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Tsoulfidis, Lefteris and Paitaridis, Dimitris

University of Macedonia, Thessaloniki - Greece, Institute of Labor (INE), Athens, Greece

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By

Lefteris Tsoulfidis* and Dimitris Paitaridis**

Mailing Address:

LEFTERIS TSOULFIDIS
Professor, Department of Economics
University of Macedonia
156 Egnatia Street, PO Box 1592
540 06 Thessaloniki, Greece
Tel. 30 31 891-788
e-mail: Lnt@uom.edu.gr

ABSTRACT

This paper presents estimates of labor values and prices of production following two approaches: The first, based on the classical and Marxian theory of value and distribution; while, the second is based on the so-called new solution to the transformation problem and its variant the Temporary Single-System Interpretation (TSSI). The major advantage of the latter approach is its simplicity along with the relatively low data requirements. Our empirical findings from the economies of China, Japan and South Korea suggest that both approaches give estimates of labor values and prices of production which are extremely close to each other as well as to actual market prices. On further examination, however, we conclude that our empirical findings are absolutely consistent with the theoretical requirements of the classical approach and contradict those of the TSSI.

JEL Classifications: C21, C43, C52, C67, D46, D57

Key Words: Marxian theory, labor theory of value, TSSI, vertical integration.

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* Department of Economics, University of Macedonia, Thessaloniki, Greece

** Institute of Labor (INE), Athens, Greece

1. Introduction

The theory of value and distribution is where the different economic approaches find common ground and object of analysis. Both classical and (the usual) neoclassical theories seek to explain equilibrium (or long-run) prices using different sets of data. The classical theory using a set of objective data that include the level and composition of output produced with the technology described by the input-output structure and the real wage, that is, the basket of goods normally purchased by workers with their money wage. By contrast, the neoclassical view using a rather subjective set of data that include the preferences of individuals, the size and distribution of endowments to individuals, and the available technical alternatives. These theories are antagonistic because they have the same object of analysis. Within the classical approach, however, there is a strand, the TSSI, claiming to fulfill the same objectives in a theoretically consistent way without having to rely on data limitations and complexities of analysis. The focus of this paper is the estimation of the monetary expressions of labor values and prices of production according to the classical view and the alternative based on a measure of monetary expression of labor time (MELT) usually associated with the so-called new solution to the transformation problem.

Proponents of the TSSI claim that most treatments of the transformation problem are static and dual in the sense that they start off with a system of equation expressed in terms of labor values arriving at prices production from the solution to a system of simultaneous equations and in the simultaneity of solution the element of time is spirited away. Furthermore, the TSSI approach uses the concept of the MELT (see Duménil, 1983; Foley, 1982; Moseley, 2011; Moseley and Rieu, 2009 and the literature cited in there) and by emphasizing the net value added, instead of the usual gross output, proposes a solution to the "transformation problem" based on the value of net output evaluated in both labor values to that in terms of prices of production. The equilibrium prices (of production) may be attained through a sequence of steps in calendar time. However, the proponents of this approach although they put forward a dynamic treatment of the so-called transformation problem, nevertheless they leave out of their analysis the development of complex dynamics whereby profit rates differentials lead to acceleration or deceleration of capital accumulation which in their turn elicit changes in demand and supply giving rise to new profit rate differentials and so forth.

In what follows, although we do not share the claims of the so-called 'newsolutionists' or the proponents of the TSSI alternative in the sense that neither the classical approach is static or dualistic, nor there is simultaneity in the solution of the so-called transformation problem, because one can introduce the (analytical) time dimension and derive the same results. In effect, the discussion on the transformation problem is originally cast in static terms and the issue at hand is the estimation of an equilibrium markup on cost of invested capital. In our approach, we argue that the difference between the monetary expressions of labor values and prices of production are surprisingly very small. We say surprisingly very small because a lot of ink has been spilled over a problem of relatively small quantitative significance, as we already know from Ricardo's numerical examples and his famous 93 percent labor theory of value. The same argument appears in Marx, of course with many qualifications. In particular, the source of profits, that is, what motivates production is the labor time employed in production and if we assume a price system in terms of labor values, then the surplus value is distributed across sectors in proportion to variable capital. But in capitalism, with profits as the motive of production, it is understood that in order for capitalists to invest in fixed capital, they need to earn profits proportional to their invested capital. Thus, in assuming an equal profit rate across sectors, we in effect say that exchange takes place in terms of prices production, which entail a redistribution of the surplus-value produced in the form of profits according to the invested in each industry capital. The exchange in terms of prices of production requires unequal rates of surplus value, in order for the industries to make an equal rate of profit. One wonders, how much difference in prices of production from labor values does this redistribution of surplus value make? Ricardo's and Marx's answer was that the difference between these two sets of prices would be very small as they argued and also showed in their representative numerical examples.

This theoretical issue was subjected to empirical testing using data from a number of diverse economies and across time. The results have shown that the difference regarding the two types of prices is, in fact, minimal and also many researchers found minimal differences of estimated prices from observed market prices. In the first empirical studies, the closeness of the three types of prices was tested using simple regressions and statistics of deviations all of which were fraught with biases for their dependence on the adopted normalization condition and chosen numéraire (Shaikh, 1984, Ochoa, 1984). Later studies (Tsoulfidis and Maniatis, 2002; Tsoulfidis and Rieu, 2006 and Tsoulfidis, 2008) have shown that the normalization condition does not impact so much on the actual proximity of estimated prices against market prices. In fact, theoretically it has been shown (Mariolis and Tsoulfidis, 2010 and 2016, ch. 3) that if the relative rate of profit (i.e., the ratio of the economy-wide average rate of profit to the maximum rate of profit) is small, smaller than say fifty percent, typically found in a number of empirical studies, all measures of deviation biased or not are bound to give quite similar results. In these empirical studies, the relative rate of profit is approximated by the ratio of net operating surplus to net value added.

There is another critique of traditional studies emanating from a strand of the classical theory known as the Temporary Single-System Interpretation (TSSI) that claims an alternative way of estimating the closeness of labor values and prices of production. Freeman (1997) initially, and Kliman (2002, 2004 and 2007) subsequently reported that high correlation coefficients between labor values and market prices should be attributed to the size of industries, and once we somehow eliminate the size-bias, the correlation coefficient becomes negligible and not statistically significant. This line of research continued in Diaz and Osuna (2005-6 and 2007) who concluded that any efforts to eliminate the size-bias are doomed to fail for we do not have any way of knowing the physical units of measurement and thus the market prices.

In this paper, we report our empirical results following both estimating methods and using input - output data of the economies of China, Japan and South Korea. In addition, we find that the alleged bias in the measures of deviation is relatively small and, therefore, does not affect the results in any qualitatively different way. The remainder of the paper is structured as follows: Section Two briefly reviews the pertinent literature. Section Three discusses the methods of estimation of labor values and prices of production according to the two contending approaches. Section Four, presents the results of the analysis and Section Five critically evaluates the two approaches. Finally, Section Six summarizes and concludes.

2. Literature Review

The empirical research on the relation between the monetary expression of labor values, prices of production and market prices using input-output data for many diverse economies or for the same economy over a number of years is extensive. The results, in most cases, have shown that the three types of prices are too close to each other. More specifically, Shaikh (2008 and 2016) reports that the mean absolute deviations (MAD) of direct prices (*i.e*., prices proportional to labor values) or prices of production from market prices in the USA are in the order of 10 percent. The research for the economies of the UK (Cockshott, *et al*. 1995, 1997 and 2005) former Yugoslavia (Petrovic, 1987), Greece (Tsoulfidis and Maniatis, 2002), Korea (Tsoulfidis and Rieu, 2006), Japan (Tsoulfidis, 2008) and China (Mariolis and Tsoulfidis 2009, Mobiler and Sanchez 2015) ascertained the closeness of these three type of prices.

The above analyses are based on detailed input-output data and the notion of vertical integration (Pasinetti, 1977) which is central to the classical Marxian analyses. As a result of a critique on various aspects of the above analysis, a strand of Marxian economists cast doubt on these results in the sense that they are bias-ridden. These authors estimate the direct prices using national income accounts data. For example, Kliman (2002 and 2004) in his study of the US economy derives estimates of labor values of each industry, which he then multiplied by the respective industry sales and subsequently he regressed the derived vectors of labor values, obtained for each year spanning the period 1977-1997, against the industry sales hypothesizing that the market prices are equal to one. Not surprisingly, he finds high correlation coefficients, well above 95 percent and certainly higher than those reported in similar studies based on input-output data (e.g., Ochoa, 1984).

