WORKING PAPER

ITLS-WP-25-24

Introducing Money into the Framework of a General Equilibrium Model

By
Truong P. Truong [a]

[a]
Institute of Transport and Logistics Studies (ITLS),
The University of Sydney, Australia

December 2025

ISSN 1832-570X

INSTITUTE of TRANSPORT and LOGISTICS STUDIES

The Australian Key Centre in
Transport and Logistics Management

The University of Sydney

Established under the Australian Research Council's Key Centre Program.

NUMBER: Working Paper ITLS-WP-25-24

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ABSTRACT: Money is an important factor in economic activities but in a general equilibrium framework the concept of money seems to be absent. In fact money is often considered only as a 'veil' in hiding real economic activities, and therefore it has been 'lifted' out of the model so that the underlying 'real' activities in an economy can be examined more clearly. However, in practice, money is more than just a 'veil'. It can provide a platform on which many activities and/or commodities can be conceived, produced and exchanged. Money is also a store of value, not of its own, but of others, and with its purchasing-power money can enable its holder to have access to, and command the usage of, many other commodities and labour (human-time) to achieve certain objectives. Money therefore can be considered as part of the infrastructure of an economy which helps the economy to grow and prosper. In the past, economic theories of money and theories of (labour and commodity) values have looked at these two sides of an economy as though they are governed by different 'laws', but in fact, there is only one set of laws which govern both the price of money as well as the values of commodities and labour. Since money can act as a means of exchange, it therefore can also act as a constraint on this exchange. This means conceptually and mathematically, the 'value of money' is actually just the Lagrangian shadow price of this monetary constraint, but expressed in terms of the values of commodities and labour (not in terms of the 'value of money' itself, otherwise this is circular reasoning). If a 'real' economy is considered as though consisting of many different value-chains linking all activities together from producers to consumers, then money can act as the shadow price level of all these activity-chains. In this paper, we examine the interactions between the different value-chains and their shadow prices, in a general equilibrium economic model. Since monetary exchange is actually at the core of almost every economic activity in a modern economy, a study of the nature and 'values' of these exchanges is important for a better understanding of the working of a 'real' economy, and the theory of general equilibrium is a useful foundation or platform on which to conduct this study.

KEY WORDS: ***value-in-use, value-in-exchange, value of time and price of money, monetary and real economic equilibrium***

AUTHORS: **Truong**

ACKNOWLEDGEMENTS: Nil

CONTACT: INSTITUTE OF TRANSPORT AND LOGISTICS STUDIES (H04)

The Australian Key Centre in Transport and Logistics Management

The University of Sydney NSW 2006 Australia

Telephone: +612 9114 1813

E-mail: business.itlsinfo@sydney.edu.au

Internet: http://sydney.edu.au/business/itls

DATE: December 2025

1. Introduction

Money is an important factor in economic activities but in a general equilibrium framework the concept of money seems to be absent.[1] In fact money is often considered only as a 'veil' in hiding real economic activities, and therefore it has been 'lifted' out of the model so that the underlying 'real' activities in an economy can be examined more clearly. However, in practice, money is more than just a 'veil'. It can provide a *platform* on which many activities and/or commodities can be conceived, produced and exchanged. Money is also a *store* of *value*, not of its own, but of others, and with its purchasing-*power* money can enable its holder to have *access* to, and command the *usage* of, many other commodities to achieve certain objectives. Money therefore can be considered as part of the *infrastructure* of an economy which helps the economy to grow and prosper.

In the past, economic theories of *money* and theories of labour and commodity *values* have looked at these two sides of an economy as though they are governed by different 'laws',[2] but in fact, there is only one set of laws which govern both the *price* of money as well as the real *values* of commodities and labour. Since money can act as a *means of exchange*, it therefore can also act as a *constraint* on this exchange. This means conceptually and mathematically, the 'value of money' is actually just the Lagrangian *shadow price* of this *monetary* constraint, but expressed in terms of the *values* of commodities and labour (*not* in terms of the 'value of money' itself, otherwise this is circular reasoning).[3] If a 'real' economy is considered as though consisting of many different *value*-chains linking all activities together from producers to consumers, then money can act as the *shadow price* level of all these *activity*-chains. In this paper, we examine the interactions between the different value-chains and their shadow prices, in a *general equilibrium* economic model. Since *monetary exchange* is actually at the *core* of almost every

[1] "Indeed, the most mathematically sophisticated and therefore most revered theories in neoclassical economics - broadly speaking, neo-Walrasian general equilibrium theories - have had great difficulty in actually finding a place for money in their schemes. 'The most serious challenge that the existence of money poses to the theorist is this: the best model of the economy cannot find room for it.' (Hahn 1982:1)" (as quoted in Ingham (1996)).

