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THE GLOBAL DISINFLATION PUZZLE. A SELECTIVE REVIEW OF THE THEORY AND EVIDENCE IN AN HISTORICAL CONTEXT

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The Global Disinflation Puzzle
A Selective Review of the Theory and Evidence in an Historical Context

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Abstract

In the last three decades average inflation rates have declined around the world. Since 1995 the number of countries with inflation rates below 10% a year increased from 98 (54% of the total) to an average of 178 in 2015-2019 (90% of the total). In the aftermath of the 2008 Global Financial Crisis (GFC), inflation in the US has averaged 1.8% a year despite an unprecedented monetary expansion, and more recently, a drop in the unemployment rate to historical lows. In the last decades, two of modern macroeconomic theory's most important relationships appear to have broken down: the Quantity Theory of Money (QTM) and the Phillips Curve (PC). This paper i) presents evidence confirming the global disinflationary trend of the last three decades, ii) identifies previous historical episodes during which the QTM appeared to break down in the US and the UK and reviews the theoretical reassessment that it provoked, iii) examines experts' reaction to the apparent current breakdown of the QTM and the PC and the alternative paradigms that have emerged, and iv) summarizes the alternative hypotheses that have been proposed to explain the global disinflation of the last few decades, focusing particularly on the effects of technological innovation and globalization.

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Changes in the general level of prices have always excited great interest. Obscure in origin, they exert a profound and far-reaching influence on the whole economic and social life of a country.

Knut Wicksell (1898)

1. Introduction

Over the last three decades, a steady decline in inflation rates in the face of an expansion in the money supply and a simultaneous decline in the unemployment rate, particularly in the US and the UK, seem to have broken two of modern macroeconomic's most important relationships: the Quantity Theory of Money (QTM) and the Phillips Curve (PC). The former is one of the oldest laws in economics, dating back to the 16th century; the latter was born in the late 1950s as an outgrowth of Keynesianism.

Since October 2008, the central banks of the G-7 countries launched an unprecedented and coordinated massive monetary expansion –euphemistically referred to as Non-Conventional Monetary Policy (NCMP) or Quantitative Easing (QE)– to stimulate an economic recovery. To the surprise of many monetary experts, this expansion did not lead to a pick up in inflation rates as would have been predicted by a simplistic interpretation of the QTM. In fact, in the last decades inflation has declined slightly, not only in G-7 countries but also in the rest of the world.[2] However, the QTM is alive and well in several countries that are outliers in terms of their inflation rates such as Argentina and Venezuela.

As to the PC, its slope –using either the unemployment or the output gap as an explanatory variable– had been flattening for decades. Moreover in the aftermath of the Global Financial Crisis of 2008 (GFC) has reversed its sign: in the US the unemployment rate fell from almost 10% in December 2009 to 3.5% in December 2019, while during the same period the annual inflation dropped from 2.8% to 1.5%. In other advanced economies, although a trade-off between unemployment and inflation persists it is much weaker than in previous decades.

[2] Countries like Argentina and Venezuela in which populism is endemic or like Zimbabwe and Congo in which institutions are less developed have continued to experience high rates of inflation. But they have become outliers.

Both developments have important implications at the theoretical amd policymaking levels. Economists have provided a variety of hypotheses to explain the strong disinflation of the last three decades.[3] These explanations do not necessarily invalidate the QTM but they raise serious questions: is its main underlying prediction "dormant" due to structural changes in the global economy? If so, when can we expect their impact to diminish or reverse and reawaken the QTM? A few years before the GFC former Fed's Chair Alan Greenspan anticipated some of these issues in a speech he gave at the Council of Foreign Relations:

> Over the past two decades, inflation has fallen notably, virtually worldwide, as has economic volatility. Although a complete understanding of the reasons remains elusive, globalization and innovation would appear to be essential elements of any paradigm capable of explaining the events of the past ten years (Greenspan, 2005).

The structure of this paper is as follows. Section 2 presents evidence that confirms the consistent fall in inflation rates around the world in the last 25 years. Section 3 presents two previous historical episodes in which QTM's traditional prediction also broke down. Section 4 summarizes the theoretical challenge posed by the most recent disinflationary trend which has apparently neutralized the main predictions of the QTM and the PC and provides a summary account of the alternative hypotheses economists have provided to explain this breakdown. The final section offers some concluding remarks and a conjecture about the future.