The presence of probable bias in the estimates of correlation coefficients was already known in the first studies (e.g., Ochoa, 1984, p. 124). Shaikh (1998, p.233) in order to avoid the possibility of bias, he abandoned the estimates based on correlations and he opted for the measures of deviations, such that the MAD or the weighted by the gross output MAD (MAWD). Kliman (2002), on the other hand, clogged in the old type of OLS regressions he tried to correct the alleged "size-induced bias" by scaling down, or in his wording by "deflating", both variables (labor values times sales and total sales) by the total (labor and non-labor) cost of production. Formally, if by $\mathbf{x}$ we denote the column vector of gross output or total sales of each industry, which is equivalent to saying that, the market prices are equal to the row vector of ones, $\mathbf{e}$, (millions of dollars). Thus, we may write $\boldsymbol{\lambda}'.*\,\mathbf{x}$, where $\boldsymbol{\lambda}$ is the row vector of labor content (value) per unit of an industry's gross output (sales) such that each industry's $\boldsymbol{\lambda}$ is a figure, usually much smaller than one, multiplied element by element (.*) by the vector of gross output, $\mathbf{x}$, the latter may be thought as multiplied in similar fashion by the row vector of ones, $\mathbf{e}'.*\,\mathbf{x}$.[1] It follows therefore that the correlation coefficient in a regression performed in the above relation, that is, $\boldsymbol{\lambda}$ against the vector of ones, $\mathbf{e}'$, will give a correlation coefficient (nearly) equal to zero, whereas a regression of $\boldsymbol{\lambda}'.*\,\mathbf{x}$ against $\mathbf{e}'.*\,\mathbf{x}$ naturally will give an *R*-square in the range of 80 or 90 percent, precisely because the *R*-square depends (almost exclusively) on the vector of $\mathbf{x}$, which appears on both the regressor and the regressand.

If we disregard from the above equation the sales, following Kliman's suggestion, and we deflate by the cost of production, that is the sum of constant, c, and variable capital, v. It follows that for each industry we get the term $1 + s(c + v)^{-1}$ regressed against the term $(c + v)^{-1}$, where s is the surplus value produced. Not surprisingly, the correlation coefficients of the two variables for all industries is somewhat improved, but it remains low because we essentially regress the markup on cost $s(c + v)^{-1}$ of each industry against the reciprocal of unit cost $(c + v)^{-1}$.

[1] Vectors are indicated in boldface letters and a prime over these letters indicates their transpose. Matrices are indicated in capital and boldface letters.

This new bias in Kliman's method of deflating was spotted by Diaz and Osuna (2005-2006, p. 356) who opted for an alternative method based on the non-labor cost alone and by using national income account data of the Spanish economy spanning the period 1986-1994 they found a combination of relatively small price-value deviations and high correlations coefficients. Diaz and Osuna (2005-2006 and 2007) subsequently performed their own deflating method by dividing through by the variable capital, in this case, we may regress $\boldsymbol{\lambda}'./\mathbf{v}'$ against $\mathbf{e}'./\mathbf{v}'$. The R-square in these regressions was around 40%, a result which is attributed to the significance of variable capital appearing on both sides of the above relation. Diaz and Osuna (2005-6 and 2011) proposed an alternative deflation through the cost of the capital stock. In this case, the dot division of vectors of labor values dot divided by the vector of capital stock, $\boldsymbol{\lambda}'./\mathbf{K}'$, is regressed against $\mathbf{e}'./\mathbf{K}'$. Naturally, the correlation coefficients increased, since the numerators are by far smaller in comparison to the common denominators. The high correlations were restored to their super high range, that is, in the range of 90 percent. From these findings, one would expect that Diaz and Osuna (2005-2006 and 2007) would rather opt for the use of bias-free measures of deviation; they instead, brought into the discussion another challenging issue associated with the physical units of measurement. They argued that since we have no way of knowing the exact physical units of measurement, therefore, we have no way of correctly estimating the labor values and prices of production and compare them between each other and also the market prices. As a consequence, Diaz and Osuna (2007) conclude that they cannot judge closeness or association of various kinds of estimated prices (be it direct prices or prices of production) and the "unknown" market prices.

The idea is that the estimated prices and their comparison with the market prices require the physical units of measurement of output produced and because we have no way of knowing the exact units of measurement the whole exercise according to Diaz and Osuna (2007) is deprived of any meaning. In the input-output analysis, however, we need not know the exact physical units of measurement; we only need to assume that whatever they are, they do not change during the analysis. Once we stipulate such an assumption then the direct prices and prices of production are derived as a proportion to market prices, whatever these might be. By way of an example, let us suppose that coffee is sold for 5 dollars a kilo, the evaluation of the product in dollars amounts to that one-fifth of a kilo will be equal to one dollar. The physical unit of measurement of coffee becomes the one-fifth of a kilo. Consequently, in input-output analysis market prices are set equal to one because it is not feasible to collect data on the physical output produced, we simply stipulate the constancy of the physical units of measurement. Leontief (1966, p. 137) for example notes "[a]ll figures in [an input-output table] can also be interpreted as representing physical quantities of the goods or services to which they refer. This only requires that the physical units in which one measures the entries in each row be redefined as being equal to the amount of output of the particular sector which can be purchased for $1 at prices which prevailed during the interval of time for which the table was constructed".[2] Once we stipulate the assumption of given physical units of measurement such that market prices are equal to one and the direct prices and prices of production are derived as a proportion to market prices, whatever these might be.

In our view, the trouble with the TSSI approach and the various normalizations (or deflating) methods associated with it is that it treats prices of production as if they were short term prices and as such have no actual role to play in the market processes. This is something explicitly recognized by Kliman (2004) who sidesteps the estimation of prices of production altogether on the grounds that such prices do not really exist. However, other followers of the TSSI approach (Diaz and Osuna, 2004 and 2007) proceed with the estimation of production prices by assuming that they change in each production cycle in order to equalize interindustry profit rates. This, however, is not exactly right because prices of production in the classical economists and Marx are determined in the long run by the given technology, along with the level of output and its allocation to industries as well as the rate of surplus value determined by the class struggle which is another way to say by the level of the real wage. Consequently, prices of production as centers of gravity of market prices can only change if technology and

[2] For a comprehensive discussion of the same issue and a relevant numerical example (Ochoa, 1984, pp. 58-70) and for a discussion within the context of Leontief's price model (Miller and Blair, 2009, ch. 2).

real wage change. This is so to speak the standard interpretation that theorizes production prices as a more concrete center of gravitation of market prices. Furthermore, prices of production are strictly connected to the monetary expression of labor values, that is, the direct prices. As a result, the famous Marx's (1982, ch. 9) two equality conditions (i.e., the total values are equal to the total prices of production and the total profits are equal to the total surplus value produced) required for the logical consistency of the Marxian system of prices hold. It goes without saying these so-called invariance conditions do not hold if one accepts successive productive periods as the TSSI approach does. The establishment of prices of production reallocates the surplus value produced according to the capital intensity of each industry relative to the average. More specifically, we expect that industries whose capital intensity is greater (lower) than the economy-wide average capital intensity they receive greater (lower) profits than the surplus value they produce. If this crucial consistency condition is violated then the theoretical status of production prices and their deviation from labor values is in serious trouble in both contesting approaches.

Although, theoretically the choice is already made in favor of the classical or standard model, nevertheless, we want to subject both competing approaches to two crucial, in our view, tests. First, we want to assess the proximity of the two types of estimated prices with respect to market prices, and second, to test the consistency of the two estimating methods with respect to the allocation of surplus value to various sectors in proportion to the capital intensities of industries relative to the economy's (weighted) average. Our estimates for the economies of China, Japan and Korea, three major economies with high quality and availability of input-output data collected on the basis of common methodology, industry detail, year and currency (USD) will form an ideal testing ground for the predictive content of the labor theory of value in its classical version and, at the same time, it will contrast these findings with those of the New Solution and its variant the TSSI approach. Furthermore, the use of data on the capital stock will shed additional light on the issues involved in these discussions.

3. Labor Values and Prices of Production

The TSSI estimating method for the labor values and production prices emphasizes the presence of both time and disequilibrium and by doing so insists on the dynamic nature of both labor values and prices of production. The two types of prices require different time dimensions according to this approach as it has been argued by Kliman (2002), Mohun (2004) and Veneziani (2004). In order to carry out these estimations, we need data on the cost of intermediate inputs plus the constituent components of value added, that is, wages and gross profits. Furthermore, we need data on total employment, in terms of the number of employees or total working hours (see the Appendix, for the set of data at the 34 industry detail). In what follows, we estimate both labor values and production prices with the employment of capital stock following the two methods of estimation (the classical and the TSSI) and the results are compared in an effort to draw useful conclusions about the desirability of both estimating methods.

