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Tests of Total Factor Productivity Measurement

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No.54: TESTS OF TOTAL FACTOR PRODUCTIVITY MEASUREMENT

by

A. Steven Englander
(General Economics Division)

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Although considerable effort has been expended on constructing measures of total factor productivity, there has been little subsequent effort at verifying that the constructed data have the expected properties. This paper proposes a number of tests to determine whether total factor productivity is measured correctly. A similar approach can be used for other economic data.

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Alors qu'un travail considérable a été mis en oeuvre pour construire des mesures de productivité totale des facteurs, peu d'efforts ont été consacrés par la suite pour vérifier que les données obtenues avaient les propriétés attendues. L'étude qui suit propose un certain nombre de tests afin de déterminer si la productivité totale des facteurs est mesurée correctement. Une approche similaire peut-être utilisée pour d'autres données économiques.

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I would like to acknowledge comments from Axel Mittelstadt, David Coe, John Martin, Derek Blades and Peter Jarrett.

TESTS OF TOTAL FACTOR PRODUCTIVITY MEASUREMENT

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TESTS OF TOTAL FACTOR PRODUCTIVITY MEASUREMENT

I. INTRODUCTION

Economists devote much effort to specifying and constructing the empirical counterparts to theoretically specified economic ~~variables.~~ Often, however, there is little subsequent examination of whether these constructs have the expected empirical properties. To some extent the need for such examination is a function of the use to which the data are to be put. In a theoretical model, it is appropriate to introduce the theoretically correct variable without reference to the success or lack thereof in relating it empirically to other variables of economic interest. When such data are used to analyse past performance or derive policy implications, however, it is important to establish that the empirical relationships between the variable and other variables of interest are consistent with economic theory.

The need for such testing depends on the extent to which the quality of the data are questioned. Certain data are considered relatively reliable, for example employment statistics and some price and wage data. Other data are frequently questioned. Aggregate total factor productivity data, the focus of this paper, are often considered weak because capital stocks and some parts of output are felt to be poorly measured.

One reason for the lack of effort at assessing the reliability of data is that it is very difficult to determine a standard by which the data should be judged. Assessments of the reliability of GNP data, for instance, tend to focus on how large the changes are from preliminary to final estimates, and on whether there is a systematic component to the changes. But there is no way of really knowing whether the final data are themselves accurate.

In some cases, however, economic theory implies criteria for testing the data by providing a strong theoretical link between the economic variable whose accuracy is questioned and other data which are more reliably measured. The estimation of these links can often be used as a basis for determining the reliability of the data being used. Obviously, the power of these tests is no greater than the reliability of the other data being used and the strength of the theoretical relationship. Thus inevitably several joint hypotheses are being tested at the same time. However, the failure of such joint hypotheses to be accepted for any reason should caution researchers against drawing strong empirical conclusions from such data.

This paper provides an approach to the ex post verification of data on total factor productivity (TFP) growth. It is an outgrowth of a paper dealing with the sources of the decline of TFP growth in OECD countries and represents an effort to test a set of TFP calculations for the aggregate business sector of a number of OECD countries, (Englander and Mittelstadt, 1988, and Englander et al., 1988). In order to include as large a set of countries as possible and make them as comparable as possible, TFP was defined in a simple and straightforward way. Labour was measured by employment, generally without further correction for hours worked, the capital stock by the gross capital stock, and output by business sector value added.

Additional inaccuracies are doubtlessly introduced by the often unavoidable practice of calculating TFP growth as a residual, under assumptions of perfect competition and separability. Thus, the accuracy of TFP calculations depends on the accurate calculation of growth in labour, capital and possibly other factors of production such as energy, materials and so on. It also requires that competitive assumptions hold, so that factors are paid their marginal products and the growth of a given factor affects output in proportion to its income share. Fixed 1985 weights were used on capital and labour because it was feared that much of the variation in shares came from movements between self-employment (where compensation is imputed) and dependent employment, but additional inaccuracies may have been introduced by the use of fixed rather than moving weights.

The literature on productivity measurement problems has been extensive but much of the effort has concentrated on ex ante specification rather than ex post verification. The methodologies adopted by Denison (1979) and Kendrick (1973), incorporating as they do many diverse and difficult to quantify effects, do not lend themselves to testing data. Baily (1981) and Jorgenson (1987) among others have focused on appropriate capital-stock measurement and the papers in Usher (1980) review this issue from a number of angles. Griliches (1971), Triplett (1986) and Gordon (1971) discuss quality and index number problems. Mendis and Muelbauer (1986) and Muelbauer (1986) are exceptional in making an effort to test rigorously the quality of the data they use in a study of U.K. manufacturing, while Griliches and Lichtenberg (1984) examine the implications of mismeasurement on apparent industry TFP performance.

In this paper the following criteria are used in selecting the tests. As no single test can be conclusive, several tests are better than none. The tests should focus on the components felt to be the most poorly measured, and to the extent possible, the test criteria should reflect the policy uses to which the data are to be put.

The question of measurement is not the concern solely of economists. In the case of TFP growth mismeasurement can have serious policy implications. Because TFP is generally calculated as a residual, it is sensitive to measurement errors in output and input growth and in the weights attached to the different factors. An understatement of TFP growth arising from an overstatement of input growth may lead policy-makers to the conclusion that technology development and diffusion is lacking and that remedial policies directed to these ends are needed. Conversely, if growth of an input, for example, capital, is understated and TFP growth consequently is overstated, one may be tempted to suggest that a capital shortage is at the root of low levels of output and labour productivity growth. Hence, policies to increase capital accumulation would be inappropriately emphasized relative to policies directed at improving the accumulation and distribution of new technology.

Such problems resulting from mismeasurement of inputs are exacerbated because the calculation of TFP as a residual induces a negative correlation between measurement errors in TFP growth and in input growth. Thus, to the extent that mismeasurement leads one to overemphasize a certain set of problems, there will be a concomitant underemphasis of other problems.

The set of econometric tests of TFP calculations presented below is not comprehensive. Rather the focus is on overall TFP measurement and components often felt to be the most poorly measured. In general, the results suggest that the long-run trends in TFP growth appear to be measured adequately, but even among some larger countries, measurement problems may make it difficult to derive any useful inferences on the short- and medium-term evolution of TFP.

The structure of the paper is as follows. First, a discussion of the intuition behind the tests is provided as well as a summary of the results. It is followed by a more detailed presentation of the test results.

II. INTUITION FOR THE TESTS AND SUMMARY OF RESULTS

The first test focuses on the published national capital-stock data used in calculating TFP growth. Implicit in the calculation of TFP growth is the assumption of a production function, with the coefficients determined by income shares. In this paper a simple Cobb-Douglas form was assumed, although more complicated and flexible forms can also be used. Alternative measures of the capital stock are constructed, under varying assumptions regarding scrapping rates and the capital to output ratio in 1970. The basis of the test is that a better measured capital stock should account for more of the variation in output than a poorly measured capital stock. The question asked is: after allowing for labour input, changes in capacity utilisation and trend TFP growth, do the constructed alternative capital stock data explain more of the variation in output than the published gross capital-stock data. To the extent that this simple production model is valid, one can compare the ability of the constructed alternative capital-stock measures and national capital-stock data to explain output movements.

Only two parameters have to be estimated, the constant term which represents the assumed fixed rate of TFP growth and the cyclical correction, because the weights of capital and labour inputs are given. The alternative capital-stock measures, which are all obtained through a perpetual inventory calculation, allow freedom for two other parameters, the initial capital to output ratio and the rate of scrapping. These alternatives, which are compared against the gross capital stock, are equivalent at an aggregate level to net capital stocks with a geometric rate of depreciation.

The alternative measures of capital stocks are unsophisticated in comparison to the highly disaggregated calculations of both net or user cost based capital stocks which have appeared in the literature. There is nothing in the procedure which would prevent more sophisticated alternative hypotheses from being compared. However, as the starting point of this analysis was great dubiousness over the usefulness of existing capital-stock data, it was felt that even a simple alternative, or even labour input by itself, would account for more of the output variation than TFP calculations based on poorly measured capital stocks.

Surprisingly, positive results are obtained supporting the national capital-stock estimates. In general, the national capital-stock and TFP series are almost as, or more closely related to output growth than is the best constructed series. In selecting the best constructed capital-stock series, two more parameters have to be estimated than in using the national capital-stock data. Moreover, the results are insensitive to starting dates, so that allowing for a shift in scrapping rates or a once and for all level change in the capital stock after 1973 did not alter the qualitative results.

These results are useful for a number of reasons. First, they suggest that national source capital-stock and TFP data generally reflect actual developments in these variables. Second, they suggest that, despite the large variations in accounting and scrapping conventions across countries, the data remain roughly comparable across countries. Thirdly, the method used to construct the alternative capital stocks used a constant exponential scrapping rate. Thus, the resultant capital stocks are analogous to the net capital-stock concept, as opposed to the gross stock concept used by most national authorities. These constructed net capital-stock data did not appear to be more closely linked to production than the national source data.

The other measurement tests do not provide as strong support for the national TFP, capital-stock and output data, but are probably more sensitive to short-term cyclical fluctuations. The second approach uses price inflation equations to test TFP against alternative productivity concepts under the assumption that TFP growth should be a better measure than variable factor productivity of how fast factor costs can grow without increasing inflation. The results suggest that while the TFP and capital-stock data convey some useful information, short-term fluctuations in these variables carry a large noise component. In four of the seven larger countries (the United States, Japan, the United Kingdom and Canada) TFP and total factor cost growth were clearly more closely related to inflation (as measured by the business-sector value-added deflator growth) than were the corresponding variable price concepts. This clear superiority is also surprising, as variable factor costs and productivity carry a weight averaging about 70 per cent in the total factor calculations. Only in Italy and France was a variable factor productivity growth measure the superior variable, while in Germany the results were virtually indistinguishable.

The third approach tests one of the bases of the capital-stock augmentation formula used to construct the capital stock. This formula assumes that there is a fixed schedule for replacement investment which corresponds to actual scrapping. In the seven major OECD economies, this estimated replacement component represents about half of total investment. Thus, capital-stock growth will be influenced by any major inaccuracy in this scrapping assumption. Moreover, there is considerable variation in estimated scrapping rates across OECD countries, which may affect the estimated growth rates of capital and their comparability across countries.