2. Declining Inflation: The Empirical Evidence

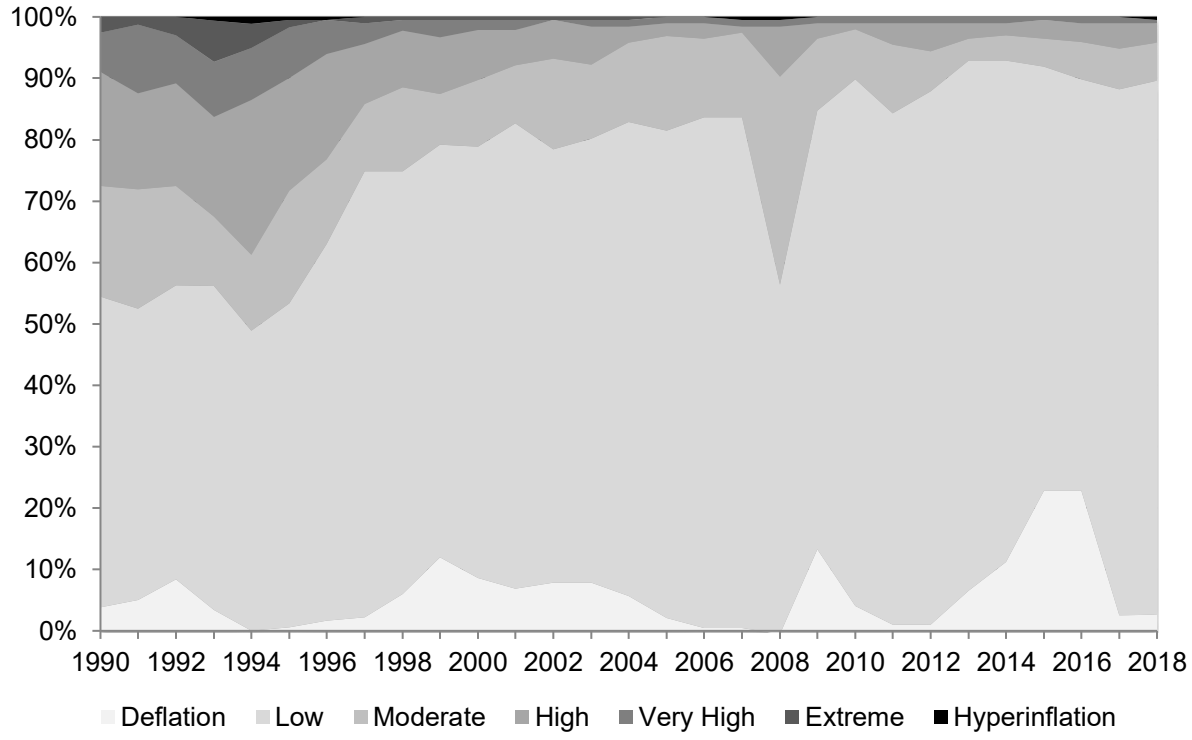
Whether inflation is high or low is relative to time and place. The literature distinguishes between high inflation, very high inflation, extreme inflation and hyperinflation. These distinctions are somewhat arbitrary. The first refers to a situation in which the inflation rate persistently exceeds 80% a year (Harberger, 1978); the second, 100% a year (Fischer, Sayah and Vegh, 2002); the third, 1,000% a year or more than 15% a month for several months (Dornbusch, Sturzenegger and Wolf, 1990), and the last is defined as starting when monthly inflation rates above 50% (Cagan, 1956). There is also "chronic inflation" which has been defined as "a condition in which price increases

[3] There deflation and disinflation are conceptually different. The latter refers to a reduction of the inflation rate to low but positive levels, while the former would indicate negative rates of growth. However, in the context of the article, it is deflationary forces that are driving the disinflation trends.

of more than 20% per annum" over an extended period of time, and of "acute" inflation, which is characterized by "rapid bursts of inflation" (Harberger, 1978). In this paper we will use the definitions: low inflation shall refer to single digit rates, moderate inflation to rates between 10% and 20%, high inflation above 20% and below 80% and very high inflation to rates of between 80% and below 1,000% a year. The definitions of extreme inflation and hyperinflation remain unaltered.

The chart below shows inflation rates around the world for the period 1990-2018 using the above definitions for a sample of countries the size of which increased from 150 countries in 1990 to 188 in 2018. As can be seen, the disinflationary trend of the last few decades has a global dimension. Only a dozen countries around the world continue to experience inflation rates above 20% a year.

Chart 1: Global Inflation Trends (1990-2018)



Source: IMF WEO, World Bank WDI databases, Reinhart and Rogoff (2010) and Inflación Verdadera for Argentina.

The chart confirms that disinflation has been a global phenomenon. Extreme inflation has completely disappeared and at the end of the second decade of the 21st century only ony case of hyperinflation survives: Venezuela. In 2018 only five countries (3% of the sample) fell into the

high inflation category (Argentina, Iran, Liberia, Sudan and Yemen) and only one in the very high inflation category (South Sudan). In 2019, Zimbabwe re-entered the groups of countries with very high inflation after a period of relative price stabiility (it had a bout of hyperinflation in 2007). In fact, 2018 marked the year with the highest percentage of countries with low inflation since 1900.

The composition of the "top ten" has changed significantly over the last three decades. In the 1990s it was mostly African countries (Democratic Republic of Congo and Angola), offshoots of the former Soviet Union such as Armenia and Ukraine as well as Brazil. There was an interlude during the first decade of the century, when even the country with the highest inflation rate in the world (Zimbabwe) experienced the worst hyperinflation in history. In the last decade, Latin America again dominates at the top echelons with two entries: Venezuela and Argentina. However, if we exclude the country with the highest inflation rate in the world during 2010-2018, the average level in the remaining nine is significantly lower than in the early 1990s (31% vs. 842% a year).