The crucial step in this enterprise is to translate the labor time magnitudes into direct prices through the device of the MELT. The latter, following the procedure suggested by Diaz and Osuna (2005-2006), we divide the sum of the gross output of the total economy by the amount of labor time that has been employed. The difficulty lies in the conversion of the constant capital (intermediate inputs and depreciation) measured in dollars (monetary terms) to labor time employed. This reduction is carried out through the concept of dated quantities of labor time. More specifically, the constant capital of the current period is divided by the MELT of the previous period. Thus, we may write:

$$MELT_t = (c_t + v_t + s_t) / [(c_t/MELT_{t-1}) + h_t]$$

where h denotes the total hours employed in a year and t stands for years. But if the current $MELT_t$ depends on the $MELT_{t-1}$ a year ago and that on the $MELT_{t-2}$ and so forth, the theoretical limit to this recursive process is the expression of all non-labor inputs to (current and past) labor time. In our effort to eliminate the possible biases in the estimation of the Chinese, Japanese and Korean $MELT$[3], we went back to ten years, which should be adequate judging from the fact that Diaz and Osuna (2005-2006 and 2007) went back to seven years. Crucial in these estimations is that in the start year the ratio of value added to currently employed labor time is used, a method inspired by the followers of the so-called “new solution” to the “transformation problem” (Foley, 1982; Duménil, 1983, *inter alia*). Subsequently, the so derived $MELT$ is used to transform the constant capital into labor values, which are augmented with the living labor in order to estimate the labor value contained in gross output, which in the next round is used for the estimation of the $MELT$. Repeating the process, any possible deviations are minimized if not eliminated as long as new living labor is added to the product.

A comparison of the two estimating methods would reveal their advantages and disadvantages and so a choice between them could be made on the basis of theoretical consistency and predictive content. It goes without saying that we do not rule out a priori the possibility that the two approaches may give quite similar results. The decisive criterion for the evaluation of each method is the relative accuracy of the predictions of market prices in combination with their theoretical consistency. If both approaches predict equally well and are both theoretically consistent with their fundamental premises, then naturally both approaches can be used for the same purpose. However, if we have to choose between them the more parsimonious is preferred to the more complex. Prices of production are estimated by bringing into the analysis the economy’s uniform rate of profit which is estimated as shown in Table 1 below.

[3] In effect, in a thought experiment, we went back in time expressing all the material inputs of the previous stage of production plus labor time up until we ended up at the time period (sufficiently long), where everything may be expressed in terms of living labor time.

Table 1. The TSSI estimation of labor values and prices of production

Variable Notation	Variable Name
1	Net Capital Stock
2	Consumption of fixed capital
3	Intermediate inputs
4=2+3	Nonlabor costs
5	Labor costs
6=5+4	Total costs
7	Net Profit
8=2+7	Gross Profit
9=7+5	Net final income
10=8+5	Gross final income
11=10+3	Total production valued at market prices
11/6	Proxy to market price (cost deflated)
12=7/1	Rate of profit
13=Σ7/Σ1	Uniform rate of profit
14=6+13*1	Total production valued at production prices
14/6	Proxy to production price (cost deflated)
15=4/MELT(-)	Non-labor costs measured in work hours (millions)
16	Millions of labor hours (adjusted)
17=15+16	Labor value of the total production
18=Σ11/Σ17	MELT(+)
19=17*18	Total production valued at direct prices
19/6	Proxy to direct price (cost deflated)

Turning now to the classical Marxian approach based on input-output data and estimating methods, we begin with the labor values, $\boldsymbol{\lambda}$, that is, the total (direct and indirect) labor requirements per unit of output produced. More specifically, the labor values are derived from the solution of the following system of equations in matrix form:

$$\boldsymbol{\lambda} = \mathbf{l}[\mathbf{I} - \mathbf{A} - \mathbf{D}]^{-1}$$

Where, $\boldsymbol{\lambda}$ is the row vector (1x34) of labor values or vertically integrated labor input coefficients, $\mathbf{A}$ is the (34x34) matrix of input-output coefficients, $\mathbf{D}$ is the (34x34) matrix of depreciation coefficients, $\mathbf{l}$ is the row (1x34) vector of adjusted for skills direct labor coefficients and $\mathbf{I}$ is the (34x34) identity matrix. Furthermore, we scale the so-estimated labor values to prices proportional to values, that is, we equate the sum of labor values expressed in money terms (direct prices) to the sum of market prices according to the usual condition of the transformation problem. That is, $\mathbf{v} = \boldsymbol{\lambda}(\mathbf{ex})/(\boldsymbol{\lambda}\mathbf{x})$ where $\mathbf{v}$ is the row vector of direct prices, $\mathbf{e}$ is the (1x34) row vector of ones identified with the market prices and $\mathbf{x}$ is the (34x1) column vector of gross output. With this normalization, the equality between the gross output evaluated in direct prices ($\mathbf{vx}$) to the gross output evaluated in market prices ($\mathbf{ex}$) will always hold true. In other words, the proposed normalization condition of prices maintains the value of money constant. In effect, the ratio $(\mathbf{ex})/(\boldsymbol{\lambda}\mathbf{x})$ represents the corresponding MELT with the difference that now it is estimated in terms of vertical integration (Pasinetti, 1977) analysis and the same time period.

The prices of production are estimated from the following equation:

$$\mathbf{P} = \mathbf{Pbl} + \mathbf{PA} + \mathbf{PD} + r\mathbf{PK}$$

where $\mathbf{P}$ is a row vector of relative prices of production, $\mathbf{b}$ is the (34x1) column vector of the basket of goods that workers normally consume with their money wage, w=$\mathbf{Pb}$, and r is a scalar representing the economy's uniform rate of profit. Both prices of production (the left-hand side eigenvector) and the rate of profit (corresponding to the maximal eigenvalue) are estimated from the solution of the following eigenequation:

$$\mathbf{P}\mathrm{r}^{-1} = \mathbf{PK}[\mathbf{I} - \mathbf{A} - \mathbf{bl} - \mathbf{D}]^{-\mathbf{1}}$$

The resulting left hand side eigenvector is normalized such that $\mathbf{p} = \mathbf{P}(\mathbf{ex}/\mathbf{px})$.

In our analysis, we use input-output data for China, Japan and Korea of the year 2009. The source of our data is the World Input-Output Database which provides data at the 34 industry detail cast in terms of current dollars.[4] In our estimation besides the matrix of input-output coefficients, we use the vectors of employment and consumption of workers coefficients. A novel feature of our investigation is the construction of matrices of depreciation and capital stock coefficients from the available same source of data. The detailed discussion of the construction of the matrices and vectors used in our analysis is given in the Appendix.

4. Results and their Evaluation

The vectors of labor values (or direct prices), $\mathbf{d}$, and prices of production, $\mathbf{p}$, according to the two estimating methods are displayed in Table 2 below. We have also estimated the TSSI direct prices and prices of production as indicated in Table 1. The first two columns of Table 2 for each of the three economies report the estimates of labor values and prices of production according to the classical estimating method and the next two columns report the TSSI estimates of direct prices and prices of production for each of the three economies for the year 2009.

[4] The data were accessed on March 15, 2016, and the link is http://www.wiod.org and the documentation is in Timmer, *et al.* (2015).

