# Wage Curve vs. Phillips Curve: Are There Macroeconomic Implications?

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**Abstract**

The standard derivation of the accelerationist Phillips curve relates expected real wage inflation to the unemployment rate and invokes a constant price markup and adaptive expectations to generate the accelerationist price inflation formula. Blanchflower and Oswald (1994) argue that microeconomic evidence of a low autoregression coefficient in real wage regressions invalidates the macroeconomic Phillips curve. This conclusion has been disputed by a number of authors on the grounds that the true autoregression coefficient is close to one. This paper shows that given the assumption of a constant price markup, micro-level real wage dynamics in fact have no observable implications for macro data on wage and price inflation.

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# Contents

# 1 Introduction

Given that the accelerationist Phillips curve and the NAIRU remain central to popular and professional discussions of inflation and unemployment, it also remains the case that, to paraphrase Robert Solow (1976), any time is a good time to reflect upon the Phillips curve. This is particularly so given that, in a recent series of influential contributions, David Blanchflower and Andrew Oswald (1994, 1995) have challenged the empirical foundations of the Phillips curve. Based upon microeconomic wage regressions showing little autoregression in real wages and so placing in doubt formulations which make wage *inflation* a function of the unemployment rate, Blanchflower and Oswald suggest that "Conventional macroeconomics seems to be at threat from these results. They are consistent with the view that it is wrong to believe in a Phillips curve". This conclusion has been challanged by a number of authors, including Olivier Blanchard and Lawrence Katz (1997), on the grounds that Blanchflower and Oswald's estimates of real wage autoregression are biased downward. The purpose of this paper is to show that, in fact, the legitimacy of the accelerationist Phillips curve does not depend upon the assumption of a particular form of microeconomic real wage dynamics.

The standard derivation of the Phillips curve has specified a dynamic relationship between wages and unemployment and then used markup pricing to produce a price inflation formula: the recent debate over the legitimacy of the accelerationist Phillips curve has focused on the specification of the dynamic wage equation. While A. W. Phillips related nominal wage inflation to unemployment, Milton Friedman's (1968) derivation of the accelerationist Phillips curve began by making expected real wage inflation a function of the unemployment rate. Once workers bargained in terms of real wages, there could not be a long-run tradoff between unemployment and inflation, although if inflation expectations were adaptive then there was room for a short-run tradeoff in which unemployment could only be kept below its natural rate at the expense of increasing inflation.

This paper's principal result is that these traditional assumptions of a constant price markup and adaptive inflation expectations are sufficient conditions to derive the accelerationist Phillips curve - no specific assumption about real wage autoregression is necessary. Intuitively, this occurs because the constant price markup assumption implies that macro-level real wages will not display the dynamics of micro-level real wages. In fact, given a constant price markup, the micro-level dynamics of the real wage have no empirically testable implications for macroeconomic time series on wage or price inflation. This result is also robust to an alternative markup assumption, which fits the empirical series well, in which cyclical movements in the markup are allowed. So, rather than being central to the debate over the validity of the accelerationist Phillips curve and the NAIRU, the micro-level dynamics of real wages may be irrelevant to it.

The contents are as follows. Section 2 discusses the standard derivation of the accelerationist Phillips curve and briefly reviews the recent debate over microeconomic wage dynamics. Section 3 shows how markup pricing implies that micro-level real wage dynamics have no observable implications for macroeconomic time series for wage or price inflation. Section 4 examines the behavior of the empirical aggregate price markup. Section 5 concludes.

# 2 A Quick Review

## 2.1 The Accelerationist Phillips Curve: Standard Derivation

The usual algebraic derivation of the accelerationist Phillips curve starts from the premise that the expected growth rate of real wages depends on the rate of unemployment. In other words, that

$$w_t - p_t^e = w_{t-1} - p_{t-1} + g + \alpha - \beta u_t \tag{1}$$

where $w$ and $p$ are the logs of the wage level and price level respectively, $u$ is the unemployment rate and $g$ is the rate of productivity growth (assumed constant).[1]

The accelerationist model assumes that inflation expectations are backward-looking: in the simplest case, this period's inflation rate is expected to equal last period's rate ($p_t^e - p_{t-1} = p_{t-1} - p_{t-2}$) and so we get

$$\Delta w_t = \Delta p_{t-1} + g + \alpha - \beta u_t \tag{2}$$

This equation is translated into a price inflation accelerationist Phillips curve with the assumption that the price markup over unit labor costs is constant

$$p_t = \mu + w_t - x_t \tag{3}$$

where $x_t$ is labor productivity. This gives us the standard accelerationist Phillips curve

$$\Delta p_t = \Delta p_{t-1} + \alpha - \beta u_t \tag{4}$$

with the NAIRU given by $u^* = \frac{\alpha}{\beta}$.

