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Commodities' Commodity Content and Prices: Empirical Evidence from the Input-Output Tables of the French Economy

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Abstract

This paper estimates the commodities' commodity content, or 'commodity values', associated with the input-output tables of the French economy for the years 1995 and 2005 and measures their proximity to actual prices. Contrary to the results reported in the majority of the relevant studies, it is found that there exist commodity values that are better approximations of actual prices than labour values. Thus, it is argued that the empirical investigation of the relationships between prices and values should not *a priori* neglect alternative value bases.

Key words: commodity contents, prices, input-output analysis.

JEL Classification: B24, B51, C67, D57.

Introduction

During the last decades there has been a growing number of empirical studies that explore the relationships between labour values, *actual* production prices and market prices. The main finding of these studies is that labour values are quite close to production prices and market prices as this can be judged by alternative measures of deviation.[1] These results are usually interpreted as giving

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[1] See Shaikh (1984; 1998); Petrović (1987); Ochoa (1989); Cockshott, Cottrell and Michaelson (1995); Cockshott and Cottrell (1997); Chilcote (1997); Tsoulfidis and Maniatis (2002); Zachariah (2006); Tsoulfidis and Mariolis (2007); Tsoulfidis (2008); Soklis (2009), *inter alia*.

support to the so-called 'empirical labour theory of value' (Stigler 1958: 361). However, it is well known that any 'basic' (*à la* Sraffa, 1960: §6) commodity can be considered as a 'value base' and, therefore, it is possible to determine the so-called 'commodity *i* values' (Gintis and Bowles, 1981; Roemer, 1986), *i.e.*, the direct and indirect requirements of commodity *i* necessary to produce one unit of each commodity as gross output. Therefore, the issue that arises is that, strictly speaking, there is no theoretical reason to choose the labour theory of value as the most relevant amongst the alternative 'value theories'. Only a few studies have tried to empirically address this issue.[2] Leaving aside the results reported in Soklis (2009), as far as we know, all the empirical studies that have used alternative commodities as value bases report that labour values are considerably better approximations of prices than commodity values and, therefore, conclude that there is an empirical basis for preferring labour as a value base. However, regarding the latter studies, the following should be mentioned: 1) The estimation of values is not compatible with the traditional definition of commodity *i* values, the main difference being that the aforesaid studies do not take into account the quantity of labour that enters into the production of the commodities; 2) the measurement of deviation between prices and values is not based on a bias-free measure; 3) they only use a few of the available commodities as value bases. The purpose of this paper is to extend the empirical investigation of the relationships between prices and values to the case of alternative value bases by taking into account the issues mentioned above. The results are based on data from the Symmetric Input-Output tables (SIOT) of the French economy (for the years 1995 and 2005).[3]

The remainder of the paper is organized as follows. Section 2 describes the model. Section 3 presents the results of the empirical analysis. Section 4 discusses the results. Section 5 concludes the paper.

The analytic framework

Assume a closed, linear system with only single-product industries, circulating capital and homogeneous labour, which is not an input to the household

[2] See Cockshott and Cottrell (1997); Tsoulfidis and Maniatis (2002); Zachariah (2006), and Soklis (2009).

[3] See Appendix 1 for the available input-output data as well as the construction of relevant variables.

sector. The net product is distributed to profits and wages that are paid at the beginning of the common production period and there are no savings out of this income.[4] All commodities are basic and there are no alternative production techniques. The system is viable, *i.e.*, the Perron-Frobenius eigenvalue ($\lambda_{\mathbf{A}}$) of the $n \times n$ matrix of input-output coefficients ($\mathbf{A}$) is less than 1. The givens in our analysis are: 1) the technical conditions of production, *i.e.*, the pair $(\mathbf{A},\mathbf{l})$, where $\mathbf{l}^{\mathrm{T}}$ is the $1 \times n$ vector of direct labour inputs (T is the sign for transpose); and 2) the real wage rate, which is represented by the $n \times 1$ vector $\mathbf{b}$. On the basis of these assumptions, the vector of labour values ($\mathbf{v}$) is defined as follows:

$$\mathbf{v}^{\mathrm{T}} \equiv \mathbf{v}^{\mathrm{T}}\mathbf{A} + \mathbf{l}^{\mathrm{T}} \qquad [1]$$

where each element v_j of the vector of labour values expresses the 'vertically integrated labour coefficient' (Pasinetti, 1973) for commodity j, *i.e.*, the direct and indirect requirements of labour necessary to produce one unit of commodity j. Now, the practice that most researchers follow when calculating the commodity i values is to simply substitute the direct labour inputs in equation [1] by the alternative direct inputs, *i.e.*, the i th row of matrix $\mathbf{A}$ (see, *e.g.*, Zachariah, 2006). However, this method does not take into account the quantity of labour, measured in terms of commodity i, that enters into the production of the commodities. Since in the actual economic systems labour enters into the production of all the commodities, it follows that the aforesaid calculation does not measure the commodity i values, *i.e.*, the direct and indirect requirements of commodity i necessary to produce one unit of gross output of commodity j. On the other hand, if we define the extended $m \times m$ ($m = n + 1$) matrix $\mathbf{C} \equiv [c_{ij}]$ (see, *e.g.*, Okishio, 1963) as:[5]

$$\mathbf{C} \equiv \begin{pmatrix} \mathbf{A} & \mathbf{b} \\ \mathbf{l}^{\mathrm{T}} & 0 \end{pmatrix}$$

[4] We hypothesize that wages are paid *ante factum* (for the general case, see Steedman, 1977: 103-5) and that there are no savings out of this income in order to follow most of the empirical studies on this topic (see footnote 1).