Table 1: The "Top Ten" Countries in Inflation

Country	1990-1999	Country	2000-2009	Country	2010-2018
D. R. of Congo	3,379.7%	Zimbabwe	2,205,860.6%	Venezuela	8,627.3%
Armenia	1,317.7%	D.R. of Congo	106.5%	South Sudan	100.2%
Angola	1,011.1%	Angola	80.3%	Sudan	32.1%
Turkmenistan	996.0%	Belarus	37.2%	Zimbabwe	27.4%
Ukraine	876.0%	Iraq	24.3%	Argentina	25.7%
Brazil	843.2%	Turkey	23.2%	Iran	21.7%
Peru	807.9%	Serbia	22.7%	Belarus	19.8%
Belarus	657.7%	Venezuela	21.0%	Yemen	17.1%
Tajikistan	591.5%	Myanmar	20.3%	Malawi	16.2%
Kazakhstan	473.2%	Eritrea	19.2%	Angola	16.1%

Source: IMF WEO Database October 2019 and April 2020 and Reinhart and Rogoff (2016).

In 2019 Zimbabwe regained a position in the top five having reached an average inflation rate of 255%.[4] And barring an attempt by the government to distort statistics (which it has done in the past), Argentina will probably also climb higher in the global rankings in 2021 given the massive monetary expansion that has taken place since the beginning of the year. An examination of the data since 1945, shows that Argentina more than any other country has been among the top ten

[4] Zimbabwe's official statistics are also misleading. Those published by the World Bank and the IMF don't reflect the hyperinflationary bout of 2007-2008.

with the highest inflations. The only exception was during the period 1991-2004. Other countries in Latin America like Brazil, Chile and Uruguay have been able to eliminate high inflation.

One interesting question is to what extent there exists a relationship between GDP per capita and inflation rates: are poorer countries more prone to inflation? Data from the IMF's *World Economic Outlook* (not always reliable given that it is based on official statistics) suggests a negative answer. The IMF divides the world into two separate groups: Advanced Economies, which includes 39 countries (Puerto Rico and Macau are included in this group) and Emerging Market and Developing Economies, which includes 155 countries. The average statistics for the period 2014-2018 (excluding outliers) are shown in Table 2 below:

Table 2: Global Inflation and GDP per capita (2014-2018)

	Advanced Economies		Emerging Market and Developing Economies	
	GDP pc	Inflation	GDP pc	Inflation
Average	43,185	1.0%	11,723	4.7%
Median	39,875	1.0%	7,947	2.7%
Maximum	94,256	2.7%	73,274	33.4%
Minimum	24,199	-0.3%	671	-0.5%

Source: IMF WEO Database October 2019. The data for Advanced Economies excludes Puerto Rico, Macau and San Marino. The table also excludes outliers for Emerging Market and Developing economies (Qatar and Venezuela) and one country for missing data (South Sudan). GDP per capita is in constant prices of 2011 at purchasing power parity. Inflation is average for the year.

There is no noticeable relationship between GDP per capita and inflation among the advanced economies. If anything, higher GDP per capita is associated with higher inflation rates. However, in this group inflation rates have not exceeded 3% a year during the period 2014-2018. When it comes to Emerging Market and Developing Economies the relationship between inflation rates and GDP per capita is also weak. This is due to the fact that two of the countries in this group with higher inflation rates (Argentina and Venezuela) also have relatively high average GDP per capita levels. If we eliminate both countries from the sample, a slight negative relationship between inflation and GDP per capita appears.

Table 3: Inflation and GDP per capita (2014-2018)

	Advanced			Emerging Market and Developing		
Inflation Rate (p.a.)	Average GDP pc	Number of Countries	% of Total	Average GDP pc	Number of Countries	% of Total
Below 1%	44,421	20	54%	13,246	33	22%
Between 1 and 2%	40,048	15	41%	16,863	30	20%
Between 2 and 5%	59,790	2	5%	14,620	41	27%
Between 5 and 10%	n.a.	0	0%	7,115	28	18%
Above 10%	n.a.	0	0%	8,075	21	14%

Source: IMF WEO Database October 2019. The data for Advanced Economies excludes Puerto Rico, Macau and San Marino. The table also excludes outliers for Emerging Market and Developing economies (Qatar and Venezuela) and two countries for missing data (Somalia and South Sudan). GDP per capita is in constant prices of 2011 at purchasing power parity. Inflation is average for the year.

In those countries included in the Emerging Market and Developing Economies category, institutional quality (as measured by V-Dem's Liberal Democracy Index) seems to have slightly more explanatory power than GDP per capita: lower institutional development is associated with higher inflation rates.

To conclude, the disinflation of the last three decades is a global phenomenon and has coincided with what is called the "Second Era of Globalization". This aspect doesn't seem to be of minor significance. In the first three decades of the "First Era of Globalization" (1870-1914), the world also experienced a similar phenomenon.