The scrapping assumptions used in national source capital calculations had a generally positive estimated impact on gross investment, but generally seemed more cyclically sensitive and more variable in their impacts than the national source calculations would suggest. Only in Germany and the United Kingdom did there seem to be little apparent relationship between scrapping and gross investment.

One interpretation of these results is that the capital stock may be overstated during downturns because more capital is taken out of service, and understated during upturns because some net investment is mislabelled as replacement investment. This could account for part of the generally highly cyclical response of investment to estimated replacement needs and the strong pro-cyclicality of TFP and capital productivity. Hence, in a period of persistent capacity slack the capital stock is likely to be overstated. This would imply that the true TFP deceleration after 1979 may be somewhat smaller than indicated by official data in those countries in which output growth has stagnated.

The final measurement test tries to determine whether service-sector output is correctly measured. In general, measured rates of manufacturing TFP growth have been a good deal higher than in services and there has been some speculation that this results from a poor division of nominal service sector output into price and quantity components. To the extent that this is the case, errors in measuring real services output will be reflected in services prices. The actual test focused on service price inflation, as there is a clear expected relationship between service price inflation and wage inflation.

The results are supportive of the notion that in most countries there is some independent variation of service prices which has a measurable effect on wages. This is consistent with other recent work (Blades, 1987; Rappoport, 1987) which failed to detect obvious signs of mismeasurement in the data. However, in a number of countries (Germany, Italy and Canada) it did not appear that service prices were being measured correctly, or at least having much effect on wages, while in France, the United Kingdom, Finland, Sweden and Australia the estimated wage equations were too poor for any inference to be drawn.

The results from all of these tests are summarised in Table 1. The overall conclusion from these efforts is that the TFP and capital-stock measures are not perfect but do convey enough information to be useful in general for empirical analysis. It appears that TFP is better measured over a period of several years than in its year-to-year or semester-to-semester fluctuations.

Turning to individual countries, the U.S. and Japanese data seemed closest to "passing" all the tests. The Canadian, U.K. and, to a lesser extent, Italian data also seemed fairly consistent with the expected relationships, while the French and German data seemed somewhat less consistent. In the latter two cases, especially, it would seem that the data are primarily useful for longer-run inferences.

It should be recalled that in each case one is testing joint hypotheses, both that the behavioural relationship proposed is correct and that the TFP and capital-stock data function as postulated in these relationships. The discriminatory value as the tests will also be lessened by data problems in other variables and limited degrees of freedom. However, a fair interpretation of the results is probably that the data are on the whole better than many analysts would have expected, but that the quality is variable.

Details on the four tests for measurement error concerning data on TFP, the capital stock, and the service sector are presented below. As much as possible uncontroversial specifications were used. However, no specification search was undertaken, nor was any effort made to re-estimate the equations until the coefficients looked plausible. In the absence of any major effort at fitting curves, the residual sum of squares was used as the basic test criterion. Hence, if an equation fit better using the TFP-based variable, it was regarded as support for the TFP data or component variable which was being tested. Exceptions to this rule are discussed below.

III. MEASUREMENT TESTS

A. Production function analysis (first test)

In this paper TFP growth is defined as

$$tfp = q - \beta k - (1-\beta)l \qquad [1]$$

where tfp is the growth rate of TFP
q is the growth rate of output
k is the growth rate of the capital stock
l is the growth rate of employment, and
β is the share of capital in output.

Short-term fluctuations of output around its trend have a major impact on short-term TFP. It is therefore appropriate to model TFP growth as consisting of trend and cyclical components and an error, i.e.

$$tfp = a + b(q - q_{tr}) + err \qquad [2]$$

where q_{tr} is the trend estimate of output growth. In effect, the error term measures the error in a production function, as [1] and [2] can be combined as

$$q = \beta k + (1-\beta)l + a + b(q - q_{tr}) + err \qquad [3]$$

The basic idea of the first test was to search for an alternative "constructed" capital-stock estimate which minimized the error in [3]; the implied growth rates of capital and TFP were then compared with the growth rates obtained from using the national source capital-stock data. An alternative capital-stock estimate capable of better explaining movements in output would be suggestive of errors in the capital-stock data. The "constructed" capital-stock series were obtained from a grid search over two dimensions -- an initial capital to output ratio and a scrapping rate. For each combination of an initial capital to output ratio and scrapping rates the capital stock was updated using the perpetual inventory method according to the formula:

$$K_t = I_t + K_{t-1}\ (1-\delta)$$

where K_t is the level of the capital stock
I_t is gross investment, and
δ is the scrapping rate.

Ten initial capital to output ratios and thirteen rates of scrapping were used (1). Thus, the best fitting capital stock was selected out of 130 possibilities.

Two variations of this procedure were attempted. In the first, the parameters a and b of equation [3] were both estimated freely. In the second, in order to conserve on degrees of freedom, b was imposed at a value of 0.8, roughly the middle of the range of cyclical productivity responses from the first set of regressions. As the results were not generally sensitive to the estimation of the cyclical factor, only the former variation is reported.

A third variation allowed the scrapping rate of the constructed capital-stock series to rise by 1.5 per cent per year, reflecting the overall upward drift observed in a number of countries. As this drift is due to the changing composition of investment, a more disaggregated analysis might have been used to obtain somewhat more precise estimates of the upward drift in depreciation. However, as the results from the third variation differed little from the previous results, the more disaggregated analysis did not seem worthwhile.

The results were surprisingly favourable to the national capital-stock estimates (Table 2). Columns 1-2 compare national source data on capital-stock growth with the best fitting constructed capital-stock series. As can be seen for most of the major countries, the fitted series were reasonably close to those from national sources. The two exceptions were the United Kingdom and France. Perhaps more important is the comparison in columns 3-4 of the errors resulting from estimating [3] from national source and constructed capital-stock series. It is evident that the fitting procedure, which requires estimating two additional parameters, in general does not produce much better results for any of the countries, with the exception of France (2). The fit for the United Kingdom is clearly better using the national source data. Turning to TFP growth estimates in columns 5 and 6, the constructed data give results which are close to those of national sources, the United Kingdom and France showing the largest differences.

A perplexing feature of the results were the estimates of the level and rate of scrapping of the capital stock from the best-fitting constructed capital-stock data. In several countries, the constructed capital stocks were larger and estimated depreciation rates much lower than in the national source data. Moreover, the selected values did not seem very realistic. This did not necessarily affect the estimated average growth rates greatly because the lower depreciation rate was offset by the higher depreciation level on a larger capital stock and a net investment component which was divided by a larger denominator. However, they do serve to smooth out the path of capital-stock growth, reducing the impact of large jumps or drops in investment. This again suggests that the data do not find the short-term fluctuations of the capital stock to be reflected in output, preferring to implicitly average the growth over several periods.

B. Price equations and TFP (second test)

One of the main reasons for examining the behaviour of TFP is that TFP growth theoretically determines how fast factor returns can rise without increasing inflationary pressures. If it does not, either because firms use some other pricing rule or because it is measured with so much error that less theoretically acceptable measures perform better in practice, then much of the value of the TFP growth measure is lost. The explicit model is used to test the relationship of TFP growth and inflation is:

$$p = f(fc, fp, Z) \qquad [4]$$

where p is output price inflation

fc is the growth in factor costs, i.e. the weighted increase in the cost of capital and variable factors

fp is the growth in factor productivity, as discussed below, and

Z is a vector of other factors.

It seems correct theoretically that the factor cost and factor price variables should be measured where possible in total factor terms, rather than, say, as labour costs and labour productivity. A large infusion of capital could move producers from one point to another on a given isoquant, raising labour productivity, but not necessarily reducing price pressures to any great extent because of the consequent lowering of capital productivity. Thus, long-run consistency suggests that the productivity and costs of all factors ultimately be reflected in prices. It is worth exploring whether these relationships are strong enough to manifest themselves in short-term price inflation equations.

The equations estimated are similar in principle to those of the INTERLINK model constructed by the Economics and Statistics Department of the OECD, but differ greatly in the estimation approach. Model equations have to be estimated so as to produce reasonable simulation results; for hypothesis testing and, particularly, for using equations to test the quality of the data, fewer rather than more restrictions seemed appropriate.

Three variations of equation [4] were tested. The first equation had total factor costs and productivity as explanatory variables, the second variable factor costs and productivity and the third total factor costs and variable factor productivity. Two output and factor definitions were used; net, which measures tfp and output prices in terms of the value-added of capital and labour, and gross, which includes energy in the formulation. For the equations using gross output and prices, labour and energy were the variable factors, while in the equations with net output and prices, labour was the only variable factor. The capital-cost term was the standard INTERLINK variable which was weighted by capital's average share from 1970 to 1985 (3). Each corresponding factor in the factor cost and productivity terms was given the same weight. Other explanatory variables were non-energy import price inflation, output growth and a dummy for the period in which for a few countries non-energy import prices were backcast using overall import prices and the energy price variable. Energy price inflation was also included in the net output price inflation equations. All variables except for the dummy were entered as four-semester second-order polynomial distributed lags, with end-point constraints. Homogeneity was not imposed on the equations.

Two patterns emerge in the results presented in Tables 3A to 3G. First, in four of the major seven countries, the United States, Japan, the United Kingdom and Canada, the specification using TFP and total factor costs had the lowest residual sum of squares in explaining net output price inflation. In Germany the results were so close as to be virtually indistinguishable. As might be expected because of the high collinearity between TFP and variable factor productivity, the equations do not show large differences in general, although for a couple of countries, the data appear to be firmly rejecting variable factor costs and productivity relative to the total factor concepts.

With respect to gross output prices, the results are not as transparent. Only in the United Kingdom, and very marginally in Japan and Canada, are the total factor variables the best fitting. Turning back to Table 1, we note that the national source capital-stock data in those countries had particularly strong relationships with the output data. It is not clear at this point why price inflation should be more closely related to TFP at the net rather than the gross level, except that the data on business sector energy use may contain substantial errors.

The second pattern of note is that for most countries, the variable factor cost and productivity specification is the poorest in fit, although in some cases it seems that the omission of total factor costs is the most important reason for this. In only two out of fourteen runs does the variable factor specification emerge as the preferred one and only marginally in these cases.