Table 2. Estimates of the two competing approaches, China, Japan and Korea 2009[5]

	China				Japan				Korea			
	d	p	TSSI d	TSSI p	d	p	TSSI d	TSSI p	d	p	TSSI d	TSSI p
1	1.875	1.324	1.386	1.194	1.054	1.139	1.073	1.141	1.310	1.272	1.148	1.171
2	0.873	0.945	0.886	0.942	0.979	1.011	1.031	1.058	0.689	0.769	0.693	0.719
3	1.311	1.100	0.970	0.961	0.899	0.895	0.911	0.897	1.101	1.072	0.994	0.968
4	1.123	1.011	1.025	0.971	1.380	1.275	1.322	1.237	0.954	0.916	0.992	0.970
5	1.150	1.020	1.019	0.965	1.153	1.113	1.127	1.100	1.040	1.007	1.046	1.022
6	1.101	0.977	0.997	0.947	1.110	1.054	1.102	1.047	1.101	1.055	1.015	0.988
7	0.972	0.973	0.998	0.973	0.977	0.971	0.988	0.983	1.180	1.072	1.077	1.044
8	0.845	0.917	1.008	0.963	0.664	0.710	0.694	0.726	0.691	0.757	1.015	0.982
9	0.903	0.938	0.995	0.957	0.928	0.956	0.969	0.992	0.787	0.797	0.981	0.954
10	0.918	0.939	1.014	0.967	1.103	1.092	1.096	1.086	0.906	0.863	0.986	0.956
11	0.883	0.937	0.982	0.962	1.036	1.067	1.036	1.068	0.992	0.985	1.019	1.001
12	0.839	0.888	1.002	0.947	0.992	0.984	0.999	0.997	0.841	0.848	0.983	0.955
13	0.873	0.883	0.999	0.946	1.022	1.043	1.010	1.032	1.003	0.921	1.027	0.991
14	0.852	0.866	1.024	0.958	1.111	1.131	1.071	1.095	0.943	0.912	0.987	0.965
15	0.896	0.884	1.022	0.958	1.017	1.026	1.002	1.012	1.011	0.924	1.031	0.997
16	0.840	0.833	0.823	0.830	1.100	1.118	1.101	1.127	0.998	0.932	1.014	0.983
17	0.885	1.187	1.015	1.165	0.904	1.027	0.896	1.021	0.833	1.113	0.998	1.072
18	0.961	0.898	1.046	0.938	1.145	1.022	1.145	1.035	1.085	0.980	1.044	1.010
19	-	-	-	-	1.198	1.076	1.207	1.086	0.984	0.863	0.889	0.866
20	0.726	0.720	0.708	0.669	0.831	0.772	0.851	0.786	0.925	0.853	0.839	0.811
21	0.726	0.723	0.708	0.673	1.060	0.972	1.087	0.986	0.949	0.913	0.888	0.864
22	1.068	0.933	0.897	0.840	0.986	0.927	1.018	0.956	1.124	1.079	1.052	1.033
23	0.858	1.096	0.876	1.109	1.086	1.114	1.100	1.117	1.025	1.153	1.052	1.113
24	0.797	1.034	0.867	1.064	0.889	0.945	0.967	0.981	0.988	1.205	0.971	1.036
25	0.872	1.060	0.978	1.101	0.992	1.001	0.927	0.956	1.074	1.223	1.076	1.136
26	0.858	0.950	0.879	0.932	1.635	1.511	1.666	1.513	1.116	1.290	1.079	1.138
27	0.750	0.976	0.772	0.964	0.741	0.833	0.725	0.820	1.110	1.108	1.032	1.031
28	0.767	0.624	0.685	0.575	0.781	0.719	0.782	0.737	0.809	0.718	0.795	0.766
29	0.726	2.197	0.769	2.225	0.503	0.985	0.477	0.933	0.505	1.245	0.512	0.848
30	1.004	1.018	1.011	1.015	1.203	1.107	1.183	1.102	1.153	1.196	0.985	1.044
31	1.532	1.249	1.285	1.170	1.326	1.196	1.302	1.191	1.535	1.648	1.297	1.408
32	1.426	1.132	1.205	1.068	1.344	1.106	1.356	1.121	1.671	1.354	1.331	1.278
33	1.138	0.995	1.108	1.000	0.953	0.934	0.970	0.944	1.206	1.046	1.095	1.052
34	0.893	1.571	0.883	1.515	1.104	1.057	1.105	1.057	1.169	1.075	1.063	1.032

[5] Industry 19 in the case of China contains no data and with total output equal to zero. As a result, we disregarded this industry in the case of China. For the nomenclature of industries see Table A2 in the Appendix.

The deviations of direct prices and prices of production are estimated through the $MAD = n^{-1}(\mathbf{d} - \mathbf{e})\mathbf{e}'$, that is, the average absolute deviations of n direct prices (or prices of production) from market prices and the $MAWD = (\mathbf{d} - \mathbf{e})\mathbf{x}(\mathbf{ex})^{-1}$, that is, the percentage absolute deviations of prices of production (or labor values) from market prices weighted by each sector's share of total output. These two are the most frequently used summary statistics of deviation; it has been argued by Steedman and Tomkins (1998) that both of these statistics along with a number of others suffer from a certain degree of bias stemming from the applied normalization condition. The size of the bias, theoretically speaking, might be serious. This is the reason that Steedman and Tomkins (1998) proposed a measure of deviation independent of the normalization condition, the d statistic defined as $d = [2(1 - \cos\theta)]^{1/2}$, where θ is the angle between the two vectors in comparison. Thus, it is interesting to compare the proximity of values and prices of production with respect to market prices judging from data taken from real economies and by doing so to obtain a more precise idea of the extent of the suspected bias. The results are displayed in Table 3 below.

Table 3. Measures of % deviation

	Classical Estimation		TSSI Estimations	
China 2009				
Measures of Deviation	Direct Prices	Prices of Production	Direct Prices TSSI	Prices of Production, TSSI
MAD	18.8%	15.8%	10.6%	14.5%
MAWD	19.6%	15.4%	8.9%	12.1%
d	25.1%	26.1%	15.6%	26.1%
Japan 2009				
MAD	15.2%	10.8%	14.7%	10.4%
MAWD	16.7%	9.9%	16.0%	9.6%
d	20.1%	14.6%	19.8%	14.1%
Korea 2009				
MAD	15.4%	15.5%	8.9%	8.9%
MAWD	16.4%	15.5%	8.1%	7.8%
d	21.2%	18.8%	14.4%	13.1%

Clearly, the three measures of deviation convey approximately the same picture with respect to the degree of closeness of the estimated prices of the two competing approaches. Starting with the standard approach, we observe that the summary statistics of deviation for the Chinese, Japanese and Korean economies are in line with those estimated for a number of other countries (See Mariolis and Tsoulfidis 2016, ch.4 and the references cited there). Turning now to the TSSI estimates, we observe that both production and direct prices are in effect closer to the unit or what amounts to the same thing market prices. Finally, from the data of Table 3, one cannot ignore the fact that the usual measures of deviation (MAD, $MAWD$) although they suffer from a certain (to our view very small) degree of bias, nevertheless they are not out of touch from the alternative and bias-free d −statistic. There are some other statistics of deviations which pretty much give the same answer with the above and they are bound to give the same answer because of the relative rate of profit, that is, the ratio of the average rate of profit over the maximal rate of profit in the three countries is small in the case of Japan and Korea is estimated at 21.31% and 24.27%, respectively, whereas in China is 47.20% which is considered relatively low and under these circumstances it has been shown (Mariolis and Tsoulfidis, 2010 and 2016, ch.4) that the usual measures of deviations give pretty much the same answer. Diaz and Osuna (2007) argued that even though one could get rid of the bias imposed by the normalization condition using the *d* or other similar statistics. In their view, one should dispense with all the measures of deviation, simply because all of them depend on the choice of physical units of measurement, which whenever they change, affect the market prices. While we do not take issue with the mathematical logic of the two authors, nevertheless their conclusions are derived simply because they violate the fundamental assumption of input-output tables, that is, the physical units of measurement are fixed and so it is not permissible to experiment freely with different physical units of measurement.[6]

[6] Frohlish (2011) argues that Diaz and Osuna (2007 and 2009) derive the alleged bias of the physical units of measurement by the inappropriate use of logarithms and their properties.

5. Evaluation of the Two Approaches

Since both approaches give quite comparable results in terms of their proximity to market prices, one wonders whether the new approach is preferred to the classical Marxian one. In our view, the defining test to determine which of the two approaches is consistent with the basic requirements of the theory that prices of production will be higher (lower) than direct prices (i.e., the monetary expression of labor values) in the industries whose capital intensity is higher (lower) than the economy-wide average. Of course, we do not want to rule out the case of industries whose composition of capital might be nearly equal to the economy's average the differences between prices of production from value might be minimal and in the limiting case zero.