3. Disinflation with Monetary Growth: Previous Challenges to the QTM

QTM is one of the oldest theories in economics. According to Schumpeter, its first "explicit, full, and—so far as it went—theoretically satisfactory presentation" appeared in 1568, with the publication of Jean Bodin's *Réponse de J. Bodin aux paradoxes de M. de Malestroit* (Schumpeter, 1957, p.296). Among the illustrious minds who over the last four centuries have championed the QTM are John Locke, David Hume, Adam Smith, David Ricardo, John Stuart Mill, W. Stanley Jevons, Alfred Marshall and Irving Fisher. In his early days, Keynes was also a "true" believer. "This Theory is fundamental," he wrote in 1923. "Its correspondence with fact is not open to question but is often misstated and misrepresented". (1923, p.75). Despite its ancient lineage the QTM has probably stimulated "more debate than any other single topic in the field of monetary theory" (Humphrey, 1974).

Part of the problem with the QTM is that it is both a theory and a macroeconomic identity (the equation of exchange).[5] To consider them as equivalent would deprive the former "of any empirical or theoretical content" (McCallum and Nelson, 2010). The identiy by definition can never "break down". The theory is associated with the idea of monetary neutrality: in the long run, money has no real impact on the economy. Therefore, to the extent that the demand for money remains relatively constant over time, any exogeneous increases in the money supply will, in the long run, lead to a proportionate increase in prices. As Friedman (1987) explained:

> On an analytical level, it [the QTM] has long been an analysis of the factors determining the quantity of money that the community wishes to hold; on an empirical level, it has increasingly become the generalization that changes in desired real balances (in the demand for money) tend to proceed slowly and gradually or to be the result of events set in train by prior changes in supply, whereas, in contrast, substantial changes in the supply of nominal balances can and frequently do occur independently of any changes in demand. The conclusion is that substantial changes in prices or nominal income are almost always the result of changes in the nominal supply of money.

In his Nobel lecture, Lucas pointed out that the QTM could be applied "with remarkable success to comovements in money and prices generated in complicated, real-world circumstances" and very few "specific economic theories" could claim a similar "empirical success" (Lucas, 1996, p.666). During the last 150 years the UK economy experienced three deflationary waves that cannot be explained by changes in the money supply. The first took place between 1873 and 1896, the second, between 1921 and 1945, and the third, between 1999 and 2016 (continuing until presently). The former ended up with the discovery of the Transvaal gold deposits in 1895 and the latter with the post WWII economic recovery. In both cases, the supposed breakdown of the QTM contributed to the emergence of new theoretical paradigms that challenged it.

The period between 1873 and 1896 in some way resembles the last three decades: globalization, rapid technological change and massive expansion of global output and a major global financial

[5] The equation of exchange is usually represented MV = PQ, where M, Q, P and V respectively denote measures of the nominal quantity of money, physical output the price level, and velocity of circulation.

crisis (1890-1891). At the same time, the expansion of the agricultural frontier in the New World, enabled by technological change and massive migrations, led to an increase in the production of cereals that kept food prices in check. Between 1873 and 1896 the price of wheat declined at almost 1% a year in real terms, while the price of gold increased at 1.1% a year. The main difference between the two periods was the rate of growth of the money supply. The end of bimetallism and the general adoption of the gold standard around the world led to a contraction in the ratio of money to output.

In the UK, between 1873 and 1896 the general level of consumer prices fell 23.5% while the monetary base increased 18%. This discrepancy led to one of the most influential and lasting theoretical innovations in macroeconomics: Knut Wicksell's theory of the natural rate of interest.[6] Wicksell developed his theory partly to explain the evolution of prices and interest rates in nineteenth century England (Jonung, 1994, p. 394). Wicksell thought this discrepancy was "indisputable evidence" against the QTM and claimed the apparent inconsistencies with "actual facts have completely discredited that theory in the eyes of most people" (Wicksell, [1906] Vol. II, p.146, 154). In his view, the QTM as a "mere truism" with limited explanatory power (Wicksell, [1898], p.41). Although under certain conditions it was "capable of being correct", it did not mean that "the quantity of the available stock of money or of individual balances serves as a direct measure of commodity prices and determines their level" (*ibid.*, pp.34-35). However, the theory could not just "be thrown overboard" (*ibid*., p.50).

Such conclusion was incorrect. The causal relationship between money and prices posited by QTM is only valid for the world economy or for a closed economy with an inconvertible currency. For a small open economy operating under the gold standard or a fixed exchange rate regime with a convertible currency, the causal relationship between money and prices reverts, i.e., the money supply is endogenous and the price level is exogenous (see Humphrey and Keleher, pp.24-25). As Glasner (1985) has pointed out, "many classical theorists sometimes confused their theories by introducing quantity-theoretic propositions into arguments to which the quantity theory was not applicable (p.55)." More specifically, it was not applicable under the gold standard, since "the

[6] The apparent breakdown in the QTM was partly caused by the end of bimetallism in Europe.

price level was determined by the value of gold, not the quantity of nominal balances" (ibid., p.47). The deflation that led to Wicksell's theory took place under the gold standard.

Although Wicksell rejected the QTM he implicitly incorporated it into his own theory of the price level (Humphrey, 1997). In fact, he also admitted that "there is no doubt that large and continuous issues of paper money lead to a corresponding fall in the value of the paper money, which, as might be expected, is in exact accordance with the principles of the Quantity Theory" ([1906], Vol.II, p.167). Wicksell specifically mentioned the experience of Colombia between 1899 and 1902 to back this assertion.

