Cambridge Journal of Economics 2005, **29,** 799–815
doi:10.1093/cje/bei043
Advance Access publication 6 June, 2005

On measuring the wealth of nations: the US economy, 1964–2001

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This paper examines the methodology of Shaikh and Tonak (*Measuring the Wealth of Nations*, 1994) underlying their calculation of estimates of productive labour in the US economy from 1964 to 2001. The focus is not on the results but on the methods that generate them. The paper finds that the compromises made by Shaikh and Tonak because of data unavailability are unreliable, and that better approximations are possible. On this latter basis, the Shaikh and Tonak methodology can be used to provide the labour and wage estimates needed for empirical investigations in the surplus-based tradition.

Key words: Productive labour, Unproductive labour, US economy
JEL classifications: B5, O51

1. Introduction

In 1994, Shaikh and Tonak presented in book form the outcome of their research programme investigating the measurement of macroeconomic magnitudes from a classically inspired surplus-based perspective (Shaikh and Tonak, 1994). This paper considers in detail the methodology and calculations regarding productive labour presented by Shaikh and Tonak (hereafter ST). While the paper's conclusions are rather critical, it is appropriate here to acknowledge the path-breaking foundations of the work at the Graduate Faculty of the New School for Social Research (now New School University) in the late 1970s and early 1980s which culminated in their book. The book was reviewed by Moseley (1995) as 'a very important addition' to the heterodox literature, 'certain to become the standard reference for further empirical work in this tradition', and 'an excellent place to begin' for 'those who are dissatisfied with the conventional descriptions and dynamics of the postwar U.S. economy' (Moseley, 1995, pp. 203, 204).

This paper focuses on the calculations presented in Appendices F and G of their book (Shaikh and Tonak, 1994, pp. 295–322). The paper is not concerned with a discussion of whether the distinction between productive and unproductive labour is meaningful, nor with a discussion of whether this or that sector should properly be

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regarded as productive. To avoid the former, the paper takes the ST discussion of the concepts for granted, and to avoid the latter, the paper follows the ST classification of productive and unproductive sectors by Standard Industrial Classification (SIC) throughout. The focus of the paper is thus confined to how the results are obtained. Before one can discuss what the data show, it has to be understood how the data are derived, and what confidence can be placed in the measurements.

The basic data used are the National Income and Product Accounts (NIPA) data produced by the Bureau of Economic Analysis (BEA), broken down by industrial division according to the 1972 SIC (1964–87) and 1987 SIC (1987–2001), and labour statistics data produced by the Bureau of Labor Statistics (BLS). The paper follows closely the ST methodology of calculation of estimates of productive labour, revises them and brings them forward to 2001. Some of the revisions are unavoidable, to do with raw data revisions, revision of the SIC to a 1987 base, and revision of the national accounts from a GNP to a GDP basis in 1991. At the level of aggregation with which this paper deals, these are not very significant.

ST were unable to apply their methodology completely because of data unavailability, and consequently had to make various approximations. Since they completed their study (the final year of their data set is 1989), more complete data have become available, classified according to the 1987 SIC, for the years 1988 *et seq.*. This means that estimates for these later years can be calculated, first on the basis of the method that ST actually used, and second on the basis of a more comprehensive application of their methodology. That is, the approximations that they made, applied to 1988–2001 data, can be evaluated in terms of their effects on the estimates. Following this evaluation, a better approximation procedure is proposed and is shown to produce estimates for 1988–2001 that are very close to those produced by as complete an application as possible of the ST methodology, and much closer than the estimates derived from the methodology incorporating the approximations that ST actually made. Further, this better approximation procedure can also be applied to the years 1964–87. The presumption is that, since it produces better estimates for 1988–2001 (in the sense just described) than those produced by applying the approximations made by ST, it might also produce better estimates for 1964–87. It is not possible to use the procedure proposed for the years prior to 1964, because of data unavailability and the difficulty of evaluating any proxy procedure for approximating its construction. This means that a complete set of data is only possible for 1964–2001.

The paper is organised as follows. The next section outlines the benchmark procedures specified by ST. The third section considers approximations to these procedures. The difficulties primarily (although not exclusively) concern productive services. The ST approximations are considered relative to the benchmark calculations for the years 1988–2001, and a different set of approximations, the SM approximations, are similarly compared. Data are then compared over the period 1964–2001, and this is followed by a short conclusion.

2. Benchmark calculations

The ST methodology is for the most part straightforward. In general, the procedure is first to calculate the number of productive workers by major SIC division, and then to calculate a relevant wage so that multiplying the two together gives variable capital in money terms.

2.1 Numbers of productive workers

The first decision is to allocate each major SIC category to a position in the circuit of capital according to whether it embraces the production of new value or whether it is located entirely in the circulation part of the circuit, embracing exclusively commercial and financial functions that alter the form of value but not its magnitude. ST's allocation is listed in Table 1, and will be followed throughout this paper.[1]

Within each division containing productive labour, the second step is to determine how much of that division's labour is productive using BLS data. BLS employment data exclude proprietors, the self-employed, unpaid volunteer or family workers, farm workers, domestic workers and non-civilian government employees; they also exclude all those on lay-off, on unpaid leave, on strike and newly hired but not yet reported. The ST procedure identifies as 'productive labour' those whom BLS identify as 'production and related workers' in mining and manufacturing, 'construction workers' in construction, and 'nonsupervisory employees' in private service-producing industries, and then maps these categories onto NIPA data. The BLS data are defined as follows.

