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Convergence of monetary equivalent of labour times (MELTs) in two Marxian interpretations

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This article is primarily concerned with a comparison of two different interpretations of the monetary equivalent of labour time (MELT), which is an essential category for the calculation of Marxian labour values. Beginning with a brief recap of these interpretations—temporal single system interpretation (TSSI) and the new interpretation (NI) of Duménil and Foley—the article emphasises the theoretical advantage of the TSS. Subsequently it refers to the second volume of Marx's *Capital* to highlight the fundamental role of the concept of turnover in Marxian value theory and argues that for the calculation of the MELT, the appropriate level of abstraction should be the turnover of social capital rather than annual statistics. At that point, the article attempts to show theoretically and mathematically that whenever empirical calculations are made on the basis of social turnover data, the MELT of TSSI essentially converges to the MELT of the NI. However, the article also notes that this convergence cannot be interpreted as a substantial equivalence of these different theoretical approaches.

Key words: Marx, Turnover of capital, Temporal single system interpretation, New interpretation, MELT
JEL classifications: B51, D46, E11, P16

1. Introduction

Over the past three decades, certain path-breaking interpretations of the Marxian labour theory of value have emerged in economic literature. Amongst these the most seminal, as well as controversial, is undoubtedly the temporal single system interpretation (TSSI) propounded by Freeman and Carchedi (1996) and Kliman (2007). TSSI was developed through critiques of other interpretations; the new interpretation (NI)

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of Duménil (1980, 1983) and Foley (1982), the single system interpretation (a simultaneous solution) of Moseley (1993) and the simultaneous dual system solution of Bortkiewicz (1975 [1905]), which was the mainstream solution to the so-called transformation problem until the 1980s. A brief recapitulation of these critiques would lead us to map the position of TSSI within Marxian economics.

The NI, which is the first critique of the mainstream view, argues that at the value added level, total price and total value are equal. NI preserves the equality of aggregate profit and surplus value by taking variable capital into consideration non-dualistically. The value of labour time (or the value of money) is deduced from this equality. However, the value of constant capital remains problematic in this interpretation so that the equality of the price rate of profit and the value rate of profit cannot be provided for.

The single system interpretation (SSI) criticises this failure and proceeds to overcome the problem by defining the value of constant capital in such a manner as to be dependent on the prices of the means of production, in the same way the value of variable capital is formulated in NI. Hence what is at stake here is turning the value and price systems into a single system at the aggregate level, with an eye to being consistent with Marx's own theory. Nevertheless, in practice, the results of the SSI turn out to be a replication of the mainstream dual solution with a scale factor because, at its base, this approach does not differ from a system of simultaneous equations. TSSI welcomes the effort of SSI to preserve the equality of prices with values at the aggregate level, but it completely rejects the assumption that the prices of the inputs are simultaneously determined together with the prices of the output. This second assumption contradicts ontological reality and leads to the mainstream physicalist results, which themselves also contradict the capitalist reality.

Embracing this theoretical position of TSSI, this article tries to develop this interpretation further by incorporating the concept of the turnover of capital into the analysis. We think that if the concept of monetary equivalent of labour time (MELT) is to be used in the analysis, then the appropriate level should be the turnover of capital, rather than standard annual statistics. In the next section, we briefly address the meaning of MELT in the labour theory of value and then try to analyse the importance of the concept of the turnover of capital by referring to the second volume of Marx's *Capital*. By exposing the difference between the turnover concept and annually aggregated standard statistics as two totally distinct abstractions from the complex nature of reality, the article claims, from a theoretical point of view, that if an empirical analysis is to calculate MELT through TSSI, then the legitimate level should be turnover. In the third section we construct a mathematical model for turnovers derived from annual statistics and come up with converging results for NI and TSSI. Finally, the article ends with an evaluation of this convergence. It would be appropriate to note at the outset that this article should be read as an attempt to initiate a discussion on the subject of incorporating the concept of turnover into TSSI, rather than as an exhaustive analysis of the subject.