According to Wicksell there was "a certain rate of interest on loans which is neutral in respect to commodity prices, and tends neither to raise nor to lower them. This is necessarily the same as the rate of interest which would be determined by supply and demand if no use were made of money and all lending were effected in the form of real capital goods. It comes to much the same thing to describe it as the current value of the natural rate of interest on capital (p.102)." He defined this rate as "the real interest of actual business" ([1906], Vol.II, p. xxv) which depended "on the efficiency of production, on the available amount of fixed and liquid capital, on the supply of labour and land, in short on all the thousand and one things which determine the current economic position of a community; and with them it constantly fluctuates" ([1898], p.106).

The divergence between the natural rate and the actual monetary rate at which businessmen could borrow funds was the primary determinant of the evolution of general prices: it would lead to an excess demand for society's savings which in turn lead to an excess aggregate demand for goods. Since the natural rate was not directly observable, it constantly fluctuated and Wicksell did not provide any guidance as to how to estimate it, it was impossible at the time to verify his theory.[7] In *Interest and Prices* he argued that during the period 1873-1896:

> There was a considerable lack of really profitable openings for the additions to liquid capital which arose out of the savings of almost all classes of the community. The increase in real capital served rather to raise real wages and the rewards of other factors of production. The natural rate of interest consequently fell

[7] Wicksell also ignored inflationary expectations and did not distinguish between real and nominal rates.

> everywhere… The money rate of interest also fell, but whether it fell to a corresponding degree must be regarded as doubtful. For effect cannot precede cause, and furthermore there were monetary influences operating in the opposite direction. The production of gold was slackening (it has caught up again only in the last few years), cash payments were resumed in several countries (France, the United States), and finally silver was extensively demonetized.

As to the global disinflation trend, Wicksell's explanation also seems applicable to the current situation:

> If there occurs such a general and enduring fall of prices as was witnessed in the last three decades before 1890, at any rate as regards world prices, this is found to be sufficiently explained by reference to the progress in the technique of production and transport: goods are produced more cheaply and are transported more cheaply, therefore they are cheaper. (1906, p.154)

Basically, in Wicksell's theory cyclical price movements were driven by productivity shocks while monetary factors "played at most a secondary, albeit potentially amplifying, role" (Laidler, 2009, p.68). The Austrians incorporated Wicksell's theory into their own theory of the business cycle (Mises, [1912], pp.354-360; Hayek, 1930, pp.114-115). In his *Treatise of Money* (1930) Keynes wrote that Wicksell's theory deserved "more fame and much more attention" than it had received and that "in substance and intention" was "closely akin" to his own (Vol I, p.186). However, by 1936 Keynes had changed his mind and in the *General Theory* (1936) he dismissed the natural rate of interest for not having anything "very useful or significant to contribute to our analysis" (p.243).

With the ascent of keynesianism, Wicksell's theory was "abandoned by monetary economists and left to antiquarians" (Leijonhufvud, 1979). Although, as we shall see below, in the late 1960s Friedman borrowed the analogy between the natural unemployment rate and natural rate of interest to reformulate the PC, he considered the latter irrelevant as a monetary policy tool. It was almost century after Wicksell published his theory that Michael Woodford reintroduced the concept of the natural rate of interest into modern macroeconomic theory by demonstrating that an inflation-targeting central bank "can steer the economy toward the natural rate and price stability by conducting policy through the application of a Taylor rule, which links the policy rate to measures

of economic activity and prices" (Lubik and Matthes, 2015). As Mankiw and Reis (2018) have pointed out, Friedman lost the argument to Woodford, "who convinced academics and central bankers to embrace the Wicksellian use of interest rates as the main policy tool and their deviation from natural rates as the key policy target" (p.90). In other words, the monetary policy rules that are prevalent in most advanced economies, which greatly contributed to global disinflation, owe more to Wicksell's "feedback rule" than to Friedman's prescriptions.

In the UK, the second disinflation *cum* monetary growth wave of the last hundred years started in the aftermath in the Great Depression. Between 1932, after England abandoned the gold standard, and 1938 the annual inflation rate in the UK was 0.2% per annum while monetary aggregates grew at 4,3% per annum and real GDP at 3,1% per annum. In 1936 Keynes published his *General Theory* which, as he wrote in the preface to the French edition, represented "my final escape from the confusions of the Quantity Theory, which once entangled me" (p. xxiii). The experience of the US during the 1930s was quite different, as money supply contracted sharply between 1930 and 1933 due to the Fed's mistakes. However, between 1933, when FDR declared the inconvertibility of the dollar, and 1938 monetary aggregates grew by almost 40% while the CPI index rose 7%.

This evidence generated "a wave of scepticism about the relevance and validity of the quantity theory of money" (Friedman, 1987, p.19). For a while the Keynesian revolution also relegated the QTM to a chapter in the history of economic thought. If capitalism could not achieve full employment, as Keynesians believed, the QTM's basic policy prescriptions were irrelevant. In fact, some of Keynes' most prominent disciples such as Kahn and Kaldor argued that concepts such as money velocity had no behavorial significance (Laidler, 1991). It was Friedman who revived the theoretical version of QTM in the late 1950s (Friedman, 1956).