[2] Steiger (1987, pp. 224-5, italics added) for example, remarked: "…attempts of both the dominating theories of value and the quantity theory of money to explain the value of money….had resulted in (i) a *dichotomy* of economic theory with entirely *different laws* for the *value of money* and the *value of commodities* and (ii) a theory of money which was unable to explain its postulated proportionality between changes in the quantity of money and the *price level* as the *inverse of the value of money*".

[3] See section 2.1. below.

economic activity in a modern economy, a study of the nature and 'values' of these exchanges is important for a better understanding of the working of a 'real' economy, and the theory of general equilibrium is a useful framework or foundation on which to conduct these studies.[4]

2. Theory

We consider the basic elements or stages of a value-chain in an economy by looking at the various behaviors of different agents in this value chain. Firstly, there is an initial 'exchange' between 'households' or 'individuals' in the economy with 'industry': household is to supply the 'factors of production' (consisting of 'labour' in the form of household *time,* and 'capital' assumed to be owned by the household but invested or used in an industry for production purposes).[5] The second stage of the activities is actual production in the industry rather than 'exchange', and the final stage is then exchange between industry as the supplier and household as the final buyer (or user) of the industry output.

2.1 The role of money in the first exchange between a 'domestic' household sector and an 'industry' sector.

Consider the following economic decision of an individual or household in a domestic[6] sector of an economy:

$$\text{Max} \quad U = U\left(t_h X_h, -t_w X_w, Q_d, Q_g\right) \tag{1}$$

$$\text{s.t.} \quad t_h X_h + t_w X_w = T_h + T_w \leq T \tag{2}$$

[4] Ostroy (1987, p. 187, italics added) observed: "…monetary exchange is an example *par excellence* of a universal economic phenomenon, and if there is one branch of the discipline that is suited to its study, it is certainly general equilibrium theory……the incorporation of monetary exchange *tests the limits of general equilibrium theory*, exposing its implicitly centralized conception of trade and calling for more decentralized models of exchange".

[5] For simplicity we consider only *labour* and capital as factors of production, but this should not affect the main arguments of our analysis. In future extensions we can include other inputs such as intermediate *commodities* produced by humans, as well as 'natural' *resources*, such as land and energy which are 'material objects' *supplied* by Nature rather than 'produced' or 'manufatured' by humans. The reason for our exclusion of other 'factors of production' in this paper, is because we want to concentrate just on one *source* or *genesis* of 'value' in an economy, and that is the *human* source ('capital' considered in this paper is assumed to be 'produced' or 'manufactured' by humans, not naturally occurring in nature such as 'genes', 'species' in the biological world, or natural parks, rivers and wild life, etc. provided by nature rather than created by humans). In other words, the 'search' for a 'value-system' in this paper is just confined to the *human* value-systems, of which 'money' is one such 'value-system'.

[6] We use the term 'domestic' not only to distinguish between household and industry but also to distinguish between 'domestic' (i.e. national) and 'global' sectors of an economy.

and $P_d Q_d + P_g Q_g \leq Y = w\{t_w X_w\} + r_d K_d$ (3)