Production and related workers. This category includes working supervisors and all nonsupervisory workers (including group leaders and trainees) engaged in fabricating, processing, assembling, inspecting, receiving, storing, handling, packing, warehousing, shipping, trucking, hauling, maintenance, repair, janitorial, guard services, product development, auxiliary production for plant's own use (e.g., power plant), recordkeeping, and other services closely associated with the above production operations.

Table 1. *Productive and unproductive divisions by SIC*

Divisions with some productive labour	Divisions with no productive labour
Agriculture, Forestry and Fishing	Wholesale Trade
Mining	Retail Trade
Construction	Finance, Insurance and Real Estate
Manufacturing	Business Services
Transportation and Public Utilities	Legal Services
Hotels and Other Lodging Places	Misc. Professional Services (1972 SIC)
Personal Services	Other Services (1987 SIC)
Auto Repair, Services, and Parking	Private Households
Miscellaneous Repair Services	General Government
Motion Pictures	
Amusement and Recreation Services	
Health Services	
Educational Services	
Social Services; Membership Organizations	
Government Enterprises	

[1] See ST, pp. 108–9. Note that Miscellaneous Professional Services is omitted from the description of unproductive services in ST Appendix F p. 295, but it is in fact included in their calculation of unproductive labour in Table F1. It is listed as a productive service in Table E1 (p. 284, line 21), but it is not in fact there included as productive (it is omitted from line 11). Hence the ST calculations are consistent in treating Miscellaneous Professional Services as unproductive, even though the textual description has some ambiguities.

Construction workers. This group includes the following employees in the construction division: Working supervisors, qualified craft workers, mechanics, apprentices, helpers, laborers, etc., engaged in new work, alterations, demolition, repair, maintenance, etc., whether working at the site of construction or working in shops or yards at jobs (such as precutting and preassembling) ordinarily performed by members of the construction trades.

Nonsupervisory employees. These are employees (not above the working supervisory level) such as office and clerical workers, repairers, salespersons, operators, drivers, physicians, lawyers, accountants, nurses, social workers, research aides, teachers, drafters, photographers, beauticians, musicians, restaurant workers, custodial workers, attendants, line installers and repairers, laborers, janitors, guards, and other employees at similar occupational levels whose services are closely associated with those of the employees listed. (US Department of Labour, Bureau of Labour Statistics, 1994, p.1221.)

For brevity, designate these three categories together as 'BLS production workers'.

For each productive SIC division, the ratio of BLS production workers to all BLS employees is calculated. Applying this ratio to the NIPA employment data ('persons engaged in production by industry', comprising full-time employees, part-time employees converted to a full-time basis, and the self-employed and small proprietors) gives the number of productive workers in each productive SIC division. Formally, let superscript i denote the SIC division, subscript p denote 'productive', subscript pn denote 'production', subscripts BLS and $NIPA$ denote the data source, and L denote employment. Then productive labour in sector i (measured in terms of full-time equivalents, or ftes) is given by

$$L_p^i = \left(\frac{L_{pn}^i}{L^i}\right)_{BLS} (L^i)_{NIPA} \tag{1}$$

if i is a productive sector, and is zero otherwise. Total productive labour (L_p) is the sum of productive labour in each sector, where the summation is over those sectors defined as productive, and total unproductive labour (L_u) is then obtained by subtraction

$$L_p = \sum_i L_p^i \tag{2}$$

$$L_u = L - L_p \tag{3}$$

2.2 Wages paid to productive workers

Having derived the number of productive workers, the ST procedure then derives a set of wage figures such that the quantity of variable capital (in money terms) can be identified. The basic procedure is as follows.

1. For each SIC division i, determine average employee compensation (ec) by the NIPA ratio of total employee compensation (EC) to total fte employees (FTE). Multiplying by the relevant NIPA employment data determines the total wage (W) in each SIC division. This imputes to the self-employed in each SIC division the average employee compensation of that division. That is

$$W^i = \left(\frac{EC^i}{FTE^i}\right)_{NIPA} (L^i)_{NIPA} = (ec^i)_{NIPA} (L^i)_{NIPA} \tag{4}$$

2. For each SIC division i, take the weekly wage (w) paid to BLS production workers, and multiply first by 52 (to convert to an annual figure) and second by the NIPA ratio of employee compensation to wages and salaries (WS) (to include employer contributions to superannuation and the like). This determines an annual average labour income for production workers in each productive SIC division. Hence

$$ec_p^i = 52(w_{pn}^i)_{BLS}\left(\frac{EC^i}{WS^i}\right)_{NIPA} \tag{5}$$

3. Multiplying by the relevant number of productive workers determines variable capital in money terms in each productive SIC division

$$W_p^i = ec_p^i L_p^i \tag{6}$$

and summing over all sectors gives total variable capital in money terms.

4. Wages paid to unproductive workers are then determined by subtraction from total wages[1]

$$W_u^i = W^i - W_p^i \tag{7}$$

and summing over all sectors determines the total wages paid to unproductive labour.

Equations (1)–(7) define the benchmark procedure, equations (1)–(3) determining ftes of productive labour, and equations (4)–(6) determining their wages.

3. Approximations

There are data problems and difficulties with (in rough order of importance) Services, Transportation and Public Utilities, Agriculture and Government Enterprises, and these are examined in turn.

3.1 Services

The Services sector is large. Services accounted for 16.1% of all employment in 1964, rising to 25.5% in 1989 and to 31.3% in 2001. Therefore, the lack of correspondence between BLS data and NIPA data in the Services sector is a major difficulty. For the years covered by the ST dataset, while there are BLS series from 1964 for both production workers and their wages in all Services industries taken together, there is no comprehensive breakdown for the individual Services divisions. Hence, there are no data to determine the first terms on the right-hand side of equation (1) and on the right-hand side of equation (5). Consequently, ST had to adopt various approximation procedures.