It was around this time that the PC was born. In its original form, as developed by British economist A.W. Phillips, it plotted nominal wages against the unemployment in the UK. During the sixties the relationship also seemed to hold in the United States. Influenced by Keynesian theory, economists and policymakers widely accepted the notion that a trade-off existed between inflation and unemployment. According to Friedman (1975), a major reason "for the prompt and rapid acceptance of the Philips Curve approach was the widespread belief that it provided the missing

equation that connected the real system with the monetary system". In his opinion, such belief was erronoeus and the argument behind the PC was fallacious.

Borrowing ideas from Wicksell, Fisher, Keynes and Cagan, in 1968 Friedman reformulated the PC. In the *General Theory* Keynes had noted that "for every rate of interest there is a level of employment for which that rate is the 'natural' rate, in the sense that the system will be in equilibrium with that rate of interest and that level of employment" (1936, p.242). Using this idea, and incorporating Fisher's distinction between real and nominal interest rates and Cagan's adaptive expectations hypthesis, Friedman argued that the only way the monetary authorities could stimulate employment with monetary growth in the short run was by generating increasing levels of inflation. According to Friedman the basic defect of the original PC was that it failed "to distinguish beween *nominal* wages and *real* wages– just as Wicksell's analysis failed to distinguish between *nominal* interest rates and real interest rates" (Friedman, 1968, p.8-9). The difference in both cases was due to inflationary expectations. The reformulated PC posited a short-term trade-off between unemployment and inflation.[8] However, in the long run, , money would have no real effect on output or employment. Lucas (1976) later demonstrated that such effect was only possible if policymakers could consistently fool economic agents. If agents had rational expectations, the PC would not hold even in the short run.

The breakdown of the original PC in the 1970s enhanced Friedman's reputation. During the rest of the decade and in the early 1980s he tirelessly argued that inflation "was always and everywhere a monetary phenomenon". One of the charts he brandished around with great effect plotted the growth in M2 and the inflation rate two years later (1983, pp. 212, 216). Friedman recognized that although "many factors other than changes in the money supply affect the precise rate of inflation" and that a "constant lag of two years" was not "a natural constant", the close relationship between both variables was "no coincidence". In fact, he argued, "similar comparisons for a much longer period yield similar results" (pp. 199, 213). During the 1970s and 1980s, the evidence was strongly on his side.[9]

[8] Phelps (1967) had almost simultaneously reached a similar conclusion but using a different line of reasoning.
[9] As late as 2003, Friedman (2003) insisted that "takes something like two years for a change in monetary growth to affect significantly the behavior of prices".

4. Disinflation with Monetary Growth: A Modern Challenge to the QTM

From a monetary standpoint the situation started to change after August 1979, when Paul Volcker was appointed Chairman of the Fed. Table 4 illustrates how the relationship between growth in the money supply (using M0, M1 and M2) and the inflation rate two years later since 1961.[10] Both the slope and the R^2 of the linear equation fell. This trend accelerated in the following decades.

Table 4: Friedman's Rule of Thumb: Money Growth and Inflation 2Years Later

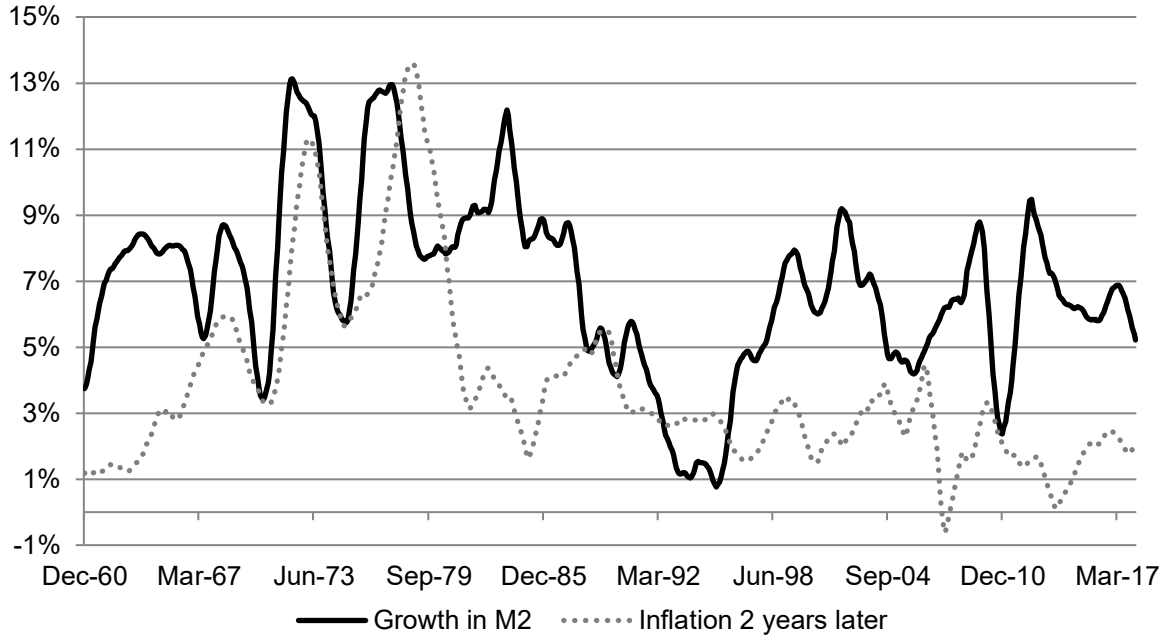
Period	OLS Estimates	M0	M1	M2
1961-1978	Slope	1.46	0.98	0.83
	R-Squared	63.3%	54.5%	43.1%
1979-1999	Slope	0.15	0.48	0.24
	R-Squared	1.5%	11.5%	9.3%
2000-2019	Slope	0.00	0.01	-0.15
	R-Squared	0.0%	0.1%	5.0%

Source: FRED.