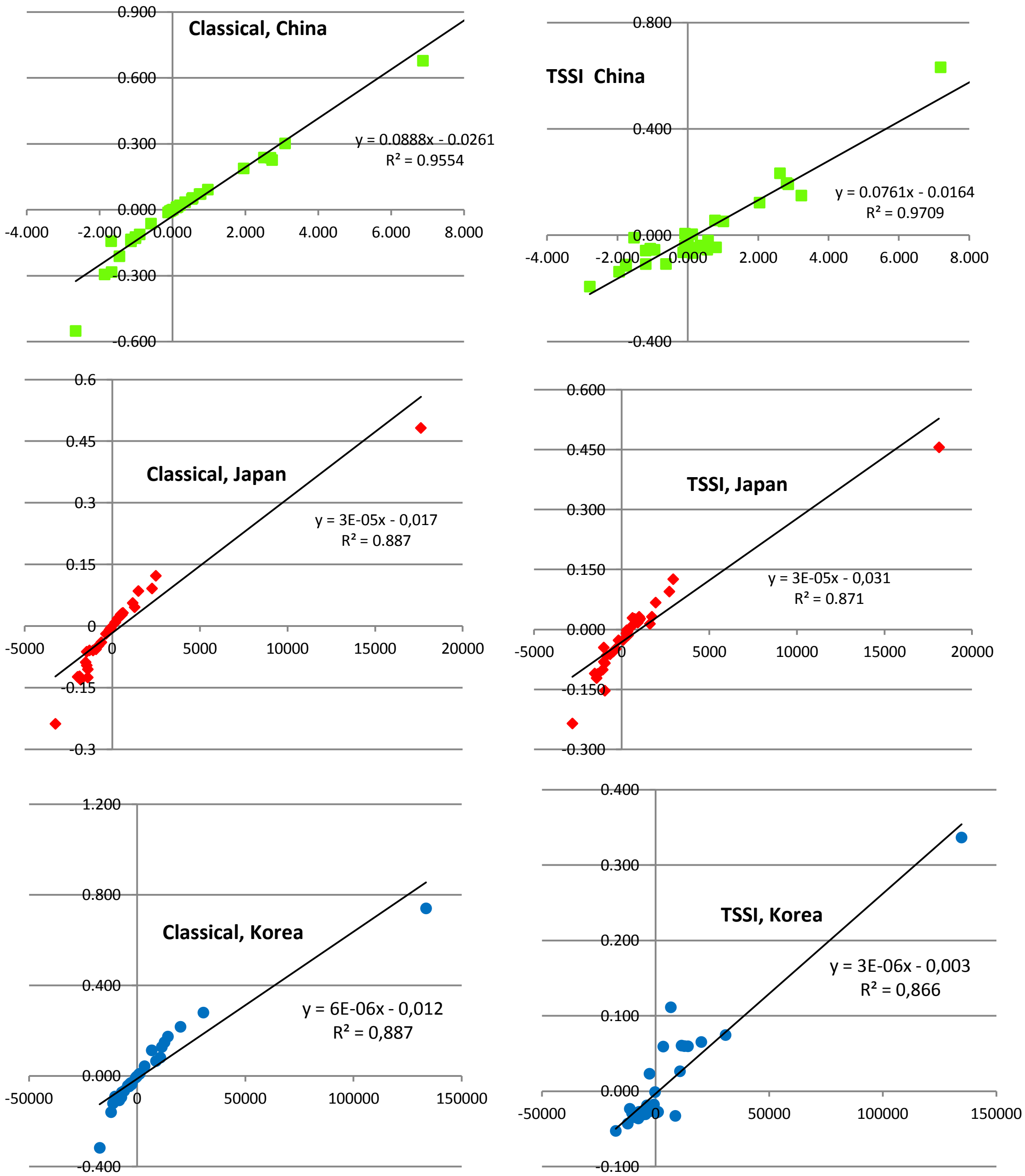
Figure 1 below displays the price of production–labor values deviations of both approaches as well as the deviations of each industry's composition of capital from the economy's average. More specifically, the notation is as follows: p-d denotes the deviations between prices of production and the monetary expression of labor values, that is direct prices according to the classical Marxian approach; VICC stands for the difference of vertically integrated composition of capital (evaluated again in terms of prices of production of the classical approach) from the average composition of capital (Pasinetti, 1977). The estimations for the VICC for each industry was were carried out as follows:

$$\mathbf{pK}[\mathbf{I}-\mathbf{A}-\mathbf{D}-\mathbf{bl}]^{-1}./\mathbf{pbl}[\mathbf{I}-\mathbf{A}-\mathbf{D}-\mathbf{bl}]^{-1}$$

where the symbol, ./, indicates element by element (or dot) division. The weighted by sales average vertically integrated capital-intensity was estimated by

$$(\mathbf{pK}[\mathbf{I}-\mathbf{A}-\mathbf{D}-\mathbf{bl}]^{-1}\mathbf{x})/(\mathbf{pbl}[\mathbf{I}-\mathbf{A}-\mathbf{D}-\mathbf{bl}]^{-1}\mathbf{x})$$

Figure 1. Price-value deviations vs. capital intensity in China, Japan and Korea



The upper panel of graphs in Figure 1 refers to China, the middle panel to Japan whereas the bottom panel of graphs refers to the Korean economy. In each panel of graphs, the left-hand side ones refer to the classical Marxian estimating methods and the right-hand side graphs to the TSSI estimating method. A visual inspection of the graphs suggests that they display quite a good fit, which appears to be consistent with the theoretical requirements according to which the price value deviations (measured on the vertical axis) are of the same direction and proportional in size to the deviation of capital intensities from the average capital intensity (horizontal axis). The goodness of the fit in the estimates of the two approaches can be judged by the pretty high coefficients of determination which ranges between 87 and 97 percent. On further examination, however, we discover that the performance of the classical estimating method in the case of Japan can be improved, if we eliminate an obvious outlier which appears in each and every one of our six graphs in Figure 1. Thus, in the case of Japan by eliminating the outlier of industry 29 (Real Estate Activities), the performance of the classical model improved as this can be judged by its R-square which increased to 95.7% and superseded the performance of the TSSI; when the same industry's outlier was removed from the TSSI estimates the R-square increased to only 91.5%. In similar fashion, in the case of the Korean economy, the elimination of the obvious outlier gave an R-square 94.5% for the classical model, whereas the performance of the TSSI model deteriorated as the R-square dropped to 64.2%! Turning now to the top pair of graphs referring to China pretty much we get the same picture, thus by removing the unquestionably problematic Real Estate industry, we observe that the R-square drops slightly from 95.5% to 94%, whereas the removal of this industry from the TSSI model reduces the R-square to 89%. These results not only show the superior performance of the classical Marxian model but also cast doubt to the true performance of the TSSI model.[7]

In effect, the results displayed in Table 4 lend overwhelming support to the classical Marxian estimating method whereas the TSSI despite the super high R-squares failed the crucial test of consistency. The classical model not only gives extremely good approximations to market prices as this can be judged by the pretty high R-square in a cross-sectional analysis, but moreover, the sign of the differences between prices of production and labor values (which show the degree of transfer of surplus value in the form of profit across industries) are fully consistent with the requirements of the

[7] We also tried regressions with percentage changes in both price-value deviations and VICC and the results were 100% consistent with the classical model and the shortcomings of the TSSI model remained the same.

classical theory. More specifically, we observe that in all of our 34 industries, the signs of transfers, positive or negative, are absolutely consistent with the signs and they are also proportional, as they ought to be, to the size differences in the capital intensities. The results for the three economies of the year 2009 corroborate with absolute consistency the theoretical requirements of the classical model. The same is not true however for the TSSI approach. For example, in the Chinese economy nine industries (7 - 14 and 16) display signs opposite to those expected from the economic theory, whereas in the Japanese economy, we observe that in industries 3, 7, 10, 12 and 33 the price value differences are opposite of the theoretically expected sign. For example, a positive difference in industry's 3 capital intensity is translated into a negative difference between the price of production and direct price. This is equivalent to saying that for industries whose capital intensity is higher (lower) than the average (indicated in the last row of Table 4) they transfer surplus value in the form of profits to the industries with capital intensity lower (higher) than the economy's average. Such a result goes contrary to the logic of capital and of course, they cannot be reconciled neither with Ricardo nor Marx. The wrong signs appear also in the case of the Korean economy, thus in 4 out of 34 industries the deviations are of the wrong sign (industries 1, 8, 9 and 12) as shown in Table 4.