[1]That Milton Friedman (1968) had such an equation in mind is clear from his comment: "Restate Phillips' analysis in terms of the rate of change of real wages - and even more precisely, anticipated real wages - and it all falls into place."

## 2.2 Micro Wage Curve vs. Micro Phillips Curve

The recent debate over the Phillips curve has focused on the validity of the starting point of the above derivation: is it valid to assume, as in equation 1, that the expected rate of change of individuals' real wages is a function of the unemployment rate? David Blanchflower and Andrew Oswald (1994) have argued that it is not. Their estimation of the wage curve was based primarily on individual-level cross-sectional regressions of the form

$$w_{ijt} = \gamma X_{ijt} + \alpha_j + \delta_t - \beta u_{jt} \tag{5}$$

where $w_{ijt}$ is the log-wage of person $i$ living in region $j$ at time $t$, $X_{ijt}$ is a vector of personal characteristics of person $i$ and $u_{jt}$ is the log of the unemployment rate in region $j$.[2] The wage concept used was nominal annual earnings with the region ($\alpha_j$) and time ($\delta_t$) fixed effects capturing differences in prices across regions and changes in the price level over time. This relationship between the level of real wages and the unemployment rate has been motivated as consistent with theoretical models such as the Shapiro-Stiglitz model of efficiency wages. Blanchflower and Oswald's estimates of real wage dynamics were based on regressions involving state or regional averages:

$$\bar{w}_{jt} = \rho\, \bar{w}_{j,t-1} + \gamma\, \bar{X}_{jt} + \alpha_j + \delta_t - \beta u_{jt} \tag{6}$$

where the bar indicates a regionally averaged variable. The reported estimates of $\rho$ from these regressions were all less than 0.3. From these results, Blanchflower and Oswald concluded that equation 1 is incorrectly specified and that the macroeconomic Phillips curve is "a kind of misspecified aggregate wage curve" which "may be a mirage produced by a combination of overly aggregated data and inappropriate specification"[3].

[2] The log-log specification was chosen by Blanchflower and Oswald on the basis of being the best empirical fit.

[3] Blanchflower and Oswald (1995).

This conclusion has been disputed by a number of authors on the grounds that Blanchflower and Oswald's estimates of the autoregession in micro-level real wages are invalid. For instance, David Card's (1995) review of *The Wage Curve* questioned its method of estimating the real wage autoregression coefficient and commented that "reports on the demise of the Phillips curve may be premature". Olivier Blanchard and Lawrence Katz (1997) also defend the traditional accelerationist Phillips curve by presenting evidence for the case that the true microeconomic relationship is well approximated as being between the change in real wages and the unemployment rate. They show that estimating accelerationist specifications for wage and price inflation such as equation 2 and equation 4 with macroeconomic data, one obtains a good fit. Blanchard and Katz agree, however, that these macroeconomic relationships are inconsistent with the wage curve and resolve this apparent tension by rejecting Blanchflower and Oswald's estimates of $\rho$. In particular, the use of annual earnings data is criticized on the grounds that such data bias estimates of $\rho$ downward by combining information on changes in wage rates with information on changes in hours worked.

Using an alternative empirical methodology, also based upon state-level data, but which instead uses hourly earnings, Blanchard and Katz reported estimates of $\rho$ ranging from 0.91 to 0.98 and presented these high values as an explanation for the good empirical fit of the accelerationist Phillips curve.[4] Bell (1997) has shown, however, that if state-specific wage trends are added to the Blanchard-Katz regression, one obtains estimates of $\rho$ that are about 0.8.[5] Thus, Bell suggests that equation 1 is indeed incorrect but that wage dynamics are close enough to it for the macroeconomic data to

[4]Specifically, Blanchard and Katz estimate an individual-level hourly wage regression including state dummies for each year and then run a panel regression of the state dummy coefficients, interpreted as demographically-adjusted wage rates, on their lagged levels and the state unemployment rate.