2. Meaning of MELT and the appropriate level of abstraction for it

Marx's labour theory of value does not aim to explain market prices. Marx constructed a value theory by which the capitalist relations of production or capital accumulation processes can be analysed through labour values, such as the rate of surplus value or rate of profit. Although in the third volume of *Capital*, Marx dwelled on the category

of price of production, the reason for this was not to arrive at a functional relationship to solve market prices but merely to depict a long-run tendency for market prices. The important aspect behind this category may be affirmed as the principle of the equivalence of prices and values at the aggregate level. (By the assumption of equal profit rates and different organic compositions amongst sectors, production prices differ; in turn, this leads to the equality of total prices and total values for the whole economy.) This principle could be sustained for the more concrete-level analysis, that is, for an analysis at the level of the market prices by leaving aside the more abstract assumptions of equal profit rates between sectors. At this point the category of MELT arises[1] as an analytical tool assuming this equality: total prices equals MELT times total values; so MELT equals total prices over total values.[2] MELT comes into being through this definition made at the aggregate level, and as a coefficient, it explains almost nothing in itself (moreover, it strongly resembles a tautology, although, as we try to explain later, it does not lead to a tautology if used in TSSI form).

The mathematical definition of MELT according to TSSI is given in equation (1):

$$\sigma_t = \frac{C_t^{\$} + V_t^{\$} + S_t^{\$}}{L_t^H + C_t^{\$}} = \frac{X_t^{\$}}{L_t^H + \frac{C_t^{\$}}{\sigma_{t-1}}} \tag{1}$$

where σ = MELT by TSSI; $V^{\$}$ = total wages; $C^{\$}$ = total expenditures for means of production (including depreciation of fixed capital); $P^{\$}$ = total profit; $X^{\$}$ = total prices at gross level (that is, GNP plus prices paid for circulating capital); L^H = total labour hours worked; C^H = constant capital in hours; t, $t-1$: subscripts denote time.

Estimation of MELT gives us a tool to calculate the value categories, that is, variable capital, surplus value and constant capital, by using the given working hours, given wages and given prices of capital at sectoral (or individual) levels. The equations that follow define how these value categories (variable capital, surplus value and constant capital, respectively) are calculated according to TSSI.

[1] 'Monetary expression of working hours' was first encountered in literature in the work of Aglietta (1979) connecting value and monetery terms in the same equation. But the first rigorous definition of monetary equivalent of labour (MEL) was put forward by Alejandro Ramos. The critique of dualism of money and labour value was made in the work of Ramos (1995), and by this critique he demonstrated that this concept is a consistent development from Marx's own theory, which deals with the distinction between the 'intrinsic' and 'extrinsic' measure of value but does not explicitly use the phrase MELT (or MEL). For various definitions and discussions of MELT through TSSI or NI and for discussions of money as a form of value with different approaches, one may refer to, in addition to those in text, Bellofiore (2009), Carchedi (1984), Foley (1983), Freeman (1998, 1999), Freeman and Carchedi (1996), Kliman (2007), Mohun (1994), Moseley (1993, 2000), and Ramos-Martinez and Rodriguez-Herrera (1996).

[2] If we assume that there were only commodity money in the market for the sake of theoretical abstraction, the MELT would be determined as the inverse of the value of a unit of gold (that is, required labour time to produce a unit of gold). This is a well-known interpretation of Marx's money theory. As Riccardo Bellofiore notes, 'money already has for Marx a *given* labour content when it *enters* the monetary circuit—and this, of course, means it has a determinate 'value of money' given *at the point of inflow* into the circuit. It is because of this that the monetary expression of labour time (MELT) can be taken as a given (2009, p. 185). Whether Marx espoused such a commodity theory of money is highly debatable. Recent discussion between Changkeun Kim, Alan Freeman and Andrew Kliman is very illuminating on this subject (Kim 2010; Freeman and Kliman 2011). Freeman and Kliman argue that 'even when a produced commodity serves as money, the MELT is the reciprocal of the exchange-value of money, not the reciprocal of the value of the money commodity' (2011, p. 206). Marx's views on commodity money and discussions on this are obviously beyond the scope of this article. (We thank anonymous referees for raising the question of commodity money in Marx's theory.)

$$\begin{aligned} V_t^H &= V_t^\$ / \sigma_t \\ S_t^H &= L_t^H - V_t^H \\ C_t^H &= C_t^\$ / \sigma_{t-1} \end{aligned} \tag{2}$$

At first impression, MELT may be suspected to lead to a circular reasoning or tautology by thinking that calculations of MELT incorporate variables that circularly depend on MELT. However, this critique is not valid for the TSSI MELT, if it is considered that MELT embraces the previous periods' parameters. Furthermore, it is calculated from total categories but used for individual levels.