However, from 1988 onwards, there are BLS data on production workers in each individual Services division, albeit with varying coverage. There are four gaps,

[1] As ST (1994, p. 112, n. 12) point out, part-time workers create a difficulty in combining BLS figures for employed workers with NIPA figures for fte employed workers. There is no way to resolve this.

whose resolution is discussed in the Appendix. With these approximations, there is sufficient information to use equations (1)–(7) to calculate benchmark estimates for the years 1988–2001 for Services sector divisions and hence the Services sector as a whole. Therefore, for these years and these years only, it is possible to form benchmark estimates by a complete application of the ST methodology and to compare these with the estimates generated by the approximations that ST used. It is further possible, for these years, to devise a different approximation procedure, which generates estimates closer to the benchmark estimates than the ST approximations for the years 1988–2001, and one that can, like the ST approximations, be used on data prior to 1988.

3.1.1 Numbers of productive workers 1988–2001

Let superscript s denote the Services sector as a whole, and superscript s, j denote the jth division of the Services sector. Then benchmark estimates (subscript B) of Services sector productive labour are just an application of equations (1) and (2):

$$(L_p^{s,j})_B = \left(\frac{L_{pn}^{s,j}}{L^{s,j}}\right)_{BLS} (L^{s,j})_{NIPA} \tag{8}$$

and

$$(L_p^s)_B = \sum_j (L_p^{s,j})_B \tag{9}$$

ST proceeded differently because of the absence of BLS disaggregated data. In place of equations (8) and (9), ST determined the number of production workers in *all* Services according to equation (1), and then weighted this figure by the total contribution to GNP by all productive Services divisions relative to the contribution to GNP by all Services.[1] So, using subscript ST as a label, the ST approximation for Services sector productive labour is

$$(L_p^s)_B \approx (L_p^s)_{ST} = \left(\frac{L_{pn}^s}{L^s}\right)_{BLS} L_{NIPA}^s \left(\frac{\sum_j GDP^{s,j}}{GDP^s}\right)_{NIPA} \tag{10}$$

and there are no ST estimates for Services divisions taken individually.[2] However, contributions to GDP are additive, so that the ST aggregate estimate can be disaggregated to productive Services divisions. Hence

$$(L_p^{s,j})_{ST} = \left(\frac{L_{pn}^s}{L^s}\right)_{BLS} L_{NIPA}^s \left(\frac{GDP^{s,j}}{GDP^s}\right)_{NIPA} \tag{11}$$

and

$$(L_p^s)_{ST} = \sum_j (L_p^{s,j})_{ST} \tag{12}$$

[1] As mentioned above, *GDP* rather than *GNP* will be used in what follows.

[2] There are no BLS data prior to 1964 to determine the first term on the right-hand side of equation (10) and, for the years 1948–63, ST estimate the data by extrapolation. While these earlier years are not the concern of this paper, such extrapolation renders the estimates for these earlier years more problematic. See also the discussion on Transportation and Public Utilities in Section 3.2 below.

Since the right-hand sides of equations (10) and (12) are identical, the disaggregated approximations of equation (11) will be used in the comparisons below. How good the ST approximation is depends upon how closely variations in contributions to *GDP* map into variations in employment.

An alternative approximation (labelled by subscript *SM*) weights the BLS ratio of production workers to all employees for *all* Services in the aggregate, and applies this weighted ratio to the NIPA employment in *each* of the SIC Services divisions in which there is some productive labour.

$$(L_p^{s,j})_B \approx (L_p^{s,j})_{SM} = \alpha^{s,j}\left(\frac{L_{pn}^{s}}{L^{s}}\right)_{BLS}(L^{s,j})_{NIPA} \tag{13}$$

and

$$(L_p^{s})_{SM} = \sum_j (L_p^{s,j})_{SM} \tag{14}$$

The weights $\alpha^{s,j}$ are, for each subdivision j, the ratio of the mean of the BLS ratio for division j, for the first five years for which it exists, to the mean of the BLS ratio for all Services for those same years. This generates the SM estimates. How good an approximation this is depends on the level of variation of BLS ratios of Services divisions relative to the BLS ratio for all Services.

Table 2 shows the benchmark calculations for 1988 and the ST and SM approximations.

The ST approximation delivers 91.2% of benchmark Services sector productive labour, whereas the SM approximation delivers 98.5%. Moreover, these figures are not peculiar to the particular year 1988. Over the period 1988–2001, the ST approximation averages 91.2% of the benchmark (with a standard deviation of 1.26), whereas the SM approximation averages 98.6% of the benchmark (with a standard

Table 2. *Services sector productive labour in 1988*

	Productive labour (000s)		
	Benchmark method equations (8)–(9)	ST method equations (11)–(12)	SM method equations (13)–(14)
Hotels and Other Lodging Places	1,303	1,102	1,298
Personal Services	1,444	976	1,447
Auto Repair, Services and Parking	1,025	1,230	1,040
Miscellaneous Repair Services	455	418	468
Motion Pictures	331	389	329
Amusement and Recreation Services	786	782	786
Health Services	6,061	6,885	5,989
Education Services	1,364	929	1,364
Social Services	1,659	635	1,586
Membership Organizations	1,115	824	1,007
Total productive services	15,543	14,170	15,313

deviation of 0.23). The SM approximation, relative to the benchmark, delivers closer means with lower standard deviations, and so must be judged superior to the ST approximation in determining both levels and changes in the numbers of Services sector productive workers.