Table 4. Price-value deviations and compositions of capital[8]

	China				Japan				Korea			
	p-d	**VICC POP**	**p-d TSSI**	**VICC TSSI**	**p-d**	**VICC POP**	**p-d TSSI**	**VICC TSSI**	**p-d**	**VICC POP**	**p-d TSSI**	**VICC TSSI**
1	-0.551	-2.661	-0.193	-2.784	0.085	1489	0.067	1935	-0.037	-2601	0.023	-2624
2	0.071	0.741	0.056	0.775	0.032	607	0.027	1050	0.081	10696	0.026	10793
3	-0.211	-1.459	-0.009	-1.526	-0.004	-80	-0.014	360	-0.029	-2383	-0.027	-2405
4	-0.112	-0.902	-0.054	-0.944	-0.105	-1397	-0.084	-961	-0.038	-3623	-0.023	-3656
5	-0.129	-1.019	-0.054	-1.066	-0.039	-624	-0.027	-186	-0.033	-2928	-0.023	-2955
6	-0.124	-1.018	-0.050	-1.065	-0.056	-929	-0.055	-492	-0.046	-3816	-0.027	-3851
7	0.001	0.008	-0.024	0.009	-0.006	-110	-0.005	330	-0.108	-8306	-0.033	-8381
8	0.072	0.770	-0.045	0.806	0.046	1275	0.032	1720	0.066	8677	-0.033	8756
9	0.034	0.345	-0.038	0.361	0.028	553	0.023	995	0.010	1152	-0.027	1162
10	0.021	0.203	-0.047	0.212	-0.011	-180	-0.010	259	-0.043	-4341	-0.031	-4380
11	0.054	0.553	-0.020	0.578	0.031	550	0.032	992	-0.007	-659	-0.018	-665
12	0.049	0.530	-0.054	0.555	-0.008	-155	-0.002	285	0.007	802	-0.028	810
13	0.010	0.107	-0.053	0.112	0.021	379	0.022	821	-0.082	-7468	-0.036	-7535
14	0.013	0.138	-0.067	0.145	0.020	322	0.024	764	-0.031	-3027	-0.023	-3054
15	-0.012	-0.123	-0.064	-0.128	0.009	157	0.010	598	-0.087	-7852	-0.034	-7923
16	-0.007	-0.072	0.006	-0.076	0.018	295	0.027	737	-0.066	-6012	-0.032	-6066
17	0.302	3.089	0.150	3.231	0.123	2486	0.126	2935	0.280	30589	0.074	30866
18	-0.063	-0.591	-0.108	-0.619	-0.123	-1977	-0.110	-1543	-0.105	-8798	-0.035	-8878
19	-	-	-	-	-0.122	-1868	-0.122	-1434	-0.121	-11192	-0.023	-11293
20	-0.006	-0.077	-0.039	-0.080	-0.059	-1303	-0.065	-867	-0.072	-7122	-0.027	-7187
21	-0.003	-0.033	-0.035	-0.035	-0.088	-1520	-0.101	-1085	-0.036	-3456	-0.024	-3487
22	-0.135	-1.143	-0.057	-1.195	-0.059	-1100	-0.062	-663	-0.046	-3725	-0.019	-3759
23	0.238	2.507	0.234	2.623	0.028	473	0.017	915	0.128	11387	0.060	11490
24	0.237	2.687	0.197	2.811	0.056	1164	0.014	1609	0.217	20012	0.065	20193
25	0.188	1.953	0.123	2.042	0.009	173	0.029	614	0.149	12636	0.060	12751
26	0.092	0.969	0.052	1.013	-0.125	-1401	-0.153	-965	0.174	14193	0.060	14322
27	0.226	2.733	0.192	2.859	0.092	2268	0.095	2716	-0.002	-186	-0.001	-188
28	-0.143	-1.685	-0.110	-1.763	-0.062	-1462	-0.045	-1026	-0.091	-10240	-0.029	-10332
29	1.471	18.337	1.456	19.18	0.482	17610	0.456	18113	0.740	133517	0.337	134724
30	0.014	0.122	0.004	0.127	-0.096	-1458	-0.081	-1022	0.043	3407	0.059	3437
31	-0.283	-1.673	-0.115	-1.750	-0.130	-1804	-0.111	-1370	0.113	6713	0.111	6774
32	-0.294	-1.866	-0.137	-1.952	-0.238	-3245	-0.235	-2816	-0.317	-17309	-0.053	-17465
33	-0.144	-1.141	-0.108	-1.194	-0.019	-361	-0.026	78	-0.160	-12077	-0.043	-12187
34	0.678	6.874	0.632	7.190	-0.047	-786	-0.048	-348	-0.094	-7335	-0.031	-7401
AVG		**3.963**		**4.344**		**4918**		**4495**		**24976**		**25201**

[8] For the nomenclature of industries see Table A2 in the Appendix.

6. Conclusions

This paper has investigated the question of the proximity of labor values and prices of production with market prices using data from the input-output tables of China, Japan and Korea, three countries with data readily available that make possible the estimations according to the two approaches, the classical Marxian and the TSSI. The empirical analysis showed that both the classical and the TSSI approaches gave quite good estimates of labor values and prices of production as this can be judged by their proximity to market prices. The results are comparable to those derived for the Canadian economy in a similar exercise with the use of a circulating capital model (Tsoulfidis and Paitaridis, 2009). A salient feature of the current study is the use of fixed capital stock for the three countries using a rather novel way through which we construct the matrix of capital stock and depreciation coefficients (see the Appendix). Thus, the inclusion of the matrices of depreciation and capital stock coefficients as well as the homogenization of the employment coefficients gave results which at first sight were supportive to both the classical and the TSSI approaches, but on further consideration we discovered that the visually better graphical performance of the TSSI did not pass the test of logical consistency of the direction and size of deviations, a test that failed to pass also in the case of the circulating capital model of Canada. By contrast, the performance of the classical approach was extremely good on all counts.

References

Cockshott, P. and Cottrell, A. (1997) Labour Time Versus Alternative Value Bases: A Research Note, *Cambridge Journal of Economics*, 21, pp. 545-549.

Cockshott, P. and Cottrell, A. (2005) Robust Correlations between Sectoral Prices and Labour Values: a Comment, *Cambridge Journal of Economics*, 29, pp. 309-316.

Cockshott, P., Cottrell, A. and Michaelson, G. (1995) Testing Marx: Some New Results from UK Data, *Capital and Class,* 55, pp. 103-129.

Diaz, E. and Osuna, R. (2005-2006) Can we Trust Cross-Sectional Price-Value Correlation Measures? Some Evidence from the Case of Spain, *Journal of Post Keynesian Economics*, 28, pp. 345-63.

Diaz, E. and Osuna, R. (2007) Indeterminacy in Price-Value Correlation Measures, *Empirical Economics* 33(3), pp 389-399.

Duménil, G. (1983) "Beyond the Transformation Riddle: A Labor Theory of Value", *Science and Society* 47:4, pp. 427-450.

Freeman, A. (1997) Time, The Value of Money and the Quantification of Value, *Unpublished paper.*

Foley, D. (1982) The Value of Money, The Value of Labor Power and the Transformation Problem, *Review of Radical Political Economics*, 14(2), pp. 37-47.

Frölich, N. 2010. Dimensional analysis of price-value deviation. Chemnitz University of Technology. https://www.tuchemnitz.de/wirtschaft/vwl2/downloads/paper/froehlich/da-value.pdf

Kliman, A. (2002) The Law of Value and Laws of Statistics: Sectoral Values and Prices in the US Economy, 1977-1997, *Cambridge Journal of Economics*, 26, pp. 299-311.

Kliman (2004) Spurious Value-Price Correlations: Some Additional Evidence and Arguments, *Research in Political Economy*. 21, 223-239.

Kliman, A. (2007). *Reclaiming Marx's "Capital": A Refutation of the Myth of Inconsistency.* Lanham, MD: Lexington Books

Leontief, W. (1966) *Input-Output Economics*, New York: Oxford University Press.

Mariolis, T. and Tsoulfidis, L. (2009). Decomposing the Changes in Production Prices into 'Capital-Intensity' and 'Price' Effects: Theory and Evidence from the Chinese Economy. *Contributions to Political Economy*, 28(1), 1-22.

Mariolis, T. and Tsoulfidis, L. (2010). Measures of Production Price-Labour Value Deviation and Income Distribution in Actual Economies: A Note. *Metroeconomica* 61(4), 701-710.

Mariolis, T. and Tsoulfidis, L. (2016). *Modern Classical Economics and Reality. A Spectral Analysis of the Theory of Value and Distribution*. Tokyo: Springer.

Marx, K. (1982) *Capital*, vol. 3. New York: Random House.

Miller, R. and Blair, P. (2009) *Input-Output Analysis: Foundations and Extensions* (Cambridge: Cambridge University Press).

Mohun S. (2004) The Labour Theory of Value as Foundation for Empirical Investigations, *Metroeconomica*, 55, pp. 65-95.

Montibeler, E., and Sánchez, C. (2014). The Labour Theory of Value and the Prices in China: Methodology and Analysis. Mimeo.

Ochoa, E. (1984) *Labor Values and Prices of Production: An Inderindustry Study of the U.S. Economy, 1947-1972* (Ph.D. Dissertation, New School for Social Research).