[5]Another way to reduce the bias due to excluded autocorrelated state-level effects is to use individual data: in regressions based on matched samples of individuals from the CPS outgoing rotations, I have also obtained estimates of about 0.8.

resemble a Phillips curve.

I will now show how, despite the apparent disagreement, the appropriate specification of micro-level real wage dynamics is unlikely to be important for the macroeconomics of wage and price inflation: given the assumption in this literature of a constant price markup, one can obtain macro-level accelerationist equations such as equation 2 and equation 4 for any value of $\rho$.

# 3 Micro Wage Curves and Macro Dynamics

## 3.1 Constant Labor Productivity

First consider the simple case in which labor productivity is constant. In this case, the Blanchflower-Oswald wage curve can be written in a simple form as

$$w_{ijt} - p_t = \alpha_i - \beta u_{jt}$$

where $w_{ijt}$ is the log wage of person $i$ who lives in region $j$ at time $t$, $p_t$ is the log of the aggregate price level and $u_{jt}$ is the unemployment rate in region $j$ (or its log, the exact specification is unimportant). An alternative specification seen in the traditional Phillips curve derivations is

$$\Delta \left(w_{ij} - p\right)_t = \alpha_i - \beta u_{jt}$$

A general form capable of encompassing both views is

$$\left(w_{ij} - p\right)_t = \rho \left(w_{ij} - p\right)_{t-1} + \alpha_i - \beta u_{jt}$$

We are interested in whether the parameter $\rho$ is important for the behavior of macro-level wage or price inflation.

As in the standard derivation of the Phillips curve above assume that wage setters have imperfect information concerning this period's price level and so bargain in terms of expected real wages.

$$(w_{ij} - p^e)_t = \rho\,(w_{ij} - p)_{t-1} + \alpha_i - \beta u_{jt} \tag{7}$$

Finally, assume that each firm employs one worker and prices as a constant markup over its labor costs

$$p_{ijt} = \mu + w_{ijt} \tag{8}$$

The wage equation can be aggregated to give

$$(w - p^e)_t = \rho\,(w - p)_{t-1} + \alpha - \beta u_t$$

where we have dropped the $i$ and $j$ subscripts to indicated averaged aggregate variables.[6] Note, however, that the price-markup equation can also be aggregated to give us

$$w_{t-1} - p_{t-1} = -\mu$$

Thus, we have

$$w_t - p_t^e = \alpha - \rho\mu - \beta u_t \tag{9}$$

Equation 9 implies that wage specifications with different values of $\rho$, which can have wildly different implications for the micro-level dynamics of the real wage, at a macro-level merely result in different intercepts in the wage equation. In fact, one can only identify $\rho$ from a regression based on aggregate data in the unlikely case in which one has

[6] Technically, this aggregation only holds for geometric averages, since, in general

$$\frac{1}{n}\sum_{i=1}^{n} x_i^{\rho} \neq (\frac{1}{n}\sum_{i=1}^{n} x_i)^{\rho}$$

However, equality does hold precisely for our two extreme cases of $\rho = 1$ and $\rho = 0$ and so the aggregation also holds for arithmetic averages for these values.

information concerning the parameter $\alpha$. The macroeconomic observational equivalence of microeconomic wage dynamics follows directly from the constant markup assumption and holds for all possible assumptions concerning price expectations.

The accelerationist Phillips curve can now be derived from equation 9 with the assumption that expected inflation this period equals inflation last period

$$p_t^e - p_{t-1} = p_{t-1} - p_{t-2} \Rightarrow p_t^e = 2p_{t-1} - p_{t-2}$$

Inserting this expected price level, we get

$$w_t - p_{t-1} = p_{t-1} - p_{t-2} + \alpha - \rho\mu - \beta u_t$$

Finally, using $w_t = p_t - \mu$ we get

$$\Delta p_t = \Delta p_{t-1} + \alpha + (1-\rho)\,\mu - \beta u_t$$

So, one can obtain an empirical accelerationist Phillips curve without making any assumptions about $\rho$. In particular, the microeconomic wage curve and macroeconomic accelerationist Phillips curve are completely compatible.[7] These derivations make it clear that adaptive inflation expectations is a crucial assumption underlying the derivation of the Phillips curve but that autoregressive real wage dynamics is not.