3.1.2 Wages of productive workers 1988–2001

Benchmark calculations of productive wages in Services are an application of equations (5) and (6) to the Services divisions:

$$(W_p^{s,j})_B = ec_p^{s,j}(L_p^{s,j})_B \tag{15}$$

where

$$ec_p^{s,j} = 52(w_{pn}^{s,j})_{BLS}\left(\frac{EC^{s,j}}{WS^{s,j}}\right)_{NIPA} \tag{16}$$

$(L_p^{s,j})_B$is given by equation (8) and

$$(W_p^s)_B = \sum_j (W_p^{s,j})_B \tag{17}$$

ST had no BLS data on production worker wages for Services divisions. Hence, they simply applied the NIPA *ec* for the whole Services sector (Shaikh and Tonak, 1964, p. 305) to their calculation of aggregate productive workers in Services in equation (10)

$$(W_p^s)_B \approx (W_p^s)_{ST} = (ec^s)_{NIPA}(L_p^s)_{ST} \tag{18}$$

where $L_p{}^s$ is calculated by equation (10). But because the right-hand sides of equations (10) and (12) are identical, this amounts to assuming that, in each Services division in each year, the average labour income of a productive worker was the same as the NIPA *ec* for the whole Services sector (Shaikh and Tonak, 1964, p. 305):

$$(W_p^{s,j})_{ST} = (ec^s)_{NIPA}(L_p^{s,j})_{ST} \tag{19}$$

where $(L_p^{s,j})_{ST}$ is given by equation (11) and

$$(W_p^s)_{ST} = \sum_j (W_p^{s,j})_{ST} \tag{20}$$

This is a drastic assumption, because it imposes uniformity on the variability between the wages of production and non-production workers both within and across Services divisions. It is only justified if positive and negative variabilities cancel each other on aggregation. But casual inspection of the differences in NIPA *ec* in Services divisions suggests that this is unlikely.

Moreover, this latter disaggregated information on variability can be used precisely, for since there are BLS data on production worker wages across all Services from 1964, weighting this data by the NIPA ratio of *ec* in a Services division to *ec* in all Services defines the SM approximation.

$$(W_p^{s,j})_B \approx (W_p^{s,j})_{SM} = 52(w_{pn}^s)_{BLS}\left(\frac{EC^s}{WS^s}\right)_{NIPA}\left(\frac{ec^{s,j}}{ec^s}\right)_{NIPA}(L_p^{s,j})_{SM} \tag{21}$$

where $(L_p^{s,j})_{SM}$ is given by equation (13), and

$$(W_p^s)_B \approx (W_p^s)_{SM} = \sum_j (W_p^{s,j})_{SM} \tag{22}$$

The outcome for 1988 is shown in Table 3. In order to isolate the effects of the different approximations in the calculation of wages in Table 3, they are each applied to the *same* benchmark quantities of productive labour given in Table 2.[1]

The ST approximation overestimates benchmark total variable capital in the Services sector by more than two-thirds (69.4%), whereas the SM approximation overestimates it by only 1.8%. Again, these figures are not an artefact of the particular year. Over the whole period 1988–2001, the ST approximation delivers an average of 172% of the benchmark figure (with a standard deviation of 3.71), whereas the SM approximation generates an average estimate of 101.5% of the benchmark estimate (with a standard deviation of 1.08). As with the estimates of numbers, but rather more emphatically, the SM approximation delivers better estimates of the benchmark figures than does the ST approximation.

3.1.3 Services 1964–87

It is worth exploring why the SM approximation should deliver superior results to the ST approximation. The SM calculations of the number of productive workers are closer to the benchmark estimates for two reasons. First, contributions to *GDP* by Services sector divisions are notoriously difficult to estimate, particularly with non-tangible outputs produced in highly labour-intensive production processes, and a variety of different methods are used in national accounts procedures, depending upon what data are available, and upon contingent assessments of what procedures

Table 3. *Services sector productive wages in 1988*

	Productive wages ($m)		
	Benchmark method equations (15)–(17)	ST method equations (18)–(20)	SM method equations (21)–(22)
Hotels and Other Lodging Places	15,835	34,288	15,450
Personal Services	17,380	38,002	15,920
Auto Repair, Services and Parking	18,565	26,981	14,537
Miscellaneous Repair Services	9,968	11,987	7,919
Motion Pictures	5,538	8,721	6,921
Amusement and Recreation services	9,508	20,695	11,124
Health Services	110,309	159,522	122,083
Education Services	19,826	35,892	19,826
Social Services	20,160	43,672	17,566
Membership Organizations	14,476	29,338	14,476
Total productive services	241,564	409,098	245,822

[1] Because BLS data for all Services exclude Private Households, the relevant all Services NIPA magnitudes in equations (16), (19) and (21) are constructed to exclude Private Households.

might be most appropriate to each division. The ST method is dependent upon such data and procedures, whereas the SM method is not. Second, the SM method takes advantage of the feature that the individual Services division BLS ratios in the Benchmark procedure are not very different from the aggregate BLS ratio for all Services. And as regards the wage calculations, the drastic nature of the assumption underlying the ST approximation has already been noted. The SM method only depends upon accepting a NIPA variation around an average BLS production wage, which is always likely to be much more accurate than a presumption of uniform wages across all Services divisions and across all production and non-production workers.