NI's MELT differs considerably from the TSSI definition, although NI also formulates it in a similar manner to overcome the dualistic understanding of value and prices. The equation (3) shows the description of NI's MELT (indicated by μ) in which nominator and denominator make up only net production.

$$\mu_t = \frac{X_t^\$ - C_t^\$}{L_t^H} \tag{3}$$

As noticed in the equation, the NI formulation does not consider the previous MELT. In fact, NI takes each period as if it were a closed circle in itself without considering the temporality or sequentiality of capital accumulation. In the NI approach, the estimated MELT cannot be used for the calculation of constant capital. The crux of this interpretation is that constant capital should be treated differently from variable capital. Our intention here is not to take up all the theoretical debates about NI, but briefly describe the two different definitions of MELT.

As far as we observe, in the English literature on the issue, there has been relatively little empirical work done within the TSSI framework.[3] We argue that this could be due to the absence of data. Annual statistics do not constitute an appropriate level for a theory such as TSSI, developed through emphasising the importance of the historical aspect of the reproduction of capital. It is theoretically incorrect to use annual statistics when calculating MELT. In this section we discuss this claim by analysing the concept of the turnover of social capital.

The previous time period presented in equation (1) must be the previous turnover of social capital. To understand the meaning of turnover of social capital we begin with analysing the concepts of the circuit of capital and the turnover of individual capital. For this we should go back to the second volume of Marx's *Capital* (1992).

To grasp the reality of capitalist reproduction, we apply certain abstractions. At the most concrete level, we have complexity of the empirical reality itself. We have statistical data as a rearrangement and aggregation of previous events for specific time periods. These statistics are abstractions, and as is the case for all abstractions, this kind of rearrangement can only be useful for the proper purposes in question. It is quite

[3] Karahanogullari (2009) tries to calculate TSSI categories for the Turkish economy, but the article is only available in Turkish. In the English literature Nick Potts developed several TSSI models but does not apply them to any country case. Andrew Kliman (2010) applies several different measures for the value categories by stressing their economic meanings but, interestingly, his TSSI definitions, which were developed in his book (2007), are not amongst them. Although the definition of capital in his analysis accords with the historical cost definition on which he made contributions and although he applies the categories of MELT, he does not calculate them as defined in TSSI. On the other side, Alan Freeman's (1998) article calculates the labour values for the UK economy by using annual statistics.

understandable that for the sake of accounting or standardisation, annual data can be taken as a practical and common reference.

For Marx, instead of the annual periodisation, the three circuits—that is, the circuit of money capital, the circuit of productive capital and the circuit of commodity capital—are the basic phases of the production of capital.[4] At this stage let us quote Marx to clarify the circuit and the turnover of capital and capital's turnover time:

> In the life of the capital, the individual circuit forms only a section that is constantly repeated, i.e. a period. . . . The circuit of capital, when this is taken not as an isolated act but as a periodic process, is called its turnover. The duration of this turnover is given by the sum of its production time and its circulation time. This period of time forms the capital's turnover time. It thus measures the interval between one cyclical period of the total capital value and the next; the periodicity in the capital's life-process, or, if you like, the time required for the renewal and repetition of the valorization and production process of the same capital value. (Marx, 1992, p. 235, 236).

Here some graphical representations would be useful. Let us define the entire turnover time of capital just described with the help of sine waves. Whenever the wave intersects with *x*-axis, which depicts the passing of time, capital completes its turnover and then a new turnover cycle begins. Accordingly, the wave starts with the advance of money capital, and, at that moment, the circuit of money capital is initiated. Labour power and means of production are bought with the help of this money and therefore production begins, which means that the circuits of commodity and productive capital are launched. At the end of this cycle, capital and surplus value are realised. Here the sine wave intersects with the line once again after the entire process of the metamorphosis of capital, which begins and ends in money form, is completed. Figure 1 depicts just two turnovers of the capital.

Here the fact that the end point of the cycle also depicts the start of a new turnover process refers to the sequential nature of turnovers. One circuit follows after another but no new circuit starts before the completion of the previous one. However, at the empirical level, we cannot find circuits in such sequences. In capitalist production, there is no such order in turnovers. Obviously individual capitalists do not need to wait for the completion of any circuit to start a new one. Credit system makes the continuity of production possible. Moreover, merchant capitalists allow production process to proceed without any need to wait for the industrial capitalist to sell his final product on the market. Therefore the individual capitalist can be involved in three circuits simultaneously.

