

Masked inflation in USA: why does productivity growth hide inflation?

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Abstract

This paper aims to analyze how productivity growth masked inflation in the USA, focusing on the peculiar period between 1990 and 2006. Between those years it seems that monetary expansion had no effect on the inflation rate, leading some Keynesian scholars to revive the old theory of John Maynard Keynes. In this analysis, we found that the inflation rate did actually rise after the monetary expansion, but in a masked way. The monetary policy in the USA didn't adjust for trend productivity growth, allowing it to lower prices. What we see in the inflation rate series is the inflation not covered by productivity growth, which is part of the true inflation produced.

1. Introduction

This study provides an analysis of the relationship between money growth, inflation rate, and productivity growth. The main idea is to show that the general price level of goods and services is directly proportional to the amount of money in circulation, as stated in the "Quantity theory of money", in contrast to what was reported by John Maynard Keynes in the "The General Theory of Employment, Interest and Money" [2]. Keynes stated that a monetary expansion would not lead to a higher inflation rate until full employment is reached. This statement has been evidently falsified by every time period after, except for the ones between 1990 and 2006 from which some confusion arose. Some Keynesian scholars saw in that period the realization of Keynes' theory. Our goal is to show that also in those years inflation has proportionally risen in a masked way, due to the role of productivity growth.

Every quantitative test performed in this paper and every cited robustness check result can be easily replicated with the shiny app, created by us, available at [Masked_inflation_app](#). The paper is structured as follows: Section 2 illustrates Keynes' statements and their flaws; Section 3 is a short description of the data used for the whole analysis; in Section 4 we explain the Micheal T. Kiley's theory and replicate his tests with different data; in Section 5 we tested the hypothesis of section 4 in the years after 2000; Section 6 is the most important one and shows that also in the 90s inflation has risen proportionally in a masked way and Section 7 concludes the paper with a concise sum-up.

2. Keynes' theory about inflation and monetary expansions

John Maynard Keynes in the "The General Theory of Employment, Interest and Money" said that is always a good idea to lower interest rates to the zero level, in order to keep us permanently in a "quasi-boom". He was aware of the argument that a runaway economic boom could lead to inflation, and that higher interest rates could be used to dampen a boom and thus forestall inflation. He however said:

Booms may create bottle-necks in which the price of some products rise. But we cannot declare that conditions of inflation have set in until unemployment has completely disappeared. - John Maynard Keynes [4].

He also affirmed that if inflation would rise:

The remedy for the boom is not a higher rate of interest but a lower rate of interest. - John Maynard Keynes [4]

A crucial point in his theory is to understand what he meant by "unemployment has completely disappeared":

We have full employment when output has risen to a level at which the marginal return from a representative unit of the factors of production has fallen to the minimum figure at which a quantity of the factors sufficient to produce this output is available. - John Maynard Keynes [4]

This means, in essence, that we have not reached full employment until all factors of production are fully employed. We will recall that, per Keynes, only at this point do we have to worry about inflation. This is a really stringent condition that almost never happened.

The theory of Keynes has been falsified by all the following periods in which, after a monetary expansion, the inflation rate rose with only one exception: the period between 1990 and 2005. This period has been characterized by monetary expansion and a low inflation rate, thus leading Keynesian scholars to find here the realization of Keynes' prediction. What they failed to take into account is the role of the productivity growth of the period, which led to lower prices, thus masking inflation.

3. Data description

The data collected are from the Federal Reserve Board's FRB/US model database and from Federal Reserve Economic Data (FRED). All the series are annual data and span from 1969 to 2019. Each monthly and quarterly data has been manipulated through the mean operator to turn them into yearly observations. Moreover, the variables, except for *prod_roh2*, *inf_cpi_stick*, and *unemprate_civ*, which are already percentage change, have been modified to retrieve the growth rate. Each retrieved growth rate variable is named as *timeseries_ld* and computed as $\text{diff}(\log(x)) * 100$. A description of the variables will follow.