Ochoa E. (1989) Values, Prices and Wage-Profit Curves in the U.S. Economy, *Cambridge Journal of Economics*, 13, pp. 413-430.

Pasinetti, L. (1977) *Lectures on the Theory of Production* (New York: Columbia University Press).

Petrovic, P. (1987) The Deviation of Production Prices from Labour Values: Some Methodological and Empirical Evidence, *Cambridge Journal of Economics*, 11, pp. 197-210.

Shaikh, A. (1984) The Transformation from Marx to Sraffa, in: A. Freeman and E. Mandel (eds.) *Ricardo, Marx and Sraffa* pp.43-84 (London: Verso).

Shaikh, A. (1998) The Empirical Strength of the Labour Theory of Value, in: R. Bellofiore (Ed.) *Marxian Economics: A Reappraisal*, vol. 2, pp. 225-251. New York: St. Martin's Press.

Shaikh, A. M. (2016). *Capitalism: Competition, Conflict, Crises*. Oxford: Oxford University

Press.
Steedman, I. and Tomkins, J. (1998) On Measuring the Deviation of Prices from Values, *Cambridge Journal of Economics*, 22, pp. 379-385.
Timmer, M. P., Dietzenbacher, E., Los, B., Stehrer, R. and de Vries, G. J. (2015). An Illustrated User Guide to the World Input–Output Database: the Case of Global Automotive Production, *Review of International Economics*, 23: 575–605
Tsoulfidis, L. (2008) Price-Value Deviations: Further Evidence from Input-Output Data of Japan, *International Review of Applied Economics*, 22, pp. 707-724
Tsoulfidis, L. and Maniatis, Th. (2002) Values, Prices of Production and Market Prices: Some More Evidence from the Greek Economy, *Cambridge Journal of Economics*, 26, pp. 359-369.
Tsoulfidis, L. and Mariolis, Th. (2007) Labour Values, Prices of Production and the Effects of Income Distribution: Evidence from the Greek Economy, *Economic Systems Research*, 19, pp.425-437.
Tsoulfidis, L. and Rieu, Dong-Min (2006) Labor Values, Prices of Production, and Wage-Profit Rate Frontiers of the Korean Economy, *Seoul Journal of Economics*, 19, pp. 275-95.
Veneziani, R. (2004) "The Temporal Single-System Interpretation of Marx's Economics: A Critical Evaluation", *Metroeconomica*, 5(1), pp. 96-114.

Appendix 1: A note on the data

The input-output tables of the Chinese, Japanese and Korean economies are available from the World Input-Output Data the link is http://www.wiod.org and were accessed on March 15, 2016, the database is at the 34 sectors level of detail. The matrix of input-output coefficients, $\mathbf{A}$, is obtained by dividing element-by-element the inputs of each industry by its gross output. The vector of direct labor coefficients, $\mathbf{l}$, is estimated using the wage bill of each sector (the product of annual wage times the number of employees) the same data base is the provider of the industry wages. The problem with this estimation is that the self-employed population is not accounted for. For this purpose, we created an index of self-employment calculated by the ratio of the total hours worked by persons engaged (the number of employees plus the self-employed) to the total hours worked by employees. The information on hours of work (in millions) is available in the same database for Japan and Korea but not for China for which we have only data for persons engaged. We created the index of self-employment using data from the International Labor Organization (ILO) http://laborsta.ilo.org for 14 sectors level of detail.

In order to account for the differences in skills across industries, we divided the annual wage of each industry by the economy's minimum wage, the so-derived ratio is in turn multiplied by the employment and so we derive the homogenized industry employment. This reduction, of course, is only meaningful when the relative wages express the differences in skills and intensity of labor, that is, employed in each sector of the economy, we do know that this may not be necessarily true as other factors such as unionization and gender may affect the market outcome. The ratio of the adjusted for skills total employment (employees plus self-employed) by the industry total output gives the vector of the homogenized employment coefficients, $\mathbf{l}$.

For the estimation of the real wage we assume that the minimum annual money wage is allocated over the basket of wage goods normally purchased by workers. Thus, we may write

$$\mathbf{b} = \left(\frac{PCE_j}{\sum PCE_j}\right) w_{min}$$

where $\mathbf{b}$ is the column vector of the basket of commodities (the real wage) normally purchased by workers with their money wage, and *PCE* stands for personal consumption expenditures of workers on goods purchased from industry $j = 1, 2, \ldots, 34$. Hence, the term in the above parenthesis stands for the share of each good in the total workers consumption expenditures (Ochoa, 1989; Mariolis and Tsoulfidis, 2016).

The vector of capital stock for the 34 industries in constant 1995 prices for the period 1995-2011 is provided in the world input-output database http://www.wiod.org along with the necessary documentation for each country. The vector of capital stock of the year 2009 was dot divided by the respective investment deflator (1995) and the capital stock in current prices that we obtained was subsequently divided by the current output. The matrix of fixed capital stock coefficients was derived from the product of the column vector of investment shares of each industry times the row vector of capital stock per unit of output (see also Montibeler and Sánchez 2014). The resulting new matrix of capital stock coefficients $\mathbf{K}$ possess the properties of the usual capital stock matrices derived and employed in the hitherto empirical studies (see Mariolis and Tsoulfidis 2016, and the literature cited there). The idea is that the investment matrices contain many rows with zero elements (consumer goods and service industries do not produce investment goods) and so the subdominant eigenvalues will be substantially lower (indistinguishable from zero) than the dominant which is another way to say that the equilibrium prices are determined almost exclusively by the dominant eigenvalue. The same is true with our case whose maximal eigenvalue will not be different from that we would obtain had we used a matrix of investment shares, while the difference between the dominant and the subdominant ones (which are nearly zero) is at maximum.

In similar fashion, the matrix of depreciation, $\mathbf{D}$, was estimated as the product of the column vector of investment shares of each industry times the row vector of depreciation per unit of output. Data for depreciation by industry is not available in the world input-output database, so we used data from other sources, namely from the database of Structural Analysis of the OECD (STAN) https://stats.oecd.org/Index.aspx?DataSetCode=STAN08BIS for Korea and from the database of the Research Institute of Economy, Trade and Industry (RIETI) http://www.rieti.go.jp/en/ for China and Japan. In order to minimize the effects of any possible methodological differences between databases, we estimated the ratio of depreciation to gross value added by industry for each country from the OECD and RIETI data sets and then we multiplied it by the corresponding gross value added data that is available in the world input-output database.

In Table A1 below we display the required data for the estimation of the MELT of the three economies.

Table A1: Monetary measures and hours worked in millions

China									
Inds	Intermediate Inputs	Depreciation	Value Added	Wages	Capital Stock	Employment millions of hours	Employees millions of hours	Ratio	Wages including S.E.
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8=6/7**	**9=4*8**
1	2492023	168220	3522600	3340990	2792800	469432	424504	1,11	3708499
2	1704951	155860	1478704	521106	2056459	26110	25564	1,02	531528
3	4027874	137873	1294099	392961	1844109	34415	33352	1,03	404750
4	3534388	96973	913261	381005	990665,2	50505	48945	1,03	392435
5	746093	10861	183622	77735	203980,9	14692	14239	1,03	80067
6	939862	26031	272030	98306	270649,7	18874	18291	1,03	101255
7	1225433	62891	390981	132084	503240,9	23505	22779	1,03	136047
8	1443416	44714	312609	91275	366642,3	2715	2631	1,03	94013
9	4370828	173826	1135471	327830	1310062	25367	24584	1,03	337665
10	1939374	61212	446075	149402	518798,5	24689	23927	1,03	153884
11	1993585	101886	753926	264231	932526,7	23859	23122	1,03	272158
12	7244539	309043	1777955	497728	1626227	28504	27623	1,03	512660
13	3575922	113201	1070671	394410	1008307	32175	31182	1,03	406242
14	8283255	217368	1594483	525941	1409506	48034	46550	1,03	541719
15	3096115	81797	748611	294712	687533,1	15841	15352	1,03	303553
16	360460	8010	217825	47548	210818,2	17949	17395	1,03	48974
17	2357887	366017	933672	237360	2942999	9949	9762	1,02	242107
18	7440057	122528	2239883	1142874	916427,8	131065	119939	1,09	1245733
19	-	-	-	-		-	-	-	-
20	1593474	159091	2401612	580381	1030003	31008	29137	1,06	615204
21	329651	32912	496835	120067	222924,7	83408	78374	1,06	127271
22	1182633	87115	711817	196649	378657,1	42973	40380	1,06	208448
23	887940	175834	955598	285695	2289417	46602	43640	1,07	305694
24	410539	61045	331761	80761	785881,6	5044	4724	1,07	86414
25	224405	13583	73819	19586	235294	2515	2355	1,07	20957
26	464818	54005	293501	62436	410040,9	4917	4605	1,07	66807
27	585504	156847	852409	188988	1497766	14482	13562	1,07	202217
28	798489	36237	1772758	460474	230225,8	9650	7704	1,25	575593
29	371813	923489	1865471	202710	11783741	3505	3477	1,01	204737
30	1836487	293149	1261704	538073	1599404	7709	7648	1,01	543454
31	1053715	159031	1283128	1112896	1292952	30518	29783	1,02	1135154
32	851281	108411	1081293	848230	795179,4	44446	43356	1,03	873677
33	1080538	54868	564593	378183	392617,6	14007	13457	1,04	393310
34	997347	82801	817909	270603	4692310	217283	206159	1,05	284133

The MELT for the year 2009 was estimated at 1.926yuan per labor hour.

