesting a potential alternative to the GDP index. More specifically, it is suggested that it is possible to organise capabilities in a kind of hierarchical order, in which some basic capabilities are to be acquired or exerted before it becomes possible to exert other, less basic capabilities, and so on. In addition, if the proportions in which every capability is used in the formation of every other capability are knowable, then something similar to the technical coefficients matrix of input-output analysis could be conceived, which we called the \aleph (aleph) capability matrix. As in the case of dynamic input-output theory, the \aleph matrix, together with a matrix of 'capital capabilities' \beth (beth) may be used to describe the potential or ideal equilibrium capability growth rates inherent in the system.

Following Lange (1957), we adopt here a somewhat more realistic simulation approach. Also, we assume a mixed or transitional economy, in which the recognition of capability structures and the search for fulfillment of expanding capability goals coexist with the material production system, including its standard processes of production, income generation and distribution, consumption, saving and investment.⁸

⁶ As it stands, the model assumes unemployed and/or underutilised labour resources. Beyond full employment, a function should be added, coupling income distribution (wage and profit shares) with the excess demand for labour. Excess demand for labour and increasing wages and wage shares may also influence technical (and other) coefficients, which could be modelled as suggested in note 3 above.

⁷ This is shown in the case of Bolivia (Buzaglo, 2015, Ch. 6).

⁸ The exemplar Sustainable Development Goals (United Nations, 2015) constitute an important recognition and endorsement of human capability growth by the international community. This document, solemnly approved at the UN, includes a set of 17 goals and 169 specific targets, to be

Hence, we have two parallel systems, namely, the regular production system with the growth equation of (1) above,

$$\text{System I: } x_{t+1} = x_t + \widehat{\alpha}^I d_t^I, \quad (9)$$

in which the I superscripts refer to output-outlay ratios and sectoral investments within the standard production System I.

System I coexists with, and is parallel to, System II, which describes the growth of capabilities (we continue to use Hebrew letters for elements in the capability space):

$$\text{System II: } \nu_{t+1} = \nu_t + \widehat{\alpha}^{II} d_t^{II} \quad (10)$$

where ν (ayin) is a dated m -vector of capability indices (e.g. the targets contained in United Nations, 2015), $\widehat{\alpha}^{II}$ is a diagonal m -dimensional matrix of incremental capability-outlay ratios, indicating the increase in the capability index associated with a unit investment spent on that capability category. Investments d_t^{II} refer to expenditure in investments in the m different capability-creating activities.

Now, there is a link between systems I and II; we assume that an $(n \times m)$ matrix ψ (shin) exists, which describes the composition in outputs (System I) of the investments realised in capability-creating activities (System II) – e.g. how one dollar spent on increasing education levels is composed of expenditures in buildings, equipment, furniture, personnel, etc. That is, matrix ψ describes how investments in the capability System II are composed of goods and services from production System I:

$$d_t^I = \psi d_t^{II} \quad (11)$$

also, if we assume that an inverse of ψ does exist:

$$d_t^{II} = \psi^{-1} d_t^I \quad (12)$$

Our new recursive growth equation for capabilities, taking account of equation (12), becomes:

$$\nu_{t+1} = \nu_t + \widehat{\alpha}^{II} \psi^{-1} d_t^I \quad (13)$$

which means that by regulating investments d_t^I in the production System I it is possible to influence the evolution of capability System II. Or more specifically, the capability growth goals in System II are to be attained through the (re)orientation of sectoral investments in System I.

A possible aspiration for a given society, for instance, may be to achieve, within a given time horizon T , a certain ν^* structure and level of capabilities – e.g. certain proportions of basic, intermediate and high capabilities. The problem may then be specified as finding, with start in $t=0$, the time-sequence of investment distribution coefficients $\{z_t\}$ that make the difference between real and desired structures as small as possible in period $t=T$:

$$\text{Find } \{z_t\} \text{ such that } \iota \left| \nu_T - \nu_T^* \right| = \min. \quad (14)$$

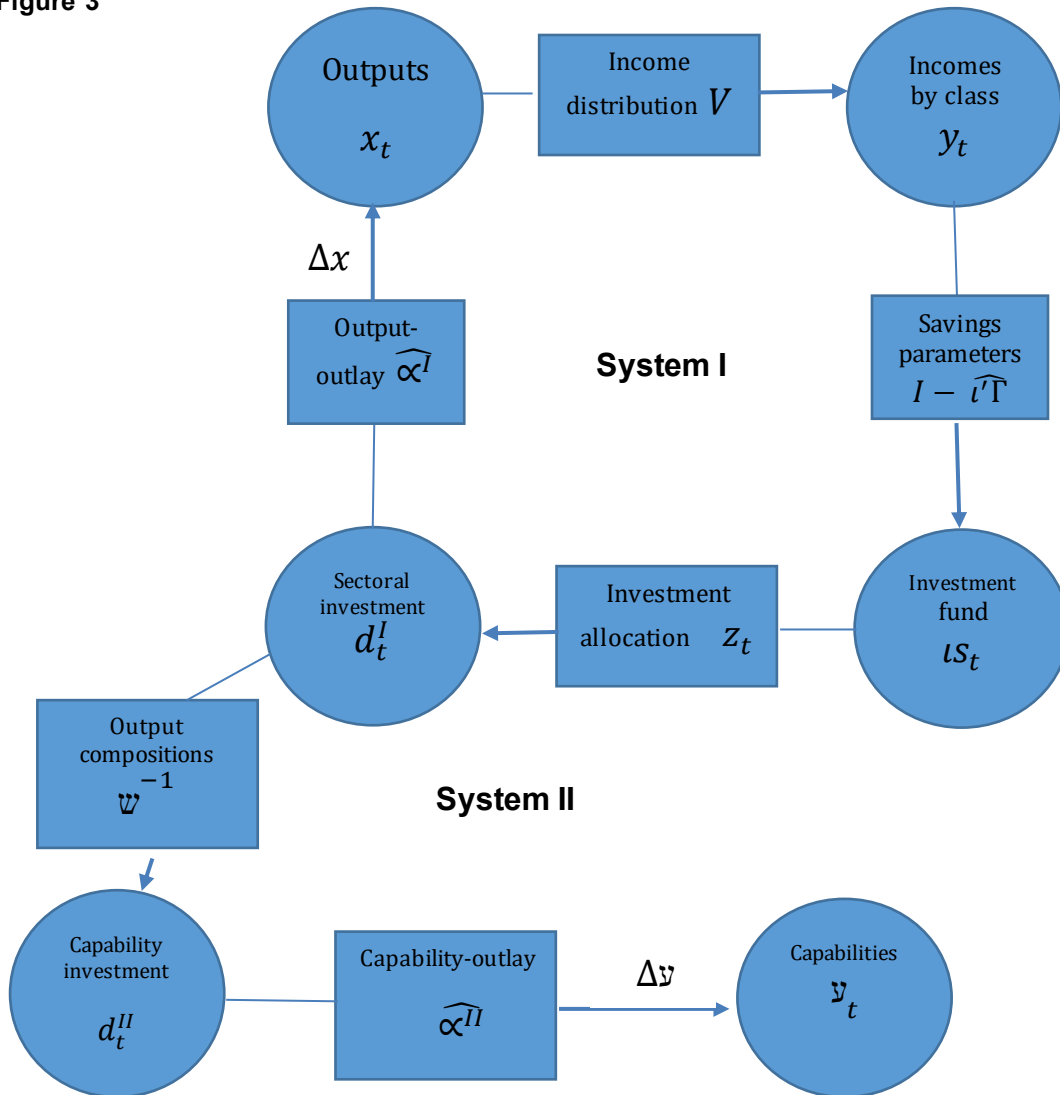
fulfilled by all countries by 2030. These goals and targets represent a compromise for every country for the creation of a specific set of human capabilities.

Another type of aspiration would be, for instance, to attain the maximum feasible level of an index of capabilities $f(v)$, reflecting the 'general social advantage' – that should today include some definition of ecological advantage:

Find $\{z_t\}$ such that $f(v_T) = \max.$, also,
find $\{z_t\}$ such that $\sum_{t=0}^T v_t = \max.$

In Figure 3, System I shows the growth of outputs x_t , and System II describes the growth of capabilities v_t . The growth of both systems is dependent on the level and structure of investments in production System I, d_t^I . But d_t^I can now be regulated so as to achieve different desired capability expansion objectives – i.e. different functions of v_t .⁹

Figure 3



⁹ As one commentator observed, in this description the growth of capabilities, v_t does not influence other parts of the economy, and has therefore a rather passive role. It should be possible, for instance, to conceive effects of capability growth on investment efficiency parameters $\hat{\alpha}^I$ and $\hat{\alpha}^{II}$. More generally, refocusing the functioning of the economy in the sense of human capability growth may have, I think, many positive effects in all aspects of economic and social life.

4. Conceiving a Post-Transitional Mode of Capability Expansion

We try now to conceive how to consider capability growth in an environment in which output growth and the output producing System I has lost much of its relevance, for instance, because of the achievement of a state of relative material non-scarcity, and/or because of changes in the socio-psychological capacity for the cognition of satiety. In such an environment, System I is a self-regulating, homeostatic provisioning system, and System II alone is relevant for analysis. We are now interested in the growth of capabilities, according to different possible, socially determined patterns. It is no longer necessary to introduce monetary categories, such as the investment outlays in the above analysis. We can think in terms of the amounts of time dedicated to the different capability-creating activities. (These activities need not be thought of as creating painful 'disutility', but as different forms of largely gratifying, de-alienating forms of expression of immanent creative powers.) We can call this new, exclusive capability system, System III. In System III, the expansion of the different capabilities depends on the amounts of time destined to capability-increasing activities within each activity sphere (such as the innovative use of existing or new knowledge, or the induction of cross-fertilisation among activities), and on the respective capability index response to the time allocated to them. Formally,

$$\nu_{t+1} = \nu_t + \widehat{\alpha}^{III} d_t^{III} \quad (15)$$

in which capabilities in the following period ν_{t+1} depend on capabilities in the current period ν_t , plus the additional capabilities created through time investments in capability-creating activities d_t^{III} , times the incremental capability-to-invested-time ratios $\widehat{\alpha}^{III}$.

5. Conclusion

Lange's (1957) 'Observations' were an enlightening contribution to the comprehension of the process of growth of material production. The ecological crisis, and the general crisis of the dominating paradigm of material production, suggest the prospect of a paradigm shift, and the convenience of reorienting economies and societies towards the development of human capabilities. It is suggested that the focus of policies and institutions should now turn towards the all-round development and flourishing of individuals and societies. This paper has attempted to show that the insights of the 'Observations' may serve to shed some light on how to conduct a transition towards such a new focus. These insights may even suggest possible modes of operation for post-transitional, capability-based economies.

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Commentary on Jorge Buzaglo ‘Expanding Human Capabilities: Lange’s “Observations” Updated for the 21st Century’

Paul Auerbach, Kingston University, London, UK

p.auerbach@kingston.ac.uk

1. Oskar Lange and Poland

Jorge Buzaglo’s writings in recent years on the economic development of poor and middle-income countries has been involved with shifting our perspective ‘from the growth of material production and consumption to a different type of growth, namely human growth... [I]n the language of *capabilities* introduced by Amartya Sen, human development is the process of increasing the domain of human capabilities/liberties’ (Buzaglo, 2016, p. 2). ‘Expanding Human Capabilities’ is an important contribution to a movement in economics away from its unthinking focus on ‘growth’, one that is taking place, albeit sluggishly, even in the mainstream (Coyle, 2015).

Buzaglo has not been content to deal with these issues from a conceptual perspective, but offers a scheme to make these goals operational. The template used, a 1957 paper by Oskar Lange designed to trace the appropriate intersectoral allocation of investment for efficient output growth, is in some ways an odd choice. Lange is most remembered at present for his model of market socialism from the 1930s, a refutation of the von Mises proposition that a socialist economy (in this context, defined as one with state ownership of property) cannot rationally allocate resources. Initially, interpretations of the debate moved in Lange’s favour, with general equilibrium theorists supporting his claim that state-owned enterprises can simply be instructed to simulate the price and output behaviour presumed to emerge in a market economy under conditions of competitive equilibrium. The debate continued for decades, with the ascendancy in recent years of an Austrian interpretation suggesting that Lange’s model (and, by implication, general equilibrium theory) fails to capture the essence of the superiority of capitalist enterprise, with its capacity for dynamic change and innovation.

After World War II, and his return to Poland, Lange replaced market socialist schema with a commitment to computerised central planning, as exemplified in the 1957 paper: an input-output framework is adapted for a strategy in which the growth of national product is linked to the rate of (physical) investment (Buzaglo, 2016, Equation 1 and Figure 1). Lange’s emphasis on physical investment, typical of central planners of the day, has been defended by Buzaglo:

‘Lange’s focus on the growth of material production was the relevant focus for a time of material penury and high aspirations of material welfare in most countries. The times are perhaps mature now for new aspirations and new paradigms, which would shift the focus towards the all-round development and flourishing of individuals and societies’ (Buzaglo, 2016, p. 2; footnote omitted).

As suggested above, the Lange model was an odd choice to serve as a template for a model of economic growth centred on human capabilities. Lange's own focus, conforming to the central planning/Soviet orthodoxy of his day, was resolutely directed towards material production, but one may question whether such an exclusive focus was appropriate even in postwar Poland. In the interwar period, Poland, newly independent in modern times, was characterised, as were other states east of the Elbe, by substantial levels of illiteracy, especially in rural areas, and with members of its elite culture (the musician Josef Hoffman; the mathematician Stanisław Ulam) often making their fortunes abroad. The catastrophe befalling the nation in 1939 devastated both mass and elite culture, with the German invaders treating the whole population as suitable only for enslavement, deportation and (most explicitly in the case of the Jews and some other groups) extermination.

The Soviet invaders from the east evinced a less explicitly exploitationist attitude towards the general population, but long before their domination of the whole country from 1945, the Soviets proceeded to dismember the elite of Polish society, as exemplified in the Katyn massacre of 1940 of over 20,000 Polish officers, policeman and members of the intelligentsia. In the post-1945 period, scientific and technical development was encouraged in Poland (with passive resistance raised to the imposition of aspects of Soviet irrationality, such as the biology of Lysenko), but the social sciences and cultural disciplines could only begin to function with some freedom of action with the alleviation of Stalinist repression after 1956.

The post-war Polish economy in which Lange was writing thus had as a backdrop the enormous changes in its human capacities that had taken place. On the one hand, there was a dismembering of the pre-war elite of a semi-developed country at the hands of the Nazis and Soviets; on the other, there was an aggressive programme of publicly financed formal education pursued by the new socialist state, complemented by industrialisation leading to the decline of the share of the population in rural areas and associated occupations. The workforce considered by Lange in the mid 1950s was rapidly achieving European norms in literacy and associated aspects of formal education: many of the continued capability deficits of this workforce were of an *in situ* kind, linked to the low technological context that workers found themselves working in, and the crude forms of administrative practice (such as the 'storming' of output in enterprises at the end of month and year to achieve plan targets) embodied in the centrally planned system. In the Lange paper, the transformation taking place in the formal education, cultural level and the lived experience of the workforce forms only a backdrop to his model in which, following the practice of centrally planned economies, the growth of national product is linked solely to the rate of (physical) investment. Below, it will be suggested that the structural basis of the Lange model in physical investment means that it can be adapted only with difficulty to a framework focusing on the role of human capacities. Furthermore, the cultivation of human capacities will be seen to play a crucial role even at the supposedly low levels of development associated with 1950s Poland.