Note also that $\Delta p_t = \Delta w_t$ and so we have

$$\Delta w_t = \Delta p_{t-1} + \alpha + (1-\rho)\,\mu - \beta u_t$$

For all values of $\rho$ this equation is observationally equivalent to equation 2, which Blanchard and Katz have argued is inconsistent with the Blanchflower-Oswald wage curve ($\rho = 0$).

[7] This particular point is not original: a demonstration of it is available, for instance, in the opening chapter of Layard, Nickell and Jackman (1991).

### 3.2 Productivity Growth

Introducing productivity growth, instead assume that the markup over *unit* labor costs is constant. In other words, if $x_{it}$ is the productivity of worker $i$ at time $t$, then firm $i$ sets its price equal to

$$p_{ijt} = \mu + w_{ijt} - x_{it}$$

Of course, an individual's productivity also affects their real wage: we can model the dynamic relationship between productivity and real wages as

$$\left(w_{ij} - p^e\right)_t = \rho\left(w_{ij} - p\right)_{t-1} + \gamma_0 x_{it} + \gamma_1 x_{i,t-1} + \alpha_i - \beta u_{jt}$$

In long-run equilibrium with $p = p^e$, we will require real wages and productivity to move proportionally: without this assumption we would obtain a trend in the labor share of output. This restriction implies that $\gamma_0 + \gamma_1 = 1 - \rho$. Now repeating the algebra of aggregation from above, we get

$$w_t - p_t^e = \alpha - \rho\mu + \gamma_0 x_t + \left(\gamma_1 + \rho\right) x_{t-1} - \beta u_t$$

which can be re-written as

$$w_t - p_t^e = \alpha - \rho\mu + \gamma_0 x_t + \left(1 - \gamma_0\right) x_{t-1} - \beta u_t \tag{10}$$

Thus, as in equation 9, the constant markup assumption implies that $\rho$ cannot be identified from macro data.

Again, inserting the price expectations formula into equation 10 and using $w_t = p_t + x_t - \mu$ gives an accelerationist Phillips curve

$$\Delta p_t = \Delta p_{t-1} + \alpha + \left(1 - \rho\right)\mu + \left(\gamma_0 - 1\right)\Delta x_t - \beta u_t$$

This differs from the previous accelerationist formula in containing the rate of productivity growth as an explanatory variable. Note, however that $\gamma_0 = 1$ is possible: in fact, it implies an appealingly simple autoregressive process for the deviation of real wages from labor productivity.

$$(w_{ijt} - p^e_t - x_{ijt}) = \rho\,(w_{ij,t-1} - p_{t-1} - x_{ij,t-1}) + \alpha_i - \beta u_{it}$$

Thus, there need not be an observable relationship between productivity growth and the change in inflation.[8]

The simple algebra of aggregation makes an important point. Not only are both the wage curve and micro-level Phillips curve ($\rho = 1$) consistent with an aggregate accelerationist Phillips curve, given the constant markup assumption *all* possible micro-dynamics for real wages produce the same observable macro behavior. Markup pricing and adaptive inflation expectations are the crucial assumptions required to derive the accelerationist Phillips curve; the microeconomic dynamics of real wages are irrelevant.

# 4 Some Evidence on the Markup

The assumption of a constant price markup over unit labor costs has been a feature of almost all Keynesian models of inflation, from standard derivations of the accelerationist Phillips curve such as the one above, to textbook derivations of the aggregate supply curve such as Dornbusch and Fischer (1994) to staggered contract models such as Taylor (1980). How reasonable an assumption is it?