Here U represents the utility ('use-value', 'wellbeing') of the individual or household. This 'utility' is generated from the use or 'consumption' of different types of 'inputs':(i) *time* input T_h used for domestic or household activities, the level of which is indicated by an 'activity' variable X_h and the average 'time-intensity' of these activities is given by the time-coefficient t_h; (ii) *time* input T_w but spent 'at work', i.e. for a production activity in an industrial sector rather than at home; the purpose of this 'work' activity is to earn a money-income to finance the consumption of *goods* rather than consumption of *time* to generate 'utility' for the household; the level of 'work' activities is indicated by a variable X_w and the average time-intensity of these 'work' activities is given by the time-coefficient t_w; note that time input into 'work' is considered as a *negative* input because work-time implies a sacrifice, or foregoing, of household domestic time; (iii) finally, money-income earned from work (as well as from other sources – see below) is used to finance the purchase of two types of commodities: Q_d which can be labeled as a 'domestic' or '<u>N</u>on-tradable' commodity because it is produced in the domestic economy and used only for domestic consumption, and Q_g which can be labeled as a 'global' or '<u>T</u>radable' commodity because can be produced either by a domestic industry or imported from a foreign producer. An example of a 'domestic' or 'non-tradable' commodity is local coffee shop selling coffee mainly to local customers rather than to tourists, or local education and health care services provided for local residents rather than for foreigners. An example of a 'global' or 'tradable' commodity is food products which are produced not only for local consumption but can also be exported. The prices of Q_d and Q_g are assumed to be different and are given by P_N and P_g respectively.

Household tries to maximize the utility of consumption (1) subject to two types of constraints: a total *time* constraint (*T*) given by equation (2) and a total *money-income* constraint given by equation (3). In the money-income constraint, it is assumed that money income can come from two different sources: from work activities in the form of wage payment $w\{t_w X_w\}$ where *w* is the monetary wage rate, and from the return to capital owned by the household but invested in

domestic industry for production K_d, the rate of return on this domestic capital is assumed to be r_d. The total money-income for household is therefore $Y=[w\{t_w X_w\}+r_d K_d]$ and this total income is used to finance the consumption of Q_d and Q_g.

Forming the Lagrangian for the household optimization decision process as:

$$\begin{aligned} \mathsf{L} &= U\left(t_h X_h, -t_w X_w, Q_d, Q_g\right) + \lambda\left[T - t_h X_h - t_w X_w\right] \\ &\quad - \mu\left[P_d Q_d + P_g Q_g - w\{t_w X_w\} - r_d K_d\right] \end{aligned} \tag{4}$$

The solution for this optimization process is described by the following conditions:

$$\partial \mathsf{L}/\partial X_h = t_h \partial U/\partial T_h - \lambda t_h \Leftrightarrow 0 \tag{5}$$

$$\partial \mathsf{L}/\partial X_w = -t_w \partial U/\partial T_w - \lambda t_w + \mu w t_w \Leftrightarrow 0 \tag{6}$$

$$\partial \mathsf{L}/\partial Q_d = \partial U/\partial Q_d - \mu[P_d] \Leftrightarrow 0 \tag{7}$$

$$\partial \mathsf{L}/\partial Q_g = \partial U/\partial Q_g - \mu[P_g] \Leftrightarrow 0 \tag{8}$$

Define the following 'value' variables:[7]

$$VoT_h \equiv \partial U/\partial T_h \tag{9}$$

$$VoT_w \equiv \partial U/\partial T_w \tag{10}$$

$$VoC_d \equiv [\partial U/\partial Q_d] \tag{11}$$

$$VoC_g \equiv [\partial U/\partial Q_g] \tag{12}$$

The meanings of these 'value' variables are as follows. Firstly, (VoT_h) represents the (marginal)[8] Value-of-Time when time is spent in household activities. Secondly, (VoT_w) is the Value-of-Time when spent at work in industry. Thirdly, (VoC_d) and (VoC_g) are the Value of Commodities or Consumption of domestic (or non-tradable) goods and global (or tradable) goods respectively.

[7] We use the symbol ≡ to denote 'definition', but use the symbol ⇔ to denote the *process* of 'interactions' between two sides of an equation to arrive at an 'equilibrium' where, if equilibrium is reached, this will be described by an equality (=) sign, or if disequilibrium is still present, then an inequality sign such as > or < is used.

[8] This term will be implied throughout our (marginal) analysis and hence will not be mentioned when the meaning is clear.