The Lange model's acceptance of use of the fixed range of sectors of the input-output model might also be questioned as a generic model for long-term growth and development. It can be conceded that such an approach was reasonably well suited to the conditions of the post-World War II era until the 1970s for Poland and other countries, capitalist and centrally planned, since this period was coincident with a 'Golden Age' of economic growth in the capitalist west that was largely taking place in the context of replicating and expanding upon interwar technologies. Centrally planned economies such as Poland could largely follow well-worn paths, such as coal and steel production, that had already been laid out by the most advanced capitalist economies: such forms of economic growth could be straightforwardly modelled in an input-output or material balances context, since there was substantively in this

period an absence of the coming on stream of dramatic forms of innovation that would obliterate sectoral categories.

Problems arose when applying such a model after the end of the Golden Age: in subsequent periods – from the 1970s up to the present day – we observe in the capitalist world the creation and obliteration of sectoral categories and their associated employment of labour because of the coming on stream of fundamental technological change (e.g. the maturation of microprocessor development) and the expansion of international competition. The planning of intersectoral allocation of investment for efficient output growth thus became a more difficult task than it had been in the 1950s and 1960s. The Lange/Buzaglo model, furthermore, assigns investment (and, presumably, newly-invented or newly adapted technologies) on a sectoral basis, but also gives consideration to the innovation or adaptation of basic or fundamental technologies (such as steam, electrification or electronics) that embody and influence a broad range of existing, or potentially existing sectors in the economy. The problems of integrating changes taking place at both the sectoral and cross sectoral levels are, as we shall see below, of even greater significance in the domain of investment in human capabilities.

Buzaglo follows Lange as template for achieving macroeconomic balance in the economy:

'In Lange's model, largely describing the functioning of an ideal planned economy, the overall rates of consumption and investment are determined by the planning authorities, and consumption of different categories of output is determined by behavioral (statistical) consumption parameters. In a capitalist market economy, or in a mixed economy, however, it may be relevant to incorporate a detailed description of the distribution of incomes among different size- or class-income groups (and the government), because different income groups have different savings and consumption behaviours. It may also be relevant for economic policy and investment strategy to have a detailed knowledge base for the design of appropriate redistribution policies for growth and equity' (Buzaglo, 2016, p. 4).

Lange thus imposes aggregate rates of consumption and investment as a means of generating stability both in Keynesian terms (through control of total expenditure), and in Marxian terms, by pre-determining the balance between the consumption and investment goods sector. The scheme offered up by Buzaglo attempts to achieve these goals in the context of societies, capitalist or not, where actors have greater degrees of freedom for independent action than in a centrally planned system: the desired goals are to be realised by predicting the behaviour of these actors, rather than having a set of parameters imposed upon these actors from above. Buzaglo's pursuit of macroeconomic balance in other than a centrally planned context is necessary and worthy, though the long history of difficulties in pursuing this goal (see the pioneering work of Tinbergen, 1952) suggests that a simple eliding and modification of the Lange centrally planned framework will not be possible: one obvious difference between the decentralised and centrally planned framework is the presence, in the former case, of an active role for the banking and financial sectors.

The need, however, to move beyond the centrally planned template is imperative. To give just one example, the important role assigned by Buzaglo to ecological considerations necessitates an economic system with elements of decentralisation: our economies and cultures would already be long gone from the effects of climate change if it were not for the enormous gains in the efficiency of energy use generated by the presence of incentives 'from

below' for firms, consumers and others over the 20th and 21st centuries to save on the costs of energy use (see Smil, 2006). Buzaglo's intentions in this direction, as in other areas, are thwarted by the inherent top-down structure bequeathed by Lange's centrally planned scheme, one which is likely to discourage ground-up initiatives on energy saving and other desirable goals.

2. Human capabilities

In Figure 3 (Buzaglo, 2016) we can observe Buzaglo's intention to put human growth at the centre of consideration of economic development by appending to the Lange structure (System I) a layer explicitly concerned with capability development (System II). A striking and radical aspect of Buzaglo's approach is that, in contrast to mainstream human capital approaches, the raising of human capabilities does not take place to facilitate some other goal such as economic growth, but for its own sake: 'by regulating investments... in the production System I it is possible to influence the evolution of capability System II... A possible aspiration for a given society, for instance, may be to achieve, within a given time horizon... certain proportions of basic, intermediate and high capabilities' (Buzaglo, 2016, p. 8).

A more realistic but, unfortunately more complex view would, like the latter approach, emphasise the expansion of capabilities as an intrinsically worthwhile goal, but the latter expansion would embody, not only advances in formal education (which seems to be what is implied by a self-contained capabilities circuit, System II), but also *in situ* learning in the context of society at large and at work (i.e. activities linked to Sector I). Economic equality and household security then emerge as essential concomitants of the process of economic development by promoting these forms of learning and by acting as a complement to formal education. All of these factors – formal education, economic equality and household security – embody and promote human capabilities. They are intrinsically worthwhile and are, at the same time, essential concomitants of economic development. These complex interactions between Systems I and II are somewhat obscured by the presence of Lange's self-contained system of material production (System I), to which has then been appended a capability system (System II) whose only link to the system of material production is the passive receipt of output from it.

In more explicit terms, when we examine equations 9-15, and Figure 3 illustrating System I and System II (Buzaglo, 2016. pp. 8-9), sectoral investment from System I feeds into increased capabilities Δy (delta ayin – a felicitous juxtaposition of ancient cultures).¹ But sectoral investment acts, in the present context, purely as a complementary good (i.e. more machinery for more educated workers): there appears to be no provision in the model for the recognition of the process of *in situ* learning that will result simply from the act of working with this machinery. In the framework here, intrinsic capability development apparently results only from formal education, which then unites with the enhanced investment in machinery – work is not an inherent source of learning, in and of itself. The latter is an important issue both for considerations of the provenance of learning in work, and of the centrality of the need to avoid unemployment to prevent hysteresis-related deterioration in capabilities. In a similar manner, in the approach taken here, equality and household security are seen as desirable aspects, rather than essential components of a development strategy: changes in income distribution

¹ The link posited between Systems I and II is the matrix ψ (shin), which describes the composition in outputs (System I) of the investments realised in capability-creating activities (System II). Matrix ψ describes how investments in the capability System II are composed of investment goods and services from production System I.

have macroeconomic effects through changes in the saving rate (System I) but are on a different circuit from that embodying capabilities (System II). In fact, equality and household security are central aspects in the cultivation of capabilities, both in the development of 'in the world' *in situ* skills and the complementary aspects of household security and equality to formal education. Their relegation in the formal model merely to desirable outcomes obviates their essential role in the process of economic development. The suggestion is not that Buzaglo would object to these sentiments (see his footnote 9), but that the formal model adopted here leads one in a different direction.

A similar issue arises with the use of the capability matrix. Buzaglo's overall perspective on the development of capabilities is not completely clear, but it is undoubtedly a sharp deviation from orthodox approaches: 'A possible aspiration for a given society, for instance, may be to achieve, within a given time horizon T , a certain ν^* structure and level of capabilities — e.g. certain proportions of basic, intermediate and high capabilities... Another type of aspiration would be for instance to attain the maximum feasible level of an index of capabilities $f(\nu)$, reflecting the "general social advantage" — that should today include some definition of ecological advantage' (Buzaglo, 2016, pp. 8-9). The ideal path to be pursued in formal terms, however, would be 'to organise capabilities in a kind of hierarchical order, in which some basic capabilities are to be acquired or exerted before it becomes possible to exert other less basic capabilities, and so on. In addition, if the proportions in which every capability is used in the formation of every other capability are knowable, then something similar to the technical coefficients matrix of input-output analysis could be conceived, which we called the tupni cimanyd fo esac eht ni sA .xirtam ytilibapac (hpela) κ -output theory, the κ matrix, together with a matrix of "capital capabilities" \beth (beth) may be used to describe the potential or ideal equilibrium capability growth rates inherent in the system' (Buzaglo, 2016, p. 7).

Once again, the formal structures adopted here might well thwart the humanistic goals being pursued, in which the broad-based development of capabilities is a key aspect of the flourishing of culture and democratic participation. Here, however, the formal goal appears to be one of linking the trajectory of the development of human capabilities to that of capital capabilities. In the wrong hands, such an approach can easily take the form of a System II that is designed 'to meet the needs of employers': we thus see in the contemporary world a movement to impose computer coding on all school children (Paul, 2016). An alternative, but ultimately more rewarding approach would be to endow children with a generalised capacity for problem-solving and analysis, with those individuals interested in studying coding in detail then doing so with less likelihood that they will be 'locked in' to a narrow range of skills.² Central to a project for directing the development of capabilities to serve human needs is the

² For the purposes of the formal system imposed here, 'basic' capabilities are those that 'are to be acquired or exerted before it becomes possible to exert other less basic capabilities' (Buzaglo, 2016, p. 7), a definition that suits the needs of the input-output structure but only occasionally conforms to another important notion of the concept 'basic'. Thus literacy in one's native language (e.g. English) is 'basic' in the sense used here because its mastery must take place before the acquisition of many other skills. It is also basic, however, in its usefulness over a broad range of capabilities. This coincidence, in the context of literacy in one's own language, of the dual meaning of the term 'basic' is not, however, a general one: a knowledge of the French language may be basic in the first sense for the higher level capability of the study of French literature, but will not be (in the Anglophone world) basic in the second sense — a necessary concomitant of the acquisition of a broad range of other capabilities. The argument here is, of course, not to be taken as one opposing the study of foreign language (perhaps ever more necessary among inward-looking Anglophones), but simply a statement that the study of French may be basic in the first sense of the word and not the second. Contrarily, the study of statistical methodology may not be basic in the sense of being a hierarchical prerequisite to the study of a range of other subjects, but may be so in the second sense by acting as a facilitator over a broad range of higher level studies. The use of the word 'basic' in the first sense here is not coincident with the more intuitive, second usage of the term, just as 'Granger causality' is not to be confused with causality.

battle against an education that imposes a narrow base of 'relevant' skills upon children. Humanistic approaches are also coincident with practical necessity: the cultivation of a broad-based range of skills and generalised capacity in individuals – endowing them with a low centre of gravity for a lifetime of work – is undoubtedly the appropriate strategy for long-term development in a changing and uncertain world. By contrast, the determinism emerging from the Lange central planning approach lends itself to a neat fit between the pre-determined development of a fixed set of material production categories and narrowly-focused skills. Making a tight linkage between material production and the cultivation of capabilities furthermore imposes a 'short-termist' bias on the latter, since the fruits of successful programmes of, for instance, formal education will emerge only with long lags when intergenerational and external effects have been realised, so that capability and capital development cannot develop in lock-step with each other.

Buzaglo's last section is a visionary one that describes a post-transitional mode of capability expansion: 'We try now to conceive how to consider capability growth in an environment in which output growth and the output producing System I has lost much of its relevance, for instance because of the achievement of a state of relative material non-scarcity, and/or because of changes in the socio-psychological capacity for the cognition of satiety' (Buzaglo, 2016, p. 10). The latter state seems to resemble Marx's 'higher state of communism' in the *Critique of the Gotha Programme*. Indeed, it might seem only prudent to delay an exclusive focus on human development to a time when material issues have been resolved;³ an intermediate position would be to follow the scientist Lyon Playfair in 1851 and suggest that, especially for richer countries, 'Industry must in future be supported... by a competition of intellects'.

But what if this staged approach – first material development, and only then a focus on human capabilities – is misplaced, or unnecessary? If we look at recent history, the economic success of Poland and Vietnam in the post-communist world has not been based upon the stocks of obsolescent physical capital that these countries had sacrificed so much to produce, but rather on the high quality of the human assets that had emerged largely as a by-product of the centrally planned system, and the attractiveness of these human assets to international capital. And if we were to rewind history back to 1947, might not an almost exclusive focus in India on literacy and capability development at the level of the village have served long-term economic development better than the brave attempts made at planned economic development (Sen, 1960)? If, in fact, the path to development successfully followed by poor countries in the past – labour intensive manufacturing production with increasing returns – is coming to an end, might it not be imperative to find an alternative, different strategy, one which, following Buzaglo, deviates from the present-day imperative in the direction of material production? We take it for granted that Bach's Leipzig in the 1730s (a society grossly underdeveloped by our present economic calculations) could mount a church service every Sunday with (usually) a new composition for chorus and orchestra by the resident *Kapellmeister*. In most local contexts in the contemporary world, such a practice, including the commitment to the costs of the extensive training of musicians, would be ranked as an unaffordable extravagance. Thus, in determining what it can 'afford', a society's level of commitment to the cultivation of human capabilities of various kinds may be as much a function of the values and power relations existing in that society as its objective level of material development: rich societies may never think themselves affluent enough to have the luxury of focusing on human values. Perhaps we should simply proceed in that direction. In the words of the sage הלל (Hillel), 'If not now, when?'

³ This argument functions as a partial justification for the failure to give appropriate consideration to the situation of poor countries in Auerbach (2016).

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A Quantum Theory of Money and Value

David Orrell, Systems Forecasting, Toronto, Canada

dorrell@systemsforecasting.com

Abstract

The answer to the question 'what is money?' has changed throughout history. During the Gold Standard era, money was seen as gold or silver (the theory known as bullionism). In the early 20th century, the alternative theory known as chartalism proposed that money was a token chosen by the state for payment of taxes. Today, many economists take an agnostic line, and argue that money is best defined in terms of its function, e.g. as a neutral medium of exchange. This paper argues that none of these approaches adequately describes the nature of money, and proposes a new theory, inspired by non-Newtonian physics, which takes into account the dualistic real/virtual properties and complex nature of money. The theory is applied to the example of the emergence of cybercurrencies.

Keywords: money, history, cybercurrencies, quantum theory

1. Introduction

According to the definition used by most economists, money is anything that serves as a medium of exchange, a store of value, and a unit of account (Ragan and Lipsey, 2011, p. 609). But what special quality is it that gives money these properties? In other words, what makes money, *money*?

Answers to the question are tied up with ideas about value, and exist over a spectrum, but have typically fallen into one of three camps. The first, known as metallism or bullionism, holds that the special ingredient is precious metal. Money should ideally be made of the stuff, or at least be backed by it. The second camp is chartalism (from the Latin *charta* for a record) which holds that coins and other money objects are just tokens, that the state agrees to accept as currency (Knapp, 1924, p. 32). In this view, money is backed by the government, which issues it and guarantees that it is accepted for things like payment of taxes. Finally, there is the dominant, hands-off school of thought, which most mainstream economists would agree with, which says that money has no unique or special qualities, but instead is defined by its roles, e.g. a medium of exchange (Samuelson and Nordhaus, 2001, p. 511).

This last view is consistent with the idea that coin money emerged as an improved system of barter. The theory goes back to Aristotle, was elaborated on by economists including Smith (1776), Jevons (1875), and Menger (1892) and still appears in modern textbooks (Ragan and Lipsey, 2011, pp. 672-3). This idea that the economy is best seen as a giant barter system, with money being nothing more than a 'lubricant in exchange', has also influenced the models used by economists (Harper, 1957). A major criticism of the Dynamic Stochastic General Equilibrium models favoured by policy makers, for example, is that they

do not include the financial sector.¹ One of the main insights of chartalists was that money existed before the invention of coins, in the form of ancient credit systems, so credit plays a more important role in their theory.

Bullionists and chartalists therefore emphasise a different aspect of money – the inherent value or the authorising stamp – while most economists treat it as an inert chip. But these theories do not adequately describe the complex properties of money. One problem is that they have little to say about the most obvious (if apparently trivial) aspect of money, which is the fact that it is based on number. In bullionism, the role of number is subsumed into the weighing of metal, in chartalism it appears as a unit of value, in mainstream economics it is summarised by the idea of a unit of account – but the idea that we can attach numbers to value in the first place is taken for granted. As discussed below, numbers have properties which are inconsistent with the real world, which is one of the reasons for money's confounding behaviour.