C. Scrapping rates and capital-stock estimates (third test)

Virtually all models of investment deal with the net acquisition of capital. The desired capital stock is modelled as a function of expected economic activity and/or the cost and profitability of capital. Investment equals the change in this desired capital stock, possibly with some lagged adjustment, plus the investment required to replace scrapped capital. This general class of models leads to scrapping entering the gross investment equation as an explanatory variable with a coefficient equal to one, although there is an alternative set of models which this does not hold (4). Empirical evidence that this coefficient was not unity would throw doubt on the accuracy of the underlying capital-stock data. Below we work through a simple model to obtain such a specification, although the restrictions implied by this specific model are far too severe to make it of interest empirically. Let

$$K^* = K^*(Q, q, \pi, cc) \quad [5]$$

and $$K_t - K_{t-1} = \phi(K^*_t - K_{t-1}) \quad [6]$$

where
- K^* is the desired capital stock
- K is the actual capital stock
- Q is the level of output
- q is the growth of output
- π is the profit rate
- cc is the cost of capital, and
- ϕ is a speed of adjustment parameter

The solution to this model is

$$K_t = a + b(\phi)X_t + (1-\phi)K_{t-1} \quad [7]$$

where X is the vector of arguments for K^* and b is the vector of their corresponding coefficients. Repeated substitution gives

$$K_t - K_{t-1} = b(\phi) \sum_{j=0}^{n} (1-\phi)^j(\Delta X) - (1-\phi)^n(K_{t-n-1} - K_{t-n-2}) \quad [8]$$

as the net gain in the capital stock. This specification has the advantage that net investment does not depend on the level of the capital stock. Moreover, if the speed of adjustment is rapid, the $(1-\phi)^n$ term is likely to be small. As $K_t - K_{t-1}$ represents net investment, the conventional formulation adds scrapping to both sides so that

$$I_t = b \sum_{j=0}^{n} (1-\phi)^j(\Delta X) - (1-\phi)^n(K_{t-n-1} - K_{t-n-2}) + IR_t \quad [9]$$

where IR_t is replacement investment. The $(1-\phi)^n(K_{t-n-1} - K_{t-n-2})$ term was dropped as being insignificant in terms of variance relative to gross investment.

As there are no real priors on the error term to be attached to [9] this equation has simply been modelled as a first-order autoregressive process. It should be noted, though, that if the error in [6] is truly normal and independent of past errors, the error term in [9] would be a moving-average process, efficiently estimated through GLS, although OLS would provide a consistent estimator.

As mentioned above, the constraints implied by [9] were not imposed. The restrictions result from an assumed adjustment process which is far too specific and rigid. Rather two broad specifications were used. In the first, the price of energy relative to capital costs, the wage relative to capital costs, the rate of output growth and the rate of profit were all entered as explanatory variables with polynomial-distributed lags. In the second specification only the profit rates, output growth and scrapping terms were entered. In some specifications the change in capacity utilisation variable from the supply block of the OECD INTERLINK model was used in place of output growth. Investment and scrapping were divided alternatively by the estimated capital stock or trend output in order to reduce heteroscedasticity. An autocorrelation correction was also introduced. Because the errors were often highly autocorrelated, it is important to consider the adjusted R^2 (which reflects the explanatory power of the variables after the model has been transformed by the autocorrelation parameter) and the size of the autoregressive parameter in assessing which model fits the data best. A model in which the autoregressive parameter greatly reduces the residual sum of squares does not necessarily lend support to the scrapping estimates.

The results are presented in Tables 4A to 4G. The investment function itself is very general, but a number of specifications are presented in order to avoid having specification or multicollinearity problems mask the relationship of scrapping and replacement investment. Two tables are provided for each country. The first has scrapping and investment normalized by the capital stock (5). The first column, as a baseline, estimates the basic specification without a scrapping rate term. Columns 2-4 introduce scrapping respectively as a four-quarter distributed lag, contemporaneously, and as a four-quarter distributed lag commencing with a two-period lead. (This is an attempt to capture the possibility that scrapping is generally done ahead of the assumed schedules.) The final two columns enter scrapping independently and interacted with capacity utilisation.

The second table presents the results when scrapping and investment are normalized by trend output. The specification in column 1 is similar to that of the first tables and the last four columns correspond to the last four columns of the first table. Column 2 enters a second alternative baseline, i.e. that scrapping is proportional to the lagged capital stock (also divided by output). Columns 3 and 4 present stripped down accelerator specifications without any of the relative factor cost terms.

In general, the results support the hypothesis that there is a positive relationship between the national-source scrapping estimates and investment, but investment appears to behave as if scrapping patterns were more spread out over time and more cyclically dependent than the national-source estimates would suggest. The United States, Japan, France, Canada, and perhaps Italy show signs of a predominantly cyclical association of scrapping and investment. For Germany and the United Kingdom, there seems virtually no relationship between scrapping and investment.

These results suggest that the estimated movements in the capital stock are probably measured badly over the short run, and particularly so during recessions and recoveries. At times investment which is a net addition to the capital stock is being labelled as replacement investment and vice versa. To the extent that this appears to be cyclically correlated, it may also help to explain some of the highly pro-cyclical nature of productivity. This is because there need not be a contemporaneous relationship between scrapping and investment. For example, a firm can scrap according to a fixed engineering schedule and replace when it seems economically propitious. Replacement investment could then lead or lag actual scrapping. This lack of coincidence between scrapping and replacement might have an observable effect on output, but obviously would not in capital-stock estimates and so would appear as a productivity shift. One hypothesis that would be consistent with the stylised facts is that much actual scrapping takes place during downturns but the replacement investment for scrapped capital generally occurs during an upturn, while scrapping is temporarily delayed. This would explain the highly pro-cyclical behaviour of capital productivity and TFP, as capital in use would be growing faster than stated by national sources during upturns and falling more rapidly during downturns.

D. Wages and service prices (fourth test)

This test is based on the maintained hypothesis that nominal services output is better measured than its decomposition into prices and quantities. It was based on two observations: a) if nominal service-sector output is better measured than its division into price and quantity components, measurement error in the services output growth will produce equal and opposite errors in service price growth; and b) a 1 per cent increase in service prices, if measured correctly, should produce an increase in wages proportional to the share of consumer services in the consumption basket. The test amounted to estimating wage equations, breaking up the price-expectations term into service and non-service components and comparing the estimated coefficient with that of the service share in consumption. A much smaller value would indicate that services price inflation has been either mismeasured with a large random component or overstated by some constant proportion.

Strictly speaking, the test applies only to consumer service rather than business service measurement. But the former is probably more important, because it represents a final good, whereas measurement errors in intermediate goods such as business services may show up as part of the estimated productivity in the sector purchasing the service, and net out overall for the business sector (6). In addition, in many cases the output data are based on consumption data, so that service sector output and consumption growth will be closely correlated. However, it should be noted that the test only relates to mismeasurement of changes in service price inflation, so that if service price inflation were mismeasured by a constant amount, the test would provide no information. At the extreme, if nominal service output is measured accurately, then identically

$$P_s Q_s = Y_s^* \quad [10]$$

where P_s is the measured service price
Q_s is the measured service real output and
Y_s^* is the assumed correctly measured nominal output.

Taking the total differential with respect to time, converting to growth rates, and rearranging, one obtains

$$p_s = y_s^* - q_s \quad [11]$$

where lower-case letters indicate rates of change. From [11] it is clear that if q_s is measured incorrectly, that error will also appear with a sign reversal in p_s.

The test is based on whether measured changes in service prices offset wages in the expected way. One can write a typical wage equation of the expectations augmented Phillips curve variety as

$$w = a + b\ L(p) - cU + dZ \qquad [12]$$

where w is wage inflation
U is the unemployment rate
Z is a vector of other factors and
L is a lag operator

and split up the price component into

$$p = \gamma\ p_s + (1-\gamma)\ p_g \qquad [13]$$

where p_g is the goods price growth rate. If [12] is an accurate description of the wage-setting process, one can estimate

$$w = a + b_1\ L(p_s) + b_2\ L(p_q) - cU + dZ \qquad [14]$$

and obtain estimates of b_1/b_2 proportionate to $\gamma/(1-\gamma)$. In [14] as in [12] the implicit assumption is that the lags on services and goods price inflation are the same. Thus [14] is as valid as such aggregate wage equations are.

Variations of [14] were estimated, using the specification of Chan-Lee, Coe and Prywes (1987). For Denmark the specification was based on a preliminary ESD estimation (7).

No effort was made to enforce homogeneity or to correct generally for simultaneity. There was more concern with simultaneity in the services variable since for some services industries wage rates feed directly into price calculations. To eliminate this, the equations were re-estimated alternatively by lagging the service-price variable and using two-stage least squares. Lagged values of goods, services and wage inflation were used as instruments in the latter case.

For the most part, personal consumption expenditure deflators were used as the price variables, but where the division into goods and services components were not readily available, consumer price index data were used. In general, however, the former seem more closely related to wage determination.

Because of the high degree of multicollinearity in [14], and the absence of a specification search across lag lengths, or alternative explanatory variables, it seemed appropriate to weaken the test criterion based strictly on the estimate value of b_1/b_2. Thus, if the estimated service price term was significant and/or equal to or greater than its theoretical value across a number of estimation techniques, it was taken as an indication of some independent service price movement manifesting itself in wages.

Tables 5A-5M report the regression coefficients on the services and non-services consumer price inflation. For comparison, a baseline regression is included which uses the overall price inflation variable as the price term. The multicollinearity index is simply the R^2 from a regression of service price inflation on the other explanatory variables and provides an indication of how much independent variation the variable contains. Note, however, that fairly reasonable results can be obtained for countries with a high degree of multicollinearity and poor results for countries with low multicollinearity.

The United States and Japan showed the strongest and most consistent effects among the larger countries, while Austria, Denmark, the Netherlands and Switzerland among the smaller countries provided indications of independent service price effects on wages. The poor results in countries with only annual data and high multicollinearity can be discounted, but it is a little puzzling to see so little effect in a number of countries with reasonably long time series and degrees of multicollinearity comparable to those of the United States and Japan. As mentioned above, one attractive explanation would be that service price inflation does not measure the true cost of services because many such services are paid for indirectly through income and payroll taxes. This would not explain, however, why the overall equations performed fairly well, as the tax term is left out in these equations as well.

NOTES

1. The initial capital to output ratios were (1.0, 1.3, 1.5, 1.7, 2.0, 2.2, 2.4, 2.6, 2.8, 3.0). The scrapping rates, as measured in per cent per year, were (1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 6, 7, 8, 9, 10).