Conditions (5)-(8) can now be written as:

$$VoT_h \Leftrightarrow \lambda \tag{13}$$

$$VoT_w \Leftrightarrow \mu w - \lambda \tag{14}$$

$$VoC_d / P_d \Leftrightarrow \mu \tag{15}$$

$$VoC_g / P_g \Leftrightarrow \mu \tag{16}$$

Condition (13) says that at equilibrium the shadow price of the total household time resource is given by (λ) and hence this can be used to define the value of household time (VoT_h). Condition (14), however, says that the value of *work* time (VoT_w) is given by two components. Firstly since work-time produces an income, this is part of the value of work-time, but this 'income' must be 'translated' into 'value' units by a conversion factor, and this conversion factor is given by μ the 'shadow price' of money (in terms of 'commodity-value'). The product term (μw) therefore represents the *commodity*-value of the wage income. The second component of the 'value of work-time' is simply its *opportunity cost*: since work-time is household-time *foregone*, therefore its opportunity cost is given simply by ($-\lambda$). Overall, therefore, the *net* value of work time is $(\mu w - \lambda)$. If $\mu w = \lambda$ then VoT_w=0. In this case, it can be said that work-time is 'neutral', i.e. it generates no *direct* utility or *dis*-utility to the worker (i.e. no extra 'pleasant enjoyment' nor discomfort, or 'pains and sufferings' etc).[9]

Finally, conditions (15) and (16) simply say that at equilibrium, the (shadow) 'price of money' can be measured either by the value of domestic (non-tradable) commodities – normalised by its price level; or the value of global (tradable) commodities – also normalized by its price level. Both of these measure the 'purchasing-power' of money with respect to these commodities respectively, and for equilibrium to be established, these different 'purchasing-powers' must be equalized, which then give the equilibrium 'shadow price' of money μ.

[9] If $VoTW$<0, the worker may try to reduce working hours, and/or employers have to raise the wage income level to compensate for this 'disutility' of work time. Conversely, if $VoTW$>0, the worker may increase the working hours to earn more income, and/or the employer may ask the worker to do extra work (without paying more wage) etc.

2.2 The role of money in production activity of the industrial sector

Consider now the representation of production activity in an industrial sector:

$$\text{Min} \quad C = C\left(L, K_d, K_g\right) \tag{17}$$

$$\text{where} \quad L = t_w X_w \tag{18}$$

$$\text{s.t.} \quad Q(L, K_d, K_g) \geq \overline{Q} \tag{19}$$

Here C is the total *money* cost of production using labour and capital inputs and Q is production output level. Labour input is measured by the total household-*time* spent at work, i.e. $L=(t_w X_w)$. Capital is assumed to be sourced from both the domestic sector, i.e. K_d, as well as from a 'global' source K_g.

The purpose of production optimization is to minimize total production cost given a fixed total output constrain level which is given by equation (19). Forming the Lagrangian for this optimization problem as:

$$\mathsf{L} = C\left(L, K_h, K_f\right) - \gamma\left[Q\left(L, K_d, K_g\right) - \overline{Q}\right] \tag{20}$$

The solution for this optimization problem is given by the following conditions:

$$\partial \mathsf{L}/\partial L = \partial C/\partial L - \gamma \partial Q/\partial L = 0 \tag{21}$$

$$\partial \mathsf{L}/\partial K_d = \partial C/\partial K_d - \gamma \partial Q/\partial K_d = 0 \tag{22}$$

$$\partial \mathsf{L}/\partial K_g = \partial C/\partial K_g - \gamma \partial Q/\partial K_g = 0 \tag{23}$$

Define $MCL = \partial C/\partial L$, $MCK_d = \partial C/\partial K_d$, and $MCK_g = \partial C/\partial K_g$ which represent the marginal (monetary) *cost* of using labour and capital (from domestic and global sector) respectively in production activity, and also $MPL = \partial Q/\partial L$, $MPK_d = \partial Q/\partial K_d$, and $MPK_g = \partial Q/\partial K_g$ which represent the marginal productivities of these inputs. Conditions (21) - (23) can be re-written as:

$$MCL \Leftrightarrow \gamma MPL \tag{24}$$

$$MCK_d \Leftrightarrow \gamma MPK_d \tag{25}$$

$$MCK_g \Leftrightarrow \gamma MPK_g \tag{26}$$

This means production will use a particular input until the *value* of the (decreasing) marginal productivity of the input is matched by its (increasing) marginal *cost*. Here 'value' is measured by the Lagrangian 'shadow price' variable γ.

Now the marginal cost of labour can be said to be given by the level of the wages, i.e. $MCL = w$, and the marginal cost of capital is determined from the rate of return on capital, i.e. $MCK_d = r_d$, $MCK_g = r_g$.