[5] In what follows, $\mathbf{C}_{(i)}$ denotes the $(m-1)\times(m-1)$ matrix derived from $\mathbf{C}$ by extracting its i th row and column, whilst $\mathbf{c}_i^{\mathrm{T}}$ ($\mathbf{c}^j$) denotes the i th row (j th column) of $\mathbf{C}$ if we extract its i th (j th) element.

which is also known as the complete or full matrix (Bródy, 1970),[6] then we can write:

$$\mathbf{v}_i^{\mathrm{T}} \equiv \mathbf{v}_i^{\mathrm{T}}\mathbf{C}_{(i)} + \mathbf{c}_i^{\mathrm{T}} \quad [2]$$

$$\omega_i \equiv \mathbf{v}_i^{\mathrm{T}}\mathbf{c}^i + c_{ii} \quad [3]$$

$$e_i \equiv (1 - \omega_i)/\omega_i \quad [4]$$

$$\mathbf{p}^{\mathrm{T}} = (1 + r)(\mathbf{p}^{\mathrm{T}}\mathbf{A} + w\mathbf{l}^{\mathrm{T}}) \quad [5]$$

$$w \equiv \mathbf{p}^{\mathrm{T}}\mathbf{b} \quad [6]$$

where $\mathbf{v}_i^{\mathrm{T}} \equiv (v_1^i, v_2^i, ..., v_{i-1}^i, v_{i+1}^i, ..., v_m^i)$ the vector of commodity i values (Gintis and Bowles, 1981: Appendix 1; Roemer 1986: 24-6; Manresa, Sancho and Vegara, 1998); v_j^i denotes the commodity i value of commodity j, *i.e.*, the total (direct and indirect) requirements of commodity i necessary to produce one unit of gross output of commodity j; $\boldsymbol{\omega}$ the total input requirements of commodity i necessary to produce one unit of itself; e_i the so-called 'rate of exploitation' of commodity i (see also Gintis and Bowles, 1981: 18), $\mathbf{p}$ the vector of production prices; w the money wage rate, and r the uniform rate of profit. Equations [2] and [5]-[6] entail that:

$$\mathbf{v}_i^{\mathrm{T}} \equiv \mathbf{c}_i^{\mathrm{T}}(\mathbf{I} - \mathbf{C}_{(i)})^{-1} \quad [7]$$

$$\mathbf{p}^{\mathrm{T}}(1 + r) = \mathbf{p}^{\mathrm{T}}\mathbf{B} \quad [8]$$

where $\mathbf{B}$ ($\equiv \mathbf{A} + \mathbf{b}\mathbf{l}^{\mathrm{T}}$) represents the matrix of the "augmented" input-output coefficients, *i.e.*, each coefficient represents the sum of the respective material and wage good input per unit of output. Thus, equation [7] gives the vector of commodity i values and, since a non-positive vector of commodity prices is economically insignificant, equation [8] implies that $(1 + r)^{-1}$ is the Perron-Frobenius eigenvalue of $\mathbf{B}$ and $\mathbf{p}^{\mathrm{T}}$ is the corresponding left-hand side eigenvector.[7]

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[6] Due to our assumption that labour is not an input to the household sector, the (m,m)th element of matrix $\mathbf{C}$ equals zero.

[7] It can be easily seen that for $i = m$, equation [7] gives $\mathbf{v}_i^{\mathrm{T}} = \mathbf{v}_m^{\mathrm{T}} = \mathbf{l}^{\mathrm{T}}[\mathbf{I} - \mathbf{A}]^{-1}$, which is the vector of labour values. The coefficients v_j^m or, more specifically, $1/v_j^m$ are considered as indexes of the productivity of labour (see, *e.g.*, Okishio, 1963).

To the best of our knowledge, the first study that empirically estimated commodity *i* values on the basis of the system described above was that of Manresa, Sancho and Vegara (1998). However, the purpose of this study was not the measurement of the deviations between prices and values but rather to demonstrate the practical feasibility of the proposed calculation methodology. It is also worth mentioning that, over the last decades, it has been recognized that the concept of total requirements for gross output is important in analyzing the interdependence amongst the industries of an economy (see Szyrmer and Walker, 1983; Milana, 1985; Szyrmer, 1986; 1992), whilst recently Mariolis and Rodousaki (2011) argued that this concept was introduced by Vladimir K. Dmitriev in his essay, published in 1898, on the theory of value in Ricardo (Dmitriev, 1974: Essay 1).

Empirical analysis

In the following we estimate the deviations of actual prices from labour values and commodity values using data from the input-output tables of the French economy for the years 1995 and 2005. Given that all commodities are basic, we use each of them as a value base. This means that, since the input-output tables describe 58 commodities for the year 1995 and 57 commodities for the year 2005, we estimate 59 vector of values for the year 1995 (*i.e.*, 58 vectors of commodity *i* values plus the vector of labour values) and 58 vectors for the year 2005. The vectors of values are estimated from the equation [7]), whilst the vectors of actual prices of production are estimated from the eigenequation [8].