2. More formally this could be tested using a Lagrange multiplier test.

3. As defined in INTERLINK, the user cost of capital is defined as the product of the gross investment deflator and the sum of the expected long-term interest, the depreciation rate and a term estimated to guarantee that total factor earnings exhausted total output over the time period. The omission of tax parameters makes this a less than perfect measure of capital costs. For more discussion, see Helliwell, et al. (1986).

4. For example, Eisner (1972), Feldstein and Foot (1971).

5. Even if it is measured with error, the capital stock in the denominator is a much smoother series and probably does not introduce much spurious correlation because of the errors.

6. It is therefore quite suggestive that productivity growth in the business service sector has been slowing, while manufacturing productivity has been growing or the former increases and the latter decreases employment.

7. The Danish equation has as explanatory variables the natural log of the unemployment rate, two-period averages of productivity growth, consumer services inflation and consumer goods inflation.

ANNEX

SOURCES AND DEFINITIONS

1. This Annex provides information about capital-stock data for the business sector underlying the calculations of changes in total factor productivity. Business sector output includes the output of the private sector and public enterprises. On the input side the capital stock excludes residential housing, except for Turkey, and general government capital.

2. For the seven major countries, Australia, Finland, New Zealand and Sweden, the capital-stock series were based on national source data. These were obtained from the OECD Analytical Data Base (ADB), which reports the capital-stock data in a consistent business sector framwework as far as possible. For the other smaller countries, the Secretariat has used the perpetual inventory method. Aggregate investment was broken down into non-dwelling construction, machinery and equipment and, where possible, transport equipment. The investment series were extended backwards over time based on country-specific data on historical growth rates of output and ratios of investment to output, similar to the methods used in Meyer-zu-Schlochtern (1987). The stock of capital was then obtained by cumulating each category of investment over time, using rates of scrapping based upon average service lives as presented in Blades (1983). A more complete description of the data sources and methodology is available from the Growth Studies Division of the OECD Economics and Statistics Department.

3. The wage share was determined by calculating the share of compensation in output in each country. The self-employed were imputed on the average compensation levels. This may lead to an underestimate of the capital share where significant portions of capital income are unreported. For Greece and Ireland the capital share was set at 20 per cent.

REFERENCES

Baily, M.N. (1981), "Productivity and the services of capital and labor", Brookings Papers on Economic Activity, No. 1, pp. 1-50.

Blades, D. (1983), "Service lives of fixed assets", OECD Department of Economics and Statistics Working Paper No. 4.

Blades, D. (1987), "Goods and services in OECD countries", OECD Economic Studies, No. 8 (Spring), pp. 153-84.

Chan-Lee, J.H., D. Coe and M. Prywes (1987), "Microeconomic changes and macroeconomic wage disinflation in the 1980s", OECD Economic Studies, No. 8 (Spring).

Denison, E.F. (1979), Accounting for slower economic growth, Washington D.C., Brookings Institution.

Eisner (1972), "Components of capital expenditures: replacement and modernization versus expansion", Review of Economics and Statistics, Vol. LIV No. 3.

Englander A.S. and A.M. Mittelstadt (1988), "Total factor productivity: macro and structural aspects of the slowdown" , OECD Economic Studies, No. 10 (Spring).

Englander A.S., R. Evenson and M. Hanazaki, (1988), "R&D, patents and the total factor productivity growth slowdown", OECD Economic Studies, No. 11 (forthcoming).

Feldstein, M. and M. Foot (1971), "The other half of gross investment: replacement and modernization expenditures" Review of Economics and Statistics, Vol. LIII, No. 1.

Gordon, R.J. (1971), "Measurement biases in price indexes for capital goods", Review of Income and Wealth, Ser. 17, No. 2, pp. 121-74.

Griliches, Z. (1971), (ed.), Price indexes and quality change, Harvard University Press.

Griliches, Z. and F. Lichtenberg, (1984), "Interindustry technology flows and productivity growth: a re-examination" Review of Economics and Statistics, No. 2, p. 324.

Helliwell, J., P. Sturm, P. Jarrett and G. Salou (1986), "The supply side in the OECD's macroeconomic model", OECD Economic Studies, No. 6 (Spring).

Jorgenson, D.W. (1987), "Productivity and economic growth", Harvard Institute of Economic Research, Discussion paper.

Kendrick, J.W. (1973), Postwar productivity trends in the United States, 1948-1969, New York: NBER and Columbia University Press.

Mendis, L. and J. Muelbauer (1986), "British manufacturing productivity 1955-1983: measurement problems, oil shocks and Thatcher effects", Centre for Economic Policy Research, Discussion Paper Series No.32.

Meyer-zu-Schlochtern, F.G.M. (1988), "A sectoral databank for thirteen OECD countries including output, employment and total factor productivity", OECD Economic and Statistics Department Working Paper (forthcoming).

Muelbauer, J. (1986), "Aggregate production functions and productivity measurement: a new look", Centre for Economic Policy Research, Discussion Paper Series, No. 34.

Rappoport, P. (1987), "Inflation in the service sector", Quarterly Review of the Federal Reserve Bank of New York (Winter).

Triplett, J.E. (1986), "The economic interpretation of hedonic methods", Survey of Current Business (January), pp. 36-40.

Usher (1980), The measurement of capital, University of Chicago Press.

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4. Scrapping and investment:

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Table 1

SUMMARY OF MEASUREMENT TEST RESULTS

	National source (gross) K stock vs. constructed stocks	TFP related to inflation (GDP deflator) (a)	Scrapping impact on gross investment	Service sector price measurement
United States	No evidence against national source capital stock	TFP, TFC best related	Strong cyclical effect, some non-cyclical	Appears adequate despite high multicollinearity
Japan	No evidence against national source capital stock	TFP, TFC best related	Cyclical and/or non-cyclical effects	Appears adequate despite high multicollinearity
Germany	No evidence against national source capital stock	All about the same	No strong effect perhaps some cyclical	Weak
France	Constructed stock fits data better	VFC, VFP best related	Cyclical effect	Weak, high multicollinearity
United Kingdom	National source K stock fits better	TFP, TFC best related	Modest cyclical or no effects	Weak, very high multicollinearity
Italy	National source K stock fits better	VFP, TFC best related	Cyclical or fixed effect	Weak to mixed
Canada	National source K stock fits better	TFP, TFC best related	Cyclical effects	Weak, high collinearity
Austria				May be adequate, high multicollinearity
Denmark				May be adequate
Finland	National source K stock fits better			Bad equation
Netherlands				May be adequate
Sweden	National source K stock fits better			
Switzerland				May be adequate, high multicollinearity
Australia	No evidence against national source capital stock			May be adequate, but generally weak equation
New Zealand	No evidence against national source capital stock			

a) TFP = total factor productivity
TFC = total factor costs
VFP = variable factor productivity
VFC = variable factor costs.

Table 2

CAPITAL STOCK ESTIMATES AND TOTAL FACTOR PRODUCTIVITY GROWTH CALCULATIONS: CONSTRUCTED VERSUS NATIONAL SOURCE DATA

(Average annual growth 1970-85 in per cent)

	Capital Stock Growth (per cent change at annual rate)		Error in output growth (percentage points)		TFP Growth (per cent change at annual rate)	
	National sources	Constructed k	National sources	Constructed k	National sources	Constructed k
	(1)	(2)	(3)	(4)	(5)	(6)
United States	3.6	3.8	0.45	0.41	0.1	0.2
Japan	8.3	6.9	0.32	0.30	2.6	2.6
Germany	3.8	3.4	0.58	0.58	1.9	1.8
France	4.4	1.5	0.10	0.06	1.9	2.6
United Kingdom	3.2	5.5	0.94	1.00	1.4	0.5
Italy	3.4	2.1	0.24	0.30	2.1	2.1
Canada	5.5	4.9	0.94	1.10	0.8	1.1
Finland	4.0	5.2	0.63	1.20	2.1	1.7
Sweden	3.4	2.4	0.39	0.44	0.7	1.1
Australia	4.2	3.2	0.96	0.93	1.0	1.3
New Zealand	4.5	1.9	1.04	1.08	-0.3	0.8

Note: See text for discussion of this test.

ref. 12

Table 3A

PRICE INFLATION EQUATIONS

UNITED STATES

Estimation period: 1962I - 1985II

Sum of coefficients on growth of	GDP deflator growth (a)			Gross output deflator (GDP plus energy)		
	1	2	3	4	5	6
Total factor costs (a)	0.57**	-	0.66**	0.79**	-	0.80**
Variable factor costs (a)	-	0.67**	-	-	0.83**	-
Total factor productivity (a)	-1.13**	-	-	-1.05**	-	-
Variable factor productivity (a)	-	-0.74**	-0.65**	-	-0.81**	-0.77**
Import prices (a)	0.09*	0.13**	0.11*	0.11**	0.12**	0.10*
Energy prices (a)	0.05	0.05	0.03	-	-	-
Output growth (a)	0.71**	0.22	0.24	0.58*	0.20	0.25
Import dummy	0.22	-0.08	-0.03	0.19	0.05	0.06
DW	2.62	2.51	2.53	2.47	2.60	2.48
ADJ.RSQ	0.91	0.90	0.91	0.90	0.91	0.91
RSS	5.63	6.38	5.87	8.28	7.81	8.14

a) Entered as four-semester, second-order, polynomial distributed lag with end-point constraint.

* Significant at 5 per cent.
** Significant at 1 per cent.

Note: In the GDP deflator growth equations capital and labour are the two factors of production with labour the only variable factor. In the gross output deflator equations energy is treated as an additional factor of production, and labour and energy are the variable factors. In the factor cost and factor productivity variables, each factor is weighted in proportion to its share so that in all cases the shares sum to 100 per cent.

Table 3B

PRICE INFLATION EQUATIONS

JAPAN

Estimation period: 1968II - 1985I

Sum of coefficients on growth of	GDP deflator growth (a)			Gross output deflator (GDP plus energy)		
	1	2	3	4	5	6
Total factor costs (a)	0.89**	-	0.78**	0.91**	-	0.82**
Variable factor costs (a)	-	0.62**	-	-	0.68**	-
Total factor productivity (a)	-1.22	-	-	1.25	-	-
Variable factor productivity (a)	-	-1.16	-0.64	-	-1.15	-0.37
Import prices (a)	-0.16*	-0.20*	-0.19**	-0.08	-0.00	-0.04
Energy prices (a)	0.09	0.21**	0.16**	-	-	-
Output growth (a)	-0.14	0.80	0.31	-1.39	0.52	-0.10
Import dummy	-	-	-	-	-	-
DW	1.79	1.59	1.68	2.09	1.84	1.98
ADJ.RSQ	0.91	0.89	0.91	0.87	0.83	0.87
RSS	12.9	16.7	13.2	19.9	27.8	20.0

For notes see Table 3A.