The same conclusion can be reached by looking at Chart 3 below, which shows the "Friedman graph" updated until 2016 (using M2 as a measure of the money supply). The chart shows that until about 1979, inflation followed M2 growth quite closely, as Friedman had argued for decades. However, their paths completely diverged during the 1980s and never reversed to the pattern of 1960-1979.

Chart 3: Growth in M2 and Inflation Two Years Later

[10] An endless and unsettled debate regarding the empirical validity of the QTM centers on the definition of money in the exchange equation. For a tre

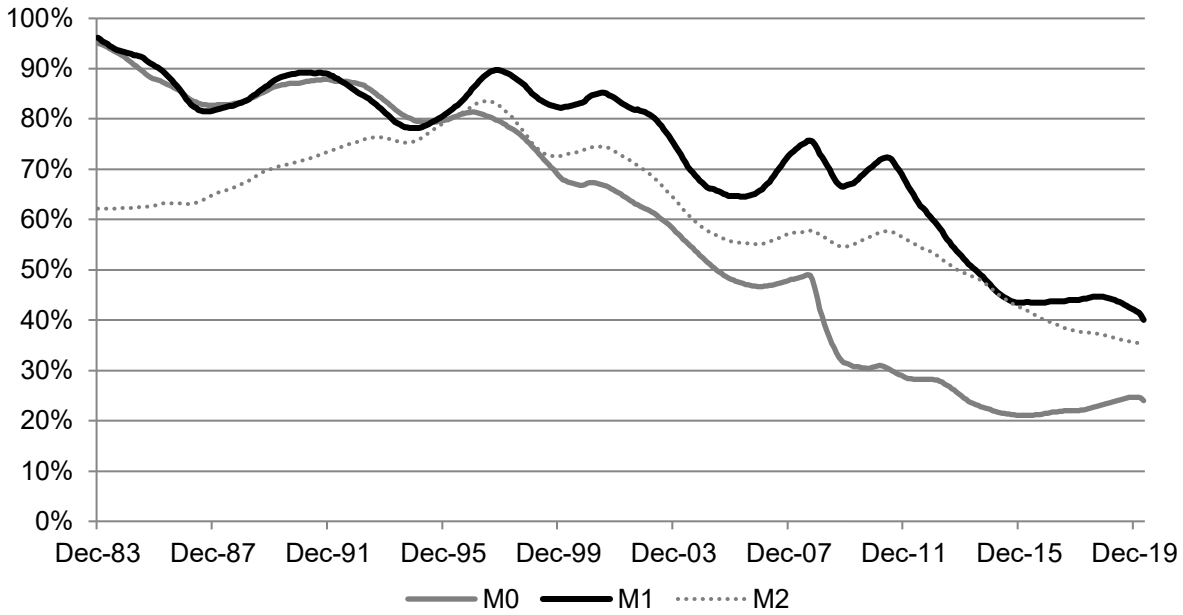


Source: FRED.

The first obvious response from a monetarist perspective would be that this is not what the QTM is all about. The theory's main prediction is that in the long run a given change in the rate of growth in the quantity of money will induce an equal change in the rate of inflation and an equal change in nominal interest rates. This is what strict neutrality implies. This statement is true for the world economy (or large open economies such as the US) and for closed economies that issue non-convertible fiat currencies. As mentioned earlier, for a small open economy with a fixed exchange rate regime the relationship between money and the price level reverses.

However, as can be seen in Chart 4 below, the long-run relationship between inflation and the rate of growth in the money supply in the US also weakened in recent decades (independently of which monetary aggregate is used). This trend accelerated since the turn of the century and most particularly after October 2008, when the Fed launched its QE policy. A sharp drop in the relationship between prices and the monetary base followed (M1 and M2 also show a similar downward trend). By the end of 2019, it had reached its lowest levels in the last 35 years.