Conditions (21)-(23) therefore can be specified as:

$$w \Leftrightarrow \gamma MPL \tag{27}$$

$$r_d \Leftrightarrow \gamma MPK_d \tag{28}$$

$$r_g \Leftrightarrow \gamma MPK_g \tag{29}$$

The next section will explain how the shadow value of the output γ can be determined.

2.3 The role of money in the final exchange between industry and the domestic household sector.

To complete the 'circular flow' of money as well as of real commodities, the final step involves an exchange between the household and industry sector, but this time, household acts as *buyer* (of commodities produced by the industry) and the industry acts as a *seller* (of its products). Their roles in this exchange are reversed as compared to the first exchange, but the medium of exchange remains the same, i.e. money.

Assuming that industry produces a 'multi-product' output (Q) can be transformed into different components: Q_N which is a 'non-tradable' commodity used for *domestic* household *consumption* (i.e. Q_d) and/or for domestic *investment* (i.e. in the formation of domestic capital ΔK_d), and (ii) Q_T a 'tradable' commodity which can be used either for import replacement of domestic

household consumption of global or tradable goods (i.e. Q_g) and/or for replacement of foreign capital (i.e ΔK_g). Therefore, we can write:

$$Q = Q(Q_N, Q_T) \tag{30}$$

with:

$$Q_N = Q_d + \Delta K_d \tag{31}$$

$$Q_T = Q_g + \Delta K_g \tag{32}$$

The price of Q_d is P_d while the price of domestic *investment* good i.e. of ΔK_d, is $P_{Kd} = (1/r_d)$. Substitution between consumption and investment in the domestic (non-tradable) sector will be governed by the relativity of the two prices: P_d and P_{Kd}, and the average price of total non-tradable output Q_N is therefore given by:

$$P_N = [P_d Q_d + (1/r_d)\Delta K_d]/Q_N \tag{33}$$

Similarly, the price of global consumption good Q_g is P_g while the price of global *investment* good i.e. of ΔK_g, is $P_{Kg} = (1/r_g)$. Substitution between these global consumption and investment goods is governed by the relativity of the two prices: P_g and P_{Kg}, and the average price of the total tradable good output Q_T is therefore given by:[10]

$$P_T = [P_g Q_g + (1/r_g)\Delta K_g]/Q_T \tag{34}$$

The overall average price of total output Q therefore is given by:

$$\begin{aligned} P &= [P_N Q_N + P_T Q_T]/Q \\ &= \{[P_d Q_d + (1/r_d)\Delta K_d] + [P_g Q_g + (1/r_g)\Delta K_g]\}/Q \end{aligned} \tag{35}$$

[10] For simplicity we assume that Q_g in equation (33) can represent both import replacement and/or export of tradable *consumption* goods which are priced at P_g and similarly ΔK_g in equation (34) can represent both import replacement and/or export of tradable *capital* goods which are priced at $P_{Kg} = (1/r_g)$.

Assuming that at equilibrium, this average price will be set equal to the optimal shadow price of output, i.e. (γ), then we can write as the final optimal condition for exchange between household and industry sector:

$$\gamma = \{ [P_d Q_d + (1/r_d)\Delta K_d] + [P_g Q_g + (1/r_g)\Delta K_g] \}/Q \qquad (36)$$

2.4 Existence of general equilibrium and the role of money

The system of exchange and production activities between household and industry can now be summarized as involving eight optimal conditions: (13)-(16) of section 2.1, (27)-(29) of section 2.2, and (36) of section 2.3. Since one of the optimal conditions must act as 'Walras's Law', therefore there are only seven *independent* equations. There are eight endogenous variables: $(\lambda, \mu, w, r_d, r_g, \gamma, P_d, P_g)$, therefore one of these variables must be considered as 'exogenous' or acting as a numeraire.[11]