For these reasons, while benchmark figures cannot be calculated for the earlier years 1964–87, it is highly probable that the SM approximation delivers more accurate results than the ST approximation for these earlier years, for the SM approximation for numbers only depends upon division BLS ratios being close to the aggregate Services BLS ratio, and there is no reason to presume any wider variation in the earlier period than in the later period. Similarly, there is no reason to presume that the NIPA variation around an average BLS production wage in all Services will generate any greater errors in the earlier than the later period, and every reason to presume it a superior assumption to one of uniform wages across all Services divisions and across all production and non-production workers.

3.2 Transportation and Public Utilities 1964–2001

3.2.1 Numbers of productive workers

Transportation and Public Utilities accounted for 5.9% of all employment in 1964, falling to 5% in 1989 (and rising 5.2% in 2001). Estimates for numbers of productive workers are obtained using equations (1)–(3) from 1964 onwards.

3.2.2 Wages of productive workers

There are no division-wide BLS data on average weekly earnings of production workers prior to 1964, and ST (Table G2) proxy the needed division-wide data using the average weekly earnings of production workers in Class 1 Railroads (SIC code 4011). There is no reason to believe that this is a good proxy. Indeed, employment in Class 1 Railroads falls continuously from 16.8% of total BLS employment in the whole division in 1964 (down from 31.7% in 1948) to 4.5% in 1989 and to 2.7% in 2001. Moreover, since BLS data on average weekly earnings of production workers in the whole division are available from 1964, the accuracy of the ST proxy can be determined for those years. Using equation (5) with the BLS wage for the whole sector, for which data are available from 1964, shows that, relative to the benchmark procedure, ST overestimate the wages paid to productive workers by 2.3% in 1964, rising to 44% by 1989; the overestimate peaks at 50.6% in 1997 before falling back to 22.7% by 2001. Hence, the ST figures for this division are not reliable.

3.3 Agriculture 1964–2001

3.3.1 Numbers of productive workers

Agriculture accounted for 5.7% of total employment in 1964, falling to 2.7% in 1989 and 2.5% in 2001. There are no BLS figures for production workers in Agriculture, Forestry and Fishing. To determine the number of productive workers, ST take the BLS ratio of production workers to all employees for Mining, and apply that to NIPA

employment in Agriculture, Forestry and Fishing. Presumably the rationale is that both are extractive industries, and in terms of factor intensities the 'land-and-capital intensive' character of Agriculture parallels the 'capital-intensity' of Mining. While plausible, this treatment is unnecessarily monolithic, for NIPA data distinguish Farms from Agricultural Services, Forestry and Fishing, and there are BLS data for Agricultural Services.

Farms. The BLS Mining ratio is used.

Agricultural Services, Forestry and Fishing. BLS data exist from 1982 and so benchmark calculations can be made from that year. Prior to 1982, the required calculations can be approximated in the manner indicated by equation (13)

$$(L_p^{ags})_B \approx (L_p^{ags})_{SM} = \alpha^{ags}\left(\frac{L_{pn}^{s}}{L^{s}}\right)_{BLS}(L^{ags})_{NIPA} \tag{23}$$

where the weight α^{ags} is defined analogously to the weight $\alpha^{s,j}$ in equation (13). Comparing the approximated BLS ratio with the benchmark BLS ratio over the years for which both exist, the approximation averages 98.2% of the benchmark (with a standard deviation of 1.3). Overall, given the relative size of the sector, the effect of the differences between ST and SM estimates is small.

3.3.2 Wages of productive workers

ST used the NIPA-derived average employee compensation for the whole sector (ec^{ag}) as a proxy for the missing BLS data, and simply multiplied the number of productive workers by ec^{ag}. The difficulty with this is that it does not distinguish wage payments to production workers from those to non-production workers, and in other sectors these differences are substantial. The SM estimates resolve this as follows.

Farms. The missing BLS sector data is proxied by that of all private industries (superscript *api*), weighted by the NIPA ratio of *ec* in Farms to that in all Private Industries. Hence, for farms (superscript *f*)

$$W_p^f = 52(w_{pn}^{api})_{BLS}\left(\frac{ec^{f}}{ec^{api}}\right)_{NIPA}\left(\frac{EC^{api}}{WS^{api}}\right)_{NIPA}L_p^f \tag{24}$$

Agricultural Services, Forestry and Fishing. The BLS wage is that for Agricultural Services and hence equations (5) and (6) can be used for the years 1982–2001. Prior to 1982, benchmark estimates can be approximated in the manner indicated by equation (21):

$$(W_p^{ags})_B \approx (W_p^{ags})_{SM} = 52(w_{pn}^{s})_{BLS}\left(\frac{EC^{s}}{WS^{s}}\right)_{NIPA}\left(\frac{ec^{ags}}{ec^{s}}\right)_{NIPA}(L_p^{ags})_{SM} \tag{25}$$

But by contrast with the application of equation (21) to productive services, equation (25) does not deliver a good approximation; in 1982 it only delivers 71.3% of the benchmark. Hence, the constructed years 1964–81 are multiplied up by the average ratio of benchmark to approximation for the five years 1982–86. The outcome is that, while relative to the SM estimates, ST substantially overestimate variable capital in money terms in the whole sector (by 15.5% in

1964, 19.1% in 1989 and 27.5% in 2001), the net effect on total variable capital is small because the weight of the sector in the total is so small.

3.4 Government Enterprises 1964–2001

3.4.1 Numbers of productive workers

Government Enterprises accounted for 1.7% of total employment in 1964, falling to 1.5% in 1989 and 1.3% in 2001.There are no BLS figures for production workers in Government Enterprises, and there is no information about how these enterprises are spread across the various SIC divisions. While ST use the BLS ratio of production workers to total employees across all private industry, it is a more reasonable conjecture that the BLS ratio for Transportation and Public Utilities is a better proxy, and this is used in the SM estimates. Again, given the relative size of the sector, the effect of the differences between ST and SM estimates is very small.