- *rgdp*: Real output for the business sector. The constant base-year market value of goods and services produced by labor and property in the United States.
<https://www.federalreserve.gov/econres/us-models-package.htm>
- *ngdp*: Nominal output for the business sector. The current market value of goods and services produced by labor and property in the United States.
<https://www.federalreserve.gov/econres/us-models-package.htm>
- *wages*: Wage and salary disbursements and supplements to wages and salaries received by U.S. residents. It's the nominal compensation per hour for the employees

of the business sector.

<https://www.federalreserve.gov/econres/us-models-package.htm>

- *prod_roh1*: Real output per hour of all persons for the business sector: labor productivity.

<https://fred.stlouisfed.org/series/OPHPBS>

- *prod_roh2*: Percentage change at annual rate of the real output per hour of all persons for the business sector, seasonally adjusted. Labor productivity, or output per hour, is calculated by dividing an index of real output by an index of hours worked by all persons, including employees, proprietors, and unpaid family workers.

<https://fred.stlouisfed.org/series/PRS84006092>

- *prod_tfp*: Total Factor Productivity at Constant National Prices for the United States. It is the ratio of aggregate output to aggregate inputs. Under some simplifying assumptions about production technology, growth in TFP becomes the portion of the growth in output not explained by growth in traditionally measured inputs of labor and capital used in production.

<https://fred.stlouisfed.org/series/RTFPNAUSA632NRUG>

- *m2*: It is an aggregated money stock measure that includes M1 plus all other financial assets which, like money, have high liquidity and certain value at any time in the future.

<https://fred.stlouisfed.org/series/M2SL>

- *inf_defl*: Price index for business output. Also called GDP Deflator in the following tables. It is a measure of the level of prices of all new, domestically produced, final goods and services in the US economy in a year.

<https://www.federalreserve.gov/econres/us-models-package.htm>

- *inf_cpi_nofe*: Consumer Price Index for All Urban Consumers: All Items Less Food and Energy in U.S. City Average. The CPI NOFE is an aggregate of prices paid by urban consumers for a typical basket of goods, excluding food and energy. This measurement, known as "Core CPI", is widely used by economists because food and energy have very volatile prices.

<https://fred.stlouisfed.org/series/CPILFESL>

- *inf_cpi_stick*: Percent Change from Year Ago, The Sticky Price Consumer Price Index (CPI) is calculated from a subset of goods and services included in the CPI that change price relatively infrequently.

<https://fred.stlouisfed.org/series/CORESTICKM159SFRBATL>

- *unemprate_civ*: Civilian unemployment rate.
<https://www.federalreserve.gov/econres/us-models-package.htm>

4. Why is inflation low when productivity growth is high?

In order to see if productivity growth did mask inflation we need to know which relationship there is between the two series.



Figure 1. Graphical representation of Labour Productivity growth and GDP Deflator growth series. Sample period: 1969-2019.

The negative correlation is evident from figure 1 and the cross-correlation function tells us that it is strong and at lag 0, meaning that using annual data the association is contemporaneous. A very reasonable explanation for this negative correlation is provided by Micheal T. Kiley in his paper "Why is inflation low when productivity growth is high" [4]. His main argument is that the federal reserve did not adjust the monetary policy to productivity growth, meaning that, for every target inflation they did not take into account the effect of productivity growth, deciding the magnitude of the monetary expansion. This lets productivity growth show its effect on prices: high productivity growth lowers production costs and leads to lower final prices because of a higher supply. This theory has two main empirical implications:

1. an increase in trend productivity growth of one percentage point is accompanied by a one percentage point in inflation;
2. one key factor leading to low inflation during periods of strong productivity growth is the absence of an adjustment in monetary policy to the shift in productivity growth. Therefore, growth in nominal wages and nominal income are invariant to changes in productivity growth.

First of all, we replicate these two tests of hypothesis with the same series that Kiley used (with a shorter sample period: 1969-2000 instead of 1950-2000) corroborating the two empirical implications.