> In reality, however, each individual industrial capital is involved in all three at the same time. The three circuits, the forms of reproduction of the three varieties of capital, are continuously executed alongside one another . . . . The reproduction of the capital in each of its forms and at each of its stages is just as continuous as is the metamorphosis of these forms and their successive passage through the three stages. Here, therefore, the entire circuit is the real unity of its three forms. (Marx, 1992, p. 181).

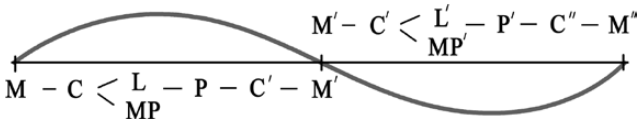

Fig. 1. *Two turnovers of capital*

[4] We already know that Marx sometimes refers to annual periods to exhibit the capital turnovers, but this was obviously only for the sake of simplicity.

'Thus industrial capital in the continuity of its circuit is simultaneously in all of its stages, and in the various functional forms corresponding to them' (Marx, 1992, p. 182).

There is no requirement that every single capital starts its turnover in a synchrony. Every day, every minute, in every instance we encounter all three circuits simultaneously. 'Thus every particular circuit has one of the functional forms of the capital as its starting-point and point of return. On the other hand the total process is in fact the unity of the three circuits, which are the different forms in which the continuity of the process is expressed' (Marx, 1992, pp. 183–84).

Furthermore, in capitalist reality, circuits differ in length for each individual capital. This complexity of empirical reality, with the unity of three circuits and non-uniformity of time-periods, seems to correspond to the interwoven patterns of sine waves depicted in the first line in Figure 2.

No one can calculate the value of money in this intricate complexity where MELT quantitatively changes its value in every single moment. Trying to apprehend these empirical changes at this level of complexity resembles an impossible task of trying to draw a map of the Earth at ta 1:1 scale.

By referring to the proper level of abstraction, Marxian concepts bring out the essence of this complexity. The conceptual difference between the turnover of individual and that of total social capital gives us the proper theoretical tool. 'The total social capital always possesses this continuity, and its process always contains the unity of the three circuits. For individual capitals, the continuity of reproduction is at certain points interrupted, to a greater or lesser degree' (Marx, 1992, p. 184).

The concept of the social turnover of capital gives rise to a perception that the turnovers of capital are synchronised. Marx abstracts a continuous and sequential systemic process from the complex reality itself. The beginning and the ending of individual turnovers become synchronised. As shown in the following quotes, Marx defines the concept as the average of individual components. This is not a deformation of reality but simply an abstraction for the sake of understanding reality. At this stage we must focus on the concept of social capital.

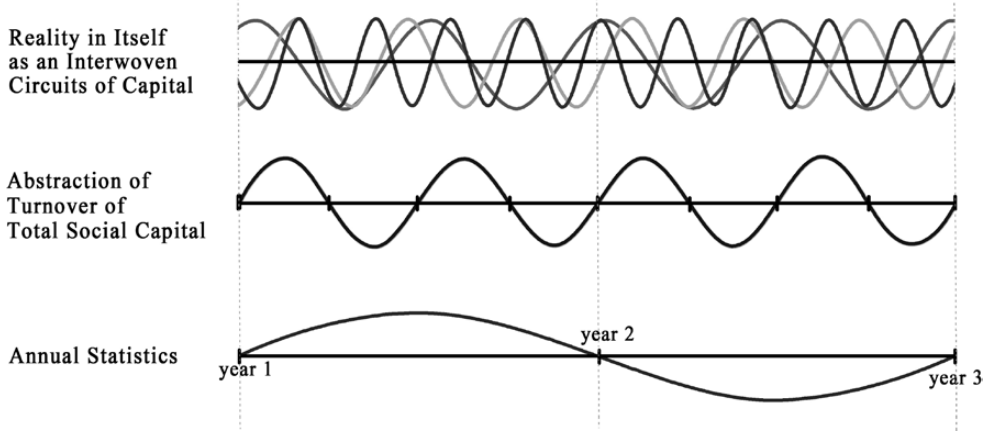

Fig. 2. *Two levels of understanding reality: abstract social turnovers and annual data*

The overall turnover of the capital advanced is the average turnover of its different component parts. . . . In so far as only different periods of time are involved, it is of course perfectly simple to take their average. (1992, p. 262)[5]

'In calculating the overall turnover of the productive capital advanced, we therefore take all its elements in the money form, so that the return to the money form concludes the turnover. . . . We can then take the average. (1992, p. 184).