Table 3C

PRICE INFLATION EQUATIONS

GERMANY

Estimation period: 1964I - 1985I

Sum of coefficients on growth of	GDP deflator growth (a)			Gross output deflator (GDP plus energy)		
	1	2	3	4	5	6
Total factor costs (a)	0.78**	-	0.79**	0.82**	-	0.83**
Variable factor costs (a)	-	0.65**	-	-	0.72**	-
Total factor productivity (a)	-0.47	-	-	-0.47	-	-
Variable factor productivity (a)	-	-0.53*	-0.27	-	-0.56*	-0.30
Import prices (a)	-0.10	-0.07	-0.12	-0.10	-0.06	-0.11
Energy prices (a)	0.04	0.06	0.04	-	-	-
Output growth (a)	-0.29	-0.25	-0.38	-0.29	-0.27	-0.37
Import dummy	-	-	-	-	-	-
DW	2.75	2.89	2.80	2.76	2.86	2.79
ADJ.RSQ	0.74	0.74	0.74	0.75	0.76	0.75
RSS	9.1	9.0	9.2	9.1	8.9	9.1

For notes see Table 3A.

Table 3D

PRICE INFLATION EQUATIONS

FRANCE

Estimation period: 1970I - 1985I

Sum of coefficients on growth of	GDP deflator growth (a)			Gross output deflator (GDP plus energy)		
	1	2	3	4	5	6
Total factor costs (a)	0.75*	-	0.69*	0.65**	-	0.68**
Variable factor costs (a)	-	0.58*	-	-	0.63**	-
Total factor productivity (a)	-0.54	-	-	-0.33	-	-
Variable factor productivity (a)	-	-1.44	-1.71	-	-0.80	-1.04
Import prices (a)	-0.05	-0.02	-0.04	-0.00	0.02	-0.01
Energy prices (a)	-0.03	0.04	-0.01	-	-	-
Output growth (a)	-0.35	0.33	0.53	-0.40	-0.11	0.08
Import dummy	-	-	-	-	-	-
DW	2.44	2.67	2.72	2.45	2.50	2.56
ADJ.RSQ	0.72	0.68	0.74	0.73	0.69	0.75
RSS	11.8	13.5	10.8	12.2	14.3	11.6

For notes see Table 3A.

Table 3E

PRICE INFLATION EQUATIONS

UNITED KINGDOM

Estimation period: 1968I - 1985II

Sum of coefficients on growth of	GDP deflator growth (a)			Gross output deflator (GDP plus energy)		
	1	2	3	4	5	6
Total factor costs (a)	0.77**	-	0.78**	0.95**	-	0.97**
Variable factor costs (a)	-	0.82**	-	-	0.87**	-
Total factor productivity (a)	-0.43	-	-	-0.62	-	-
Variable factor productivity (a)	-	-0.61	-0.19	-	-0.61	-0.32
Import prices (a)	-0.01	-0.01	-0.01	0.09	0.07	0.08
Energy prices (a)	0.16	0.09	0.17	-	-	-
Output growth (a)	0.05	0.26	-0.10	-0.15	0.05	-0.35
Import dummy	-0.60	-0.35	-0.52	-0.84	-0.83	-0.71
DW	2.11	2.36	2.01	1.75	1.83	1.67
ADJ.RSQ	0.89	0.89	0.89	0.90	0.90	0.90
RSS	20.7	21.3	21.1	22.6	23.3	23.3

For notes see Table 3A.

Table 3F

PRICE INFLATION EQUATIONS

ITALY

Estimation period: 1965I - 1985II

Sum of coefficients on growth of	GDP deflator growth (a)			Gross output deflator (GDP plus energy)		
	1	2	3	4	5	6
Total factor costs (a)	0.53	-	0.57	0.73**	-	0.69**
Variable factor costs (a)	-	0.58*	-	-	0.66**	-
Total factor productivity (a)	-1.50	-	-	-0.79	-	-
Variable factor productivity (a)	-	-1.43	-1.32	-	-1.30	-1.27
Import prices (a)	0.10	0.09	0.09	0.12	0.13	0.11
Energy prices (a)	0.08	0.06	0.07	-	-	-
Output growth (a)	0.76	0.74	0.62	0.07	0.53	0.44
Import dummy	-0.18	0.06	-0.04	-0.34	-0.22	-0.20
DW	1.54	1.61	1.57	1.49	1.61	1.53
ADJ.RSQ	0.79	0.79	0.80	0.81	0.80	0.82
RSS	61.3	61.4	59.0	69.8	72.1	67.2

For notes see Table 3A.

Table 3G

PRICE INFLATION EQUATIONS

CANADA

Estimation period: 1968I - 1985II

Sum of coefficients on growth of	GDP deflator growth (a)			Gross output deflator (GDP plus energy)		
	1	2	3	4	5	6
Total factor costs (a)	1.15**	-	1.2**	1.07**	-	1.3**
Variable factor costs (a)	-	0.88**	-	-	0.80**	-
Total factor productivity (a)	-2.56*	-	-	-3.9**	-	-
Variable factor productivity (a)	-	-1.1	-2.0*	-	-2.5**	-2.9**
Import prices (a)	0.22	0.58	0.08	-0.22	-0.12	-0.27
Energy prices (a)	-0.34	-0.51	-0.24	-	-	-
Output growth (a)	1.35	-0.15	0.55	2.61**	0.97*	1.13**
Import dummy	-0.10	-1.20	0.21	0.45	-0.06	0.69
DW	2.21	1.83	2.18	2.09	1.71	2.12
ADJ.RSQ	0.68	0.59	0.67	0.74	0.67	0.74
RSS	23.6	30.0	24.3	21.8	28.0	21.9

For notes see Table 3A.

Table 4

SCRAPPING AND INVESTMENT REGRESSIONS

The variables used in the regressions are defined below

IBV.K	Investment as share of capital stock
IBV.QT	Investment as share of trend output (quadratic trend)
PENB.UCC	Ratio of energy prices to the cost of capital
WSSE.UCC	Ratio of wages to the user cost of capital
RQBV	Growth in real output
DIFU	Change in capacity utilisation (based on INTERLINK variable IFU1)
PRO.K	Profits divided by capital stock
PRO.Q	Profits divided by trend output
SCRB.K	Scrapping as share of capital stock
SCRB.Q	Scrapping as share of trend output
IFU	Level of capacity utilisation
K.Q	Capital to output ratio

Table 4A

SCRAPPING AND INVESTMENT

UNITED STATES

Estimation period: 1962I - 1985II

LHS variable	IBV.K 1	IBV.K 2	IBV.K 3	IBV.K 4	IBV.K 5	IBV.K 6
RHS variables:						
PENB.UCC (a)	3.9 E-3	-1.7 E-3	1.3 E-3	1.3 E-3	3.7 E-3	1.6 E-3
WSSE.UCC (a)	1.2 E-3**	7.9 E-4**	1.3 E-3**	1.4 E-3**	1.3 E-3**	1.1 E-3**
RQBV (a)	-	2.2 E-3**	2.2 E-3**	-	-	-
DIFU (a)	9.6 E-4	-	-	2.9 E-3*	-1.8 E-3	6.3 E-4
PRO.K (a)	-4.0 E-2	0.07	0.09	9.3 E-2	-0.12	-1.3 E-1
SCRB.K (a)	-	1.69	-0.48 (b)	-0.64 (c)	0.73 (b)	2.6 (c)
SCRB.K*(IFU-1)(a)	-	-	-	-	8.1** (b)	8.9** (c)
IFU (a)	0.21**	-	-	-	-	-
RHO	0.90	0.81	0.93	0.93	0.89	0.86
DW	1.49	1.14	1.17	1.30	1.65	1.63
ADJ.RSQ	0.70	0.68	0.67	0.61	0.74	0.72
RSS	0.91 E-4	0.97 E-4	0.11 E-3	0.12 E-3	0.81 E-4	0.79 E-4

Table 4A (continued)

LHS variable	IBV.QT 1	IBV.QT 2	IBV.QT 3	IBV.QT 4	IBV.QT 5	IBV.QT 6	IBV.QT 7	IBV.QT 8
RHS variables:								
PENB.UCC (a)	7.3 E-3*	9.0 E-3**	-	-	3.6 E-3	3.6 E-3	7.0 E-3	4.0 E-3
WSSE.UCC (a)	2.2 E-3**	1.5 E-3**	-	-	2.4 E-3**	1.2 E-3**	2.2 E-3**	9.1 E-4**
RQBV (a)	-	-	2.6 E-3*	-	3.9 E-3**	-	-	-
DIFU (a)	4.9 E-3	7.4 E-3**	-	2.2 E-3	-	4.2 E-3*	-1.2 E-3	6.8 E-3*
PRO.Q (a)	-4.4 E-2	-7.3 E-2	0.12*	0.10	-0.01	8.6 E-2	-0.09	3.9 E-2
SCRB.Q (a)	-	-	-0.50	-0.29 (b)	-0.02 (b)	3.9 E-1 (c)	0.81 (b)	1.4 (c)
SCRB.Q*(IFU-1) (a)	-	-	-	1.7 (b)	-	-	5.7* (b)	3.6* (c)
IFU (a)	0.20	-	-	-	-	-	-	-
K.Q(-1)	-	-1.1 E-1**	-	-	-	-	-	-
RHO	0.88	0.54	0.99	0.99	0.92	0.73	0.88	0.54
DW	1.67	1.59	1.28	1.49	1.39	1.66	1.75	1.69
ADJ.RSQ	0.58	0.72	0.52	0.44	0.62	0.62	0.60	0.74
RSS	0.28 E-3	0.22 E-3	0.37 E-3	0.43 E-3	0.26 E-3	0.25 E-3	0.27 E-3	0.21 E-3

a) Sum of four-semester, second-order, polynomial distributed lag with end-point constraint.
b) Contemporaneous value only.
c) Sum of four-semester, second-order, polynomial distributed lag with two quarter lead on scrapping variable.