	GDP Deflator	Wages	Nominal Output
(Intercept)	6.24*** (0.88)	6.40*** (0.95)	6.65*** (1.07)
ma_prod_roh1_ld	-1.20** (0.40)	-0.24 (0.43)	0.41 (0.49)
R ²	0.23	0.01	0.02
Adj. R ²	0.21	-0.02	-0.01

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

Table 1: The first regression output tests empirical implication 1 and the other two tests empirical implication 2. Sample period: 1970-2000. Standard errors of estimated parameters in parentheses

The coefficient on productivity growth in the GDP Deflator regression (table 1) indicates that a one-percentage-point increase in productivity growth is accompanied by, approximately, a one-percentage-point decline in inflation. This simple regression tested the first empirical implication and this is not controversial because as Kiley said:

If monetary policy did not adjust the medium-run target for nominal income growth when productivity growth changes, Implication 1 is in the long run an identity. - Michael T. Kiley [5]

If the monetary policy would instead adjust the target for the nominal income growth, medium-run inflation would be independent of trend productivity growth. The zero

coefficients on productivity growth in Wages regression and Nominal Output (table 1) show that nominal wages and nominal income are independent of productivity growth thus testing also the second empirical implication. We decided to test the GDP Deflator regression with different inflation series: we used the CPI NOFE which does not take into account farm and energy sectors, because prices often change for exogenous reasons, and CPI Stick which takes into account only a subset of goods and services that change price relatively infrequently. The same regressions of table 1 and table 2 have been replicated also with the other two different measures of productivity growth of our dataset corroborating the results.

	GDP Deflator 1	CPI NOFE	CPI Stick
(Intercept)	6.24*** (0.88)	7.46*** (0.79)	8.43*** (0.91)
ma_prod_roh1_ld	-1.20** (0.40)	-1.28** (0.36)	-1.49** (0.42)
R ²	0.23	0.30	0.31
Adj. R ²	0.21	0.28	0.28

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

Table 2: Three regression outputs testing empirical implication 1 with different inflation measures. Sample period: 1970-2000. Standard errors of estimated parameters in parentheses

Table 2 shows that using these more appropriate measures of inflation the results are still robust. Replications with different measures of productivity lead to the same conclusions. Furthermore, we implemented a regression keeping in the model also the unemployment rate and the first lag of inflation to see if the coefficient of productivity growth still remains significant and, as table 3 shows, it does at the 95% confidence interval.

	Traditional Phillips Curve	* With MA Productivity Growth
(Intercept)	3.43** (1.17)	4.80*** (1.23)
lag1_inf_defl_ld	1.07*** (0.12)	1.00*** (0.12)
unemprate_civ	-0.59* (0.22)	-0.60** (0.20)
ma_prod_roh1_ld		-0.53* (0.22)
R ²	0.77	0.81
Adj. R ²	0.75	0.79

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

Table 3: The first regression output is the replication of a traditional Philips Curve model. The second regression output is a modified one: 2 years backward moving average of *prod_roh1_ld* has been added. Sample period: 1970-2000. Standard errors of estimated parameters in parentheses

This model is nothing more than a traditional Philips curve model with the inclusion of productivity growth and it is also remarkable that using whatever measure of inflation and productivity growth the one we implemented explains more variance than the traditional one (higher adjusted R squared).

5. Does Kiley's theory hold beyond 2000

Once we can be sure that the monetary policy did not adjust for trend productivity growth and that we can spot the effects on the inflation series in the USA before 2000, we tried to see if the test would lead to the same results also with the new sample period between 2000 and 2019.