Finally, the number of turnovers of the total social capital equals the sum of the capital turned over in the various branches of production, divided by the sum of the capital advanced in these branches. (1992, p. 346).

It should further be noted that, just as here, in the same private business, the two capitals I and II have, in the strict sense, different turnover years . . . so too the various private capitals in the same branch of production begin business at quite different points in the time and hence complete their annual turnover at different times of the year. The same average calculation that we applied above to I and II also serves here to reduce the turnover years of the various independent parts of the social capital to a uniform turnover year. (1992, p. 347)

This average calculation leads us into the sequences of turnovers of social capital as depicted in the second line of sine wave in Figure 2. As a consequence of average process, we assume that all individual turnovers start and end at the same time in accordance with the social turnovers. At this point we should also note that this synchronisation is not the same as the simultaneity concept in Bortkiewicz's interpretation, which is completely different from Marx's ideas.

Marx's use of simultaneity refers to the continuous and interwoven succession of circuits. 'As a whole, then, the capital is simultaneously present, and spatially coexistent, in its various phases. But each part is constantly passing from one phase or functional form into another, and thus functions in all of them in turn. The forms are therefore fluid forms, and their simultaneity is mediated by their succession' (Marx, 1992, p. 184).

On the opposite side, Bortkiewicz's conception of simultaneity contains two assumptions that deform the reality of capital. First, capitals have a turnover time of exactly one year. Second, the turnovers are synchronised.[6] These two assumptions lead to the collapse of the whole theoretical basis for a proper analysis of the historical aspect of the capital process.[7]

Now we can return to the problem of determining the appropriate level of abstraction for the calculation of the MELT. MELT is a universal, economy-wide concept (Freeman 1998). Its universality is due to the social/macroeconomic character of money and, as such, labour value. MELT equates the total labour time with the total prices at the gross level for a given turnover period of social capital. As a universal category, MELT comprises all individual processes. It intersects all the individual turnovers and is determined by them. However, theoretically it is not defined and cannot be calculated at the level of the turnover of individual capital.

To be sure, MELT changes its value after the realisation of individual capitals. Only if capital completes its turnover, the labour value is born along with market prices.[8] Value

[5] Marx also notes the qualitative distinctions between the parts of the constant capital. Distinction between the turnovers of fixed and constant capital must be investigated; however, this is outside the scope of this article.

[6] Here we acknowledge the contribution and valuable critiques of Alan Freeman.

[7] As an aside, if we demonstrate the simultaneous interpretation in the graph that follows, it is because inputs and outputs are valued simultaneously that the turnover of capital would appears as a closed cycle.

[8] It is not necessary for market prices to be production prices because any price can be attached to these commodities on the market according to the conditions of supply and demand.

and price appear at the end of each individual turnover. As we already showed, in reality, some capital is realised in every single instance.[9] It is true that MELT perpetually changes. However, as has been shown, the reality cannot be grasped at this level of abstraction. The turnovers of social capital give us the proper and relevant theoretical tool.

One must not confuse social turnovers with annual statistics. The latter is not an appropriate level of abstraction for Marxian economics. This is so because annual data aggregate the turnover in a year, so much so that they do not allow the sequentiality of the value process to be involved in analysis, and therefore the temporality of value vanishes. If we use annual statistics instead of turnover statistics, some certain required calculations within a year will be ignored. When MELT (and all value categories) changes its value through many turnovers in a year, and, if one calculates MELT only at the end of each year, this will be a wrong estimation.[10] To be consistent with MELT's theoretical position, MELT must be calculated at the appropriate level of abstraction—that is, turnovers of social capital.

To calculate MELT, what a researcher must do is derive social turnovers from the annual statistics.[11] In the next section we study the relationship between these theoretically derived turnover statistics and the two MELTs.