## 4.1 Cyclicality of the Aggregate Markup

Defining the average markup over unit labor costs as

$$\mu_t = \frac{P_t}{\frac{W_t L_t}{Y_t}} = \frac{P_t Y_t}{W_t L_t} \tag{11}$$

[8]One can also note, though, that Robert Gordon's estimation of the accelerationist Phillips curve usually includes a productivity gap variable: see for instance Gordon (1997).

where $P_t$ is the price of non-farm business output, $W_t$ is the average level of employee compensation, $L_t$ is total labor input and $Y_t$ is real business output, we can measure it empirically as the ratio of nominal non-farm business output excluding housing (from the NIPA data) to total nominal compensation of employees (from the BLS Productivity and Cost release). Figure 1 graphs this series with NBER recession periods shaded. The figure shows that the constant markup assumption is seriously at odds with reality. A distinct pro-cyclical pattern is clear, with dips apparent during all cyclical low points. Over 1960:1 to 1996:4, the markup has a correlation with unemployment of $-0.16$ and with the output gap (defined as the deviation of output from trend with the trend estimated on an NBER peak-to-peak basis) of 0.36.[9]

Table 1 reports some simple regression results for the aggregate price markup, using the sample 1962:1 to 1996:4: t-statistics are in parentheses. The regression in the first column shows that there is a high degree of autocorrelation in the price markup over unit labor costs with a fourth-order polynomial distributed lag estimated for 8 lag coefficients revealing an $\bar{R}^2$ of 0.706. The second column reports that including the output gap adds significant explanatory power: the coefficients suggest that the change in the output gap has a sizeable positive effect followed by a smaller negative effect. Since changes in the output gap are positively autocorrelated, these estimates impart a relatively strong pattern of procyclicality to the markup.[10]

What is the cause of this procyclicality? Equation 11 makes it clear that the answer must be some combination of prices rising relative to wages during expansions and/or

[9]The peak-to-peak trend calculation treats the "double-dip" of the early 1980s as one recession: in other words, the period between the 1980 and 1982 recessions is not considered an output peak.

[10]This evidence of a procyclical markup over unit labor costs may seem to contradict evidence of countercyclical price markups, as presented for instance by Julio Rotemberg and Michael Woodford (1991). This is not necessarily the case, however, since their evidence on countercyclical markups refers to the price markup over *marginal* cost.

procyclical productivity due most likely to labor hoarding. However, the former would imply a counter-cyclical real wage, which is well known not to be the case. Thus, we may suspect that productivity movements are responsible: the third regression in Table 1 confirms this. Accounting for movements in productivity relative to its trend (again defined on a peak-to-peak basis) leads to the statistically significant coefficients on the output gap disappearing.

The procyclicality of the aggregate markup thus occurs because workers do not ease nominal wage demands sufficiently during recessions to offset declining productivity and firms do not raise prices enough to offset the consequent increase in unit labor costs. To see that firms do not adjust prices fully to reflect movements in costs, observe the behavior in Figure 2 of the annualized quarterly inflation rates of unit labor costs and output prices (as measured by the non-farm business output deflator). This figure clearly shows that unit labor costs are substantially more variable than output prices: over the period 1960:1 to 1996:4 these two series have almost identical sample means (4.02 for price inflation versus 4.04 for cost), but unit cost inflation has a variance of 4.84, which is over twice the value for the variance of output price inflation (2.08).

This pattern is consistent with firms and workers setting wages and prices according to trend productivity: the final two columns look at a productivity-adjusted markup which is calculated by replacing observed real output with the value consistent with trend productivity. Figure 3 graphs this adjusted price markup along with the unadjusted series. The figure shows that the adjusted series does not exhibit steep declines during recessions: in fact, it moves somewhat counter-cyclically, having a correlation with the output gap of -0.29 and with the unemployment rate of 0.03. The regression in the fifth column of Table 1 confirms a weak countercyclical pattern with signs on the contemporaneous and lagged output gap which are the opposite to that for the unadjusted markup, although smaller in magnitude and adding considerably less explanatory power.

### 4.2 Re-Formulating Wage-Price Dynamics

The regression results suggest that we can re-formulate the price and wage equations as

$$\left(w_{ij}-p^{e}\right)_{t}=\rho\left(w_{ij}-p\right)_{t-1}+\gamma_0\hat{x}_{it}+\gamma_1\hat{x}_{i,t-1}+\alpha_i-\beta u_{jt} \tag{12}$$

$$p_{it}=\mu+w_{ijt}-\hat{x}_{it}+\eta u_{jt} \tag{13}$$

where $\hat{x}_{it}$ is trend productivity. Thus, real wages, while insensitive to cyclical movements in productivity, are procyclical due to the effects of unemployment and, controlling for productivity movements, the markup over unit labor costs is slightly countercyclical, with this modelled by the introduction of an unemployment term into the markup equation. Now aggregating up we get

$$w_{t-1}-p_{t-1}-\hat{x}_{t-1}=-\mu-\eta u_{t-1}$$

Thus, our aggregate wage equation is

$$w_t-p_t^e=\alpha-\rho\mu+\gamma_0\hat{x}_t+(1-\gamma_0)\hat{x}_{t-1}-\beta u_t-\rho\eta u_{t-1} \tag{14}$$