3.4.2 Wages of productive workers

ST follow the exactly the same procedure as in Agriculture, and in the same manner this will overestimate variable capital in money terms because the annual average labour income will be biased upwards as non-production workers on average earn rather more than production workers. The SM estimate attempts to avoid this, and follows the structure of equation (24), using the data for Government Enterprises rather than Farms, and Transportation and Public Utilities rather than all Private Industries. Relative to the SM estimate, ST substantially overestimate variable capital in money terms in the whole sector (by 4.3% in 1964, 11.3% in 1989 and 25.8% in 2001) but, even more than with Agriculture, the net effect is tiny because the weight of the sector in the total is so small.

4. Results 1964–2001

This section brings all the foregoing together. Hereafter, the ST estimates derive from the benchmark procedure and the ST approximations to it, for both numbers and wages. Likewise, the SM estimates derive from the benchmark procedure and the SM approximations to it, for both numbers and wages. Figure 1 shows the ST approximations for the total numbers of productive workers, and the wages paid to them, as proportions of the SM approximations. In 1964, the ST estimate for numbers of productive workers is 99.7% of the SM estimate, and for their wages 107.6%. By 1989, the final year of the ST dataset, the corresponding numbers are 96.4 and 120.8. By 2001, they are 95.1% and 124.1%. The overestimate of ST productive wages per productive worker is attenuated somewhat by the ST underestimate of productive numbers. Measured against common totals, the ratio of productive to total workers, and the ratio of their wages, are shown in Figures 2 and 3. Finally, using a common value for aggregate value added in money terms enables a comparison of the implied rates of surplus value, determined as the ratios of aggregate money value added less productive wages, or surplus value, to productive wages. Estimates of the rate of surplus value are shown in Figure 4.

For ST, the average rate of surplus value over the period 1964–82 was 1.71; by 2001, there was an increase over this average of nearly a third (29.8%). For SM on a comparable basis, the average to 1982 was 1.97, with an increase by 2001 of more

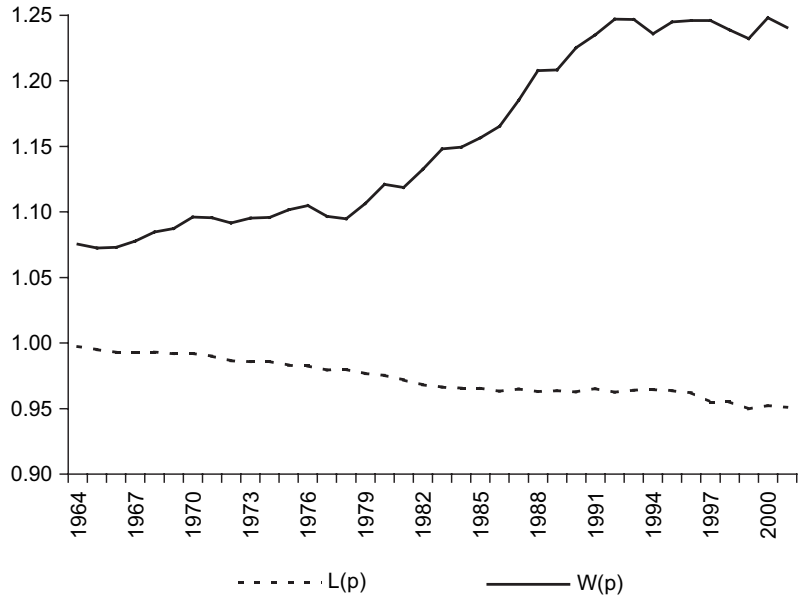

Fig. 1. *Productive workers and their wages. ST estimates to SM estimates, 1964–2001.*

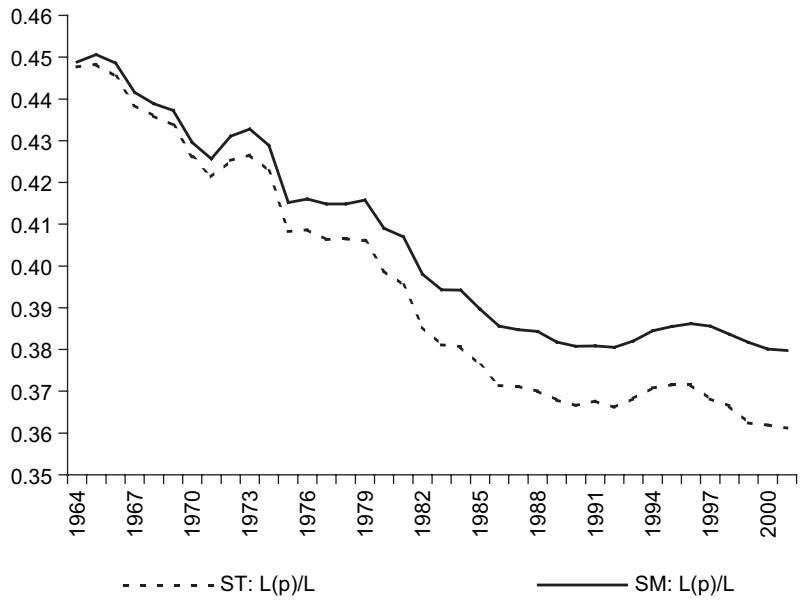

Fig. 2. *Ratios of productive to total labour, SM and ST estimates, 1964–2001.*

than half (52%). While both ST and SM estimates identify that something dramatic happened in the US economy at the beginning of the 1980s, marking a major and lasting change with what went before, the ST method of approximation, compared with the SM method, substantially understates its impact on the rate of surplus value.