3. Social turnover and the behaviour of MELTs

Assume that annual data for wage, profit, means of production, depreciation of fixed capital and labour time worked are all available. Also assume that annual changes for each variable can differ for each variable, and social capital annually completes N turnovers, which is greater than 1. Here we do not discuss the question of how to estimate the number of turnovers in a year. The number of turnovers is the same for each variable, which is equal to the number of turnovers of social capital. We keep the pace of yearly increase for the social turnovers within these years. However, for each variable, the pace can differ because each variable can have a different rate of yearly change.

If one year consists of N turnovers then these can be written as follows:

$$A_0 \rightarrow A_1 \rightarrow A_2 \rightarrow \ldots \rightarrow A_n \rightarrow \ldots \rightarrow A_N \tag{4}$$

Here A_0 denotes the given initial condition which leads to the first turnover. Although the price sequence like equation (4) can be constructed in various ways, it has to provide the condition written in equation (5).

[9] If gold money exists as a dominant money form, and every commodity gets its price equivalance in relation to the value of gold (that is, MELT equals the inverse of the value of a unit of gold), then MELT changes its value when the quantity of gold production and/or required labour time to produce a unit of gold changes.

[10] In an inflationary (deflationary) period MELT is underestimated (overestimated) when yearly statistics are used instead of turnover statistics. In an inflationary period, increase in MELT does not catch up with the increase in price level because it is not calculated according to turnover. Therefore, the value of variable capital increases abnormally and inadvertently, so surplus value and rate of profit decrease continuously in the period. It can even take on negative values, which is theoretically nonsense. (Although the rate of exploitation can take negative values for individual sectors, surplus value at the gross level cannot be negative. This can only be possible due to the omission of some required calculations.) Symmetrically for a deflationary period, we can expect undervaluation of variable capital and overvaluation of the surplus value.

[11] To calculate each individual value, categories such as industrial profit rates or sectoral exploitation rates, one should consider the individual turnover processes along with the MELT calculated through the turnover of social capital. However, we note that this more concrete issue should be reserved for another article.

$$\sum_{i=1}^{N} A_i = F \tag{5}$$

Namely, the sum of the turnovers has to be equal to the relevant annual data, which is denoted F in equation (5).
Now, let the price sequences of the capital elements be as:

$$\begin{aligned} C_0^{\$} \to C_1^{\$} \to C_2^{\$} \to \ldots \to C_k^{\$} \to \ldots \to C_N^{\$} \\ V_0^{\$} \to V_1^{\$} \to V_2^{\$} \to \ldots \to V_k^{\$} \to \ldots \to V_N^{\$} \end{aligned} \tag{6}$$

C and V stand for the constant and variable capital, respectively. In a same way we can construct the labour time sequence as:

$$L_0^H \to L_1^H \to L_2^H \to \ldots \to L_k^H \to \ldots \to L_N^H \tag{7}$$

and profit sequences as:

$$P_0^{\$} \to P_1^{\$} \to P_2^{\$} \to \ldots \to P_k^{\$} \to \ldots \to P_N^{\$} \tag{8}$$

Since the total output in one turnover is equal to the sum of the constant capital, variable capital and profit, we can write the total output price sequence as:

$$X_0^{\$} \to X_1^{\$} \to X_2^{\$} \to \ldots \to X_k^{\$} \to \ldots \to X_N^{\$} \tag{9}$$

We can calculate corresponding values for the ith turnover in the TSSI approach with definitions:

$$C_i^H = \frac{C_i^{\$}}{\sigma_{i-1}}, \quad V_i^H = \frac{V_i^{\$}}{\sigma_i}, \; S_i^H = L_i^H - V_i^H \tag{10}$$

and NI approach:

$$C_i^H = \frac{C_i^{\$}}{\mu_i}, \quad V_i^H = \frac{V_i^{\$}}{\mu_i}, \; S_i^H = L_i^H - V_i^H \tag{11}$$

Here, C_i^H denotes the constant capital, V_i^H denotes the variable capital and S_i^H denotes the surplus value for ith turnover.