A crucial issue concerning the investigation of the relationships between prices and values is the choice of a theoretical appropriate measure of price-value deviation. Most of the studies on the relationships between prices and commodity values have used the correlation coefficient between prices and values as "measure of deviation". However, as is well known, the results obtained on the basis of the traditional measures of deviation (such as correlation coefficient, mean absolute deviation, mean absolute weighted deviation, root-mean-square-percent-error) depend on the arbitrary choice of either the numeraire or the physical measurement units.[8] In the current study, we avoid the said

[8] For a detailed discussion of the problem of measuring the deviation of prices from labour values, see Steedman and Tomkins (1998).

problems by using the so-called '*d*-distance' (Steedman and Tomkins, 1998: 381-2), which constitutes a measure of price-value deviation that is free from numeraire and measurement-unit dependence.[9] The *d*-distance is defined as $d \equiv \sqrt{2(1-\cos\theta)}$, where θ is the Euclidean angle between the vectors $\pi_i^{\mathrm{T}}(\hat{\mathbf{v}}_i)^{-1}$ and $\mathbf{e}$, π_i^{T} is the vector derived from $\pi^{\mathrm{T}} \equiv (\mathbf{p}^{\mathrm{T}}, w)$ if we extract its i th element, $\hat{\mathbf{v}}_i$ a diagonal matrix formed from the elements of $\mathbf{v}_i$ and $\pi_i^{\mathrm{T}}(\hat{\mathbf{v}}_i)^{-1}$ the ratio of prices to values.[10] Since the *theoretically* minimum value of $\cos\theta$ equals $1/\sqrt{n}$, the theoretically maximum value of the *d*-distance (D) equals $\sqrt{2[1-(1/\sqrt{n})]}$. Thus, we may define the normalized *d*-distance', as d/D (see also Mariolis and Soklis, 2010: 94).

The results from the application of the previous analysis to the input-output tables of the French economy for the years 1995 and 2005 are reported in Tables 1-2 and Figures 1-2.[11] Table 1 reports the largest and smallest price-value deviations for the year 1995, whilst Table 2 reports those for the year 2005.

The first row on the left side of Tables 1-2 refers to the deviations of prices from labour values,[12] whilst the remaining rows report the deviations of prices from commodity values.[13] The last row on the right side of the tables refers to the average deviations of prices from commodity values, *i.e.*, the sum of the deviations divided by the total number of commodities that are used as value bases.

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[9] Mariolis and Soklis (2010) have shown that there exists an infinite number of numeraire-free measures (*à la* Steedman-Tomkins) of price-value deviation, whose ranking is *a priori* unknown, and the choice between them depends on either the theoretical viewpoint or the aim of the observer. Furthermore, it is worth noting that Mariolis and Tsoulfidis (2011) demonstrated that for realistic values of the relative rate of profit (*i.e.*, not considerably greater that 40%), the Steedman-Tomkins distance and the traditional measures, such as the 'mean absolute deviation', the 'mean absolute weighted deviation' and the 'root-mean-square-percent-error', tend to be close to each other.

[10] Note that for $i \neq m$ we get $\pi_i^{\mathrm{T}} = (p_1, p_2, \ldots, p_{i-1}, p_{i+1}, \ldots, w)$, whilst for $i = m$ we get $\pi_i^{\mathrm{T}} = \pi_m^{\mathrm{T}} = \mathbf{p}^{\mathrm{T}}$. Furthermore, since market prices are taken to be equal to 1 (see Appendix 1), the *d*-distance between market prices and values is estimated on the basis of the Euclidean angle (θ) between the vectors $(\pi_i^{\mathrm{M}})^{\mathrm{T}}(\hat{\mathbf{v}}_i)^{-1}$ and $\mathbf{e}$, where π_i^{M} is the vector derived from $(\pi^{\mathrm{M}})^{\mathrm{T}} \equiv (\mathbf{e}^{\mathrm{T}}, w_{\min}^{\mathrm{M}})$ if we extract its i th element. Thus, it follows that for $i \neq m$ we get $(\pi_i^{\mathrm{M}})^{\mathrm{T}} = (1,1,1,\ldots,w_{\min}^{\mathrm{M}})$, whilst for $i = m$ we get $(\pi_i^{\mathrm{M}})^{\mathrm{T}} = (\pi_m^{\mathrm{M}})^{\mathrm{T}} = \mathbf{e}^{\mathrm{T}}$. I am grateful to Theodore Mariolis for an enlightening discussion on this point.

[11] The precision in internal calculations is set to 16 digits. The analytical results are available on request from the author.

[12] The vectors of labour values and actual prices of production for the years 1995 and 2005 are reported in Appendix 2, Tables 2.1-2.2 and 2.3-2.4, respectively. Note that we report the 'complete' *à la* Bròdy (1970) vectors, *i.e.*, we include the value/price of the real wage bundle as the last element of the vectors.

[13] The price-commodity value deviations that are found to be less than the corresponding price-labour value deviations are indicated by bold characters.

Table 1
Deviations of prices from values, 1995

Value bases / *d/D (%)*	*Actual prices of production vs values*	*Market prices vs values*	*Value bases* / *d/D (%)*	*Actual prices of production vs values*	*Market prices vs values*
Labour	11.3	65.6	Post and telecommunication services CPA: 64	15.6	70.4
Coal and lignite; peat CPA:10	17.4	**58.4**	Financial intermediation services CPA: 65	14.6	70.1
Crude petroleum and natural gas CPA: 11	18.9	**57.4**	Insurance and pension funding services CPA: 66	11.6	68.1
Metal ores CPA: 13	24.3	**48.4**	Services auxiliary to financial intermediation CPA: 67	15.6	70.7
Other mining and quarrying products CPA: 14	21.5	**61.0**	Real estate services CPA: 70	12.4	67.7
Printed matter and recorded media CPA: 22	16.8	70.1	Computer and related services CPA: 72	15.3	71.5
Coke, refined petroleum products and nuclear fuels CPA: 23	16.8	**57.5**	Research and development services CPA: 73	24.1	69.2
Other non-metallic mineral products CPA: 26	16.2	**57.5**	Other business services CPA: 74	**10.8**	**62.0**
Electrical energy, gas, steam and hot water CPA: 40	13.1	**51.3**	Sewage and refuse disposal services CPA: 90	14.7	70.2
Construction work CPA: 45	21.8	**30.1**	Membership organization services CPA: 91	14.4	72.2
Trade, maintenance and repair services of motor vehicles and motorcycles CPA: 50	**8.8**	67.4	Recreational, cultural and sporting services CPA: 92	13.3	67.1
Wholesale trade and commission trade services CPA: 51	**6.2**	67.9	Other services CPA: 93	14.3	67.4
Retail trade services CPA: 52	**7.3**	67.4	Private households with employed persons CPA: 95	13.2	66.1
Hotel and restaurant services CPA: 55	12.0	67.5	Average deviation of prices from commodity values	15.6	66.2
Land transport; transport via pipeline services CPA: 60	**9.4**	68.0			