2.4.1 A 'value theory' of money and a 'monetary theory' of price level.

Classical (and neoclassical) economic theories of *value* and theories of *money* are in fact all theories about 'values', but the concept of 'values' need to be clarified before an understanding of these theories can be clear. From a conceptual point of view, one can distinguish between at least three different types of 'values' (i) 'intrinsic' value, or 'value *in existence*' which is the value attached to a 'thing' or a 'being' for its 'existence' rather than for any 'function' or 'use' of that thing in human activities (ii) value *in use* (or utility) is the value attributed to an 'object' when it is 'used' in human activities; this 'value-in-use' can be assessed *by* and *from the perspective* of either the direct *user* of that object (for e.g. by an employer of the value of a worker's labour), and/or the 'object of the use' itself (i.e. by the worker of his/her own labour);[12] and finally (iii) value *in exchange,* which traditionally would refer to the (intrinsic or use) values

[11] This is a 'practical' or 'pedestrian' way of 'proving' the existence of a general equilibrium in a Walrasian model, i.e. by just counting the number of unknowns and independent equations; a theoretically more rigorous method would have to follow, for example, an Arrow and Debreu (1954) approach, which is beyond the scope of the present paper.

[12] Naturally these assessments would be different, but that is precisely where the role of a 'market' is: to bring these assessments into 'equilibrium'.

of the *commodities* or *objects* (such as money) contained or carried through in the exchange rather than the value of the exchange activity itself.[13]

Based on the above concepts and definitions of the term 'value', we can now proceed to try to establish, firstly what can be called as a 'value theory of money', and then a 'monetary theory of commodity price'. The former is a theory which tries to explain the 'value' (or *shadow* price)[14] of *money* based on the concepts of *commodity* 'use-value' including the 'use-value' of labour-time as a 'commodity' between household and industry. The next theory is about *prices* which by definition, (a price) is a *rate of exchange* between two commodities or objects, and if one of them is 'money' then we can refer to this as a 'monetary price'. A 'monetary theory' of the price level is therefore also based on a 'value theory' of money in the first place, because the two types of 'theories' are related, and 'money' is used in exchange, not as a 'commodity' on its own, but only as a means of exchange.

From section 2.1, equation (5) defines the 'value' (*use-value*) of household-*time* but if this time is *used* in the *household* for domestic household activities ($VoT_h = \lambda$). Next, equation (6) also defines the 'value' of household time, but since his time is *used* at work rather than at home, its (use) value must be different. Also, because the *direct* user of this time is the employer of labour in industry rather than the household itself, so the 'use-value' of this time (as it 'appears' to the household) is not λ but actually $-\lambda$, because it is a 'cost' (a loss of opportunity for spending this time at home) and not a 'value'. The *use-value* of household time as it appears to the employer/industry is reflected in the money wage (w) paid to household for its time, but this money wage must be converted into *value*-wage, and the factor of conversion must come from a 'value theory of money'. This theory simply considers the 'value of money' as the shadow price of the constraint on all monetary transactions or exchanges, between the household and the

[13] Therefore, a term such as 'exchange-value' can be considered as a misnomer if it is used to mean either the 'value' *of* the exchange activity itself and/or 'value' which has been 'created' or 'transformed' by the exchange activity. However, this latter meaning of the term 'exchange-value' is *not* a misnomer but it is an important meaning *if* it is considered in the context of a *Marxian* theory of 'value'. Here, 'Marxian value' recognizes neither 'intrinsic value' nor 'use-value' as 'value' for commodities or even for human labour. Instead, Marxian theory first uses the *quantity* of human labour (not value) to define 'commodity value' (i.e. 'glorifying human quantity' to the level of 'commodity-value'). Then, 'exchange' or 'trade' is used not to define 'value' (which has already been defined) but to define the *process of transformation* or *process of alienation* of all (traditional concepts of 'values' such as intrinsic value and/or use values) towards just a single type of so-called 'commodity-value' but based on human (labour) *quantity* (not value or 'spirit').

[14] Since the market for money is just a 'shadow' of the 'real' market for commodities.

domestic as well as global production i.e. equation (3). From this constraint we can derive the 'shadow price of money' i.e. (μ) which is simply the (marginal) 'value' of a unit of money when used to satisfy this constraint.[15]

If this 'shadow price of money' (μ) is then used as a 'conversion factor' for the money wage, then the value of the wage rate, or the 'value-wage' can then be written as (μw). This represents the 'value' of household's labour-time *received* by the household to compensate for 'value of time' lost (i.e. $-\lambda$) because household time has been diverted or allocated into 'work-time'. The *net* value received by the household for its time spent at work is therefore given by ($\mu w - \lambda$) and this value is used to define a 'value of work (i.e. labour) time' i.e. $VoT_w = (\mu w - \lambda)$.