Now we can calculate the annual sum of the capital elements, labour times, profits and total outputs. From equation (10), the annual sum of constant capital and variable capital in the TSSI approach can be calculated with the equations given next:

$$C_{TSSI}^H = \sum_{i=1}^{N} \frac{C_i^{\$}}{\sigma_{i-1}} \tag{12}$$

$$V_{TSSI}^{H} = \sum_{i=1}^{N} \frac{V_i^{\$}}{\sigma_i} \tag{13}$$

The same values in the NI approach can be written with using equation (11).[12]

$$C_{NI}^{H} = \sum_{i=1}^{N} \frac{C_i^{\$}}{\mu_i} \tag{14}$$

$$V_{NI}^{H} = \sum_{i=1}^{N} \frac{V_i^{\$}}{\mu_i} \tag{15}$$

The NI approach applies directly to annual data. These will give annual values without using turnovers. Our aim is to compare the annual values of TSSI with NI, that is, equations (12) with (14) and (13) with (15). Because the surplus value is the difference between annual labour time and variable capital and the total output equal to the sum of constant capital, variable capital and the surplus value, it is enough to compare only constant and variable capital for determining the relation between the annual results of the TSSI and NI interpretations.

Now we can clearly see from equations (12) to (15) that the problem of determining the relationship between the two interpretations' annual results is indeed the problem of determining the relationship between two interpretations' MELT behaviour. Whenever TSSI MELT and NI MELT are equal to each other for every turnover, the two interpretations will give the same annual values for variable capital and surplus value. Moreover, for every turnover when TSSI MELT is equal to the next turnover's NI MELT, the two interpretations give the same annual values for constant capital. As a result the condition of the equality of the annual values of capital and surplus value is attained through constant and equal MELT within turnovers.

Let the rate of change of the TSSI MELT between two consecutive turnovers be Θ_i. From equation (1) it can be defined as:

$$\Theta_i = \frac{\sigma_i}{\sigma_{i-1}} = \frac{X_i^{\$}}{\sigma_{i-1} L_i^{H} + C_i^{\$}} \tag{16}$$

Under the condition that in any successive turnover the TSSI MELT remains the same, we arrive at the following equation:

$$\Theta_i = \frac{X_i^{\$}}{\sigma_{i-1} L_i^{H} + C_i^{\$}} = 1 \Rightarrow X_i^{\$} = \sigma_{i-1} L_i^{H} + C_i^{\$} \Rightarrow \sigma_{i-1} = \frac{X_i^{\$} - C_i^{\$}}{L_i^{H}} \tag{17}$$

This is nothing but the equality of TSSI MELT of $(i-1)$th turnover to the NI MELT of the ith turnover. Thus we can write the rate of change of the TSSI MELT conditions as:

[12] NI raises objection to equation (14) because here the value of constant capital is derived from the prices. However, for the sake of comparision, we proceed by imputing this equation to NI.

$$\begin{aligned} \sigma_{i-1} < \mu_i &\Rightarrow \Theta_i > 1 \\ \sigma_{i-1} > \mu_i &\Rightarrow \Theta_i < 1 \\ \sigma_{i-1} = \mu_i &\Rightarrow \Theta_i = 1 \end{aligned} \tag{18}$$

This situation yields the convergence conditions of TSSI MELT to NI MELT. For any i, when the TSSI MELT for the $(i-1)$th turnover is smaller than the NI MELT for the ith turnover, the TSSI MELT rises between the $(i-1)$th and ith turnover, then for the ith turnover TSSI MELT approaches the NI MELT and vice versa.

If we define the rate of change of NI MELT:

$$\Phi_i = \frac{\mu_i}{\mu_{i-1}} = \frac{X_i^{\$} - C_i^{\$}}{\mu_{i-1}\, L_i^H} \tag{19}$$

and the ratio between TSSI MELT and NI MELT for the ith turnover and successive turnovers is as in equation (20):

$$R_i = \frac{\sigma_i}{\mu_i}, T_i = \frac{\sigma_{i-1}}{\mu_i} \tag{20}$$

We can reach another equation through writing labour time for the ith turnover in terms of the TSSI MELT from equation (16) and putting it into equation (19), which relates the rate of change of TSSI MELT and NI MELT as:

$$\Phi_i = \Theta_i\, R_{i-1} \frac{X_i^{\$} - C_i^{\$}}{X_i^{\$} - \Theta_i\, C_i^{\$}} \tag{21}$$

From equations (16) and (19), equation (21) can be written as:

$$R_i = \frac{X_i^{\$} - \Theta_i\, C_i^{\$}}{X_i^{\$} - C_i^{\$}} \tag{22}$$

It gives the ratio between TSSI MELT and NI MELT for the ith turnover. Dividing both sides of equation (22) by equation (16) will give

$$T_i = \frac{X_i^{\$} / \Theta_i - C_i^{\$}}{X_i^{\$} - C_i^{\$}} \tag{23}$$

Equations (22) and (23) with (18) is adequate to analyse the relationship between the two interpretations of MELT and between the annual values of both interpretations. Whilst the R_i, $i = 1,2, \ldots, N$ sequence gives the measure of proximity of annual values of variable capital and surplus value, the T_i, $i = 1,2, \ldots, N$ sequence gives the measure of proximity of annual values of constant capital with two interpretations. We can conclude from equations (22) and (23) that, when the Θ_i is close to 1 (i.e. the rate of change of TSSI MELT between successive turnovers becomes smaller), then both interpretations will give close values for constant capital, variable capital and the surplus value.