Table 2
Deviations of prices from values, 2005

Value bases / *d/D (%)*	*Actual prices of production vs values*	*Market prices vs values*	*Value bases* / *d/D (%)*	*Actual prices of production vs values*	*Market prices vs values*
Labour	11.5	31.7	Post and telecommunication services CPA: 64	14.5	**27.6**
Coal and lignite; peat CPA:10	19.4	40.9	Financial intermediation services CPA: 65	14.8	**17.7**
Crude petroleum and natural gas CPA: 11	20.1	39.2	Insurance and pension funding services CPA: 66	**11.5**	**29.4**
Metal ores CPA: 13	24.8	44.8	Services auxiliary to financial intermediation CPA: 67	15.4	**31.1**
Other mining and quarrying products CPA: 14	2.4	9.1	Real estate services CPA: 70	12.4	**19.7**
Printed matter and recorded media CPA: 22	16.9	**30.9**	Computer and related services CPA: 72	15.1	**26.0**
Coke, refined petroleum products and nuclear fuels CPA: 23	17.6	38.0	Research and development services CPA: 73	24.6	46.0
Other non-metallic mineral products CPA: 26	16.3	35.0	Other business services CPA: 74	**9.6**	**26.7**
Electrical energy, gas, steam and hot water CPA: 40	13.6	34.2	Sewage and refuse disposal services CPA: 90	14.4	**23.5**
Construction work CPA: 45	18.1	**20.6**	Membership organization services CPA: 91	22.6	32.8
Trade, maintenance and repair services of motor vehicles and motorcycles CPA: 50	**9.7**	34.6	Recreational, cultural and sporting services CPA: 92	13.0	**25.9**
Wholesale trade and commission trade services CPA: 51	**7.8**	33.3	Other services CPA: 93	14.2	**29.5**
Retail trade services CPA: 52	**9.1**	36.4	Private households with employed persons CPA: 95	13.3	**20.3**
Hotel and restaurant services CPA: 55	11.8	**30.1**	Average deviation of prices from commodity values	15.6	34.1
Land transport; transport via pipeline services CPA: 60	**10.4**	36.8			

In order to get a complete picture of the price-value deviations, in Figure 1 we display the deviations of the vector of production prices from each vector of commodity values for both years of our analysis and in Figure 2 we display the relevant deviations of the vector of market prices from each vector of commodity values. The deviations for the year 1995 are measured in the vertical axis, whilst those for the year 2005 are measured in the horizontal axis. Finally, the price-labour value deviations are taken as the origin of the axes.

Figure **1**
Deviations of actual production prices from values, 1995 and 2005
(percentages)

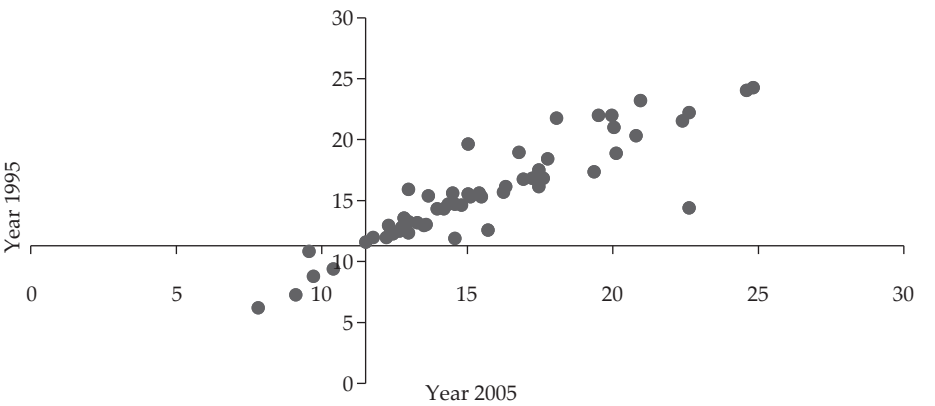
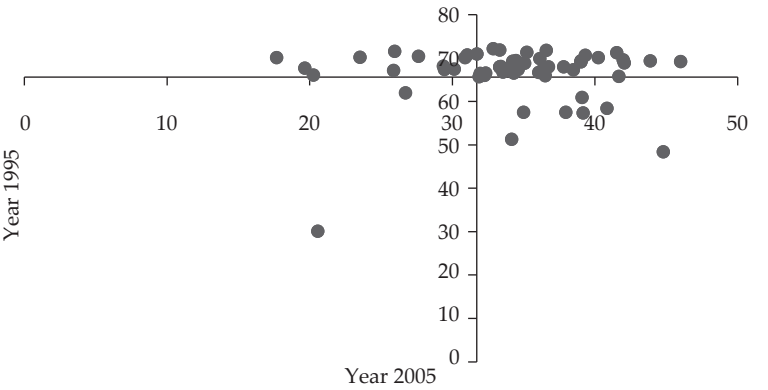


Figure **2**
Deviations of market prices from values, 1995 and 2005
(percentages)



Thus, it follows that the points below the horizontal axes of the figures indicate price-commodity value deviations that are less than the price-labour value deviation for the year 1995, whilst the points above the horizontal axes indicate price-commodity value deviations that are greater than the price-labour value deviation for the year 1995. Accordingly, the points on the left side of the vertical axes of the figures indicate price-commodity value deviations that are less than the price-labour value deviation for the year 2005, whilst the points on the right side of the vertical axes of the figures indicate price-commodity value deviations that are greater than the price-labour value deviation for the year 2005. Thus, a point on the lower-left quadrants of the figures indicates that there exists a vector of commodity values that is better approximation of prices than labour values for both years of our analysis, whilst the points on the upper-right quadrants of the figures indicate vectors of commodity values that are worse approximations of prices than labour values for both years of our analysis. For example, the five points on the lower-left quadrant of Figure 1 indicate that there exist five vectors of commodity values that are better approximations of actual production prices than labour values.