Finally, in all these exchanges, between the household and commodity-producing sectors (of the national as well as 'global' economies), money acts as a means of exchange, i.e. as a 'commodity-in-exchange' rather than a 'commodity-in-consumption' or 'commodity-in-production'. Therefore, its 'value' or 'shadow price' is used simply as a means for balancing between different value-markets, with the *monetary* price levels acts as the market clearance mechanisms. Therefore, at equilibrium we must have:

$$\mu = VoC_d / P_d = VoC_g / P_g = VoT_w / w \qquad (37)$$

Equation (37) can be viewed as a type of 'monetary theory' for the market prices level, ranging from the market for labour-time (monetary price is w), to the markets for commodities (monetary prices are P_d, P_g)[16] Therefore, as Steiger (1987)[17] has remarked: "…attempts of both the dominating theories of value and the quantity theory of money to explain the value of money….had resulted in …a theory of money which was unable to explain its postulated proportionality between changes in the quantity of money and the *price level* as the *inverse of the value of money*". From equation (37) above, we can see clearly that this so-called 'inverse

[15] This shadow price clearly must depend on both the *supply* as well as the *demand* for money which in this paper, we have considered only the latter but not the former. Implied in constraint (3) therefore is a 'given' quantity of *supply* of money which can be introduced into the model if an additional set of constraint is shown for the money market, where demand for money is equalized with the supply quantity. This can be done in a future extension of our model when issues about, not just monetary policies, but also fiscal and trade policies, will be studied.

[16] The market for *investment* rather than consumption goods is reflected in the *levels* of the capital rates of returns r_d and $r_{g..}$

[17] See footnote 2 above.

relationship' between the 'value of money' (i.e. μ) and the price levels of all commodities (i.e. P_d, P_g, w) can now be 'explained' not through the supply of a money quantity (which is assumed to be 'given' in out model), but via all the demand for this 'money' which is reflected in constraint (3) of our model.

2.4.2 'Value of time' as a numeraire for a theory of *money* and theories of commodity *values*.

As mentioned above, in our model, there are eight endogenous variables but only seven independent equations, therefore, one variable must be considered as 'exogenous' or acting as a numeraire. If we now consider the shadow price or 'value of time' λ as a numeraire (for example, let λ=1), then the system of equations (13)-(16) can now determine absolutely, not only the level of to the 'value of money' (μ), but also of all other 'prices'.

Time-*value*, (not just labour-time or *quantity* as considered in all previous 'classical' theories of so-called 'labour theory of value'), therefore can be seen as a potential numeraire for any particular 'value-system' of an economy. After all, the 'welfare', 'wellbeing', or 'standard of living' of any particular country or economy must take into account, not just the *material* wellbeing (i.e. *commodity* values) of that economy into account but also *non-material* wellbeing, of which *time quality* of life or 'value of time' is an important factor. 'Time is money' has always been recognized in classical economic theories of value and money, as *labour-time* or labour-*quantity* is the source of all 'values' including that of money. But the associated, accompanying, or 'shadow' relationship between labour-*value*, or *value* of *time*,[18] and all other 'values' including the value of a commodity, object, activity, money, and ultimately value of *life* itself (in different environments or societies), is not always recognized. Therefore, when using a 'time-*value*' as a 'numeraire' for all other types of 'values' including that of commodity, money, exchange prices, etc., in a Walrasian general equilibrium economic system, we are not just solving a *technical* issue of how to define an 'absolute' price level for all the *relative* 'values, costs, prices' in the system, but also *highlighting* the most fundamental issue in economics which often is sidelined rather than addressed, and that is: what is the *core* or *basic value* which a

[18] The issue of 'value of time' – rather than just 'quantity of time' – is addressed or found mostly only in the literature of so-called 'household production' (Becker (1965), Lancaster (1966)) or in the literature on travel activities (e.g. DeSerpa (1971), Hensher (1976), Truong and Hensher (1985)), etc. rather than in the 'mainstream' classical or neoclassical economic literature.

society would like to attach to its economic system (rather than the reverse and illogical question: what is the 'standard' which a society would like its economic system to set for its *core* or *basic value* as a society).