Japan									
Inds	Intermediate Inputs	Depreciation	Value Added	Wages	Capital Stock	Employment million of hours	Employees million of hours	Ratio	Wages including S.E.
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8=6/7**	**9=4*8**
1	6189286	1718550	6187374	593826	43685854	5048	757	6.67	3960820
2	2486482	213150	528524	296736	3562424	92	89	1.03	305638
3	22795591	1349845	13200218	6128192	33586120	2715	2598	1.04	6373320
4	2238831	176585	1326584	1278366	5973687	916	693	1.32	1687443
5	252995	7590	114958	76245	594057	64	43	1.49	113605
6	2561946	186451	1152860	850947	2848219	567	486	1.17	995608
7	6367491	810442	5114192	2861213	20079862	1557	1450	1.07	3061498
8	10565259	487843	5782751	244669	11083425	30	30	1.00	244669
9	18765116	2382263	7284176	3046734	31882166	688	685	1.00	3046734

10	9831305	860733	3140612	2440597	15310437	1066	996	1.07	2611439
11	4041365	575897	1908692	1065678	11477561	439	407	1.08	1150933
12	34964967	3578463	12840886	6331697	44095875	2750	2543	1.08	6838233
13	12666957	1655810	6876776	3868694	35755072	1490	1437	1.04	4023442
14	23103304	4418094	10644247	6207634	59266678	2408	2339	1.03	6393863
15	30254858	2493368	9452360	5171732	42263569	1939	1907	1.02	5275166
16	2542580	151966	676292	470016	5932167	356	266	1.34	629821
17	14040052	4845422	10542211	2342452	75308205	850	850	1.00	2342452
18	33087419	4826344	27879873	19015651	33559298	10357	8386	1.23	23389251
19	6085786	715071	4685871	3653125	6446355	779	624	1.25	4566407
20	16233116	3834560	35610199	16468735	58325086	5433	5063	1.07	17621546
21	8137697	1904177	20095258	11696269	51635142	8445	6520	1.30	15205149
22	14694711	2166162	13443808	6517548	26555024	7145	5362	1.33	8668338
23	7649702	2075935	12746669	8677857	72313311	5067	4709	1.08	9372086
24	4627525	489990	2378457	1215426	10274550	250	247	1.01	1227581
25	1889677	342971	1409942	610366	6025256	72	72	1.00	610366
26	2553309	621549	3561929	5061496	18075842	692	681	1.02	5162726
27	5634294	3244980	10251225	1942781	42534808	1124	1114	1.01	1962209
28	15464230	3706398	24140770	8398213	25630953	2552	2465	1.04	8734141
29	9239562	19668375	59818459	2582846	630505675	1808	1528	1.18	3047758
30	35846327	7582456	37298053	27195058	106879578	10416	8943	1.16	31546267
31	18314847	18575717	40921030	29576822	79477143	7973	7972	1.00	29576822
32	2781573	3659759	18608340	16498747	19239760	3648	3638	1.00	16498747
33	16385361	3442086	26040900	14643248	88095485	9454	8826	1.07	15668275
34	15731518	4117945	23683571	13605985	85024019	7667	5988	1.28	17415661

The MELT for the year 2009 was estimated at 1071 yen per labor hour.

Korea									
Inds	Intermediate Inputs	Depreciation	Value Added	Wages	Capital Stock	Employment (million of hours)	Employees (million of hours)	Ratio	Wages including S.E.
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8=6/7**	**9=4*8**
1	27137129	2470221	26614994	2849651	145933926	3730	367	10.15	28923956
2	1629084	270201	2220545	584008	7234507	43	38	1.12	654088,8
3	68945063	1986170	13070073	6210223	31749267	602	500	1.20	7452268
4	31941070	1326153	11610452	6767861	26909120	766	636	1.20	8121433
5	3742704	98309	899996	676455	3003670	75	62	1.20	811746,5
6	4779405	172656	1374321	861577	2978661	89	74	1.20	1033892
7	24448311	1433337	10551212	8432024	17423066	501	416	1.20	10118429
8	103717068	1497422	5538814	1416810	13581974	123	102	1.20	1700173
9	109764143	4859307	23519662	9257683	44866478	448	373	1.20	11109220
10	33425925	2068511	12002816	6203612	14842039	724	601	1.20	7444334
11	21735702	2049971	10168002	6089540	27673999	323	269	1.20	7307447
12	214797706	9214361	42201294	15789326	79231000	1371	1139	1.20	18947191
13	74296791	3341748	23665826	15616362	21712112	1131	940	1.20	18739635
14	197603444	12663726	62444499	30056204	146823822	2074	1723	1.20	36067445
15	167021425	7436181	45036514	29338608	57005412	1439	1195	1.20	35206329
16	13481611	551298	4494719	2858608	6410464	278	231	1.20	3430330
17	46282996	9660120	18380485	4293134	242398947	216	152	1.42	6096251
18	115848679	4733398	66576643	43020949	82617720	4100	2887	1.42	61089748
19	3444243	509329	5305526	2417512	6179459	554	390	1.42	3432866
20	21860840	1447024	33674523	14733785	27578339	3114	2193	1.42	20921974
21	34817491	3262535	44784818	20525241	52682995	4550	3204	1.42	29145842
22	46156187	1343759	23237775	15623271	67204508	5195	3659	1.42	22185044
23	27425632	3382743	18296398	10625963	165036225	1322	931	1.42	15088867
24	15694133	1423302	10469990	5032580	94440867	746	525	1.42	7146263

25	7072875	1201389	4718511	2699790	42561667	276	194	1.42	3833701
26	10009481	1685025	6677602	3862921	60232960	460	324	1.42	5485348
27	28239690	7276997	19152463	7942348	68215846	582	410	1.42	11278134
28	53293329	3862804	65035458	22842672	33104212	1609	1133	1.42	32436594
29	25533554	13589561	73427904	6616243	1174396057	1390	979	1.42	9395066
30	42668367	4359371	67574272	39314133	406119950	3984	2806	1.42	55826069
31	30790897	19735927	63706558	46089727	565604901	1818	1280	1.42	65447412
32	16418860	5097750	63448698	55200219	72536740	3448	2428	1.42	78384310
33	34915440	4281351	43092090	29422874	35500697	1699	1197	1.42	41780480
34	32746137	4120037	35862563	22813297	50855804	4838	3407	1.42	32394881

The MELT for the year 2009 was estimated at 4576 won per labor hour.

Table A2: Nomenclature of Industries

1	Agriculture, Hunting, Forestry and Fishing	18	Construction
2	Mining and Quarrying	19	Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel
3	Food, Beverages and Tobacco	20	Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles
4	Textiles and Textile Products	21	Retail Trade, Except of Motor Vehicles and Motorcycles; Repair of Household Goods
5	Leather, Leather and Footwear	22	Hotels and Restaurants
6	Wood and Products of Wood and Cork	23	Inland Transport
7	Pulp, Paper, Paper, Printing and Publishing	24	Water Transport
8	Coke, Refined Petroleum and Nuclear Fuel	25	Air Transport
9	Chemicals and Chemical Products	26	Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies
10	Rubber and Plastics	27	Post and Telecommunications
11	Other Non-Metallic Mineral	28	Financial Intermediation
12	Basic Metals and Fabricated Metal	29	Real Estate Activities
13	Machinery, Nec	30	Renting of M&Eq and Other Business Activities
14	Electrical and Optical Equipment	31	Public Administration and Defense; Compulsory Social Security
15	Transport Equipment	32	Education
16	Manufacturing, Nec; Recycling	33	Health and Social Work
17	Electricity, Gas and Water Supply	34	Other Community, Social and Personal Services