Traditional theories also see money as being inherently stable and inert (rather like gold, which is an inert metal) while in fact it is a powerfully psychoactive substance, which resonates in strong but unpredictable ways with human psychology.² And far from being stable, its nature and our relationship with it have changed radically throughout history, ranging from the detailed accounting systems of ancient Mesopotamia, in which debts were carefully recorded on clay tablets; to the gold-lust of Spanish conquistadors after their discovery of the New World and its copious supplies of precious metal; to the fintech firms producing the latest payment system.

Another problem is that these approaches don't apply well to cybercurrencies. As Georg Friedrich Knapp wrote in his 1905 book, *The State Theory of Money*, 'the metallists fail to explain currency systems that have no metal. The chartalist has no trouble in explaining them; they are the touchstone of his theory' (Knapp, 1924, pp. 38-39). But both these schools, along with many economists, have trouble with something like bitcoins, which are not made of metal, are not much use for paying taxes, and are not sanctioned by any powerful authority. As Alan Greenspan said: 'I do not understand where the backing of Bitcoin is coming from. There is no fundamental issue of capabilities of repaying it in anything which is universally acceptable, which is either intrinsic value of the currency or the credit or trust of the individual who is issuing the money, whether it's a government or an individual' (Kearns, 2013). Nonetheless, cybercurrencies have proved their metal – you can buy things with them. So maybe the problem is not with cybercurrencies, but with our theories of money.

2. Number Versus Reality

Is money best seen as a commodity, or as an idea? Is it real, or virtual? This question goes to the heart of money, and to the debate over what counts as currency.

It is often pointed out, especially by those sympathetic to the chartalist school, that money is not actually a 'thing' but a kind of abstract credit system, and that it is a distraction to focus on material objects such as coins or notes. Alfred Mitchell-Innes wrote in 1914 that, 'The eye has never seen, nor the hand touched a dollar,' in the same way that it hasn't touched a square inch (Innes, 1914, p. 155). However, we first need to distinguish between

¹ As former Deputy Governor of the Bank of Canada William White points out, 'An important practical aspect of [DSGE] models is that they make no reference to money or credit, and they have no financial sector' (White, 2013, p. 84).

² As Stanford University neuroscientist, Brian Knutson, noted of his experiments: 'Nothing had an effect on people like money – not naked bodies, not corpses. It got people riled up. Like food provides motivation for dogs, money provides it for people' (Levy, 2006, p. 38).

money, and its units. For example, while economics textbooks may routinely state that money serves as 'a unit of account', this is like saying that length serves as a unit of measurement. What they really mean is that monetary *units*, such as dollars, serve as units of account, which is not the same thing as money itself. We can't pay each other with units.

So the question then becomes, what are these units measuring? Economists have usually answered this, when pressed, by saying that it measures some quantity such as 'labour' (classical economics – see Smith, *The Wealth of Nations*) or 'utility' (neoclassical economics – see Jevons, 1957). But another approach is to say that it measures – money. After all, when we say that electrons have a fixed electrical charge equal to $-e$ (negative one elementary charge) we don't necessarily try to parse 'electrical charge' down to some finer description. In the same way, we can treat 'money' as a fundamental quantity. Monetary value is a measure of money content in currency units, where here we use 'value' in its quantitative sense, as in a value provided by an instrument reading, and 'money content' is a quantity of money.

In this picture, money is therefore seen as a conserved, transferable stuff, or quantity, like electric charge. But just as in physics it is sometimes easier to understand the concept of electric current in terms of electrons, or light in terms of photons, so we can analyse currency in terms of the actual things which are exchanged in transactions – such as coins, or notes, or money transfers of any kind.

Here we bump into another, apparently trivial but actually rather revealing, linguistic problem. Something like an electronic transfer does not resemble the classic notion of a self-contained thing, so it might seem inappropriate to describe it as a sort of object being passed from one person or place to another. But this is to misunderstand the nature of objects. The main insight of quantum physics was that matter is composed, not of independent, billiard ball-like atoms, but of entities which behave in some ways as waves, and in other ways as particles. A beam of light, for example, is an electromagnetic wave, but it is also a stream of particles known as photons. The (very real) electromagnetic force which holds objects together is transmitted through the exchange of so-called virtual photons. At a quantum level, matter is fundamentally dualistic: neither the particle nor the wave description is complete by itself. The same can be said of money objects, which bind the properties of numbers and things, the virtual to the real.

Consider, for example, a U.S. dollar bill. On the one hand, it is a physical object which can be owned, traded and above all valued. On the other hand, it represents '1', which is why it is emblazoned (in 15 places) with that number. And numbers and things are as different as waves and particles. Numbers live in the abstract, virtual world of mathematics, while things live in the real world – and it is the tension between its two sides which give money its powerful but often paradoxical nature. Numbers are exact (even where they represent exact probabilities) while qualities, such as perceived value, depend on the person and the context. Numbers can grow without limits, while natural processes tend to be bounded (being on the wrong side of compound interest has historically been a major reason for people falling into slavery or peonage). Numbers are universal, while objects can be owned, or become scarce. Numbers are hard and fixed, like the particle aspect of matter. Concepts or judgements such as worth or value are fuzzy, like the wave aspect of matter.

The trade of money objects for goods or labour in a market means that those things attain a numerical value as well, namely the price, by contagion, just as the atoms in iron spontaneously align in a magnetic field. Market prices are therefore an emergent property of the system, in the sense that they emerge from the use of money objects. For example, coin money was used in ancient Greece and then Rome as a means for paying and supplying the troops. A Roman soldier's base pay of a denarius per day, coupled with the requirement for

suppliers to pay fixed taxes, would imply certain approximate price bounds for food, shelter, etc., and these prices would in turn propagate through to any goods that were traded – but ultimately market prices emerged from the use of the coins.

The central concept of money is, therefore, that it is a means to attach exact, timeless numbers to the fuzzy and transient concept of real-world value. The point of doing this is to facilitate certain transactions (e.g. tax payment, exchange, settling of scores, rewards, motivating people) by shifting them to a mathematical space, with its addition, subtraction, and compound interest. While markets assign prices to all kinds of things, money objects are unique in that their value is designed to be objectively fixed and stable. For other goods, their values are indeterminate until the moment they are exchanged for money (just as, according to quantum mechanics, the position or momentum of a particle is fundamentally undetermined until it is measured, at which point it 'chooses' a value). This special status makes money objects desirable in themselves. It is often said that money is just a medium of exchange so need have no value itself; but by attaching numbers to money objects, in a kind of alchemy, we *make* them valuable. If a society decides that cattle must be used for payments, then cows suddenly become more precious – one cause of overgrazing (Davies, 2002, p. 44). A stack of hundred-dollar bills may only be paper, but it can evoke as much desire as a bar of gold. The distinction between intrinsic and external value, between real and virtual, is blurred.

3. A Quantum of Money

Because concepts such as value and authority are socially negotiated, it is not always clear cut whether something should be considered a money object or not. For example, a cheque is an instruction to debit one account and credit another with a certain amount, but its value may be in the eye of the beholder. As one bank writes: 'The reason we have a hold funds policy is that a cheque is not the same as cash – it is a promise to pay by one party to another party. If the first party doesn't have sufficient funds in their account at another financial institution, or if the cheque is fraudulent, that other financial institution can refuse to pay the item and return it unpaid to us.'³ In this case we would define the money object to be the amount that is actually transferred virtually through the banking system when the cheque is cashed. However if the cheque is endorsed and is itself exchanged between people and accepted as payment, then it becomes a kind of quasi-money object in its own right, with the difference that it is backed less by the state than by the credit of the writer, with the spread between these reflected in a possible discount rate. Banknotes got started in a similar way, but they only fully became money when they were guaranteed by a central bank.

Perhaps the best way to measure the 'moneyness' of an object – its ability to hold money – is to ask how well its market price corresponds to its designated numerical value, and how well equivalence is maintained. In general, this will depend on the authority of the issuer, which varies both geographically and with time. An example is the case where the value of a coin equals its stamp value in the region where it is issued, but elsewhere reflects its metal content; or where a substandard coin trades for less than its face value. This price equivalence also depends on the existence of markets which will accept the object as payment. Private moneys, such as the medieval bills of exchange, are limited not by region but to a circle of users who accept them in exchange.

Money could, in principle, emerge naturally from markets without top-down design or intervention, but the evidence shows that it is better described as a planned social technology. Instead of money emerging from markets, it is historically more accurate to say

³ See <https://www.tdcanadatrust.com/document/PDF/520866.pdf>

that money-based commercial markets emerged from money, after some pump priming from the state.⁴ Money's behaviour depends on its design and its context, and is shaped and controlled by a variety of forces, such as social customs, power structures, financial institutions, market regulations, physical and intellectual property rights, and so on, but its distinguishing, if rarely-mentioned feature, is its connection to number.

Rather than defining money in terms of its roles as a means of exchange, a store of wealth, an accounting device, a signifier of debt, a measure of labour or utility, a symbol for something else, or insisting that it can be made only from metal (bullionism) or through government edict (chartalism) or that it is not fundamentally different from other goods and is really nothing special (mainstream economics), it makes more sense to see money as a quantity in its own right whose roles emerge, deliberately or not, from its use in society. Money is useful for accounting because it is based on number, and has well-defined units. Its roles as store of value and means of exchange are conflated: it is a store of value because money objects are designed to be exchangeable for other things in the economy; it is exchangeable because it is seen as a store of value. The question of real-world value is highly subjective, but the numerical value of money is precisely defined, and this is both the central dichotomy at its heart, and the delicate balancing act which keeps it aloft.

The word 'quantum' has been applied to all kinds of things outside physics and is often misused to evoke a vague sense of spooky, non-mechanistic behavior. The phrase is especially problematic in economics, which has often been accused of suffering from physics envy; and one always needs to be careful about importing analogies from the hard sciences to social sciences (though it is ironic that many theories in economics seem to be explicitly based on Newtonian or Victorian mechanics, without causing too much controversy, while insights from slightly more recent areas of physics tend to be viewed as bordering on the mystical (Orrell, 2012, pp. 109-114)). However the use of the term, and more generally the comparison with non-Newtonian physics, is constructive here for the following reasons:

1. Money is seen as a fundamental quantity (from the Latin *quantum*).
2. Money objects contain a fixed amount of monetary value, in the same way that an electron contains a fixed amount of charge.
3. Money objects bind the virtual to the real, and abstract number to the fuzzy idea of value, in a way similar to the particle/wave duality in quantum physics.
4. Just as the properties of a substance such as water emerge from the quantum interactions of molecules, so prices emerge from the use of money objects.
5. Money serves as a means to quantify value, in the sense of reducing it to a mathematical quantity – but as in quantum measurement, the process is approximate.

By attaching numbers to our idea of value, in an attempt to quantify it, the money system binds together two very different things, and it is this fusion which gives rise to its complex behaviour. Money objects are our contribution to the quantum universe; and as with quantum physics, the problems in interpretation seem to appear when we try to reduce a system to exact numbers. Perhaps the greatest cause of confusion is that, by attaching numbers to value, money appears to be directly measuring value, which isn't quite the same thing: in general there is no simple, direct relationship between prices and value.

The inherently dualistic nature of money is reflected in its history, which, as David Graeber describes, involves an 'alternation between periods of virtual and metal money' (Graeber, 2011, p. 214). During a virtual phase, money is seen primarily as a score in a

⁴ Historian Michael Crawford calls the development of markets an 'accidental consequence of the coinage (Crawford, 1970)'.

ledger, while in a physical phase, money is seen primarily as material wealth; however, the two sides cannot be separated, so money always retains the essential characteristics of each. These reversals are written like strata in the historical record, and each layer shows money in a different aspect. Early agrarian empires were dominated by virtual credit, where the value of a clay tablet lay in the inscription, and not so much in the clay. The Axial Age (800 BC to 600 AD) saw the widespread adoption of coinage made from precious metals. The Middle Ages, which lasted for almost the next 1,000 years, saw a swing back towards virtual credit, with a shortage of precious metals and the invention of banking instruments such as bills of exchange. The massive influx of gold and silver from the New World in the mid-16th century began the metal-money era that led eventually to the international Gold Standard. Since the Nixon Shock of 1971, when fiat currencies decoupled completely from gold, we have been in a virtual age, exemplified by the arrival of cybercurrencies such as bitcoin.

Viewed this way, the opposing theories of bullionism and chartalism can be seen as each emphasising a different side of money. The situation resembles the long debate over the properties of light, with one school claiming it was made of particles, the other it was made of waves, until the question was finally resolved by saying it was both at the same time, with the different aspects presenting themselves in different contexts.

4. Emerging Markets

Implicit to traditional theories is the idea that money has to be backed by some pre-existing quantity, be it real (e.g. metal) or virtual (e.g. the law of the state). It, therefore, inherits its value passively from outside. But from a quantum perspective, rather than money being backed by something of monetary value, it is the other way round – market value comes from the use of money. This has implications for the way we interpret phenomena such as cybercurrencies, and, in particular, helps to explain their ability to boot themselves up from nothing more than a set of rules and an internet connection.

As mentioned above, money objects are unique in that they have a fixed, defined monetary value, which makes them desirable in themselves – so the more something looks like money, the more valuable its numbers become, in a self-reinforcing dynamic. And just as market prices emerge from the use of money objects, so the money system expands with its markets. A cybercurrency is supported not by metal or the state, but by something much more distributed and amorphous – its network of users. A property of networks is that their power expands rapidly with size (sometimes called the fax effect, since fax machines were of little use until enough people had them). The value of a cybercurrency – and the trust it embodies – therefore grows in the same way with the size of the network of users, so can initially be near-zero. Note that the two opposite sides of money, which represent positive credit and negative debt, in a sense cancel each other out, so a kind of conservation principle is observed, as when matter/antimatter pair particles are created from the quantum void. It is therefore not necessary to begin with an external debt or a source of value, because the two can expand together. Numbers which were just numbers, can suddenly become worth a great deal.

When Satoshi Nakamoto mined the first bitcoins in January 2009, he (if it is a he) had to give them away to get people interested. They had numbers, and a unit of account, but no value. In October of that year, users set up a web site quoting a price which corresponded to the cost of electricity required to mint a coin. This worked out at the time to about 0.0008 dollars per bitcoin, so a thousand bitcoins was worth about 80 cents. Once a price was available, people began to trade, but it remained a game – until May 2010 when a software

engineer managed to buy two pizzas for 10,000 BTC, by posting a request on the bitcoin forum. Someone accepted the bitcoins and ordered the pizzas using a credit card.

Bitcoins were becoming things, and their numbers were attaching themselves to other things. Within the space of months, all kinds of things could be bought with bitcoin (not all of them legal, which was why the FBI closed down the Silk Road website in 2013). Today, the price paid for each of those pizzas works out to about a million dollars. Bitcoin, therefore, began with no backing at all, unless you count the cost of electricity (more on this below), but its usefulness grew with the network as more people accepted the coins. And in the end, a currency doesn't need to be backed – it needs to be used.

One reason cybercurrencies have met with resistance – from economists such as Alan Greenspan but also the general public – is because they do not conform to our traditional ideas about money and value. According to bullionism, a money object needs to contain a certain amount of metal, whose inherent value is taken as granted. According to chartalism, the value of a money object is specified by an authority, whose power is assumed to exist. When the first bitcoins were mined, they had neither inherent value, nor the power of an authority. Instead the two aspects – the real and the virtual – grew together, reinforcing each other as the number of users expanded. There was no clear transition or a particular date when it was officially established that bitcoin should be accepted as money at a certain exchange or price level; rather a kind of creeping phase transition, where bitcoin began to look less like an interesting experiment and more like money, until a critical mass of users was achieved.

When faced with a new phenomenon, such as bitcoin, that does not fit with preconceived beliefs, the simplest strategy is to deny its existence, for example by saying that it is not real money, or does not have 'real meaning' as the People's Bank of China put it in 2013. But when you can use bitcoin to buy ether to buy a stake in a decentralised autonomous organization (DAO), which can invest in start-up companies, including new blockchain-based schemes, and so on, we have to accept that this cyber-economy deserves to be taken seriously by the economics community. Indeed, it is serving as a kind of monetary petri-dish, allowing us to see how currencies get started and either perish or survive, and also to test out our ideas about money.