When TSSI MELT is constant within successive turnovers R_i and T_i equals 1 and the two interpretations give the same constant capital, variable capital and surplus value for the ith turnover. If TSSI MELT rises between successive turnovers, R_i and T_i becomes less than 1 and from equations (20), (10) and (11) we can say that the TSSI interpretation gives greater values for constant capital and variable capital (and then smaller surplus value). The situation is reversed in the case of falling TSSI MELT.

On the other hand, when the number of turnovers increases, all rates of change for MELTs between any successive turnovers approach unity and, thus, Θ_i approaches 1. For this reason, for any turnover schema, convergence behaviour will occur for a higher number of turnovers. Although for some cases convergence will be achieved later, for others it will be achieved sooner. Since this convergence behaviour occurs regardless of the turnover schema, when the number of turnovers is increased, both interpretations give closer annual values. This conclusion is valid for any economically reasonable turnover pattern.

4. Conclusion

It has been attempted to emphasise that nothing other than derived social turnover statistics is the appropriate level for making empirical investigations using the TSSI. Annual statistics lead to pernicious theoretical inconsistency if used in TSSI calculations. Moreover, it is interesting that when we apply turnover statistics, the calculations of TSSI and its contending NI give rise to closer empirical results. From here one can conclude, with some caution, that for practical purposes in value calculations, a Marxian researcher can use annual statistics with NI formulations (which is the easy one) for obtaining TSSI results. However, one must be aware of the fact that the two interpretations have obviously different theoretical backgrounds and, theoretically, the two calculations give different results at more concrete levels. Convergence of results is due to the statistical constraints and reference of social turnovers, both of which are, in our view, the imperative aspects of any empirical research.[13] Furthermore, the model exhibits that only for special cases (such as stable increase of variables) do both results equal each other. In other cases, if the number of turnovers is not high enough, there is

[13] In his article Alan Freeman (1996) points to an existence of a convergence pattern between values and prices. However, this case is not exactly the same as our convergence result. Freeman constructs a general continuous mathematical model to display a trajectory of values by means of sequential approach of TSSI and emphasizes the difference between values in equilibrium and values in sequential analysis. However, it is well known that both values are equal only in the case of the absence of technological change. Moreover, by making the period of reproduction progressively shorter in the model, Freeman achieves the result that the sequence of values and prices converge. 'What they converge uniformly to is the continuous case, in which the period of reproduction is treated as infinitely small' (Freeman, 1996, p. 262). However, this is not a general conclusion. As Freeman notes: 'The condition for this is the absence of singularities or "sudden steps" in the stock or price vectors' (1996, p. 262). Although he does not give a precise reason for this convergence, readers could easily infer from the article that this stems from the equilibrium-like feature of the smooth operation of the market in the condition of absence of crisis. We are aware of the fact that at crisis moments, this smoothness vanishes and thus equilibrium conditions do also; therefore the distinction of values imposes itself again.

In our article the convergence mechanism is quite different from that of Freeman because we assume neither smoothness nor absence of technological change. Nevertheless, the convergence we reach resembles Freeman's case only in terms of the following aspect. We put forwards the argument that turnover data have to be used in the TSSI approach, and furthermore, these data should be derived from the given annual statistics. If no information other than the number of turnovers and annual data is available (which is the usual case), this derivation requires a kind of 'smoothness' assumption to fill these gaps, that is, turnovers.

room for potential difference, as the TSSI theoretically expects. However, to obtain a basic empirical result, either method can be applied by assuming the number of turnovers is sufficiently high. It should not be forgotten, however, that these approaches define value categories substantially differently, therefore, even with the same MELTs, calculations of each value category, that is, variable capital, constant capital and surplus value, must give rise to different empirical results.

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