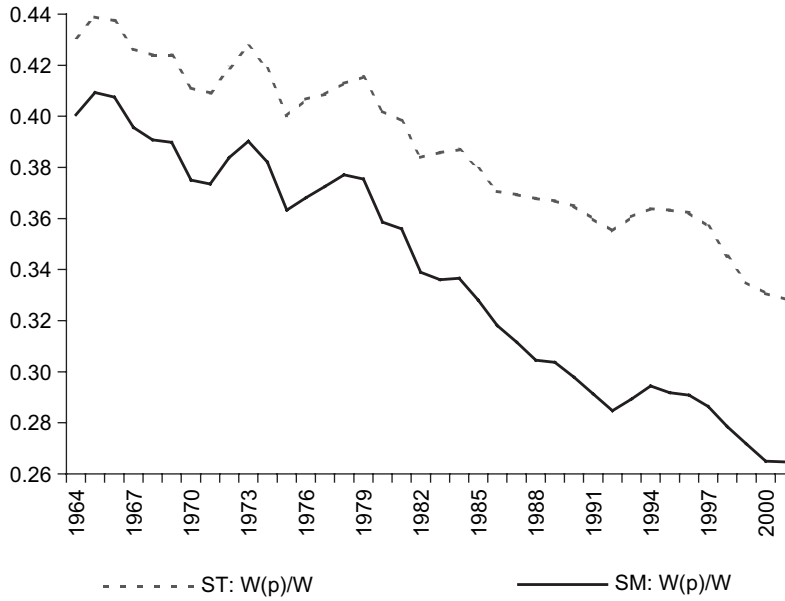

Fig. 3. *Ratios of productive to total wages, SM and ST estimates, 1964–2001*

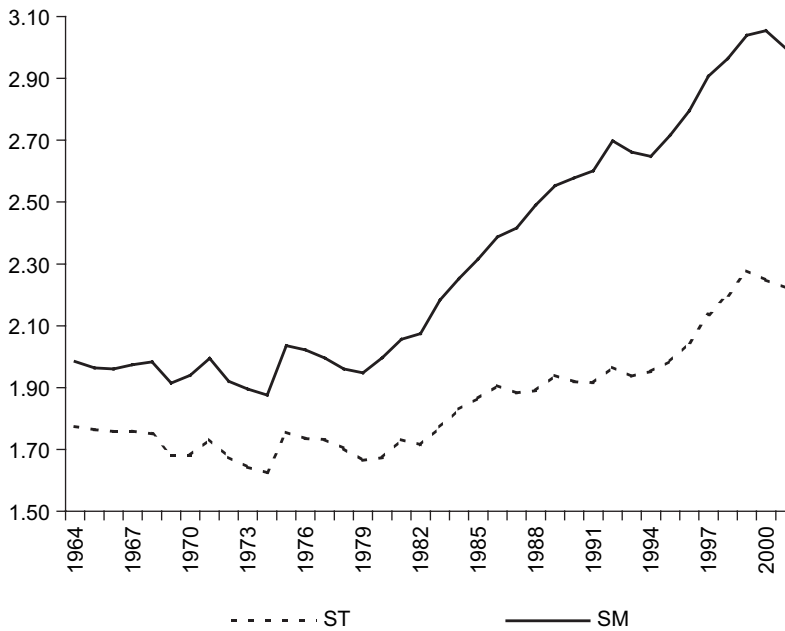

Fig. 4. *Estimates of the rate of surplus value on a common basis, 1964–2001.*

5. Conclusion

In the presentation of their methodology in their 1994 book, ST have performed a signal service to those interested in quantifying some of the key variables of the surplus-based tradition of classical economics as it culminated in the work of Marx. If that tradition is to be kept alive, its relevance has to be demonstrated, and one way of doing this is to show that it has important things to say about the empirical development of contemporary capitalist economies.

This paper has focused on the general methodology of calculation of productive labour presented by ST. It suggests that the approximations that ST made, particularly (although not exclusively) with regard to productive Services divisions, are not good ones, and that better ones are possible. The standard of comparison is the benchmark ST methodology, which can be applied (almost) exactly to data from 1988 to 2001. The ST estimates are also carried forward to those years, and a different set of approximations are suggested, yielding the SM estimates. The SM estimates are much closer than the ST estimates to the benchmark estimates for these years, and the nature of their construction suggests that this is likely also to be true for the years 1964–87, although certainty is not possible. ST have successfully demonstrated that it is possible to construct plausible measures of productive and unproductive labour, and the wages they are paid. With the modifications suggested here, there is no obstacle to a detailed examination of trends in the US economy during the last third of the twentieth century.

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Appendix A

A.1 Electronic data sources

Bureau of Economic Analysis, National Income and Product Accounts:
<http://www.bea.gov/bea/dn/nipaweb/SelectTable.asp?Selected=N>

Bureau of Economic Analysis, GDP by Industry:
<http://www.bea.gov/bea/dn2/gpo.htm>

Bureau of Labor Statistics, National Employment, Hours and Earnings:
<http://data.bls.gov/labjava/outside.jsp?survey=ee>

Establishments are classified into an SIC category on the basis of their principal product or service. The industrial classification for the years 1964–87 is the 1972 SIC; the second entry for 1987 and subsequent entries for years to 2000 are determined by the 1987 SIC. The SIC change means that there are always two figures for 1987; the paper generally takes the later SIC figure, but at the level of aggregation of this paper, the differences resulting from the change in SIC are small. Services divisions are at 2 digit level (70–89 in both SICs) and all Services are the aggregate of these.