More specifically, the main empirical findings derived from Tables and Figures 1-2 and the associated numerical results can be summarized as follows:

1. The actual production price-value deviation for the year 1995 is almost 11.3% whilst that for the year 2005 is almost 11.5%. The market price-value deviation for the year 1995 is almost 65.6%, whilst that for the year 2005 is almost 31.7%. Also, the actual relative rate of profit ρ ($\equiv r/R$), where R ($\equiv (\lambda_A)^{-1} - 1$ denotes the maximum rate of profit, is almost 35.8% ($r \cong 32.2\%$, $R \cong 89.9\%$) for the year 1995 and almost 36.0% for the year 2005 ($r \cong 30.8\%$, $R \cong 85.5\%$).[14]
2. The average deviation of actual production prices from commodity values is almost 15.6% for both years of our analysis. The average deviation of market prices from commodity values is almost 66.2% for the year 1995 and almost 34.1% for the year 2005.
3. The deviations of actual production prices from the vector of commodity values associated with the commodities 50 (trade, maintenance and repair services of motor vehicles and motorcycles; retail sale of automotive fuel), 51 (wholesale trade and commission trade services, except of motor vehicles and motorcycles), 52 (retail trade services, except

[14] It should be noted that all the relevant empirical studies (see footnote 1) have found a relative rate of profit that is in the range of 17-40 percent, an actual production price-labour value deviation that is in the range of 6-20 percent and a market price-labour value deviation that is in the range of 7-37 percent. Consequently, our results regarding the market price-labour value deviations for the year 1995 show a significant divergence from those reported in similar studies.

of motor vehicles and motorcycles; repair services of personal and household goods), 60 (land transport; transport via pipeline services) and 74 (other business services) are less than the corresponding actual production price-labour value deviation for both years of our analysis. Furthermore, the deviation of production prices from the vector of commodity values associated with commodity 66 (insurance and pension funding services) is less than the corresponding production price-labour value deviation for the year 2005.

4. The deviations of market prices from the vectors of commodity values associated with commodities 45 (construction work) and 74 (other business services) are less than the corresponding market price-labour value deviation for both years of our analysis. Furthermore, the deviations of market prices from the vectors of commodity values associated with commodities: *a*) 10 (coal and lignite; peat), 11 (crude petroleum and natural gas), 13 (metal ores), 14 (other mining and quarrying products), 23 (coke, refined petroleum products and nuclear fuels), 26 (other non-metallic mineral products) and 40 (electrical energy, gas, steam and hot water) for the year 1995; and *b*) 22 (printed matter and recorded media), 55 (hotel and restaurant services), 64 (post and telecommunication services), 65 (financial intermediation services), 66 (insurance and pension funding services), 67 (services auxiliary to financial intermediation), 70 (real estate services), 72 (computer and related services), 90 (sewage and refuse disposal services), 92 (recreational, cultural and sporting services), 93 (other services) and 95 (private households with employed persons) for the year 2005 are less than the corresponding market price-labour value deviations.
5. The smallest actual production price-value deviation for the year 1995 is 6.2% and corresponds to the vector of commodity values associated with commodity wholesale trade and commission trade services, except of motor vehicles and motorcycles, whilst the smallest market price-value deviation for the year 1995 is almost 30.1% and corresponds to the vector of commodity values associated with the commodity construction work. The smallest actual production price-value deviation for the year 2005 is 7.8% and corresponds to the vector of commodity values associated with commodity wholesale trade and commission trade services, except of motor vehicles and motorcycles, whilst the smallest market price-value deviation for the year 2005 is 17.7% and corresponds to the vector of commodity values associated with commodity financial intermediation services.[15]
6. The largest actual production price-value deviation for the year 1995 is 24.3% and corresponds to the vector of commodity values associated with the commodity metal ores, whilst the largest market price-value deviation for the year 1995 is 72.2% and corresponds to the vector of commodity values associated with the commodity membership organization services. The largest actual production price-value deviation for

[15] The aforesaid vectors of commodity values are reported in Appendix 3, Tables 3.1-3.4. The direct and indirect requirements of a commodity necessary to produce one unit of itself are indicated by bold characters.

the year 2005 is 24.8% and corresponds to the vector of commodity values associated with the commodity metal ores, whilst the largest market price-value deviation for the year 2005 is 72.2% and corresponds to the vector of commodity values associated with the commodity research and development services.

Discussion

As it can be shown, the relation between prices and values depends in a complex way on the technical conditions of production and income distribution.[16] Thus, it is impossible to *a priori* determine whether the labour values or some commodity values will be the best approximation of prices in the real world. Some researchers have reported results that indicate that there is an empirical basis for preferring labour as a value base and interpreted these results as giving support to the empirical strength of the labour theory of value. In our view, the aforesaid results are not sufficient in order to neglect alternative value bases because: 1) the estimated magnitudes in these studies are not the commodity i values, *i.e.*, the direct and indirect requirements of commodity i necessary to produce one unit of each commodity as gross output; 2) the measure of deviation used to assess the proximity of values to prices is not bias-free; and 3) only a few of the available commodities were used as value bases.