	GDP Deflator	CPI NOFE	CPI Stick	Wages	Nominal Output
(Intercept)	1.69*** (0.34)	2.07*** (0.19)	2.26*** (0.26)	2.24** (0.60)	3.72** (1.10)
ma_prod_roh1_ld	-0.04 (0.15)	-0.04 (0.08)	0.04 (0.12)	0.42 (0.26)	0.12 (0.48)
R ²	0.00	0.02	0.01	0.12	0.00
Adj. R ²	-0.05	-0.04	-0.05	0.08	-0.05

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

Table 4: The first three regression outputs test empirical implication 1 with different measures of inflation. The last two regression outputs test empirical implication 2. Sample period: 2000-2019. Standard errors of estimated parameters in parentheses

As we can see from table 4 it seems that only the empirical implication 2 is verified for this sample period. This result is not expected because if both of them were falsified we could think that the monetary policy did adjust for trend productivity growth but what we see is that there is no association between productivity growth and inflation, nominal income, and nominal wages growth. A possible explanation for this odd behavior could be the inability of productivity measures to capture what they have to, after the 90s. The last 20 years, indeed, feature a great amount of innovation, many of these coming from the ICT sector, but if we look at the productivity growth series (figure 2) it seems that innovation decreased with respect to the previous years.

There are different views on what factors explain the slowdown. But one view challenges the very reality of the slowdown, arguing that the slowdown wholly or largely reflects the failure of the productivity statistics to capture recent productivity gains, particularly those from new and higher-quality ICT goods and services. - Kemal Dervis, Zia Qureshi [3]

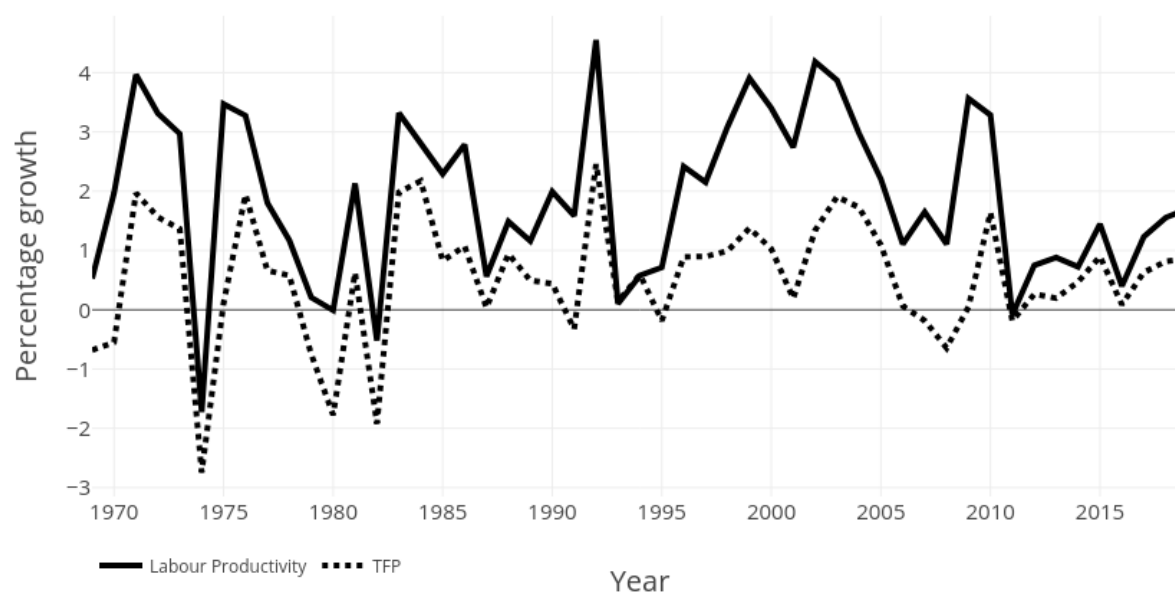


Figure 2. Graphical representation of Labour Productivity growth and Total Factor Productivity growth series. Sample period: 1969-2019.