A.2 Productive labour and unproductive labour

A.2.1 Productive labour (ftes) in services: Benchmark estimates 1988–2001

There are four gaps in the Services divisions, and these are resolved as follows.

1. For Hotels and Other Lodging Places (SIC 70), there are no data on production workers for the whole division, but there are data on production workers for Hotels and Motels (SIC 701), and BLS employment in SIC 701 covers around 90% of NIPA full-time and part-time employees in SIC 70 over the period. Hence, using data on SIC 701 to approximate SIC 70 is not likely to lead to large errors.
2. For Personal Services (SIC 72), there are again no data for the whole division, but there are data on Laundry, Cleaning and Garment Services (SIC 721), Beauty Shops (SIC 723) and Miscellaneous Personal Services (SIC 729), which between them cover around 84% of total employment in the division over the period. Using the sum of these three digit industries for both production workers and total workers to approximate the data for the whole of SIC 72 is again not likely to lead to large errors.
3. There are no data at all on production workers in Educational Services (SIC 82), and so the BLS ratio of production workers to all employees for Services as an aggregate is used as a proxy.
4. As regards Membership Organizations (SIC 86) there is only production worker data for the subdivision Professional Organizations (SIC 862). While employment in SIC 862 is only about 2% of employment in the whole division, the BLS ratio of production workers to all employees in SIC 862 is the only information available to represent the whole division. As long as the nature of the labour process in the three-digit level components of the division does not vary very much, using the BLS ratio from SIC 862 may well be a reasonable procedure, despite its being unrepresentative in total employment terms.

A.2.2 Approximation procedure for ftes 1964–2001

Prior to 1988, the data are very incomplete. For example, there are no BLS data on production workers prior to 1972 in Auto Repair, Services, and Parking, Miscellaneous Repair Services, Health Services, Legal Services, Social Services, and Professional Organizations. There are no data prior to 1981 for Business Services, prior to 1982 for Agricultural Services, and prior to 1988 for Motion Pictures and Amusement and Recreation Services.

BLS ratios do not change dramatically through time. So for Agricultural Services the missing data are approximated by applying the BLS ratio for all services to Agricultural Services, Forestry and Fishing (superscript *s*, *ag*), but weighting it by the ratio (α) of the (geometric) mean of the BLS ratio for Agricultural Services for the first five years for which it does exist, to the (geometric) mean of the BLS ratio for all services for the same years

$$L_{pn}^{s,ag} \approx \alpha^{s,ag} \left(\frac{L_{pn}^{s}}{L^{s}} \right)_{BLS} (L^{s,ag})_{NIPA} \tag{26}$$

where, letting $\tau(s, ag)$ be the first year for which the BLS ratio exists

$$\alpha^{s,ag} = \frac{\Pi_{t=\tau(s,ag)}^{\tau+4} \left(\frac{L_{pn}^{s,ag}(t)}{L^{s,ag}(t)} \right)}{\Pi_{t=\tau(s,ag)}^{\tau+4} \left(\frac{L_{pn}^{s}}{L^{s}} \right)} \tag{27}$$

Substituting *j* for *ag* in the superscripts of equations (26) and (27) defines the same procedure for productive service subsectors, where $\tau(s, j)$ is the first year for which the BLS ratio exists for each service subsector *j*.

A.2.3 Wages of productive workers in services: benchmark estimates 1988–2001
Ideally, wages paid to a production worker in service subdivision j are calculated by

$$W_{pn}^{s,j} = 52(w_{pn}^{s,j})_{BLS}\left(\frac{EC^{s,j}}{WS^{s,j}}\right)_{NIPA} \tag{28}$$

For the same years as the numbers of production workers, the wage data are incomplete. To deal with the missing data in the benchmark figures,

1. For Hotels and Other Lodging Places (SIC 70), use the BLS production wage in Hotels and Motels (SIC 701).
2. For Personal Services, use a weighted average of the BLS production wages paid in Laundry, Cleaning and Garment Services (SIC 721), Beauty Shops (SIC 723) and Miscellaneous Personal Services (SIC 729), the weights being total production workers in the three-digit subdivision to total production workers in Personal Services.
3. For both Educational Services and Membership Organizations, use the BLS production wage for all Services multiplied by the NIPA ratio of *ec* in Education (resp. Membership Organizations) to *ec* in all Services.

$$W_{pn}^{s,j} \approx \left[52(w_{pn}^{s})_{BLS}\left(\frac{EC^{s}}{WS^{s}}\right)_{NIPA}\right]\left(\frac{ec^{s,j}}{ec^{s}}\right)_{NIPA} L_{pn}^{s,j} \tag{29}$$

A.2.4 Approximation procedure for productive wages in Services 1964–87
The data on production wages are incomplete for the same dates and same sectors as for numbers of production workers. Because of the variability of nominal wages both across sectors and across time, proxies constructed according to the method of equation (27) will be meaningless. Instead, use equation (29) for each Services division.

A.3 Money value added

Aggregate value added in money terms is net domestic product less the imputations for *GDP* less general government wages. (Some care is needed to avoid double counting.) This is different from the ST method of estimation (Shaikh and Tonak, 1994, ch. 3); ST aggregate money value added averages 1.12 of the SM estimate over the period 1964–89, with a standard deviation of 0.015. While the difference this makes is small, in the construction of the data represented in Figure 4 the SM estimate of aggregate money value added is used to calculate both rates of surplus value.