In this study we explored the empirical relationships between prices and values, based on a definition of commodity i values that is compatible with the notion of direct and indirect requirements for gross output. Furthermore, we used each of the available commodities as a value base and we used a measure of deviation that is free from numeraire and measurement-unit dependence. The results of this study indicate that there exist commodity i values that are better approximations of prices than labour values. In our view, these

[16] For the theoretical investigation of the relationships between prices and labour values, see Parys (1982) and Bidard and Ehrbar (2007), whilst for the so-called problem of transforming values into prices, see, *e.g.*, Pasinetti (1977: chapter 5, Appendix) and Reati (1986). For the theoretical relationships between prices and commodity values, see Mariolis (2000; 2001) and Soklis (2009: Appendix 2), whilst for a new approach to the relationships between prices and values, see Mariolis (2010). Finally, it is worth noting that a typical finding of many empirical studies is that the production price-profit rate relationship is, more often than not, monotonic (see, *e.g.*, Sekerka, Kyn and Hejl, 1970; Krelle, 1977; Petrović, 1987; Da Silva and Rosinger, 1992; Shaikh, 1998; Han and Schefold, 2006). Thus, it is expected that the production price-value deviations of actual economic systems will vary in the same direction with the rate of profits.

results, which are in line with those reported in Soklis (2009), do not (or, more precisely, cannot) provide support to an alternative value theory, but rather cast doubt on the argument that there is an empirical basis for neglecting alternative value bases.

Concluding remarks

This paper extended the empirical investigation of the relationships between prices and values to the case of alternative value bases. Contrary to the results reported in the majority of the relevant studies, it has been found that there exist commodity values that are better approximations of actual prices than labour values. Thus, it may be argued that the empirical investigation of the relationships between values and actual prices should not *a priori* neglect alternative value bases. Although we do not consider that these results can provide support to an alternative value theory, they certainly cast doubt on the logic of the so-called 'empirical labour theory of value' (Stigler, 1958: 361).

Future research efforts should use more disaggregated input-output data from various countries and concretize the model by including the presence of fixed capital and the degree of its utilization, depreciation, turnover times, taxes and subsidies, and joint production activities.

Appendix 1

A note on the data

At the time of this research, the SIOT and the corresponding levels of sectoral employment of the French economy (for the years 1995, 1997 and 1999 through 2005) were available via the Eurostat website (<http://ec.europa.eu/eurostat>). Given that technical change over time could be considered as rather 'slow', we have chosen to apply our analysis to the tables of the years 1995 and 2005. The input-output tables describe 59 products, which are classified according to Classification of Product by Activity (CPA). The described products of the French economy and their correspondence to CPA are reported in Table A1 below. However, all the elements associated with: 1) the product with code 37 (secondary raw materials) for both years; and 2) the product with code 12 (uranium and thorium ores) for the year 2005 equal zero and, therefore, we

remove them from our analysis. Thus, we derive SIOT of dimensions 58×58 for the year 1995 and 57×57 for the year 2005.

The market prices of all products are taken to be equal to 1; that is to say, the physical unit of measurement of each product is that unit which is worth of a monetary unit (see, *e.g.*, Miller and Blair, 1985: 356). Thus, the matrix of input-output coefficients **A** is obtained by dividing element-by-element the inputs of each sector by its gross output.

It need hardly be said that, in the real world, labour is not homogeneous and, therefore, the levels of sectoral employment derived from the SIOT correspond to heterogeneous labour. However, in the case of economic systems with heterogeneous labour, any attempt to explore the price-value deviation(s) is devoid of economic sense (see Steedman 1977: chapter 7 and pp. 178-9; 1985). Thus, in accordance with most of the relevant empirical studies, we use wage differentials to homogenize the sectoral employment (see, *e.g.*, Sraffa, 1960: §10; Kurz and Salvadori, 1995: 322-5), *i.e.*, the vector of inputs in direct homogeneous labour ($\mathbf{l} \equiv [l_j]$), is determined as follows: $l_j = (L_j / x_j)(w_j^{\mathrm{M}} / w_{\min}^{\mathrm{M}})$, where denote the total employment, gross output and money wage rate, in terms of market prices, of the j th sector, respectively, and $w_{\min}^{\mathrm{M}}$ the minimum sectoral money wage rate in terms of market prices. Alternatively, the homogenization of employment could be achieved, for example, through the economy's average wage; in fact, the empirical results are robust to alternative normalizations with respect to homogenization of labour inputs. The described reductions of course are only meaningful when the relative wages express with precision the differences in skills and intensity of labour that is employed by each sector of the economy (*ibid.*). In any other case the choice of homogenization procedure is, of necessity, arbitrary. Furthermore, by assuming that workers do not save and that their consumption has the same composition as the vector of the final consumption expenditures of the household sector ($\mathbf{h}_{ce}$) directly obtained from the input-output tables, the vector of the real wage rate ($\mathbf{b} \equiv [b_i]$) is determined as follows: $\mathbf{b} = (w_{\min}^{\mathrm{M}} / \mathbf{e}^{\mathrm{T}}\mathbf{h}_{ce})\mathbf{h}_{ce}$, where $\mathbf{e}^{\mathrm{T}} \equiv [1,1,\ldots,1]$ denotes the row summation vector identified with the vector of market prices (see also, *e.g.*, Okishio and Nakatani, 1985: 66-7). Finally, it must be noted that the available input-output tables do not include inter-industry data on fixed capital stocks and on non-competitive imports. As a result, our investigation is restricted to a closed economy with circulating capital.