3 Conclusions

Money is an important factor in many economic activities of an economy, but money is only a means and platform for exchange and/or creation of commodity values rather than being a source of 'value' of its own. Classical economic theories of money recognize that the 'value of money' is derived from the values of commodities or of labour, of which money acts only as a store keeper or exchanger of values. Value flows in an economy through what is often called a 'value-chain' and here money can act as an 'infrastructure' to facilitate and/or protect these 'chains'. Value flows, however, not just from commodities but also from the very source which created all these commodities and which is human-labour *time* measured not just in *quantities* but also in 'value': the 'value of life' which should form the foundation on which measures of economic 'wellbeing' be estimated. In the past, economic theories of 'value' (especially in 'production' activities) often neglect this aspect of human welfare and consider it only as a matter of numbers or quantity. Only in so-called 'consumption' or 'household' activities that the issue of 'time-quality' becomes a focus of attention, in the various attempts by economists to measure the *value* of household activity *time* (not just commodities). In this paper, we have shown that indeed a study of the *value* of human (labour) time can in fact provide a foundation (a 'numeraire') for all other attempts at measuring the economic and social values of the *physical* commodities and the (physical, economic as well as social) environment in which these values exist, which up to now seems to be neglected. Even within a 'comparative static' framework of a general equilibrium model, the analysis of time-value can still be productive, as has been illustrated in this paper.[19]

[19] Time value does not have to be considered in the context of *instantaneous* time as in most *dynamic* economic models, but also in the context of time *periods* or time *intervals* (see. for example, May ((1970), Starr (1987)).

References

Arrow, K.J., and Debreu, G. (1954). “Existence of an equilibrium for a competitive economy. *Econometrica* 22, 265-90.

Gary Becker (September 1965). "A theory of the allocation of time". *The Economic Journal*. **75**(299): 493–517. doi:10.2307/2228949, JSTOR 2228949],

DeSerpa, A. C. (1971). "A theory of economics of time". *The Economic Journal*. **81**(342): 233–46.

Hahn, F. (1982) Money and Inflation, Oxford: Blackwell.

Hensher, D. A. (1976). “Valuation of Commuter Travel Time Savings: An Alternative Procedure“. In I. G. Heggie (ed.) *Mode Choice and the Value of Travel Time.* Oxford University Press, Oxford, chapter 4, 108-131.

Ingham, Geoffrey (1996) “Money is a social relation” Review of Social Economy, 54(4), Routledge.

Lancaster, Kelvin J. (1966). "A New Approach to Consumer Theory", *Journal of Political Economy*, **74**(2):132–157. doi:10.1086/259131. JSTOR 1828835. S2CID 222425622],

Marx, Karl (1844) [2012]. *Economic Manuscripts: Critiques of Political Economy. The Commodity* Marxists.org. Retrieved 13 March 2012.

Marx , Karl (1887) [1971]. *Capital,* Volume 1, Progress Publishers, Moscow.

May, Josef (1970) “Period Analysis and Continuous Analysis in Patinkin’s Macroeconomic Model”, Journal of Economic Theory, 2, 1-9.

Ostroy, Joseph M. (1987). “Money and General Equilibrium”, a Chapter in Eatwell, J, Milgate, M, and Newman, P. (editors) General Equilibrium, The New Palgrave. The Macmillian Press Limited.

Starr, Ross (1987). “Sequence Economies”, a Chapter in Eatwell, J, Milgate, M, and Newman, P. (editors) *General Equilibrium*, The New Palgrave. The Macmillian Press Limited.

Steiger, Otto (1987). “Monetary Equilibrium”, a Chapter in Eatwell, J, Milgate, M, and Newman, P. (editors) *Money*, The New Palgrave. The Macmillian Press Limited.

Truong T. P., and Hensher, D. A. (1985). “Measurement of travel time values and opportunity cost from a discrete-choice model“, *Economic Journal* 95 , 438-51.

Walras, Léon (1874-7). Eléments d’économie politique pure. Definitive edn, Lausanne: Corbaz, 1926.Translated by William Jaffé as Elements of Pure Economics. London: George Allen & Unwin, 1954; New York: Orion.