One of the most convincing explanations for the mismeasurement is provided by the Schumpeterian perspective of Professor Philippe Aghion, who stressed on different occasions that when creative destruction takes place, it becomes problematic to understand what part of the variation of prices is imputable to inflation and what part of it is imputable to productivity growth. The French professor calls this statistical question “the imputation problem” and he describes it in the subsequent way:

Missing growth is a function of the frequency and size of quality improvements from creative destruction versus other types of innovation (such as improvements incumbents make to their own products). If the statistical office is correct to assume that the quality-adjusted inflation rate is the same for creatively destroyed products as for surviving incumbent products, then the market share of surviving incumbent products should stay constant over time. If instead the market share of these incumbent products shrinks systematically over time, then the surviving subset of products must have higher average inflation than creatively destroyed products. For a given elasticity of substitution between products, the more the market share shrinks for surviving products, the more the missing growth. - Philippe Aghion [1]

It is not a case that creative destruction innovation has played a very important role in the last 20 years largely increasing with respect to the precedent years. It's important to stress that: if classical measures of productivity growth are not effective, can the monetary policy adjust for trend productivity growth (even if they wanted to do so)? We can still rely on previous conclusions also for the new sample period.

6. Masked inflation (1990-2006)

In the 90s the macroeconomic performance has been exceptionally good and this is evident looking at any of the three most important macroeconomic series: inflation, unemployment, and real growth. No aspect of U.S. policy in the 1990s is more widely hailed as a success than monetary policy and the Fed Chairman Alan Greenspan is often viewed as a miracle worker.

Many Americans share the admiration that Senator John McCain expressed during his presidential bid. When the senator was asked about Greenspan's conduct of monetary policy, McCain said that if anything were to happen to the Fed chairman, as president he would take the strategy followed in the movie Weekend at Bernie's: He would prop up the chairman's body, give him some sunglasses, and keep him on the job as long as possible. - N. Gregory Mankiw [7]

Among the three macroeconomic series, the inflation one is for sure the most relevant from the monetary policy perspective. Indeed, although there is no doubt that central bankers also influence unemployment and real growth, according to standard theories of monetary policy, central-bank actions have only a transitory effect on unemployment and real growth. By contrast, the effects of monetary policy on inflation continue in the long run and indeed are strongest. The 90s has been a decade with a low average inflation rate and very stable compared with the previous twenty years even if there was a strong monetary expansion that kept the interest rate low. What concerns us is if Alan Greenspan did a very good job or was, instead, very lucky.

I'm baffled. I find it hard to believe...What I'm puzzled about is whether, and if so how, they suddenly learned how to regulate the economy. Does Alan Greenspan have an insight into movements in the economy and the shocks that other people don't have? - Milton Friedman [2]

Many reasons can explain the good performance without giving credit to the FED but this paper focuses on masked inflation. The idea pointed out by the economist Ludwig

von Mises, talking about the 1920s, is that, when the economy is highly productive and business costs make consumer prices fall, inflation is harder to discern. This concept applies very well also to the 1990s.