Table **A1**
Product classification

No.	*CPA*	*Nomenclature*
1	01	Products of agriculture, hunting and related services
2	02	Products of forestry, logging and related services
3	05	Fish and other fishing products; services incidental of fishing
4	10	Coal and lignite; peat
5	11	Crude petroleum and natural gas; services incidental to oil and gas extraction excluding surveying
6	12	Uranium and thorium ores
7	13	Metal ores
8	14	Other mining and quarrying products
9	15	Food products and beverages
10	16	Tobacco products
11	17	Textiles
12	18	Wearing apparel; furs
13	19	Leather and leather products
14	20	Wood and products of wood and cork (except furniture); articles of straw and plaiting materials
15	21	Pulp, paper and paper products
16	22	Printed matter and recorded media
17	23	Coke, refined petroleum products and nuclear fuels
18	24	Chemicals, chemical products and man-made fibres
19	25	Rubber and plastic products
20	26	Other non-metallic mineral products
21	27	Basic metals
22	28	Fabricated metal products, except machinery and equipment
23	29	Machinery and equipment
24	30	Office machinery and computers
25	31	Electrical machinery and apparatus
26	32	Radio, television and communication equipment and apparatus
27	33	Medical, precision and optical instruments, watches and clocks
28	34	Motor vehicles, trailers and semi-trailers
29	35	Other transport equipment
30	36	Furniture; other manufactured goods
31	37	Secondary raw materials
32	40	Electrical energy, gas, steam and hot water
33	41	Collected and purified water, distribution services of water
34	45	Construction work

Table **A1, continuation…**

35	50	Trade, maintenance and repair services of motor vehicles and motorcycles; retail sale of automotive fuel
36	51	Wholesale trade and commission trade services, except of motor vehicles and motorcycles
37	52	Retail trade services, except of motor vehicles and motorcycles; repair services of personal and household goods
38	55	Hotel and restaurant services
39	60	Land transport; transport via pipeline services
40	61	Water transport services
41	62	Air transport services
42	63	Supporting and auxiliary transport services; travel agency services
43	64	Post and telecommunication services
44	65	Financial intermediation services, except insurance and pension funding services
45	66	Insurance and pension funding services, except compulsory social security services
46	67	Services auxiliary to financial intermediation
47	70	Real estate services
48	71	Renting services of machinery and equipment without operator and of personal and household goods
49	72	Computer and related services
50	73	Research and development services
51	74	Other business services
52	75	Public administration and defense services; compulsory social security services
53	80	Education services
54	85	Health and social work services
55	90	Sewage and refuse disposal services, sanitation and similar services
56	91	Membership organization services
57	92	Recreational, cultural and sporting services
58	93	Other services
59	95	Private households with employed persons

Appendix 2

Labour values (LV) and prices of production (POP)

Table 2.3
Labour values, 2005

CPA	LV	CPA	LV
01	0.0492	40	0.0545
02	0.0433	41	0.0669
05	0.0428	45	0.0733
10	0.1108	50	0.0734
11	0.0444	51	0.0786
13	0.1525	52	0.0719
14	0.0724	55	0.0739
15	0.0655	60	0.0745
16	0.0481	61	0.0609
17	0.0820	62	0.0783
18	0.0748	63	0.0743
19	0.0813	64	0.0679
20	0.0746	65	0.0789
21	0.0752	66	0.0670
22	0.0808	67	0.0701
23	0.0487	70	0.0177
24	0.0690	71	0.0449
25	0.0789	72	0.0849
26	0.0757	73	0.0958
27	0.0762	74	0.0815
28	0.0845	75	0.0918
29	0.0848	80	0.1054
30	0.0695	85	0.0820
31	0.0874	90	0.0651
32	0.0849	91	0.0800
33	0.0852	92	0.0732
34	0.0795	93	0.0571
35	0.0820	95	0.1258
36	0.0795	Real wage	0.4863

Table 2.4
Prices of production, 2005

CPA	POP	CPA	POP
01	0.1036	40	0.1021
02	0.0754	41	0.1305
05	0.0668	45	0.1297
10	0.1598	50	0.1171
11	0.0712	51	0.1235
13	0.2399	52	0.1042
14	0.1374	55	0.1200
15	0.1355	60	0.1127
16	0.0807	61	0.1280
17	0.1589	62	0.1417
18	0.1431	63	0.1211
19	0.1433	64	0.1105
20	0.1376	65	0.1195
21	0.1518	66	0.1081
22	0.1394	67	0.1079
23	0.1034	70	0.0299
24	0.1445	71	0.0795
25	0.1530	72	0.1187
26	0.1391	73	0.1545
27	0.1625	74	0.1203
28	0.1543	75	0.1229
29	0.1585	80	0.1284
30	0.1441	85	0.1081
31	0.1688	90	0.0922
32	0.1664	91	0.1199
33	0.1493	92	0.1163
34	0.1816	93	0.0849
35	0.1960	95	0.1371
36	0.1477	Real wage	0.8330

Table **2.3**
Labour values, 2005

CPA	*LV*	*CPA*	*LV*
01	0.0492	40	0.0545
02	0.0433	41	0.0669
05	0.0428	45	0.0733
10	0.1108	50	0.0734
11	0.0444	51	0.0786
13	0.1525	52	0.0719
14	0.0724	55	0.0739
15	0.0655	60	0.0745
16	0.0481	61	0.0609
17	0.0820	62	0.0783
18	0.0748	63	0.0743
19	0.0813	64	0.0679
20	0.0746	65	0.0789
21	0.0752	66	0.0670
22	0.0808	67	0.0701
23	0.0487	70	0.0177
24	0.0690	71	0.0449
25	0.0789	72	0.0849
26	0.0757	73	0.0958
27	0.0762	74	0.0815
28	0.0845	75	0.0918
29	0.0848	80	0.1054
30	0.0695	85	0.0820
31	0.0874	90	0.0651
32	0.0849	91	0.0800
33	0.0852	92	0.0732
34	0.0795	93	0.0571
35	0.0820	95	0.1258
36	0.0795	Real wage	0.4863