* Significant at 5 per cent.
** Significant at 10 per cent.

Table 4B

SCRAPPING AND INVESTMENT

JAPAN

Estimation period: 1968II - 1985II

LHS variable	IBV.K 1	IBV.K 2	IBV.K 3	IBV.K 4	IBV.K 5	IBV.K 5
RHS variables:						
PENB.UCC (a)	-1.9 E-3	3.1 E-4	4.9 E-4	6.0 E-4	-1.7 E-3	-4.3 E-3*
WSSE.UCC (a)	-1.5 E-6	-2.0 E-6**	-2.1 E-6**	-1.8 E-6*	-1.4 E-6	-1.7 E-6
RQBV (a)	-	3.0 E-3	3.9 E-3*	-	-	-
DIFU (a)	-3.0 E-3	-	-	1.4 E-3	-6.4 E-3	-3.4 E-3
PRO.K (a)	-1.1 E-1	0.42**	0.40**	0.55**	-5.6 E-2	-3.0 E-1
SCRB.K (a)	-	0.65	-0.06 (b)	0.80 (c)	-0.36	3.0 (c)
SCRB.K*(IFU-1)(a)	-	-	-	-	15.1** (b)	2.4 E+1** (c)
IFU (a)	0.72*	-	-	-	-	-
RHO	0.94	0.46	0.56	0.52	0.94	0.90
DW	1.68	1.81	1.62	1.65	1.76	1.65
ADJ.RSQ	0.70	0.97	0.95	0.96	0.71	0.77
RSS	0.23 E-3	0.23 E-3	0.27 E-3	0.23 E-3	0.22 E-3	0.17 E-3

Table 4B (continued)

LHS variable	IBV.QT 1	IBV.QT 2	IBV.QT 3	IBV.QT 4	IBV.QT 5	IBV.QT 6	IBV.QT 7	IBV.QT 8
RHS variables:								
PENB.UCC (a)	-1.9 E-3	2.4 E-3	-	-	2.8 E-3	2.7 E-3	-3.9 E-4	-2.7 E-3
WSSE.UCC (a)	-2.7 E-6**	-8.7 E-7	-	-	-2.9 E-7	-6.9 E-7	-2.1 E-6**	-3.1 E-6**
RQBV (a)	-	-	8.5 E-4	-	2.7 E-3	-	-	-
DIFU (a)	-1.9 E-3	4.9 E-3	-	5.7 E-4	-	2.9 E-3	-3.1 E-3	-2.1 E-4
PRO.Q (a)	-8.2 E-2	0.29**	0.30**	0.24**	0.27**	0.31**	-0.01	-2.1 E-1
SCRB.Q (a)	-	-	0.35	-0.03 (b)	0.02 (b)	3.8 E-1 (c)	-0.24 (b)	-3.6 E-1 (c)
SCRB.Q*(IFU-1) (a)	-	-	-	1.7 (b)	-	-	0.74** (b)	1.2 E+1** (c)
IFU (a)	7.5 E-1**	-	-	-	-	-	-	-
K.Q(-1)	-	0.02	-	-	-	-	-	-
RHO	0.16	0.39	0.65	0.66	0.62	0.57	0.32	0.19
DW	1.63	1.75	1.65	1.60	1.66	1.72	1.77	1.58
ADJ.RSQ	0.95	0.85	0.67	0.63	0.70	0.75	0.92	0.95
RSS	0.22 E-3	0.40 E-3	0.52 E-3	0.58 E-3	0.47 E-3	0.41 E-3	0.27 E-3	0.20 E-3

For notes see Table 4A.

Table 4C

SCRAPPING AND INVESTMENT

GERMANY

Estimation period: 1964I - 1985II

LHS variable	IBV.K 1	IBV.K 2	IBV.K 3	IBV.K 4	IBV.K 5	IBV.K 6
RHS variables:						
PENB.UCC (a)	4.1 E-3	-6.0 E-3*	-3.2 E-3	-2.7 E-3	2.4 E-3	4.1 E-3
WSSE.UCC (a)	-4.2 E-4**	-2.2 E-4	-5.7 E-6	-1.6 E-5	-2.8 E-4	-4.8 E-4*
RQBV (a)	-	2.2 E-3*	2.1 E-3*	-	-	-
DIFU (a)	-8.6 E-4	-	-	1.3 E-3	-4.2 E-3	-2.7 E-4
PRO.K (a)	-0.02	-0.01	0.06	1.5 E-1	0.04	-6.6 E-2
SCRB.K (a)	-	3.0	-0.61 (b)	-6.1 E-1 (c)	-0.80 (b)	8.8 E-1 (c)
SCRB.K*(IFU-1) (a)	-	-	-	-	12.9* (b)	2.0 E+1** (c)
IFU (a)	5.1 E-1**	-	-	-	-	-
RHO	0.85	0.83	0.84	0.83	0.88	0.86
DW	1.70	1.53	1.23	1.27	1.48	1.62
ADJ.RSQ	0.54	0.46	0.37	0.29	0.37	0.48
RSS	0.15 E-3	0.19 E-3	0.22 E-3	0.24 E-3	0.20 E-3	0.16 E-3

Table 4C (continued)

LHS variable	IBV.QT 1	IBV.QT 2	IBV.QT 3	IBV.QT 4	IBV.QT 5	IBV.QT 6	IBV.QT 7	IBV.QT 8
RHS variables:								
PENB.UCC (a)	9.0 E-3	1.2 E-2	-	-	-5.7 E-3	-3.4 E-3	1.5 E-3	7.1 E-3
WSSE.UCC (a)	-6.1 E-4*	-6.6 E-4	-	-	3.8 E-6	6.6 E-5	-2.9 E-4	-7.3 E-4
RQBV (a)	-	-	3.1 E-3	-	3.8 E-3	-	-	-
DIFU (a)	8.8 E-4	6.0 E-3**	-	-8.0 E-4	-	2.8 E-3	-3.7 E-3	1.8 E-3
PRO.Q (a)	6.7	3.0 E-1**	0.10	0.12	0.02	0.10	0.04	-5.7 E-2
SCRB.Q (a)	-	-	-0.12	-0.39 (b)	0.23 (b)	-	0.12 (b)	4.2 E-1
SCRB.Q*(IFU-1) (a)	-	-	-	3.5 (b)	-	-2.2 E-1 (c)	6.7 (b)	1.5 E+1** (c)
IFU (a)	8.4 E-1**	-	-	-	-	-	-	-
K.Q(-1)	-	-3.9 E-1**	-	-	-	-	-	-
RHO	0.88	0.98	0.83	0.88	0.84	0.86	0.86	0.90
DW	1.77	1.60	1.42	1.42	1.44	1.31	1.59	1.57
ADJ.RSQ	0.42	0.48	0.25	0.24	0.22	0.13	0.20	0.34
RSS	0.65 E-3	0.58 E-3	0.95 E-3	0.96 E-3	0.89 E-3	0.94 E-3	0.89 E-3	0.66 E-3

For notes see Table 4A.

Table 4D

SCRAPPING AND INVESTMENT

FRANCE

Estimation period: 1970I - 1985II

LHS variable	IBV.K 1	IBV.K 2	IBV.K 3	IBV.K 4	IBV.K 5	IBV.K 6
RHS variables:						
PENB.UCC (a)	8.7 E-3**	3.4 E-3	2.6 E-3	4.9 E-3*	8.9 E-3**	9.3 E-3**
WSSE.UCC (a)	-5.3 E-4**	-9.6 E-5	-1.5 E-4	4.4 E-4	-5.9 E-4**	-7.1 E-4**
RQBV (a)	-	2.6 E-3*	2.6 E-3*	-	-	-
DIFU (a)	-1.6 E-3	-	-	2.2 E-3	-7.0 E-3**	-1.3 E-3
PRO.K (a)	0.12**	0.19*	0.16*	1.7 E-1*	0.12**	9.8 E-2*
SCRB.K (a)	-	-2.65	-1.0 (b)	-	0.80 (b)	2.6 (c)
SCRB.K*(IFU-1)(a)	-	-	-	-11.2** (c)	19.7** (b)	22.5** (c)
IFU (a)	6.3 E-1**	-	-	-	-	-
RHO	0.55	0.79	0.78	0.91	0.33	0.18
DW	1.71	1.53	1.53	1.80	1.62	1.74
ADJ.RSQ	0.89	0.56	0.59	0.43	0.92	0.96
RSS	0.45 E-4	0.70 E-4	0.72 E-4	0.60 E-4	0.48 E-4	0.37 E-4

Table 4D (continued)

LHS variable	IBV.QT 1	IBV.QT 2	IBV.QT 3	IBV.QT 4	IBV.QT 5	IBV.QT 6	IBV.QT 7	IBV.QT 8
RHS variables:								
PENB.UCC (a)	1.9 E-2**	1.9 E-2	-	-	1.6 E-2**	2.1 E-2**	2.0 E-2**	2.0 E-2**
WSSE.UCC (a)	-9.1 E-4**	-6.5 E-5	-	-	-6.7 E-6	-4.0 E-5	-8.8 E-4**	-8.4 E-4**
RQBV (a)	-	-	2.8 E-3	-	7.6 E-3**	-	-	-
DIFU (a)	-9.0 E-5	9.5 E-3**	-	4.8 E-3	-	5.5 E-3	-7.2 E-3	3.9 E-3
PRO.Q (a)	0.14**	1.8 E-1**	0.10	0.13*	0.20**	0.21**	0.16**	1.3 E-1**
SCRB.Q (a)	-	-	0.34	0.14 (b)	-2.1** (b)	-3.9** (c)	-0.18 (b)	-6.4 E-1 (c)
SCRB.Q*(IFU-1) (a)	-	-	-	-1.9 (b)	-	-	13.0** (b)	1.3 E+1** (c)
IFU (a)	1.1**	-	-	-	-	-	-	-
K.Q(-1)	-	-2.6 E-1**	-	-	-	-	-	-
RHO	0.35	-0.47	0.80	0.22	0.29	0.41	0.14	0.12
DW	1.72	1.94	1.27	1.20	1.77	1.74	1.80	1.81
ADJ.RSQ	0.81	0.92	0.30	0.79	0.80	0.74	0.85	0.90
RSS	0.18 E-3	0.14 E-3	0.40 E-3	0.45 E-3	0.22 E-3	0.20 E-3	0.21 E-3	0.12 E-3

For notes see Table 4A.