The problem then is not with cybercurrencies, but with theories of money which were shaped by previous monetary eras of Gold Standard or state fiat currencies. If fiat currencies are the touchstone of chartalism, as Knapp wrote, then cybercurrencies are the touchstone of the theory presented here, which sees money as a fundamental quantity rather than something dependent on external pre-existing causes, and value as an emergent property of the money system.

Traditional theories may in fact have affected the design of bitcoin, which in many respects seems to have been intended as a virtual version of gold. The future supply of bitcoins is limited to a cap of 21 million; for comparison, the total amount of mined gold in the world is estimated to be about 6 billion ounces. Bitcoin's proof-of-work mining process is also highly energy intensive, much like the mining of gold. In part this is a security feature, because it imposes a cost on attempts to disrupt the blockchain; but it may also reflect the idea that money, to be valuable, needs to be backed by something else – in this case, electricity. Adam Smith, who equated value with labour, would have approved (assuming that the labour of computers counts). However, this does raise the question of whether an alternative approach which simplifies the mining process would be more efficient (for example a proof-of-stake algorithm rewards miners with something like interest payments on their holdings). It will be ironic if the world's leading cryptocurrency founders because it is too much like gold.

5. Conclusion

The core idea of the theory presented here is that money objects are entities (taking many different forms) which have an assigned monetary value. Because number and value are fundamentally different, such money objects exhibit dualistic properties. For things other than money objects, the relationship between value and price is something that emerges indirectly from the use of money, so is an emergent property which depends on a wide variety of social factors.

Money objects, with their dual real/virtual nature, have one foot in the abstract world of number and computation, and another in the real world of physical things. Just as forces, such as magnetism, are communicated by exchanging virtual particles, so commercial transactions involve the exchange of money objects, whose dualistic properties – both contradictory and reinforcing – feed into the economy, and are registered as oscillations between real and virtual phases in the 5000-year history of markets. While money occupies a special place in the intersection between the world of real objects and ideas of social value, its dualistic properties are experienced by society as a whole (Orrell and Chlupatý, 2016, pp. 169-175).

One of these properties of money that interests us today is the ability of cybercurrencies to boot themselves out of the ether. The question is not whether such things count as money – they clearly do – but whether they can offer concrete advantages over traditional currencies, and prevail as part of the monetary system. A prerequisite for their widespread adoption is that we shed our outmoded, Newtonian theories about money, which were developed for earlier monetary eras.

This paper has not gone into implications for things like monetary policy, or explored in detail the interesting question of how currencies in general emerge into widespread use.⁵ Describing money systems as a kind of emergent phenomenon might sound a little dismissive, as if there is no point in exploring further the dynamics of their creation or use; but this is far from being the case, as seen again by a comparison with physics. The remarkable and life-supporting qualities of water, for example, are an emergent result of the complex quantum interactions between water molecules. Solid-state physics, whose useful applications include computers, is similarly based on the emergent properties of materials (Laughlin, 2005, p. 80). Exploring how money systems grow or are imposed, and either reach a critical mass or fail, is an equally fascinating area of study. Bitcoin may draw its authority from its network of users, but in a way the same can be said of any form of money; the difference is that conventional currencies get a boost from the state. The recent and ongoing emergence of a diverse ecosystem of cybercurrencies offers economists a unique opportunity to study the process by which currencies come into use, with governments, corporations, and other organisations all playing a role.

As shown by the history of money, debates over the nature of money are not just theoretical questions, but go to the heart of how the economy is managed (as during the Gold Standard). Again, treating money systems as an emergent property may seem to undercut this assertion – after all, the discovery of the quantum properties of water molecules did not affect the way we do plumbing. But money, unlike water, responds to the way we think about it. And by treating money as an inert chip, and omitting it from key economic models, we have blinded ourselves towards its true potential, for improving our lives or for creating chaos. Will new currencies help to rebalance our economic system? Can we design currencies to aim for particular societal outcomes? Does it make sense for private banks to carry out the bulk of money creation by issuing loans, given that money is not a passive accounting system but an

⁵ This topic is explored in more detail in Orrell and Chlupatý (2016).

active and powerful substance? Only by acknowledging the complex, dualistic, and above all lively nature of money can we fully address such questions, and incorporate money properly into our study of the economy.

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Complexity Modelling in Economics: the State of the Art

Bruna Bruno, Marisa Faggini, and Anna Parziale, University of Salerno, Italy

brbruno@unisa.it, mfaggini@unisa.it, aparziale@unisa.it

Abstract

The economic crisis happening across the world over the last few years describes a range of interdependencies and interactions, and has highlighted the fundamental flaws of neoclassical economic theory: its unedifying focus on prediction and, above all, its inability to explain how the economy really works. As such, it is increasingly recognised that economic phenomena cannot be exclusively investigated as being derived from deterministic, predictable and mechanistic dynamics. Instead, a new approach is required by which history-dependence, organic and ever-evolving processes are also accounted for. As this view implies new challenges and opportunities for policy, we will focus our attention on innovative components of Complexity Theory for the study of economics and the evaluation of public policies.

Keywords: complex systems, economics, public policies

1. Introduction

The economic crisis happening across the world over the last few years describes a range of interdependencies and interactions, and highlights the fundamental flaws of neoclassical economic theory: its unedifying focus on prediction and, above all, its inability to explain how the economy really works.

The reductionist approach, applied by neoclassical economic theory, overlooks the dependencies and interconnections between different elements and their influence on macroeconomic behaviour, and it too often fails as an analytical approach (Morin, 1992). Its goal is to reduce the overall behaviour of a system to a number of essential elements and then to study these parts separately – the system can then be analysed in every detail. The reconstructed behaviour of this system is obtained by simply re-aggregating its components (the principle of overlap). The focus of the reductionist approach is not to study the unfolding of the patterns its agents create, but rather to simplify its questions creating a separation between reality and its formal representation.

The last century was dominated by the notion that science would yield answers of the simplest kind to a wide range of applicable problems. In particular, the sciences went through the 20th century developing and perfecting a model based on 19th-century hard sciences. Due to an increasing body of experiential knowledge using science in the quest for precise answers, it is now agreed that such certainty is illusory in the field of economic theory.

During the last two decades a new field of interdisciplinary research, named ‘science of complexity’, or ‘complexity theory’ emerged from the interplay of physics, mathematics,

biology, economics, engineering, and computer science oriented to overcome the simplifications and idealisations that have led to unrealistic models in these sciences.

The goal of complexity theory is to explain, in a multidisciplinary way, how complex and adaptive behaviour can arise in systems composed of large numbers of relatively simple components with no central control and with complicated interactions. No more aggregates reduced to the analysis of single, representative, individual parts, ignoring by construction any form of heterogeneity and interaction – instead the aggregate emerging from the local interactions of agents. From this point of view the system is different from the sum of its parts.

The behaviours of complex systems depend on the interactions (often with retroactive character) among parts, and not so much (or not only) from the characteristics of the parts themselves; the behaviour of the single parts themselves does not give us an explanation of the behaviour of the 'whole'. Even if all the simpler constitutive parts are analysed and a complete and exhaustive understanding of their operation is reached, we are not able to understand the system as a whole.

Moreover these systems can show structural instability: small modifications can imply markedly different outputs. For this reason our understanding of the behaviour of a system at a certain point might be valid only for a very small space around this point.

In economics, complexity theory challenges fundamental orthodox assumptions (equilibrium, representative agents, rational choices) and seeks to move beyond them, emphasising the power of networks, feedback mechanisms and the heterogeneity of individuals. It does not work anymore by simplifying, linearising and dividing, but by observing the relevance of interrelationships among the components of systems – as well as their relationships with the environment and vice versa – in determining collective behaviours.

Economic scientists who rely on viewing the social system as a static system – with linear relationships, equilibrium and connections that fit relatively simple equations – have to turn to new economic theories to understand how the economy really works and how governments might manage the economic system more effectively. So it is time to explore new ways of managing our economy – aimed at evolution and change, rather than only in the pursuit of competition, efficiency and growth.

This new approach is not just an extension of standard economics but a different way of seeing the economy as a system where actions and strategies constantly evolve, where time becomes important, where structures constantly form and re-form, where phenomena appear that are not visible to standard equilibrium analysis, and where a meso-layer between the micro and the macro becomes important (Arthur, 2013).

Static equilibrium and perfect rationality, ignorance of innovation, downplaying of institutions and the assumption of zero-sum market transactions are assumptions relaxed in favour of 'an economy made up of millions of overlapping activities, in which individuals, businesses and other institutions are highly connected and constantly interact, where preferences change and markets shift in unpredictable ways. It is a description that is immediately more recognisable in reality' (Kay, 2012). Its main concepts include emergence, adaptation, self-organisation, patterns, agents, networks, wholeness, interdependent interactions among divergent yet connected parts, learning and memory, change and evolution, holism and synergy (Manson, 2001).

This paper starts from the premise that there is a lot wrong with conventional economics and that insights from new economic thinking need to be taken seriously. The idea is to investigate economic phenomena – not as derived from deterministic, predictable and mechanistic dynamics – but as history-dependent, organic and always evolving processes. Because this view implies new challenges and opportunities for policy and for managing economic crises, we will focus our attention on innovative components of complexity theory.

The paper is structured as follows. Section 2 discusses the distinguishing characteristics of complex systems, and section 3 unpacks the implications of applications of complexity to economics. The latter shows how the insights and methods of complexity science can be applied to assist policymakers.

2. Complexity Theory: More is Different

Both macro and micro events, from predictions of the general performance of the economy to more local issues such as climate change, sustainability, demographic change and migration, transnational governance and security, among others, seem beyond our understanding and control. The issues involved in each of these areas transcend disciplinary boundaries and making progress will require a significant interdisciplinary effort and a paradigm change in scientific thinking (Gilbert and Bullock, 2014).

Complexity theory is a highly interdisciplinary research programme that encompasses a broad range of theories, empirical work and methods – involving not only economists, but psychologists, anthropologists, sociologists, historians, physicists, biologists, mathematicians, computer scientists and others across the social and physical sciences.

Beyond this, however, it is difficult to be much more precise, as the notion of complexity is itself extremely equivocal¹ and open to debate. For this reason, it is not possible to give an exact definition of what is meant by ‘complexity’.

To some, complexity theory is merely the study of branches of different sciences, each with its own examples of complex systems, while others argue that there is a single natural phenomenon called ‘complexity’, which is found in a variety of systems, and which can be the subject of a single scientific theory or approach. Nevertheless both positions seem to agree about the object of study of complexity, i.e., complex systems.

A ‘complex system’ is composed of many parts that interact with and adapt to each other and, in so doing, affect their own individual environments and, hence, their own futures. The combined system-level behaviour arises from the interactions of parts that are, in turn, influenced by the overall state of the system.

Therefore ‘complexity’ is a characteristic of a system and arises because of the interaction among the components of a system (Cilliers, 1998); it is not so much the properties of the individual components, but their relationships with each other that shape complex behaviour. The properties of the system emerge as a result of these interactions; they are not contained within individual elements (Durlauf, 2011). Complex systems generate unpredictable dynamics which enable their elements to transform in ways that are surprising – through adaptation, mutation, transformation, and so on.

Deconstructing a complex system into individual components destroys the system’s properties. Thus, complex systems, such as the brain, living organisms, social systems, ecological systems, and social-ecological systems, must be studied as global systems. In this sense we are unable to mathematically derive the complex emerging properties from the organised interactions of its entities and hence the reductionist method of traditional science does not work. And *vice versa*, if the system is ‘complicated’ – we *can* apply it.²

¹ The MIT physicist Seth Lloyd provided over 45 definitions, indicating just how much disagreement there is on what is meant by complexity (Horgan, 1997, pp. 303).

² A car composed of thousands of parts whose interactions obey precise, simple, known and unchanging cause-and-effect rules is a complicated system. For this it can be well understood using normal engineering analyses. An ensemble of cars travelling down a highway, by contrast, is a complex system. Drivers interact and mutually adjust their behaviours based on diverse factors such as perceptions, expectations, habits, even emotions (OECD Global Science Forum, 2009).

We can summarise the set of features that are widely associated with complex systems in this way (Cilliers et al., 2013):

- **Large number of components.** Complex systems usually consist of a large number of components that influence and are influenced by others. The individual elements of a system are influenced directly by the behaviour of the system as a whole, and at the same time their interactions lead to the emergent behaviour at the aggregate level of the system. These dynamic interactions are characterised by three properties:
 - Nonlinearity.** Nonlinearity means that the superposition principle³ does not work. This implies that while linear thinking is based on the belief that the whole is only the sum of its parts, the nonlinearity refers to the fact that the whole is more than its parts. So, small causes can have large effects and *vice versa*. This is a precondition for complexity.
 - Feedback loops.** A part of a system receives feedback when the way its neighbours interact with it at a later time depends upon how it interacts with them at an earlier time. This is a mechanism by which change in a variable will result in either amplification (positive feedback) or a dampening (negative feedback) of that change. An example⁴ of a positive feedback loop could be between income and consumption. The bigger the income *per capita* in an economy, the more people consume. This will produce a further increase in their *per capita* income, and so on. The interplay between the two feedbacks is just one of the few examples of a self-perpetuating process that complex systems possess (Orrell, 2010).
 - Self-organisation.** A system that is characterised and acts through many adapting elements is called self-organising. These participating elements establish an organisational structure that does not require any central coordination. Self-organising systems will adapt themselves continuously in autonomous ways, so as to better cope with various internal and external perturbations. The generated organisation results from internal constraints and mechanisms, which are based on local interactions between its components. The Invisible Hand of Adam Smith could be a typical example of self-organisation in economics.
- **Emergence.** Emergence relates to the dynamic nature of interactions between components in a system (Gallegati and Kirman, 2012). The dynamic character of emergent phenomena is not a property of a pre-established, given whole – but arises and becomes apparent as a complex system evolves over time (Goldstein, 1999). Emergent properties could be defined as properties that occur at a different levels of aggregation, rather than the description of the components of the system. In any event, the hallmark of this kind of complexity is novelty and surprise which cannot be anticipated through any prior characterisation. All that can be said is that such systems have the potential for generating new behaviours. Markets are a well-known example of emergence. A market exists as long as buyers and sellers exist and they exchange goods and money. ‘Markets’ are related to the activity of buying and selling and can be neither explained by the properties of buyers or sellers, nor by the characteristics of trade (Noell, 2007).

³ A system is linear if one can add any two solutions to the equations that describe it and obtain another, and multiply any solution by any factor and obtain another (Ladyman, Lambert and Wiesner, 2012, p. 4).

⁴ As suggested importantly by Ron Wallace, feedback has been functionally explored in a wide variety of systems ranging from molecular signalling pathways to monopolistic economies (Albert et al., 2000).

- **Open systems.** Open systems refer to systems that interact with other systems or the outside environment, whereas closed systems refer to systems having relatively little interaction with other systems or the outside environment. Complex systems are thermodynamically open systems. The interactions make it difficult to determine the border of a complex system, so we need to understand the system's complete environment before we can understand the system – remembering the environment itself is complex.
- **Path dependence.** 'Path dependence can mean just that: Where we are today is a result of what has happened in the past. For example, the statement "we saved and invested last year and therefore we have assets today" might be more fashionably expressed as, "the capital stock is path dependent"' (Margolis and Liebowitz, 1998). Because they change with time, complex systems have histories. Not only do they evolve through time, but their past is co-responsible for their present behaviour. Any analysis of a complex system that ignores the dimension of time is incomplete, at most a synchronic snapshot of a diachronic process.
- **Power laws.** A power law implies that small occurrences are extremely common, whereas large instances are rare. Many man-made and naturally occurring phenomena, including city sizes, incomes, word frequencies and earthquake magnitudes, are distributed according to a power-law distribution. Complex systems are sometimes characterised by probability distributions that are best described, instead of by a normal distribution, by a power law. This slowly decreasing mathematical function can predict, probabilistically, future states of even highly complex systems. There is good evidence for the presence of power-law distributions in many economic variables, such as returns, order flow, volume and liquidity.