Table **2.4**
Prices of production, 2005

CPA	*POP*	*CPA*	*POP*
01	0.1036	40	0.1021
02	0.0754	41	0.1305
05	0.0668	45	0.1297
10	0.1598	50	0.1171
11	0.0712	51	0.1235
13	0.2399	52	0.1042
14	0.1374	55	0.1200
15	0.1355	60	0.1127
16	0.0807	61	0.1280
17	0.1589	62	0.1417
18	0.1431	63	0.1211
19	0.1433	64	0.1105
20	0.1376	65	0.1195
21	0.1518	66	0.1081
22	0.1394	67	0.1079
23	0.1034	70	0.0299
24	0.1445	71	0.0795
25	0.1530	72	0.1187
26	0.1391	73	0.1545
27	0.1625	74	0.1203
28	0.1543	75	0.1229
29	0.1585	80	0.1284
30	0.1441	85	0.1081
31	0.1688	90	0.0922
32	0.1664	91	0.1199
33	0.1493	92	0.1163
34	0.1816	93	0.0849
35	0.1960	95	0.1371
36	0.1477	Real wage	0.8330

Appendix 3

Commodity values (cv)

Table **3.1**
Wholesale trade and commission trade services values, 1995

CPA	*CV*	*CPA*	*CV*
01	0.1008	40	0.1020
02	0.1192	41	0.1729
05	0.0851	45	0.1505
10	0.3820	50	0.1098
11	0.1592	**51**	**0.1642**
12	0.0208	52	0.1183
13	0.0104	55	0.1501
14	0.1577	60	0.1268
15	0.1500	61	0.1604
16	0.1108	62	0.1560
17	0.1511	63	0.1468
18	0.1621	64	0.1237
19	0.1497	65	0.1193
20	0.1692	66	0.1184
21	0.1467	67	0.1348
22	0.1594	70	0.0354
23	0.1412	71	0.0523
24	0.1567	72	0.1730
25	0.1535	73	0.1541
26	0.1659	74	0.1350
27	0.1730	75	0.1447
28	0.1612	80	0.1636
29	0.1839	85	0.1304
30	0.1772	90	0.1125
31	0.1597	91	0.1267
32	0.2058	92	0.1240
33	0.1455	93	0.1231
34	0.1771	95	0.1328
35	0.1882	Real wage	0.9036
36	0.1673		

Table **3.2**
Wholesale trade and commission trade services values, 2005

CPA	*CV*	*CPA*	*CV*
01	0.1293	40	0.1005
02	0.0982	41	0.1440
05	0.0798	45	0.1614
10	0.1848	50	0.1401
11	0.0755	**51**	**0.1904**
13	0.3012	52	0.1266
14	0.1803	55	0.1626
15	0.1744	60	0.1450
16	0.0942	61	0.1316
17	0.1801	62	0.1601
18	0.1766	63	0.1432
19	0.1948	64	0.1261
20	0.1847	65	0.1318
21	0.1674	66	0.1133
22	0.1738	67	0.1199
23	0.1024	70	0.0364
24	0.1771	71	0.0832
25	0.1785	72	0.1503
26	0.1871	73	0.1905
27	0.1914	74	0.1498
28	0.1879	75	0.1517
29	0.1992	80	0.1720
30	0.2305	85	0.1471
31	0.2037	90	0.1081
32	0.1993	91	0.1398
33	0.1900	92	0.1403
34	0.2067	93	0.1075
35	0.1904	95	0.1912
36	0.1876	Real wage	1.5196

Table 3.3
Construction work values, 1995

CPA	*CV*	*CPA*	*CV*
01	0.0260	40	0.0775
02	0.0321	41	0.1483
05	0.0289	**45**	**0.1355**
10	0.2119	50	0.0367
11	0.1095	51	0.0394
12	0.0267	52	0.0370
13	0.0139	55	0.0367
14	0.0458	60	0.0418
15	0.0343	61	0.0620
16	0.0447	62	0.0572
17	0.0424	63	0.0570
18	0.0428	64	0.0519
19	0.0399	65	0.0408
20	0.0421	66	0.0449
21	0.0404	67	0.0495
22	0.0412	70	0.0337
23	0.0915	71	0.0176
24	0.0411	72	0.0546
25	0.0409	73	0.0629
26	0.0442	74	0.0424
27	0.0480	75	0.0639
28	0.0421	80	0.0539
29	0.0475	85	0.0423
30	0.0363	90	0.0435
31	0.0412	91	0.0547
32	0.0547	92	0.0533
33	0.0394	93	0.0392
34	0.0432	95	0.0381
35	0.0541	Real wage	0.2592
36	0.0441		

Table 3.4
Financial intermediation services values, 2005

CPA	*CV*	*CPA*	*CV*
01	0.0777	40	0.0755
02	0.0500	41	0.1206
05	0.0578	45	0.0984
10	0.1842	50	0.0853
11	0.0834	51	0.1294
13	0.1568	52	0.1048
14	0.0882	55	0.0902
15	0.0953	60	0.0846
16	0.0702	61	0.0853
17	0.1106	62	0.0935
18	0.0944	63	0.1077
19	0.0986	64	0.0826
20	0.0871	**65**	**0.2569**
21	0.1043	66	0.1096
22	0.1029	67	0.1337
23	0.0822	70	0.0467
24	0.0891	71	0.0823
25	0.0882	72	0.0838
26	0.0873	73	0.1147
27	0.0993	74	0.0992
28	0.0931	75	0.0946
29	0.0986	80	0.0941
30	0.0912	85	0.0786
31	0.0971	90	0.0682
32	0.0983	91	0.0943
33	0.0932	92	0.0942
34	0.0951	93	0.0689
35	0.0988	95	0.0993
36	0.0914	Real wage	0.7889

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