Table 4E

SCRAPPING AND INVESTMENT

UNITED KINGDOM

Estimation period: 1967II - 1985II

LHS variable	IBV.K 1	IBV.K 2	IBV.K 3	IBV.K 4	IBV.K 5	IBV.K 6
RHS variables:						
PENB.UCC (a)	3.1 E-3*	2.3 E-3	1.5 E-3	-2.1 E-4	8.8 E-4	2.8 E-3
WSSE.UCC (a)	-3.1 E-4	-5.6 E-4	-4.9 E-5	8.4 E-4	5.1 E-4	-1.2 E-4
RQBV (a)	-	1.3 E-3	1.2 E-3	-	-	-
DIFU (a)	1.5 E-4	-	-	2.2 E-5	-1.2 E-3	1.9 E-3
PRO.K (a)	4.0 E-2	1.9 E-2	-5.2 E-3	4.1 E-2	5.9 E-2	-1.3 E-2
SCRB.K (a)	-	0.40	-0.02 (b)	-6.7 E-1 (c)	-0.39 (b)	-2.0 E-1 (c)
SCRB.K*(IFU-1) (a)	-	-	-	-	3.32** (b)	4.2** (c)
IFU (a)	8.8 E-2**	-	-	-	-	-
RHO	0.38	0.65	0.62	0.65	0.40	0.55
DW	1.93	2.09	2.05	2.13	2.18	2.49
ADJ.RSQ	0.60	0.31	0.32	0.18	0.62	0.49
RSS	0.45 E-4	0.49 E-4	0.52 E-4	0.50 E-4	0.42 E-4	0.33 E-4

Table 4E (continued)

LHS variable	IBV.QT 1	IBV.QT 2	IBV.QT 3	IBV.QT 4	IBV.QT 5	IBV.QT 6	IBV.QT 7	IBV.QT 8
RHS variables:								
PENB.UCC (a)	3.0 E-3	3.1 E-3	-	-	2.4 E-3	7.6 E-4	1.9 E-3	6.8 E-3
WSSE.UCC (a)	1.7 E-3*	1.8 E-3	-	-	1.8 E-3	2.5 E-3	2.3 E-3	3.8 E-4
RQBV (a)	-	-	-8.6 E-5	-	1.6 E-3	-	-	-
DIFU (a)	2.5 E-3	-1.2 E-3	-	1.3 E-3	-	-2.3 E-3	-2.1 E-3	4.4 E-3
PRO.Q (a)	3.7 E-2	5.3 E-3	3.6 E-2	1.5 E-2	1.4 E-2	2.9 E-2	3.8 E-2	-2.5 E-2
SCRB.Q (a)	-	-	0.72**	0.70** (b)	-0.05	-1.5 E-1 (c)	-0.16 (b)	2.5 E-1 (c)
SCRB.Q*(IFU-1) (a)	-	-	-	0.44 (b)	-	-	1.04 (b)	2.2 (c)
IFU (a)	5.6 E-2	-	-	-	-	-	-	-
K.Q(-1)	-	-1.1 E-2	-	-	-	-	-	-
RHO	0.32	0.37	0.62	0.62	0.42	0.26	0.31	0.46
DW	2.05	2.10	1.83	1.97	2.08	2.09	2.12	2.20
ADJ.RSQ	0.94	0.92	0.73	0.68	0.91	0.93	0.93	0.89
RSS	0.36 E-3	0.34 E-3	0.66 E-3	0.80 E-3	0.42 E-3	0.37 E-3	0.38 E-3	0.32 E-3

For notes see Table 4A.

Table 4F

SCRAPPING AND INVESTMENT

ITALY

Estimation period: 1964II - 1985II

LHS variable	IBV.K 1	IBV.K 2	IBV.K 3	IBV.K 4	IBV.K 5	IBV.K 6
RHS variables:						
PENB.UCC (a)	4.6 E-4	-1.3 E-4	-2.2 E-3	-6.3 E-5	4.3 E-4	1.1 E-4
WSSE.UCC (a)	-5.8 E-7	-2.7 E-7	2.2 E-7	3.3 E-7	-5.7 E-7	1.3 E-7
RQBV (a)	-	3.1 E-3**	3.1 E-3**	-	-	-
DIFU (a)	2.3 E-3	-	-	2.4 E-3**	8.5 E-4	2.9 E-3
PRO.K (a)	1.2 E-1**	0.10*	0.09*	2.0 E-1**	0.12**	1.9 E-1**
SCRB.K (a)	-	0.91	0.22 (b)	1.2 (c)	0.19 (b)	1.0 (c)
SCRB.K*(IFU-1)(a)	-	-	-	-	4.3* (b)	1.5 (c)
IFU (a)	1.3 E-1*	-	-	-	-	-
RHO	0.40	0.65	0.68	0.20	0.46	0.23
DW	1.80	1.91	1.93	1.86	1.84	1.83
ADJ.RSQ	0.87	0.77	0.76	0.93	0.84	0.92
RSS	0.15 E-3	0.14 E-3	0.15 E-3	0.12 E-3	0.16 E-3	0.12 E-3

Table 4F (continued)

LHS variable	IBV.QT 1	IBV.QT 2	IBV.QT 3	IBV.QT 4	IBV.QT 5	IBV.QT 6	IBV.QT 7	IBV.QT 8
RHS variables:								
PENB.UCC (a)	9.3 E-4	3.5 E-4	-	-	-5.6 E-5	-1.7 E-4	8.8 E-4	-2.8 E-4
WSSE.UCC (a)	-6.3 E-7	5.6 E-7	-	-	-1.4 E-8	4.9 E-7	-9.2 E-7	1.3 E-7
RQBV (a)	-	-	6.0 E-3**	-	4.6 E-3**	-	-	-
DIFU (a)	6.2 E-3*	3.6 E-3*	-	4.3 E-3*	-	3.6 E-3*	2.8 E-3	7.4 E-3**
PRO.Q (a)	1.1 E-1**	1.3 E-1**	0.10**	0.13**	0.11**	1.8 E-1**	0.11**	2.0 E-1**
SCRB.Q (a)	-	-	0.04	0.46 (b)	0.68	8.0 E-1 (c)	0.58 (b)	6.4 E-1 (c)
SCRB.Q*(IFU-1) (a)	-	-	-	0.47 (b)	-	-	2.4 (b)	-1.0 (c)
IFU (a)	1.6 E-1	-	-	-	-	-	-	-
K.Q(-1)	-	-3.9 E-2	-	-	-	-	-	-
RHO	0.31	0.36	0.44	0.37	0.41	0.19	0.28	0.22
DW	1.85	1.85	1.87	1.83	1.82	1.91	1.84	1.88
ADJ.RSQ	0.85	0.85	0.84	0.83	0.84	0.90	0.85	0.90
RSS	0.51 E-3	0.46 E-3	0.47 E-3	0.58 E-3	0.46 E-3	0.43 E-3	0.52 E-3	0.39 E-3

For notes see Table 4A.

Table 4G

SCRAPPING AND INVESTMENT

CANADA

Estimation period: 1968I - 1985II

LHS variable	IBV.K 1	IBV.K 2	IBV.K 3	IBV.K 4	IBV.K 5	IBV.K 6
RHS variables:						
PENB.UCC (a)	1.4 E-2**	2.2 E-3	1.7 E-3	-2.5 E-4	9.6 E-3*	9.1 E-3
WSSE.UCC (a)	-1.3 E-3**	-4.4 E-4	-4.9 E-4	-2.3 E-4	-9.0 E-4*	-1.1 E-3*
RQBV (a)	-	-1.7 E-3	-1.1 E-4	-	-	-
DIFU (a)	-7.8 E-3**	-	-	-4.0 E-3**	-5.5 E-3**	-5.5 E-3*
PRO.K (a)	0.01	0.29	0.22	0.22	0.09	-2.4 E-2
SCRB.K (a)	-	0.07	0.89* (b)	3.8** (c)	0.71 (b)	3.4** (c)
CRB.K*(IFU-1)	-	-	-	-	10.0** (b)	10.0* (c)
IFU (a)	0.24**	-	-	-	-	-
RHO	0.43	0.91	0.91	0.79	0.54	0.73
DW	1.61	1.37	1.39	1.45	1.62	1.64
ADJ.RSQ	0.78	0.20	0.31	0.62	0.70	0.69
RSS	0.11 E-3	0.19 E-3	0.17 E-3	0.95 E-4	0.12 E-3	0.73 E-4

Table 4G (continued)

LHS variable	IBV.QT 1	IBV.QT 2	IBV.QT 3	IBV.QT 4	IBV.QT 5	IBV.QT 6	IBV.QT 7	IBV.QT 8
RHS variables:								
PENB.UCC (a)	2.6 E-2**	2.6 E-2*	-	-	1.2 E-2	2.9 E-4	0.02**	1.6 E-2
WSSE.UCC (a)	-1.8 E-3*	-1.2 E-3	-	-	-1.0 E-3	-4.5 E-4	-1.48*	-2.1 E-3*
RQBV (a)	-	-	-6.1 E-3*	-	-3.3 E-3	-	-	-
DIFU (a)	-1.4 E-2*	-5.5 E-3	-	-7.3 E-3**	-	-7.6 E-3**	-0.01**	-7.3 E-3
PRO.Q (a)	9.3 E-2	2.3 E-1*	0.27*	0.20	0.17	1.9 E-1**	0.09	-8.6 E-2
SCRB.Q (a)	-	-	-0.39	0.75** (b)	0.65 (b)	3.4** (c)	0.57 (b)	3.8** (c)
SCRB.Q*(IFU-1) (a)	-	-	-	-0.11 (b)	-	-	5.1 (b)	8.9* (c)
IFU (a)	0.23	-	-	-	-	-	-	-
K.Q(-1)	-	-7.3 E-2	-	-	-	-	-	-
RHO	0.47	0.46	0.95	0.89	0.86	0.79	0.56	0.76
DW	1.65	1.62	1.32	1.33	1.45	1.42	1.64	1.54
ADJ.RSQ	0.80	0.80	0.19	0.30	0.33	0.63	0.74	0.69
RSS	0.45 E-3	0.41 E-3	0.84 E-3	0.73 E-3	0.64 E-3	0.35 E-3	0.44 E-3	0.28 E-3

For notes see Table 4A.