Summing up, complex systems are dynamic, nonlinear systems with multiple equilibria, evolving in time and space, which self-organise from local interactions and are strongly characterised by historical dependencies, complex dynamics, thresholds and multiple equilibria (Carpenter et al., 1999; Levin, 1999).

As a result, main methodologies applied in complexity are quite different from those used in traditional science. They include agent-based modelling (otherwise known as computer simulation), cellular automata, catastrophe theory, complex adaptive systems, data mining, dynamical systems theory (otherwise known as chaos theory), fractal geometry, genetic algorithms, neural networking (otherwise known as distributed artificial intelligence), power law, scale-free networks, self-organised criticality and synergetics.

3. Complexity Modelling in Economics

For a long time, scientific models were built starting from the consideration that causal mechanisms of natural phenomena were linear and characterised by the superposition principle. In this sense, effects are proportional to causes, small inputs produce proportionally small outputs, and the whole simply equals the sum of its parts. Thus, it is possible to divide a complicated system into simpler constitutive parts, separately analyse each component and, finally 'reconstruct' the behaviour of the system by re-aggregating its components.

This reductionist approach too often overlooks the dependencies or interconnections among elements and their influence upon macroeconomic behaviour. Its focus is not to study

the unfolding patterns its agents create, but rather to simplify its questions to make them manageable and user-friendly. Unfortunately, these principles, imposed by the Cartesian paradigm of simplification, have created a separation between reality and its formal representation.

In economics, the neoclassical theory based on this principle describes 'smart people in unbelievably simple situations', while the real world involves 'simple people [coping] with incredibly complex situations' (Beinhocker, 2012, p. 52).

In fact, in order to abstract from heterogeneity, which allows the application of rigorous calculus to economics to gain deep insights embedded in a formal, elegant framework, the explanation of human behaviour is brought back to that of a representative agent: an agent that has complete information and acts with rationality when making choices and his choices are aimed to optimize his utility or profit. This agent must present perfect knowledge and complete information. On the base of such an information and knowledge, he must be able to make every sort of necessary complex calculation. He has time and ability to weigh every choice against every other choice and, finally, he is fully aware of all possible choices. Further, individual preferences are taken to be given *a priori*, rather than constructed and revised through on-going social processes; they are primitive, consistent and immutable. He operates according to the rational choice imperative: given a set of alternatives, choose the best.

This process of choice postulates utility values associated with possible perfectly foreseen states of the world in which situations with higher utilities are preferred to those with lower ones. Those preferences are defined over outcomes, known and fixed, so that decision makers maximise their net benefits by ordering and choosing the alternative that yields the highest level of benefits. Possible differences regard only quantitative and not qualitative levels.

Complete information implies that each individual reaches the same conclusion, only Gaussian deviation from the norm is allowed and they cancel each other out in the average. It is not important that the direct relation of each individual with another is only seen through the relation with the market – through the money that compensates for every deviation from the norm.

The behaviour of all the agents together is treated as corresponding to that of an average, or representative, individual. In this way, aggregate quantities and their relationships are derived directly from the analysis of the micro-behaviour of this representative agent. The solution of this optimisation problem is an individual demand curve, used as the exact specification of the aggregate deduced by simply summing up the behaviour of agents that compose a market or an economy. Therefore, the result of decision problems of the representative economic unit is obtained *sic et simpliciter* by aggregating quantities.

There are not significant differences between micro and macro levels: the dynamics of the latter is just the summation of dynamics of the former. The behaviour of an economic group is adequately represented by that of a group whose members have the identical characteristics of the average of the group.

But these assumptions are inadequate to describe a world in which agents use inductive rules of thumb to make decisions: they have incomplete information, they are subject to errors and biases, they learn to adapt over time, they are heterogeneous, they interact with each other and, put simply, are not rational in a conventional sense. Therefore we end up with totally unrealistic hypotheses because they don't reflect real individual behaviour (Robles, 2007) or the complexity of human decision making (Shapiro and Green, 1994). As observed by Friedman:

‘Truly important and significant hypotheses will be found to have “assumptions” that are wildly inaccurate descriptive representations of reality, and, in general, the more significant the theory, the more unrealistic the assumption ...’ (Friedman, 1953, p.14).

This affirms the theory of rational expectations, with the assumption that agents also have, implicitly, the knowledge of the model from which the consequences of their actions descend. This will give the economic actors much more knowledge than econometricians building the model have access to (Sargent, 1993).

Economic agents cannot obtain perfect knowledge of the global consequences of their actions; they are not able to equate costs and benefits of knowledge; behaviours that deviate from the average do not cancel each other, but they could reinforce each other. Each individual can reach only a partial knowledge that is focussed around his/her own ‘world’ (local information) and react to external shocks in different ways (local rationality).

While it could be the case that the assumption of rational behaviour is credible for a small subset of people, it is certainly the case that not all agents are equally rational, as is implicit in conventional theoretical models. In the real world, agents are ‘bounded rational’. This typically means that the belief formation process of each agent can be described as a simple function of certain past data available to each agent. Individual beliefs are rational in the sense that given an agent’s information set, the agent’s beliefs correspond to the probability statements that describe the environment under study. Under appropriate conditions, they evolve non-optimal but highly effective heuristics for operating in complex environments. There is no assurance that, when faced with novel environments, individuals will shift efficiently to new heuristics.

These interactions not only influence macro patterns but also create increasingly complex networks that allow them to compensate for having limited information and facing formidable information processing costs. In the Walrasian economy, agents do not interact at all.

Rational agents operate in equilibrium markets where crises can only be triggered by acute exogenous disturbances, such as hurricanes, earthquakes or *political* upheavals, but certainly not precipitated by the market itself. If one tried to endogenise some of those elements into economic models, it would become clear that they produce systemic instabilities which are fundamentally incompatible with a system in equilibrium. In this framework the interdependencies between agents are typically restricted in various ways that generally involve direct interdependencies, as opposed to the interdependencies that are implicit in market transactions. Changes in outcomes are seen as movements in equilibria and not as natural progressions in a dynamic process.

From this dominant mechanical world view the scientific community is moved towards a view of the world as interconnected: where variation cannot be ignored, where new behaviours can emerge, where change is not predictable and understandable in simple, single-dimension relationships. In recent years this alternative view is named complexity theory: the scientific framework devoted to study complex systems.

Undergoing an incursion in time, we can trace the notion of complex system to Aristotle who said, ‘The whole is greater than the sum of its parts’, but in economics the roots (Tema, 2015) of the complexity view can be found in two seminal papers – by Anderson (1972) and Rosenblueth and Wiener (1945).

In particular, from Anderson's pioneering paper,⁵ 'More is different', economists at Santa Fe Institute, Stanford, MIT 'have focused on creating a new kind of scientific research community based on the complexity science' (Naciri and Tkouat, 2015). The result in economics has been born of a long-term research programme of complexity economics that 'is not an adjunct to standard economic theory, but theory at a more general, out of equilibrium level' (Arthur, 1999). From here numerous contributions to complexity economics have occurred in different research areas (Beinocher, 2006).

Complexity economics builds from the proposition that the economy is not necessarily in equilibrium: economic agents (firms, consumers, investors) constantly change their actions and strategies in response to the outcome they mutually create. This further changes the outcome, which requires them to adjust afresh. Agents thus live in a world where their beliefs and strategies are constantly being 'tested' for survival within an outcome or 'ecology' these beliefs and strategies together create (Arthur, 2013; 2015).

Under equilibrium, by definition, there is no scope for improvement or further adjustment, no scope for exploration, no scope for creation, no scope for transitory phenomena, so anything in the economy that takes adjustment – adaptation, innovation, structural change, history itself – must be bypassed or dropped from theory. The result may be a beautiful structure, but it is one that lacks authenticity, life and creation.

The relevance of complexity does not deny the value of equilibrium models. Equilibrium may well remain at the core of economic theory. However, even the most casual observer recognises that most markets, political systems and social systems do not sit at rest but are constantly in flux. We have to focus on the constant dis-equilibrium or continuously shifting micro-equilibrium points, rather than a pre-defined equilibrium point. Even if an equilibrium state exists in theory, it may be totally irrelevant in practice. The equilibration time is far too long – as Keynes noted, in the long run we are all dead – and therefore often irrelevant to understanding what is going on, and it can be hard to identify if the system settles there (Bouchaud, 2008). To overcome the limitations of orthodox theory, what was done was to relax restrictive assumptions and introduce more realistic behaviours – heterogeneity, institutional effects, dynamics, endogenous innovation and so on. Nevertheless much of this work introduces just one element of realism to an otherwise standard model without abandoning the core idea that the economy is an equilibrium system.

Complexity theory seeks explanations of how the economy works by additionally requiring empirical validity: to accept human behaviour, imperfect institutions, and the complex interactions and dynamics of the economy as they really are, rather than what an idealised model says. No more an aggregate reduced to the analysis of a single, representative, individual, ignoring by construction any form of heterogeneity and interaction, but instead the aggregate emerging from the local interactions of agents. The economy considered as a complex system, emphasises a bottom-up, agent-based approach to model the economic systems made by interconnected layers populated by more and more complicated agents (people, families, firms, banks, central banks, international institutions, multinationals...).

⁵ 'The ability to reduce everything to simple fundamental laws does not imply the ability to start from those laws and reconstruct the universe.(...) The constructionist hypothesis breaks down when confronted with the twin difficulties of scale and complexity. The behavior of large and complex aggregates of elementary particles, it turns out, is not to be understood in terms of a simple extrapolation of the properties of a few particles. Instead, at each level of complexity entirely new properties appear, and the understanding of the new behaviors requires research which I think is as fundamental in its nature as any other' (Anderson, 1972, p.393).

3.1 Managing Complex Systems

Understanding of complex systems is possible only if we build appropriate models.

A model represents an attempt to link seemingly related phenomena logically into a theoretically coherent framework. This framework is based on an underlying theory that allows one to analyse a range of relationships, providing a causal structure with, or without, a feedback mechanism. More importantly, however, a scientific model is built by making restrictions on observable relationships.

The specification of a causal mechanism and reductionism on potential relationships are the distinguishing characteristics of a model (Faggini, 2009).

The study of economic systems has traditionally been based on three types of models: visual models, mathematical models, and empirical models.

- Visual models are simply pictures of an abstract economy. Nevertheless most visual models are visual extensions of mathematical models.
- Mathematical or theoretical models consist of a set of mathematical equations that provide a useful description of how an economy works.
- Empirical models are mathematical models designed to be used with data. They are used to verify the qualitative predictions of theoretical models and convert these predictions to numerical outcomes by using statistical and econometric techniques.

Development in the field of computer science allowed building a fourth type of model: computational models.

Computational methods are used to replicate and understand market dynamics emerging from the interaction of heterogeneous agents, and to develop models that have predictive power for complex market dynamics. They are based on simulation, i.e., a set of instructions, rules, equations or constraints by which to show the interaction of numerous variables, including hidden feedback and secondary effects, that are not so apparent in purely mathematical or visual models. For this reason they are considered to be the natural way to manage the complexity of economic systems.

Even if, in this class of model, we also have simplified mathematical models⁶ that try to abstract the most important qualitative elements into a solvable framework, there is one method that is particular to the study of complex systems and has largely been developed and applied in this field – agent-based modelling. Traditionally, agent-based models (ABM) are used for studying phenomena from biology, such as social insects and immune systems. Here, simple agents interact locally with simple rules, merely responding predictably to environmental cues, and not necessarily striving for an overall goal. Nevertheless, we observe a synergy which leads to a higher-level whole with much more intricate behaviour than the component agents. The field of Artificial Life produced a number of models based on simple agent rules capable of producing a higher-level identity, such as the flocking behaviour of birds, which were called ‘swarms’ or Agent Based Models (ABM).

Agent-based models or ‘agent-based computational economics’⁷ (Boero et al., 2015) and ‘multi-agent systems’ have been used to model very different kinds of complex systems, from the simulation of socio-economic systems to the elaboration of scenarios for logistics optimisation, from biological systems to urban planning. The goal of ABM is to separately and

⁶ The tools used in such studies include dynamical systems theory, information theory, cellular automata, networks, computational complexity theory, and numerical methods like Montecarlo simulation, integration methods, linear algebra and spectral methods.

⁷ <http://www2.econ.iastate.edu/tesfatsi/ace.htm>

individually simulate the agents and their interactions, allowing the emergent behaviours of the system to appear naturally (Dosi et al., 2010; Gallegati et al., 2010). These models investigate how aggregate outcomes arise from the micro-processes of interactions among many agents.

4. Public Policies in Economic Complex Systems

The aim of policy until now has been to regulate economic systems mechanistically toward desirable outcomes, by manipulating positive/negative incentives towards individual choice – not considering that preferences and behaviours are socially constructed under various social and economic influences.

Policy recommendations are based on the optimisation of some measure of societal preferences reflected in an objective function, often a form of efficiency, using models that are essentially mechanic and deterministic. The aim is to produce a ranking of alternative strategies identifying the optimum one and assuming the decision-maker has a well-characterised system model and can represent uncertainty with probability distributions over the input parameters to that model.

Moreover, because the economy is viewed as naturally being in a state of efficiency, interventions are justified by market failures: the need to create some public good, or the need to avoid some negative effects or externalities.

When the crisis came, the serious limitations of existing economic models immediately became apparent. Policy-makers during the crisis found the available models of limited help because they failed to predict it and seemed incapable of explaining what was happening to the economy.

The approach of conventional policy has been theoretically built-in by the influence of mainstream economic theory and this has been one of the most serious reasons for recent policy failures. The principal cause of this failure was not the size of the state or the magnitude of the action or resources involved, but the theory and methodology used for policy design and implementation. If policymakers had better models, they might have been able to run more and different policy scenarios and gained different insights into the crisis. Politics and judgment will always play a key role in major policy decisions – but better models can help the policymakers to anticipate and understand key patterns that involve or concern humans, thus enabling wiser decisions about policy interventions.

The vision of the economy as a complex system provides a completely different policy perspective yielding new ways of designing and implementing policies, and in particular suggesting that a more integrated and holistic policy approach towards economic systems can produce better results. It focuses attention on dynamic connections and evolution, not just on designing and building fixed institutions, laws, regulations and other traditional policy instruments.

As cause and effect in complex systems are distributed, intermingled and not directly controllable, policymakers need to become more comfortable with strategies that aim to influence, rather than control. Policymakers 'would have to content themselves with constantly observing and, where possible, influencing a system over which they have much less control than one has been led to think' (Kirman, 2016). They should aim to find and exploit desirable attractors; identify and avoid dangerous tipping points; and recognise when a system is in a critical self-organising state.

Policy needs to be suitably tailored to specific problems and has to take into account that a policy instrument launched today might not necessarily work tomorrow. The economic system is constantly evolving in unpredictable ways.

Of course, this does not mean that we are operating in the dark, that the success or otherwise of a policy is merely a matter of chance. The more knowledge we have of how people are connected in the relevant networks – of who might influence whom and when – the more chance a policy has of succeeding. Much of this knowledge is held at decentralised levels. Decentralisation may ‘work’, because it is a ‘patching algorithm’ – a means of solving public policy problems defined over a most complex ‘social welfare landscape’ (Faggini and Parziale, MPRA, 2011).

Decentralisation can help shorten the feedback loops that inform decision-making, so actors can respond more quickly to developments (Jones, 2011). If every single different level of governance⁸ finds solutions as a result of interdependencies with each other level, the result can be high overall welfare. Conversely, if the different levels of governance are disconnected, the result is a lower level of overall welfare.