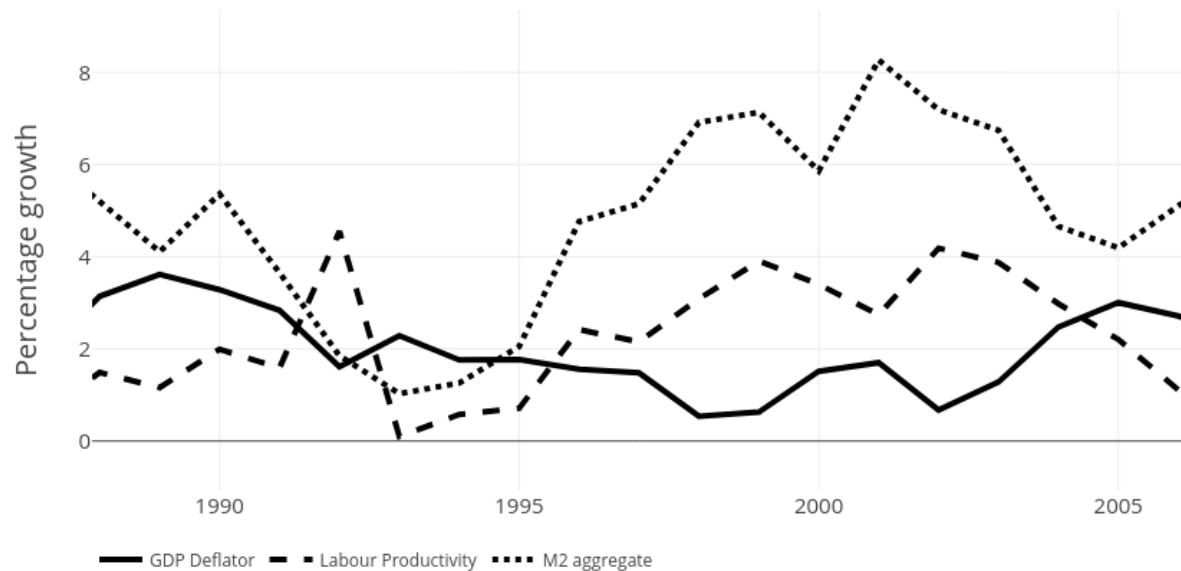


Figure 3. Graphical representation of Labour Productivity growth, M2 Aggregate growth, and GDP Deflator growth series. Sample period: 1988-2006.

In addition to the high productivity, in this period there was the globalization of the labor market, which brought in cheap goods from countries with lower labor costs.

If prices should fall by, say, 3% a year, but in fact rise by 3%, what is happening? The explanation is that government is creating (and injecting into the economy) enough new money to raise prices by 6%. Of course, this is masked. It appears that prices are only rising by 3%, when they are actually rising by 6%. - Hunter Lewis [6]

The graph in figure 3 shows that when there is a monetary expansion but the productivity growth increase, the inflation rate is not reactive to the money growth. To detect this phenomenon we tried to perform two simple regressions: The first one uses only money growth to explain the inflation rate, while the second one also adds productivity growth as a regressor. To clean them from noise, a 2 years backward moving average is computed for both productivity growth and M2 growth. The second lag of M2 growth is

used because we know, from the cross-correlation function analysis, that money growth and inflation rate, on a sample period of 50 years, are associated with highest strength at lag 2.

	GDP Deflator (1)	GDP Deflator (2)
(Intercept)	1.15*	2.00***
	(0.53)	(0.38)
lag2_ma_m2_ld	0.16	0.30***
	(0.10)	(0.07)
ma_prod_roh1_ld		-0.67***
		(0.14)
R ²	0.15	0.66
Adj. R ²	0.10	0.62

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

Table 5: The first regression output tests the simple association between money growth and inflation rate. The second regression output tests the same thing adding productivity growth. Sample period: 1988-2006. Standard errors of estimated parameters in parentheses

As the first model of table 5 shows, money growth seems not to be associated with the inflation rate during the period of interest (the coefficient is low and not statistically significant). However, the second model of table 5 shows that when we account for productivity growth, money growth becomes extremely significant and has a higher coefficient. What is important to notice is that the effect of productivity growth (significant and strong) completely covers the effect of money growth. One percentage-point increase in money growth is associated with a 0.3% increase in the inflation rate but if productivity growth increases by one percentage point the inflation rate decrease by 0.67%. Finally, the model with both money growth and productivity growth explains a lot of the variance in the inflation rate during this period (and also in the larger sample period 1969-2006).

7. Conclusions

In this study, we assessed how productivity growth can mask the inflation rate when the monetary policy doesn't adjust for it. The main finding is that even in the odd

period between 1990 and 2006 when the macroeconomic performance was very good and the monetary expansion seems not to have any effect on the inflation rate, the money growth did indeed increase the true inflation rate. It is the opinion of the authors that it is difficult to judge, in a simultaneous way, if the heads of central banks are doing a good work and that before elevating figures such as Alan Greenspan, leading others to replicate the same policies, it is wise to substantiate their effects. It is indeed controversial that few months after Greenspan left the position of Fed Chairman the bursting of the United States housing bubble happened. For further research, testing our findings also in different countries could make them stronger and more general.

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