Table 5A

WAGES AND SERVICE PRICE INFLATION

UNITED STATES: 1964II - 1986II

	Baseline (a)	Services split out (a)	Baseline (b)	Services split out (b)	Instrument for services (a)
Service price inflation (c)	--	0.63 (0.18)	--	0.49 (0.18)	0.63 (0.18)
Non-service price inflation (c)	--	0.49 (0.13)	--	0.66 (0.14)	0.48 (0.13)
Overall price inflation (c)	1.08 (0.11)	--	1.12 (0.13)	--	--
SEE	0.51	0.51	0.56	0.57	0.51
DW	2.01	2.05	1.82	1.82	2.06
Adj. R^2	0.79	0.79	0.75	0.74	0.78

Mean services weight 0.41 Multicollinearity index 0.87

Table 5B

JAPAN: 1971II - 1985II

	Baseline (a)	Services split out (a)	Baseline (b)	Services split out (b)	Instrument for services (a)
Service price inflation (c)	--	0.43 (0.16)	--	0.32 (0.18)	0.38 (0.19)
Non-service price inflation (c)	--	0.18 (0.15)	--	0.67 (0.13)	0.24 (0.27)
Overall price inflation (c)	0.61 (0.13)	--	0.33 (0.11)	--	--
SEE	0.89	0.89	1.08	1.08	0.93
DW	1.52	1.57	1.27	1.35	1.62
Adj. R^2	0.93	0.23	0.89	0.90	0.93

Mean services weight 0.47 Multicollinearity index 0.72

a) RHS price terms include contemporaneous values.
b) RHS price terms exclude contemporaneous values.
c) As measured by PCE deflator.
Standard errors in parentheses.
Note: The baseline regression uses a standard distributed lag on the overall PCE deflator or CPI growth as the explanatory price variable for wages.

Table 5C

GERMANY: 1964I - 1985II

	Baseline (a)	Services split out (a)	Instrument for services (a)
Service price inflation (c)	--	0.04 (0.23)	0.46 (0.67)
Non-service price inflation (c)	--	0.68 (0.15)	0.74 (0.27)
Overall price inflation (c)	0.82 (0.17)	--	--
SEE	0.90	0.90	1.13
DW	2.34	2.54	2.00
Adj. R^2	0.75	0.75	0.61

Mean services weight 0.33 Multicollinearity index 0.37

Table 5D

FRANCE: 1964II - 1984II

	Baseline (a)	Services split out (a)	Baseline (b)	Services split out (b)	Instrument for services (a)
Service price inflation (d)	--	0.21 (0.17)	--	0.10 (0.23)	0.13 (0.27)
Non-service price inflation (d)	--	0.77 (0.11)	--	0.88 (0.15)	0.83 (0.16)
Overall price inflation (d)	1.05 (0.08)	--	0.97 (0.13)	--	--
SEE	0.67	0.68	0.98	0.95	0.70
DW	1.56	1.66	1.62	1.78	1.66
Adj. R^2	0.85	0.85	0.68	0.70	0.81

Mean services weight 0.36 Multicollinearity index 0.75

a) RHS price terms include contemporaneous values.
b) RHS price terms exclude contemporaneous values.
c) As measured by the CPI.
d) As measured by PCE deflator.

Note: The baseline regression uses a standard distributed lag on the overall PCE deflator or CPI growth as the explanatory price variable for wages.

Table 5E

UNITED KINGDOM: 1965I - 1985II

	Baseline (a)	Services split out (a)	Baseline (b)	Services split out (b)	Instrument for services (a)
Service price inflation (c)	--	-0.03 (0.42)	--	0.56 (0.52)	-0.56 (0.53)
Non-service price inflation (c)	--	0.88 (0.38)	--	0.24 (0.47)	1.34 (0.48)
Overall price inflation (c)	0.87	--	0.77 (0.15)	--	--
SEE	1.95	1.95	2.33	2.36	1.99
DW	1.56	1.52	1.35	1.35	1.38
Adj. R^2	0.55	0.55	0.36	0.35	0.53

Mean services weight 0.35 Multicollinearity index 0.92

Table 5F

ITALY: 1972II - 1985II

	Baseline (a)	Services split out (a)	Instrument for services (a)
Service price inflation (d)	--	0.07 (0.15)	0.33 (0.47)
Non-service price inflation (d)	--	0.78 (0.17)	0.68 (0.24)
Overall price inflation (d)	0.92 (0.18)	--	--
SEE	2.06	2.05	2.19
DW	1.93	1.98	1.89
Adj. R^2	0.59	0.59	0.54

Mean services weight 0.28 Multicollinearity index 0.42

a) RHS price terms include contemporaneous values.
b) RHS price terms exclude contemporaneous values.
c) As measured by PCE deflator.
d) As measured by the CPI.
<u>Note</u>: The baseline regression uses a standard distributed lag on the overall PCE deflator or CPI growth as the explanatory price variable for wages.

Table 5G

CANADA: 1966II - 1986I

	Baseline (a)	Services split out (a)	Baseline (b)	Services split out (b)	Instrument for services (a)
Service price inflation (c)	--	-0.27 (0.54)	--	-0.43 (0.58)	-0.05 (0.65)
Non-service price inflation (c)	--	1.09 (0.36)	--	1.13 (0.38)	0.95 (0.42)
Overall price inflation (c)	1.09 (0.27)	--	1.05 (0.34)	--	--
RHO	0.46	0.41	0.52	0.41	0.40
SEE	1.15	1.14	1.20	1.19	1.16
DW	1.92	1.91	1.93	1.91	1.89
Adj. R^2	0.45	0.47	0.37	0.43	0.47
Mean services weight	0.43	Multicollinearity index		0.77	

a) RHS price terms include contemporaneous values.
b) RHS price terms exclude contemporaneous values.
c) As measured by PCE deflator.

Note: The baseline regression uses a standard distributed lag on the overall PCE deflator or CPI growth as the explanatory price variable for wages.

Table 5H

AUSTRIA: 1972 - 1985

	Baseline (a)	Services split out (a)	Baseline (b)	Services split out (b)	Instrument for services (a)
Service price inflation (c)	--	0.58 (0.33)	--	0.06 (0.62)	0.50 (0.35)
Non-service price inflation (c)	--	0.32 (0.24)	--	0.32 (0.43)	0.41 (0.27)
Overall price inflation (c)	0.88 (0.21)	--	0.45	--	--
SEE	1.03	1.13	1.62	1.72	1.17
DW	1.49	1.50	1.18	1.15	0.86
Adj. R^2	0.89	0.87	0.74	0.70	0.86

Mean services weight 0.38 Multicollinearity index 0.72

Table 5I

DENMARK: 1968 - 1985

	Baseline (a)	Services split out (a)	Baseline (b)	Services split out (b)	Instrument for services (a)
Service price inflation (c)	--	0.33 (0.23)	--	0.01 (0.38)	0.50 (0.23)
Non-service price inflation (c)	--	0.66 (0.11)	--	0.81 (0.20)	1.58 (0.10)
Overall price inflation (c)	1.10 (0.11)	--	1.15	--	--
SEE	1.00	1.19	1.81	1.83	0.97
DW	2.21	1.83	2.12	2.27	1.96
Adj. R^2	0.90	0.86	0.70	0.70	0.92

Mean services weight Multicollinearity index 0.39

a) RHS price terms include contemporaneous values.
b) RHS price terms exclude contemporaneous values.
c) As measured by PCE deflator.
<u>Note</u>: The baseline regression uses a standard distributed lag on the overall PCE deflator or CPI growth as the explanatory price variable for wages.

Table 5J

FINLAND: 1972 - 1985

	Baseline (a)	Services split out (a)	Baseline (b)	Services split out (b)	Instrument for services (a)
Service price inflation (c)	--	0.05 (0.55)	--	0.86 (0.50)	1.60 (1.33)
Non-service price inflation (c)	--	0.26 (0.46)	--	-0.51 (0.40)	-0.49 (1.02)
Overall price inflation (c)	0.39 (0.38)	--	0.18 (0.28)	--	--
SEE	2.29	2.44	2.35	2.19	3.36
DW	1.88	1.83	1.78	1.65	1.93
Adj. R^2	0.81	0.78	0.80	0.83	0.58

Mean services weight 0.36 Multicollinearity index 0.85

Table 5K

NETHERLANDS: 1971II - 1986I

	Baseline (a)	Services split out (a)	Instrument for services (a)
Service price inflation (d)	--	0.46 (0.31)	0.68 (0.67)
Non-service price inflation (d)	--	0.42 (0.24)	0.29 (0.69)
Overall price inflation (d)	0.82	--	--
SEE	0.90	0.91	0.92
DW	1.87	1.85	1.84
Adj. R^2	0.86	0.85	0.85

Mean services weight 0.34 Multicollinearity index 0.83

a) RHS price terms include contemporaneous values.
b) RHS price terms exclude contemporaneous values.
c) As measured by PCE deflator.
d) As measured by the CPI.

Note: The baseline regression uses a standard distributed lag on the overall PCE deflator or CPI growth as the explanatory price variable for wages.

Table 5L

SWITZERLAND: 1971I - 1983II

	Baseline (a)	Services split out (a)	Instrument for services (a)
Service price inflation (c)	--	0.80 (0.30)	0.59 (0.43)
Non-service price inflation (c)	--	0.14 (0.17)	0.25 (0.23)
Overall price inflation (c)	0.73 (0.12)	--	--
SEE	1.15	1.11	1.41
DW	2.80	3.05	2.80
Adj. R^2	0.64	0.59	0.34

Mean services weight 0.44 Multicollinearity index 0.72

Table 5M

AUSTRALIA: 1971I - 1986I

	Baseline (a)	Services split out (a)	Instrument for services (a)
Service price inflation (c)	--	0.26 (0.21)	0.19 (0.29)
Non-service price inflation (c)	--	0.21 (0.35)	0.29 (0.41)
Overall price inflation (c)	0.43 (1.27)	--	--
SEE	1.70	1.73	1.74
DW	2.04	2.22	2.10
Adj. R^2	0.71	0.72	0.71

Mean services weight 0.27 Multicollinearity index 0.43

a) RHS price terms include contemporaneous values.
b) RHS price terms exclude contemporaneous values.
c) As measured by the CPI.
Note: The baseline regression uses a standard distributed lag on the overall PCE deflator or CPI growth as the explanatory price variable for wages.

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