The existence of multiple interdependencies means that a lot of these independent actions at system level can be handled using computational methods to approach search problems. The main idea is that if the best solutions are selected in many iterations, the algorithm will converge to a single, very powerful solution. Taking into account that no unique solution exists, the research can be done through a searching algorithm on a fitness landscape – a dynamic landscape in which complex systems move searching for optimum conditions and adapt themselves continually to environmental changes imposed by policymakers.

Policymakers should plan their interventions on the basis of seeking to shape the ‘fitness landscape’ and altering the behaviour of economic system, rather than the current approach which, in crude terms, identifies a problem and aims to solve it through one or two incentive-based policies arising from an empirically defective framework

Of course, this does not take away the importance of overarching policy goals, clearly defined strategy or even national policy instruments, but rather points to the need for a richer policy framework that bridges the divide between national strategic priorities and the grassroots realities that policy is attempting to influence.

Policy therefore needs to be dynamic. Rather than thinking of policy as a fixed set of rules or institutions engineered to address a particular set of issues, we should think of policy as an adapting portfolio of experiments that helps shape the evolution of the economy over time (Beinhocker, 2012).

When dealing with complex problems it is not enough to keep intervening to modify institutions; rather, ‘we must invent and develop institutions which are “learning systems”, which are ‘capable of bringing about their own continuing transformation’ (Schön, 1973). We must develop institutions that are able to influence rather than command – where this influence is not devoted to directing the economic system towards a particular direction as that system itself⁹ may not necessarily be evolving in efficient state.

⁸ Relations across levels of government have changed over the last two decades. Decentralisation has made local and regional governments more powerful in formulating and delivering policy. This change from a centralised and ‘vertical’ system has made governance more complex by involving a wider range of stakeholders at different levels. As a result, both horizontal and vertical relationships are increasingly important. Understanding this complex network of relationships, as well as developing effective collaboration between levels of government, is critical to enable efficient policy making and service delivery.

⁹ We would make neither statements nor predictions as we do today, but would rather make probabilistic statements about the trajectories that the economy might follow. The difference with our current

In this sense complexity economics neglects political economy if, with this term, we mean how a government with limited resources tries to satisfy the needs and desires of its citizens. Here government interventions are devoted to reducing or eliminating some form of market failure in order to re-establish the conditions of Pareto optimality. However, to the extent we are dealing with a complex economy the policies should not be expected to achieve specific outcomes.

'We have to rethink the way in which economic policy is conceived and enacted... [...] Far from advancing toward a precise analytical model capable of being used for forecasting, and thus of guiding economic policy, the nature and ambitions of economic policy would have to change' (Kirman, 2016).

The first necessary step is the modification of expectations arising from policies (i.e. pairings of goals and rules/instruments) by shifting emphasis from static optimisation under constraints to adaptability. We must search for the right policy that *reacts* to the evolution of the system rather than *pushing* it in a desired direction. To this end, an important contribution could be offered by ABMs that could allow enable us to 'test' the outcomes of policy interventions.

Of course not all areas of government activity are complex, and for those areas that are not, a more traditional, directive approach is likely to be best. But these areas are often not where the most pressing challenges lie. The insights from complexity can help where other approaches are failing, and here there is a strong case for governments using them.

5. Conclusions

Traditional economics is built upon very strong assumptions that quickly become axioms. These concepts are so strong that they supersede any empirical observation (Nelson, 2002). While the other disciplines, like physics, have learned to be suspicious of axioms this change has not yet taken hold in economics, where ideas have solidified into dogmas.

The increasing complexity and interconnectedness of economic systems can no longer be neglected by economic theory and need a paradigm change in economic thinking. It is time for economists to explore entirely new approaches and combine equilibrium methods with new approaches. It is time to investigate economic phenomena – not as derived from deterministic, predictable and mechanistic dynamics – but as history-dependent, organic and always-evolving processes. Of course, it is all easier said than done, and the task looks so formidable that some economists argue that it is better to stick with the implausible but well-behaved theory of perfectly rational agents rather than to venture into trying to model the infinite number of ways agents can be irrational.

Because complexity theory implies new challenges and opportunities for policy and for managing economic crises, economics should focus attention on its innovative components for the study of economic phenomena and the implementation of public policies. In particular as economic systems consist of locally interacting agents who are all continuously pursuing advantageous opportunities, such an economy may very well be studied in the framework of complex adaptive system theory (see Anderson et al., 1988).

Complexity theory goes well beyond traditional policy and economic instruments. Attention is focused on dynamic connections and evolution, not just on fixed structure. The decision making process under complexity involves policymakers having to go beyond strict

approach is that these trajectories would not be 'equilibrium' paths and their evolution would be largely endogenous.

and traditional determinism if they wish to act efficiently. In complex systems prediction and control are generally made possible by identifying the cause-and-effect relation and then controlling the causes – so policymakers need to focus attention not only on control but also on strategies that aim to influence. The effects of different policies may be highly nonlinear, rendering history a poor guide to evaluating policy effectiveness (Durlauf, 1997) because policy implementation will depend critically on the nature of the interdependencies. ‘Economics can do better, it’s time to move on’ (Beinhocker, 2006, p. 23).

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Reply to Commentaries on ‘The Labour Theory of Property and Marginal Productivity Theory’

David Ellerman, University of California/Riverside, USA
david@ellerman.org

Abstract

Jamie Morgan’s commentary (Morgan, 2016) on my paper ‘The Labour Theory of Property and Marginal Productivity Theory’ (Ellerman, 2016) and Ted Burczak’s later comments (Burczak, 2016) raise a number of issues that surely will occur to other readers and that need to be addressed. I take the occasion to expand upon the arguments and to explore some related issues. In the narrative that unfolds, Frank H. Knight plays the role of the sophisticated defender of the system of renting, hiring and employing human beings. He was quite clear that the social role of economics is to develop an idealised model, the competitive free enterprise model, and then to frame the normative discussion in terms of that model. Knight would agree with the whole thread of heterodox ‘criticism’ that the actual economy falls far short of the ideal – which is why I largely eschewed the descriptive shortcomings of ideal model as a purported model of the actual economy. Instead my paper focused on developing a critique of the key part of the *idealised* model, the marginal productivity theory of distribution under competitive conditions. That critique is based on the usual juridical principle of imputing legal responsibility in accordance with factual responsibility – the principle whose property-theoretic application is the modern treatment of the labour theory of property.

Historically, heterodox economics faced a fork in the road in the 19th century: whether to criticise ‘the system’ by developing the inchoate ‘labour theory’ as a theory of value or a theory of property. Marx and much of left-wing economics took the labour-theory-of-value road, whereas my paper is part of a modern attempt – Thomas Hodgskin (1832) being an earlier attempt – to take the labour-theory-of-property road. As we will see, much of the debate still revolves around these two roads.

Keywords: labour theory of property, power relations, employment system of renting persons, Marxism, theories of exploitation, the corporate legal form

1. Introduction

I am grateful to both Jamie Morgan and Ted Burczak¹ who made substantive comments on and raised good questions about my paper, ‘The Labour Theory of Property and Marginal

¹ Full disclosure: Ted Burczak is a long-time supporter of the modern treatment of the labour theory of property as expressed in his book *Socialism after Hayek* (2006). The late dean of American institutional economics (whose specialty was theories of property), Warren Samuels, read the book and supplied the dust-jacket blurb that read in part: ‘Burczakian socialism = (Hayek + Nussbaum + Sen + Ackerman + Resnick and Wolff) = Ellerman = legal-economic democracy. Brilliant!...’ I credit Burczak’s book with helping Samuels to fully understand that treatment of the labour theory of property. When he died, Samuels was at work on the second draft of a paper entitled: ‘On Precursors in the History of Economic Ideas: Is Karl Marx a Precursor of David Ellerman?’ (2007). We were in disagreement about the paper since I was in favour of the ‘fork-in-the-road’ imagery and argued that a whole lot of misunderstanding would result from presenting Marx’s labour theory of value as a ‘precursor’ along the same road as the modern labour theory of property. Some quotes from Samuels’ unpublished paper are in Ellerman (2014). My objections were summarised in my later paper on Marx (Ellerman, 2010).

Productivity Theory' (Ellerman, 2016) on the *Economic Thought* Open Peer Discussion forum. Many of the points they raise will surely occur to others and really need to be addressed.

2. Power Relations and the Maldistribution of Wealth

One general point of Morgan's commentary was that my treatment of the labour theory of property (LTP) did not address power relations (typically resulting from the maldistribution of wealth). In this case, my reluctance to go charging into the swamp of discussions about economic, political, sociological and psychological 'power relations' was deliberate. The fact that most real-world contractual relations involve inequalities of power and wealth is surely a truism. The real point is that power relations are irrelevant to the critique provided by LTP since it is *not* a critique based on unequal power relations and thus the critique would not be resolved by, say, wealth redistributions or more countervailing power to collectively bargain the human rental contract.

There is a logical or methodological point at stake here. The point is that if one is going to criticise a practice or a whole system *because of X* (e.g., unequal power relations or the maldistribution of wealth), then one is implicitly accepting the framing that this X-critique of the practice or system would be resolved if X was removed. If a defender of the system posits a version without X and the critic says, 'It's still wrong,' then the defender is well justified in asking: 'Why don't you tell me the real reason why you think the system is wrong, and stop engaging in apparently ancillary discussions about X?'. Morgan says the presentation of LTP is perhaps 'incomplete' because it lacks this sort of ancillary discussion about X = unequal power relations.

In contrast, neoclassical theory does have a theory about power relations expressed in the juxtaposition between the ideal of competitive markets on the one hand and monopolistic/monopsonistic markets on the other. There is also a neoclassical theory of exploitation which applies to the non-competitive case which would fall short of the ideal since input suppliers would be paid less than the value of the marginal product of their inputs and output buyers would pay more than the marginal cost of the outputs. Thus neoclassical theory does have a theory based on power relations, the power of a monopsonistic buyer of inputs or a monopolistic seller of outputs.

The neoclassical apologists for the employment system would like nothing better than to have an excuse to avoid the main point about the inalienability of responsible agency in favour of engaging with critics in endless discussions about the economic, political, sociological and psychological nuances of power relations – in addition to the usual discourse about making markets more competitive. I made it quite clear the LTP critique was *not* based on such power relations and such resulting 'exploitation', and I take that to be a virtue of the theory, not a vice.

Ted Burczak raises a related point about the causal relationship between the maldistribution of wealth and the employment relation.

'Is the employer-employee relationship really the cause of income and wealth inequality (as the outcome of labour leveraging) or is the employer-employee relationship the result of unequal distribution of productive assets?' (Burczak, 2016).

Surely the answer is that the causal relationship is one of circular causation (as Gunnar Myrdal called it) in a case of self-reinforcing 'positive' feedback.

This raises a second methodological point. When asking a question about our system of renting people, it may be very helpful to transpose the question to one about the earlier system of owning other people, i.e., slavery.

For the question in hand, there was also a relationship of circular causality between unequal power relations (e.g., between victor and vanquished in battle) and slavery (e.g., enslaved prisoners of war). Greater power created more enslavement, and more slaves (as soldiers and workers) created greater inequalities of power. Surely one can recognise that circular self-reinforcing dynamics in either the case of owning or renting other people without therefore concluding that the problem lies in the unequal distribution of power. Would voluntarily owning or renting other people be acceptable if it arose, for whatever reason, out of essentially equal power relations? The analysis based on the labour theory of property and inalienable rights would apply just as well in that case of essentially equal power relations so I did not engage in such an ancillary discussion – although the commentators have good grounds to raise those questions explicitly.

3. The Consequences of Abolition

Burczak raises a related question about the consequences of abolishing the system of renting people (e.g., by a constitutional amendment) while leaving intact 'given the current distribution of wealth'.

The first point to make is that while the maldistribution of wealth is not 'the problem' *per se* in the institution of renting people, the critique of the misappropriation of the whole product (whose value is the profits) in the employment system is, *by the same token*, a critique of the past misdistribution of wealth *resulting* from that 'institutional robbery' (there are, of course, other unjust sources of wealth such as conquest, violence and ordinary uninstitutionalised fraud and robbery). Hence the abolition of renting people in the future would not, by itself, address the even trickier question of rectifying past robberies. It would be like abolishing slavery while leaving the whole *ante-bellum* system of wealth intact, e.g., not supplying '40 acres and a mule' to the freed slaves, which is exactly what happened historically.

This reaches to second part of Burczak's point:

'Could it be possible that many of us would be better off (in terms of material standard of living) to allow the rich to hire the non-rich into employment relationships, thus mitigating the desirability of abolishing wage-labor?' (Burczak, 2016).

Using my second methodological point, we can transpose the question back to slavery to see a similar problem for the freed slaves.

'But the sanctity of personal freedom in Western legal systems, the doctrine of inalienable rights, makes it impossible for a person effectively to pledge his future earning power in exchange for present resources' (Knight, 1947, p. 152).

The freed slaves, lacking the freedom to sell or mortgage themselves by the doctrine of inalienable rights, lacking the necessary capital due to the Radical Republican proposal of '40 acres and a mule' failing in Congress, and possibly lacking some of the knowledge and skills

to operate as independent farmers, resulted in many becoming sharecroppers and debt peons (often to their former masters) – a milder ‘slavery by another name’.

Burczak considers a concrete example.

‘For instance, if the law prevented my relatively richer (in capital and talent) local roofing contractor from hiring employees and if, as a result, that contractor only accepted self-directed tasks that s/he could complete alone, leaving the potential employees even poorer in an absolute material sense, why would we want to embrace such a legal regime?’ (Burczak, 2016).

Firstly, it should be noted that in the Yugoslav socialist version of ‘self-management’, the small family/craft businesses were allowed on simple pragmatic grounds to have a few (e.g., up to five) non-member workers.

Secondly, even with a universal requirement of, say, the worker cooperative form of business, there is always a tendency to reproduce the employment relation by having a semi-permanent class of temporary or probationary workers who are not members – as is happening around the edges of the Mondragon cooperatives. That may well be the outcome of the roofing contractor if the cooperative requirement was imposed without other changes.

In the US today, we still have the legacy of slavery over a century-and-a-half after the abolition of slavery (without the broader changes) and where the freed slaves were only a small portion of the population. It is difficult to imagine the changes that should be made after centuries of the human rental system and where the ‘unrented’ workers would constitute ‘the great mass of the population’ (Knight, 1965, p. 271). The relatively smaller changes to go from subjects in a monarchy or other autocratic government, to citizens in a political democracy is still a work in progress in the industrialised countries and still has a long way to go in much of the world.

4. Basic Neoclassical Apologia Based on Voluntariness, not Absence of Power Relations

Furthermore, the *basic* neoclassical-Austrian-classical-liberal defence of the system of renting, hiring or ‘employing’ people is not that markets are ideally competitive (when they really aren’t) but that the market contractual relations are *voluntary*. Unfortunately, most of the left-wing criticism argues that wage labour is $X =$ ‘not really voluntary’ – which is superficial because it accepts the classical liberal framing that human rentals would be acceptable if they were ‘truly’ voluntary. And then defenders and critics of the system can again charge off with swords waving into the bog of arguments about whether or not unequal power relations prevent market contracts from being ‘really’ voluntary.

One way to better understand the neo-abolitionist critique of a truly voluntary contract to rent persons (Ellerman, 2015), is (using the second methodological point) to transpose the arguments back to a hypothetical economy based on civilised voluntary slavery contracts. The most sophisticated defenders of slavery argued in favour of an idealised system of implicitly or explicitly voluntary self-enslavement contracts in which the employer could buy labour by the working-lifetime instead of just for specified periods of time. They recognised that the existing system of slavery often fell far short of that and they wanted to reduce those abuses.