Substituting out the aggregate wage level and inserting the price expectations formula again gives us an accelerationist Phillips curve:

$$\Delta p_t=\Delta p_{t-1}+\alpha+(1-\rho)\,\mu+(\gamma_0-1)g-(\beta-\eta)u_t-\rho\eta u_{t-1} \tag{15}$$

where $g$ is the trend rate of productivity growth.

So, as long as $\beta>\eta$, the only new implication from the re-formulated equations is that the accelerationist Phillips curve will have a negative coefficient on the lagged unemployment rate if $\rho$ is non-zero. However, an alternative possibility could be that

| | Unadjusted Markup | | | Adjusted Markup | |
|---|---|---|---|---|---|
| Sum of 8 Lags | 0.779 (12.92) | 0.802 (14.87) | 0.787 (14.81) | 0.732 (12.37) | 0.728 (12.2) |
| Output Gap | | 0.658 (9.79) | 0.031 (0.32) | | $-0.164$ $(-3.17)$ |
| Output Gap(-1) | | $-0.691$ $(-6.7)$ | 0.071 (0.44) | | 0.227 (2.95) |
| Output Gap(-2) | | $-0.207$ $(-2.11)$ | $-0.238$ $(-1.48)$ | | $-0.135$ $(-1.75)$ |
| Output Gap(-3) | | 0.252 (3.44) | 0.147 (1.5) | | 0.049 (0.96) |
| Productivity Gap | | | 1.125 (8.28) | | |
| Productivity Gap(-1) | | | $-1.027$ $(-4.98)$ | | |
| Productivity Gap(-2) | | | $-0.061$ $(-0.3)$ | | |
| Productivity Gap(-3) | | | 0.139 (1.02) | | |
| $\bar{R}^2$ | 0.705 | 0.841 | 0.895 | 0.763 | 0.778 |

Table 1: Cyclicality of the Aggregate Price Markup

the true $\rho$ does equal zero but that the micro-level wage curve includes lags of the unemployment rate. Indeed, Blanchflower and Oswald (1994, pg. 169) have reported significant negative effects for lagged unemployment in non-dynamic wage regressions. Thus, the fact that empirical implementations of the Phillips curve such as Gordon (1997) find significant effects on inflation of lagged unemployment rates tells us essentially nothing about $\rho$. Our earlier conclusion is thus robust: differing values of $\rho$ still produce observably identical inflation dynamics.

# 5 Conclusions

The standard derivation of the accelerationist Phillips curve takes as its starting point the assumption that the expected change in real wages is a function of the unemployment rate. As a result, a recent debate over the legitimacy of the macroeconomic Phillips curve has focused on whether this is a reasonable assumption. This paper has shown, however, that once one makes the also-standard assumption of a constant price markup, then the specification of micro-level real wage dynamics has no observable implications for macroeconomic time series data on price or wage inflation. While the assumption of a constant price markup over unit labor costs is systematically incorrect, the alternative assumption of a marginally countercyclical markup once we have adjusted for movements in productivity fits the data well and is also consistent with this result. Since a particular formulation of real wage dynamics is not required to obtain the accelerationist Phillips curve, it may be more useful to reflect instead upon another assumption which is crucial to its derivation - adaptive inflation expectations - and whether a rational alternative can capture the autoregression which is present in empirical inflation regressions.

Another important conclusion concerns macroeconomic methodology. Blanchflower and Oswald (1994) state in their concluding chapter: "A. W. Phillips curve ... is, if anything at all, a kind of misspecified aggregate wage curve. The autoregression - indeed unit root - imposed by Phillips seems largely to disappear when micro data are used .... Paradoxically, the use of macroeconomic data may have done macroeconomists a disservice". An alternative lesson seems more appropriate: economists are ill-served when conclusions about macroeconomics are drawn from micro data without consideration of the restrictions imposed by aggregation.

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