Who were some of those sophisticated defenders of voluntary slavery contracts? The most sophisticated modern defender of the human rental system was Frank H. Knight who

pointed out that Adam Smith's classical liberal defence of competitive markets was built on a foundation provided by the three pillars of classical liberal thought.

'The classical exposition of the new doctrine in its positive aspect was Adam Smith's *Wealth of Nations*, published in 1776. Interestingly enough, the political and legal theory had been stated in a series of classics, well in advance of the formulation of the economic theory by Smith. The leading names are, of course, Locke, Montesquieu, and Blackstone' (Knight, 1947, p. 27, fn. 4).

As I have pointed out elsewhere (e.g., Ellerman, 2010a, 2015b), all three of these founders of classical liberal thought *accepted* a civilised voluntary slavery contract. Locke's defence of such a contract, which he renamed 'drudgery' (*Second Treatise*, §24), is too well known to quote, but the passages from Montesquieu and Blackstone are little known.

'This is the true and rational origin of that mild law of slavery which obtains in some countries; and mild it ought to be, as founded on the free choice a man makes of a master, for his own benefit; which forms a mutual convention between two parties' (Montesquieu, 1912 [1748], Vol. I, Bk. XV, Chap. V).

Like Locke and Montesquieu, Blackstone would reject an uncivilised 'contract' where the master had the power to legally kill the slave and such a slave would be free 'the instant he lands in England'.

'Yet, with regard to any right which the master may have lawfully acquired to the perpetual service of John or Thomas, this will remain exactly in the same state as before: for this is no more than the same state of subjection for life, which every apprentice submits to for the space of seven years, or sometimes for a longer term' (Blackstone, 1959 [1765], section on 'Master and Servant').

In spite of being defended by Knight's 'great names' in classical liberal thought (not to mention modern libertarians such as Harvard's late Robert Nozick (1974)), the voluntary master-slave contract is today recognised as being invalid in the advanced democracies. What are the reasons why it is outlawed?

- Was it because the real wages (paid in food, clothing, and shelter) of the slaves were below the value of their marginal product (or contained less labour-time than was expended by the slaves) – which would only imply higher real wages?
- Was it because of the hugely unequal power relations between the prospective masters and slaves – which would only argue for some countervailing power on behalf of the slaves?
- Was it because of the obscenely unequal distribution of wealth and income between masters and slaves – which would argue for redistributive policies like the more progressive income taxes, larger estate taxes, and perhaps a guaranteed minimum income suggested by today's progressive reformers to address today's human rental system?

No, these were not the reasons why that voluntary contract was *abolished* (as opposed to being modified or reformed in the above indicated ways). The self-sale contract, like today's self-rental contract, is invalid for reasons inherent in the contract itself, not because of the inevitable inequalities in power relations used to get people to consent to it. I have elsewhere (1992, 2010a, 2015a) outlined the intellectual history of the inalienable rights doctrine that descends to modern times from the Reformation (inalienability of conscience) and the Enlightenment through the abolitionist and democratic movements. That critique also applies to the voluntary human rental contract that is the basis for today's employment system. This neo-abolitionist critique is not grounded on the X of power relations (or non-competitive markets in the neoclassic proffered self-critique) – or for that matter on the whole train of X, Y, and Z abuses so well described by Marx the economic sociologist/historian in his volumes of moral invective² that covered up for the lack of a sound theoretical critique based on the labour theory of value and exploitation.

Frank Knight was annoyed with, and suspicious of, the whole idea of inalienable rights; if there was something inherently wrong with buying labour on a long-term basis, then he might have correctly sensed that the same sort of argument would apply to the short-term rentals of persons – for as James Mill put it:

'The only difference is, in the mode of purchasing. The owner of the slave purchases, at once, the whole of the labour, which the man can ever perform: he, who pays wages, purchases only so much of a man's labour as he can perform in a day, or any other stipulated time' (Mill, 1826, Chapter I, section II).

Hence Knight was quick to offer a different rationale for the abolition of slavery.

'The abolition of slavery or property in human beings rests on the fact that slaves do not work as effectively as free men, and it turns out to be cheaper to pay men for their services and leave their private lives under their own control than it is to maintain them and force them to labor' (Knight, 1965, p. 320).

5. The Fundamental Myth and the *Laissez-Faire* Imputation Mechanism

Morgan's treatment of the fundamental myth was somewhat confused with the way the assets and liabilities created in production are imputed in the absence of any legal trial (the *laissez-faire* mechanism of imputation).

Firstly, the fundamental myth is not part of the legal system (since capital is perfectly rentable); it is part of the standard ideology accepted by *both* the left and right concerning the 'rights of capital'. It is the idea that the right to the product (and discretionary management rights over production) are part and parcel of the 'ownership of the means of production'. The idea is easily defeated by pointing out that in our present system, capital goods are just as rentable as persons, and the legal party that ends up owning the product and managing the process of production is determined by who rents what or whom. In short, 'being the firm' is a contractual role determined by the pattern of contracts (e.g., capital hiring labour rather than the reverse – which of course depends in part on power relations). It is not a prior property

² As Albert O. Hirschman put it, Marx's 'works exhibit a simple juxtaposition of scientific apparatus and moralistic invective, wholly *unversöhnt*' [unresolved] (Adelman, 2013, p. 570).

right – as seems to be indicated by the common phrase ‘ownership of the firm’ as if residual claimancy is already ‘owned’ prior to market contracts being made one way or the other.³

The fundamental myth is not a part of the legal system but it *is* part of neoclassical capital theory and corporate finance theory (see Ellerman, 1992) and is apparently accepted, or perhaps not even noticed, by the purported heterodox Cambridge critics of capital theory (Harcourt, 1972) who only criticise orthodox capital theory because of $X =$ aggregate notions of capital, reswitching, and all that.

The second point is about how the property system works – how it imputes the liabilities for the used-up inputs and the ownership of the produced outputs in the normal operation of *any* private property market economy (such as a labour-managed market economy with the human rental contract abolished). Somehow in Morgan’s treatment of this mechanism, there was no mention of the input liabilities (the negative product) which together with the produced outputs (the positive product) comprise the ‘whole product’.

The algebraic symmetry in the concept of the whole product (what neoclassicals just call the ‘production vector’) seems to be a particularly difficult point for anyone to understand. One does not have to be a mathematician to know about negative numbers in addition to positive numbers. One does not have to be an accountant to know about expenses in addition to revenues. And one does not have to be a neoclassical economist to understand that inputs are used up in addition to outputs being produced in production. Why is it so difficult to think in an algebraically symmetric manner about production?

The *laissez-faire* imputation mechanism is *not* a system where someone grabs the produced outputs and the Law says, ‘Let it be’. It is the system where one party has already paid all the costs (i.e., appropriated the negative product) and then the Law says, ‘Let it be’ when that same party sells the produced outputs. Thus the Law or ‘Invisible Judge’ imputes the whole product to that one party who got into the contractual position (thanks to the human rental contract) of being the last owner of the input services used up in production (treating the productive activity of the people working in the firm as one of those used-up inputs) and thus was in the defensible position to claim and sell the produced outputs.

The market imputation mechanism has nothing to do with the fundamental myth. But there is something ‘fundamental’ associated with that market mechanism of imputation, namely the Fundamental Theorem (unmentioned by Morgan) which gives the conditions such that *laissez-faire* imputation would be in accordance with the basic juridical principle of imputing legal responsibility according to *de facto* responsibility, i.e., would be in accord with the modern treatment of the labour theory of property. Those conditions and the theorem are outlined in the paper (see Ellerman, 2014 for more details). The final part of the paper shows how the renting of persons inherently violates those conditions due to the *de facto* inalienability of responsible agency. Thus the ‘natural system of private property and free contracts’ is in fact based on the inherently invalid human rental contract (whose longer-term version is already abolished) which allows ‘an institutional robbery – a legally established violation of the principle on which property is supposed to rest’. This quote is from John Bates Clark (in the paper) when Clark confidently thought that marginal productivity theory would ‘seal the deal’ for the idealised competitive human rental system and show it was not an institutional robbery.

³ As a personal aside, I am embarrassed to note that I was in the thrall of the fundamental myth when I first published on this topic in the pink of youth (Ellerman, 1973) and it took a couple of years to work my way out of it. To understand the market mechanism of appropriation, one needs to first understand that product rights are not already part of the ‘ownership of the means of production’ – which is why the whole question of appropriation in production rarely comes up in the conventional literature. The whole question is supposedly already settled by the ‘ownership of the means of production’ or in the equivalent non-Marxist phrase, the ‘ownership of the firm’.

Morgan also argued that by focusing on the institutional robbery at the root of the human rental system, I was somehow neglecting the grotesque mal-distribution of wealth, that:

‘... is a source of power, which in turn is rooted in socio-economic relations and is manifested in influence. This, for example, is basic to Piketty and many others’ argument regarding the institutional problems of wealth and income inequality...’ (Morgan, 2016, p. 41).

In terms of the historical analogy, by focusing on the underlying master-slave relation, one is ‘neglecting’ the mal-distribution of wealth between masters and slaves (and the resulting power/socio-economic relations) which could be addressed by more progressive taxes and social redistributive programs. One should differentiate the root of the problem from the symptoms. Just as one can have financial leverage by renting other people’s money and getting its returns, so one can have human leverage by renting other people themselves and thereby appropriating the (positive and negative) fruits of their labour. The grotesque mal-distribution of wealth and income today results from (i.e., is the accumulated symptoms of) centuries of institutional robbery by thus ‘leveraging’ human beings, first in the system of owning other people, and more recently by the current system of renting other people. And in the aforementioned circular causation, that maldistribution of wealth and power will ensure that the human rental system survives to include the next generation.

Yes, the maldistribution of wealth and income is ‘basic to Piketty’ and to similar progressive and even left-leaning Nobel-prize-winning economists. But that is a focus on the accumulated symptoms or effects, not on the root cause, and their various redistributive palliatives do not reach to the root – which is the whole institution of the renting of human beings. In terms of the historical analogy, a redistribution of *antebellum* wealth in favour of the slaves (surely, a good thing), while keeping the institution of ownership of other persons intact, would not get to the root of the problem. Morgan is correct that my neo-abolitionist focus on the root cause may seem to some as being ‘incomplete’ without some fashionable hand-wringing about all the accumulated symptoms.

6. Personhood

On the basic issue about the inalienability of responsible agency, Morgan notes that this is:

‘... at root an argument concerning the nature of personhood, the nature of what it means to be human. It is an ontological claim. So one might also note that Ellerman’s case – in at least its normative dynamic – requires a clear ontological argument regarding the nature of personhood (and species-hood), and the possible consequences of personhood for socio-economic forms, including the case for economic democracy’ (Morgan, 2016, pp. 41-2).

Morgan is certainly correct as a matter of moral philosophy and I have written extensively about this elsewhere (1988, 1992). But the social scientist can take a more modest stand by not arguing the moral philosophical question of whether or not a certain principle is right or wrong, but by arguing the analytical/factual question of whether or not a given system violates a certain principle (regardless of what one thinks about the principle).

Consider the case of Milton Friedman who was a great advocate of 'positive economics' and who at the same time argued that the idealised competitive system involving human rentals satisfied 'the ethical proposition that an individual deserves what is produced by the resources he owns' (Friedman, 1976, p. 199). Friedman did not try to philosophically argue for the supposed principle, which he called the 'capitalist ethic' (Friedman, 2002, p. 164); he only argued that the competitive system in fact satisfied the principle. Or consider Frank Knight who argued that the competitive system satisfies:

'... justice by the principle of equality in relations of reciprocity, giving each the product contributed to the total by its own performance ("what a man soweth that shall he also reap")' (Knight, 1956, p. 292).

One can argue against their assertions, as I do in the paper, without indulging in a moral argument over the principle 'what a man soweth that shall he also reap'.

In fact, I think it is largely a waste of time to dive into moral philosophy and argue with the intellectual hirelings of the employment system over the moral principle of 'what a man soweth that shall he also reap' or the moral status of institutionally treating persons as things. Nor is that necessary. One only has to show that the system of renting persons violates that principle and treats persons as things since the employees (*qua* employees) in an employment firm owe zero percent of the negative fruits of their joint labour (the input-liabilities) and own zero percent of the positive fruits of their joint labour (the output-assets) – exactly the legal role of rented things.

The defenders of the faith in the 'science of economics' are perfectly free to disagree with the moral principles at stake by saying, 'Yes, employees have the institutional role of rented things, but that is OK' or 'Yes, employees appropriate zero percent of the (positive and negative) fruits of their labour, but that is OK'. However, I think the defenders of the faith will wisely choose to just avoid this whole set of arguments. When they want to prove their value to their social masters by doing intellectual battle with critics of the system, they will search for some member of the dwindling band of Marxian economists to serve as their foil (Ellerman, 2008, 2010c) in arguments about whether or not 'wages are too damn low' due to power relations in non-competitive markets, about the labour theory of value, or about abolishing the 'private ownership of the means of production'.

Furthermore, one of the dogs that didn't bark in Morgan's commentary was my whole discussion of marginal productivity theory (MPT) which was one of the main points of the paper since I have written about the LTP extensively elsewhere (Ellerman, 1992; 2014). In particular, there was no commentary on the stunning success of neoclassical theory to get liberal-progressive thinkers to implicitly accept the *metaphorical* application of the responsibility principle in MPT as correct in theory, since 'critics' such as Lester Thurow (1975), John Rawls (1971), and Steve Keen (Chapter 6, 2011) only attack such things as X = measurement difficulties in practice, X = non-competitiveness of labour markets, and X = the background mal-distribution of wealth – all of which were long ago acknowledged by sophisticated defenders of the system of human rentals such as Frank Knight.

This raises a more general point. Many heterodox economists, and progressive thinkers in general, take it as given that the social role of economic theory is to be a descriptive science, and then they castigate orthodox economics for being so unrealistic, e.g., the above mentioned 'criticisms' of marginal productivity theory. But to understand the social role of economic theory, one has to consult a thinker of the depth and forthrightness of Frank Knight who openly acknowledges that 'economic theory is not a descriptive ... science'. There you have it; the secret is out. As Knight explains:

'Economic theory is not a descriptive, or an explanatory, science of reality. Within wide limits, it can be said that historical changes do not affect economic theory at all. It deals with ideal concepts which are probably as universal for rational thought as those of ordinary geometry' (Knight 1969, p. 277).

The point of orthodox economics is:

1. to outline an idealised system, i.e., the free enterprise, free market, competitive private property system (including human rentals of course), and then
2. to frame the whole normative discussion in terms how to get the real-world economy to better approximate that idealised model.

Heterodox economists who think they developing a 'critique' of the system by showing how the 'ideal concepts' so poorly describe the actual economy are, in fact, working well within the orthodox paradigm. In fact, 'everyone' (including orthodox economists) knows that the ideal concepts are poor descriptors; that was never their purpose.

In order to critique the system, one needs a critique of the *ideal* model, not simply another banal recital of how the actual economy falls short of the ideal model. Marginal productivity theory plays a key role in showing how the idealised model would allegedly satisfy the demands of justice in distribution. The point of my paper was to use the labour theory of property (the property-theoretic version of the juridical principle of imputation) to show that the idealised model of the free enterprise, free market, competitive human rental system does not satisfy the principles of justice *even in theory*. Hence the paper did not discuss difficulties in actually measuring marginal productivity or imperfections in the labour market. It did not discuss the fact that almost all actual markets are not competitive or that the given prior distribution of property can hardly be assumed to be just, or all the other points that are easily acknowledged by sophisticated defenders of the human rental system such as Frank Knight.

7. Kirzner's Entrepreneurship Theory

Burczak's third point is that:

'There is an argument, made for instance by Israel Kirzner (1974), that the hiring party is the responsible agent of production and, thus, the rightful appropriator of the entire product (i.e., the output assets and input liabilities)' (Burczak, 2016).

The hiring party is, of course, the *legally* responsible party who, by bearing the legal liabilities involved in production, has the *legally* rightful claim on the outputs. That is a correct description of how the market system of appropriation works. The question, however, is about the *factual* responsibility.

Kirzner's theory is built on the image of the entrepreneur as arbitrager. The entrepreneur in production is seizing an opportunity to arbitrage between input and output markets, which is seen as being more complicated than, but not differing in kind from, an arbitrager in commodity markets. There is no questioning of the contracts involved (e.g., the

human rental contract) as if the contracts were no more problematic than buying and selling wheat or crude oil in commodity markets. There is no argument that *de facto* responsible agency has somehow been actually alienated by the employees; the whole question is not even raised.

Frank Knight was a more sophisticated defender of the human rental system in addition to anticipating the essentials of Kirzner's theory.

'Under the enterprise system, a special social class, the business men, direct economic activity; they are in the strict sense the producers, while the great mass of the population merely furnish them with productive services, placing their persons and their property at the disposal of this class; the entrepreneurs also guarantee to those who furnish productive services a fixed remuneration' (Knight, 1965 [1921], p. 271).

And Knight faces up to the point that the rented workers have the legal role of rented instruments by arguing that this is essentially the factual situation.

'It is characteristic of the enterprise organization that labor is directed by its employer, not its owner, in a way analogous to material equipment. Certainly there is in this respect no sharp difference between a free laborer and a horse, not to mention a slave, who would, of course, be property' (Knight 1965, p. 126).

Kirzner may approach this perspective when he, like much of the popular business press, treats the entrepreneur as some sort of *ubermensch* who has such powerful creative agency that everyone else involved in the enterprise is, in comparison, a drone-like piece of material equipment. I take that aspect of Knight's and Kirzner's apologia – that the other humans working in an enterprise are factually like employed material equipment – to be beneath criticism like the slavery apologists' view that the slave was factually a beast of burden like Knight's horse.

8. Marx and the Wage System

I pointed out that Marx's exploitation theory, even if successful, only concluded that 'wages are too damn low' which is not a critique of the wage system *per se*. However, Burczak comments:

'Finally, Marx was pretty clear about seeking to abolish the wages system, rather than advocating higher wages in an employment system' (Burczak, 2016).

Yes, Marx was clear on seeking to abolish the wage system. The first point is that Marx was also clear on seeking to abolish 'private ownership of the means of production' and the result has been that every revolution made in Marx's name has resulted not in abolishing wage labour, but only in nationalising it. Secondly, I was not talking about Marx's views but his theories. Marx only brought a value theory (plus a lot of non-theoretical moral invective) to a property-theoretic fight – so it would not do the job, even if successful as a theory of value and exploitation.

A similar example is John Rawls (Ellerman, 2010a). Aside from spending a lifetime writing about justice without once considering the human rental contract as being inherently problematic, Rawls also shared the Harvard Philosophy Department with Robert Nozick who advocated that a 'free system' should allow a person to voluntarily sell himself into slavery (1974, p. 331). No one would doubt that Rawls' personal view was against allowing such a civilised slavery contract, but the remarkable thing is that Rawls' theory of inalienable rights (such as it was) does not rule it out. Rawls refers to Montesquieu's argument that one cannot alienate *all* one's rights as they are 'beyond all price'. But as noted above, Montesquieu goes on to approve alienating some basic rights in a mild form of voluntary slavery. And Rawls similarly goes to hold:

'This explanation of why the basic liberties are inalienable does not exclude the possibility that even in a well-ordered society some citizens may want to circumscribe or alienate one or more of their basic liberties' (Rawls, 1996, p. 366).

'Unless these possibilities affect the agreement of the parties in the original position (and I hold that they do not), they are irrelevant to the inalienability of the basic liberties' (Rawls, 1996, p. 367, fn. 82).

So while Rawls' personal views were no doubt against such a contract, his *theory*, like Montesquieu's, left plenty of room for Nozick.

Burczak's last point is that:

'Perhaps contemporary Marxists are a dwindling group, but a large subset of them supports cooperative production relationships, very much like David Ellerman (e.g., Jossa 2014, Wolff 2012)' (Burczak, 2016).

It should first be noted that Marx and Marxists have always supported cooperative production – as the Bolsheviks 'supported' the worker soviets – as a transitional institution to full socialism. In the whole sorry history of Marxian socialism in the 20th century, there was not a single Marxist revolution that established a market economy of worker cooperatives (although Yugoslav eventually tried out a muddled hybrid) or even a multi-party political democracy (not even Yugoslavia). Real-existing Marxist socialism was always a system of near-universal state employment as, for instance, in Cuba which only in the last few years has started to 'allow' non-state worker cooperatives.

In today's world, it seems that many heterodox thinkers have bonded with the word 'socialism' in the pink of youth, e.g., Bernie Sanders who self-sabotaged his U.S. presidential campaign by trying to validate his youthful bonding with the word by redefining Scandinavian social democracy as 'democratic socialism' (which in the U.S. is considered an oxymoron). But Marxian socialism has always had the *sine qua non* of 'government' or, excuse me, 'social' ownership of the means of production. Marxists such as Richard Wolff and Bruno Jossa interpret 'cooperative production' as meaning 'worker self-management' at least on the shopfloor coupled with 'social ownership of the means of production' (in some muddled remix of the Yugoslav socialist system). What could go wrong with that?

In terms of characterising different systems, Marxist socialists, like Jossa, take the 'ownership of the means of production' as the key differentiator, not the renting of persons (wage labour). If wage labour were the criterion, then Jossa and Cuomo see a *reduction ad absurdum* since:

'If this definition is accepted, the system with publicly-owned production means and centralized planning is a form of capitalism' (Jossa and Cuomo, 1997, p. 113).

Imagine that; Soviet or Chinese communism being seen as essentially a form of state capitalism! They continue:

'This classification contradicts a long tradition of thought; and it is also for this reason that it can barely be assumed to be the most acceptable one. The other possibility is to adhere to the classical distinction between firms with privately-owned production means and firms with publicly-owned production means. In this case one will have capitalism on the one hand and two or more forms of socialism on the other: and provided the Soviet socialist model is not viewed as an 'ideal type' ..., these forms of socialism are reduced to no more than three...: (i) the Lange-Taylor model, (ii) socialism with autonomous firms run by managers, and (iii) socialism with labour-managed firms' (Jossa and Cuomo, 1997, p. 113).

The last version (iii) is the Marxist socialist version of 'cooperative production'. In contrast, genuine worker cooperatives, like the Mondragon cooperatives, are *private* democratic organisations.

Marx's notion of the 'ownership of the means of production' (as including the right of management and ownership of the product) played the key role (not wage labour) in his thought as Jossa and Cuomo explain. And it is perhaps Marx's greatest blunder (as explained in the whole previous discussion of the fundamental myth). In Medieval times, the ownership of land was seen as including the ownership of the product of the land and the governance of the people living on and working the land. The landlord was the Lord of the land. Marx's blunder was to carry over that feudal notion of 'ownership' from land to capital, the 'ownership of the means of production.'

'It is not because he is a leader of industry that a man is a capitalist; on the contrary, he is a leader of industry because he is a capitalist. The leadership of industry is an attribute of capital, just as in feudal times the functions of general and judge were attributes of landed property' (Marx 1977, pp. 450-451).

But in the human rental system, the right to govern people in production is legally based on the employment contract, and the right to the (positive) product goes to the party who has already appropriated the negative product (i.e., paid the costs of production including the wages) so those rights are attached to the contractual role of being the hiring party and are not part and parcel of the 'ownership of the means of production' (which is why that view is a myth, the fundamental myth). Marx's view that the management and product rights are part of capital also accounts for the misnomer of 'capitalism' to denote the human rental system.⁴

⁴ I no longer use the word 'capitalism' to denote the human rental system for the second reason that a critic of 'capitalism' is automatically assumed to be a critic of private property. Quite the opposite, the critique of 'capitalism' on the basis of the labour theory of property is a critique in the name of a just private property system based on the most legitimate reason for property appropriation, namely people getting the fruits of their labour. To paraphrase Gandhi, 'I think private property *would* be a good idea' –

As one might expect, Frank Knight, was quite clear on ‘capitalism’ being a misnomer and that the employer-entrepreneur may not be the owner of the capital, i.e., may not have the ‘ownership of the means of production’.

‘Karl Marx, who in so many respects is more classical than the classical themselves, had abundant historical justification for calling, i.e., miscalling – the modern economic order “capitalism”. Ricardo and his followers certainly thought of the system as centering around the employment and control of labor by the capitalist. In theory, this is of course diametrically wrong. The entrepreneur employs and directs both labor and capital (the latter including land), and laborer and capitalist play the same passive role, over against the active one of the entrepreneur. It is true that entrepreneurship is not completely separable from the function of the capitalist, but neither is it completely separable from that of labor. The superficial observer is typically confused by the ambiguity of the concept of ownership’ (Knight, 1956, p. 68, fn. 40).

Thinkers who, in their mature thought, have not managed to fight their way out of the paper bag of the simplistic Marxist notion of the ‘ownership of the means of production’ (as including product and management rights) are hardly in a position to understand the restructuring of property and personal rights in a *private* worker cooperative (Ellerman, 1984). In a worker cooperative or democratic firm, the worker’s membership rights are personal rights (not property rights that, for instance, could be sold or bequeathed) based on their inalienable rights to the joint private ownership of the fruits of their labour and on their own inalienable rights of self-governance – not on product and ‘self-management’ rights delegated from the benevolent ‘social’ owners of the means of production.

9. The Corporation as a ‘Deeply Problematic’ Legal Entity

The last major point raised by Morgan is about the corporation as a ‘deeply problematic’ (Morgan, 2016, p. 39) legal entity and the whole corporate governance debate. I did not directly address these issues in the paper but I am glad to briefly comment on them. I am afraid that much of the progressive commentary attacking the very idea of a corporation as a separate legal party (i.e., separate assets and liabilities from the individual members) is largely superficial and the policy recommendations that follow from the arguments would be quite counterproductive.

Here in the United States, these arguments are often focused on the *Citizens United* case which many critics think was based on the argument that corporations are legal ‘persons’ and thus should have the same constitutional rights as natural persons – even though the judge writing the dissenting opinion noted specifically that this was *not* the argument (Ellerman, 2010b). The policy recommendation drawn from this ‘criticism’ is that only *natural* persons should have the rights of free speech by way of making political campaign contributions. No policy would be better for the super-rich 1% than this silly idea wherein, to echo Anatole France’s sarcasm, the average person on the street and one of the Koch brothers would each have an equal right to as much public voice as they could individually afford. Any legal organisation which might amplify the public voice of ordinary

as opposed to the property-is-theft system (Proudhon) based on renting human beings so as to appropriate the fruits of their labour.

citizens by joining them together in a labour union or a non-profit NGO would also *not* be a natural person and thus would also be forbidden, along with conventional corporations, from constitutionally protected associational speech in the form of campaign contributions.

Far from being ‘deeply problematic’, the basic idea of a corporation as a separate legal party from its members is an important social invention (e.g. to foster risk-taking innovation). It should not be attacked simply because it is the most common legal shell for institutional robbery of the whole system of renting persons (which is just as ‘problematic’ when the employers are natural persons or partnerships). The corporate form should be preserved for the democratic, labour-managed firms of the future after the abolition of the human rental contract, and it is the form for the fledgling worker cooperative corporations of today, e.g., those incorporated under cooperative *corporation* law such as the law I co-drafted for Massachusetts back in the early 80s (Ellerman and Pitegoff, 1982).

The long quote by John Kay (Morgan 2016, p. 40) from the *Financial Times* is also typical of the superficial analysis and criticism of the corporate form. Kay makes the point that shareholders are not really ‘owners’ since they can’t just walk into ‘their’ corporation and grab something as their personal property and use it to pay off a personal debt. But that is a banality – true in a worker cooperative or in any other organisation (e.g., any club, association, or NGO) that is a separate legal party from the individual member – so it has little to do with corporate governance debate.

Kay also makes the point that the shareholders’ right to appoint the directors who select the managers is only ‘theoretical’. This is the common lament about the separation of ownership and control in the large, publicly-traded corporations so that the ‘shareholders’ democracy’ exists only in theory, not in practice. But the nontrivial point that one will not find in the *FT* is that ‘shareholders’ democracy’ would not be democratic even if it did exist in practice.

The simple reason is that democracy is the collective form of *self*-government, and the people being managed by the directors and their managers are the people working in the corporation, not the far-flung shareholders. The so-called ‘shareholders’ democracy’ if it existed in practice, not just in theory, would be like the people of Russia going through a whole set of vigorous discussions, deliberations, and debates and then voting to elect the government of Poland. But, alas, as liberal critics would lament, such a ‘democracy’ would only be ‘theoretical’ in Kay’s words if the voting rights of the Russian people to elect the government of Poland were usurped by the unaccountable nomenklatura of the Communist Party. Unfortunately, the real critique of the corporate governance debate about ‘shareholders’ democracy’ will not be found in the writings of liberal critics like John Kay or printed in the pages of the *FT*.

I have written at length over the decades about how differently a democratic corporation would be structured (Ellerman, 1984; 1990). But contrary to the apparent policy recommendation of the book (Tombs and Whyte, 2015) referenced by Morgan and subtitled ‘Why corporations must be abolished’ – I would never suggest that the corporate form should be abolished so that the worker-members would have unlimited personal liability for their cooperative’s economic liabilities. Again, this policy recommendation would only be favourable to the rich since only they could then afford to undertake the risks of enterprise on any scale.

Apparently the real concern of Tombs and Whyte, and much of the other ‘anti-corporate’ literature cited by Morgan, is that crimes of commission and negligence committed by corporate managers might go unpunished – which is a very real fear given the extent to which the present-day legal and legislative system is suborned to the corporate employers – which is reminiscent of the way the judges, state legislatures, and politicians of the ante-

bellum South were suborned to the economic masters of that time. The underlying normative principle of that critique is that corporate managers, like other people, should be held legally responsible for their *de facto* responsible actions – a legal principle that in its application to questions of property appropriation is called ‘the labour theory of property’, the topic of my paper.

10. Concluding Remarks

I have tried to address the points raised by Morgan and Burczak, taking some occasions to expand upon the arguments and touch on broader issues. I took Frank H. Knight as my adversary-helper since he was surely one of the most sophisticated and forthright of the apologists for the human rental system and its economic theory.

One of Knight’s points was particularly relevant to the discussion, namely that economic theory aims to build an idealised model and then to frame the normative discussion in terms of that ideal. So much of the heterodox criticism focuses on the fact that the actual economy falls far short of that competitive free market ideal – instead of being focused on the ideal itself. The case in point is the crucial role of the marginal productivity theory of distribution that is so key to the claim that the ideal model obeys the principle of justice (e.g., ‘what a man soweth that shall he also reap’) – even if the reality falls short of that ideal.

The point of the paper was to change the framing from that sort of a price-theoretic argument (marginal productivity pricing of inputs) to the property-theoretic framing of: who is to appropriate the liabilities and assets created in a productive enterprise? Then applying the normal juridical principle of imputing legal responsibility in accordance with factual responsibility coupled with the non-metaphorical fact that only humans and not things can be morally or legally responsible – all leads to the rather different conclusion that all the people who work in a productive enterprise constitute the legal party who should appropriate the positive and negative fruits of their joint labour.

Some practical people, even conservatives, who have looked at the matter objectively without all the filters, blinders, and misconceptions of economic theory have come to the same conclusions.

‘Here is the most urgent challenge to political invention ever offered to the jurist and the statesman. The human association which in fact produces and distributes wealth, the association of workmen, managers, technicians and directors, is not an association recognised by the law. The association which the law does recognise – the association of shareholders, creditors and directors – is incapable of production and is not expected by the law to perform these functions. We have to give law to the real association, and to withdraw meaningless privilege from the imaginary one’ (Percy, 1944, p. 38).

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