Chart 4: Long-Run Relationship between Inflation and Growth in Monetary Aggregates

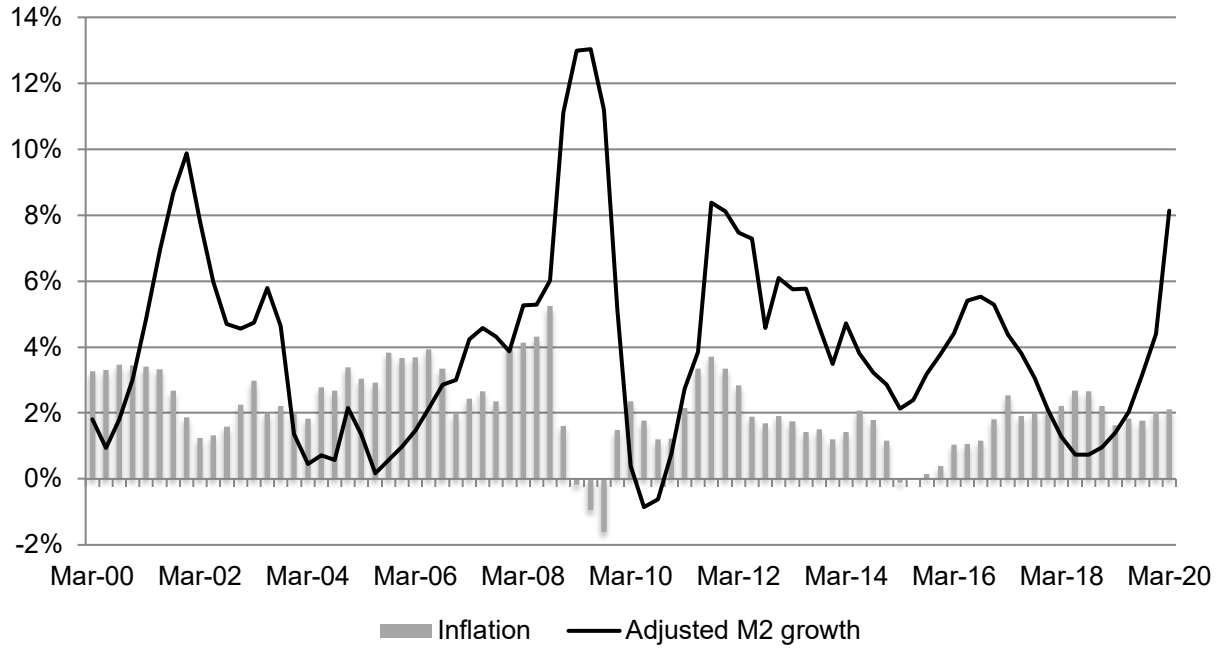


Source: FRED using data monthly data since January 1959. The graph measures the evolution of the ratio of inflation to growth in monetary aggregates on a monthly basis over rolling periods of 25 years.

From a monetarist perspective, the obvious response is that during this period the demand for money increased (i.e., velocity decreased), which in turn explains why inflation remained subdued. As Friedman (1992) pointed out, "changes in demand for money can have the same effect as changes in the demand" (p.46). The latter was supposedly stable. As a result, "substantial changes in prices or nominal income are almost always the result of changes in the nominal supply of money, rarely the result of changes in demand for money" (ibid., p.46).

However, at the end of the eighties, Poole (1987) observed that after Volcker's appointment the money demand function "seems to have fallen apart, and is apparently not a reliable basis for monetary policy after all". Back then it was due to a substantial increase in nominal interest rates; currently partly due to an equally significant fall in rates.

Chart 5: Relationship between Inflation and Adjusted Growth in M2



Source: FRED using quarterly data since January 1959. Adjusted growth is equal to the percentage increase in nominal M2 minus growth in real GDP.

As late as 2005, Friedman continued to argue that "velocity is ordinarily very stable, fluctuating only mildly and rather randomly around a mild long-term trend from year to year". In a cross-country study of OECD countries from 1970 until 2005, Teles and Uhlig (2013) found that the long term relationship between average inflation and the growth of monetary aggregates "is tenuous at best" but that the fit improved significantly when correcting for real output growth and the opportunity cost of money. However, they observed that after 1990 there was considerably less inflation variability and the relationship between money growth and inflation weakened due to a lower elasticity of the demand for money. Based on this evidence they concluded that the QTM was "still alive".

At the time, Friedman noted that since 2000 "the rate of growth in the quantity of money has been trending downward and in the past year has consistently been in the range of 4% to 6%, just about the rate required for a rapidly growing non-inflationary economy". However, as Chart 5 above shows, in the case of the US, even adjusting for real GDP growth, the discrepancy between the inflation and money growth rates has been highly volatile. A simple regression analysis of inflation

and adjusted M2 growth since 1960 suggests that their relationship has also significantly changed in the last two decades, implying a fundamental change in the demand for money (i.e., a secular drop in velocity):

Table 5: The Changing Nature of the Relationship of Inflation and Adjusted M2 Growth

Period	Slope	R^2
1960-1978	0.5	26.5%
1979-1999	0.4	22.8%
2000-2019	-0.1	8.8%

Source: FRED using quarterly data since January 1959. Adjusted growth is equal to the percentage increase in nominal M2 minus growth in real GDP.

By the early 2000s, the evidence also suggested that the PC was breaking down. Econometric models confirmed that its slope had become close to zero (IMF, 2013). Partly in response to this evidence, a "New Keynesian" formulation of the PC (NKPC) emerged that posited that, due to nominal rigidities, a trade-off existed in the short-run between inflation and the output gap, while in the long-run inflation remains constant at the non-accelerating inflation rate of unemployment (Galí and Gertler, 1999).

However, for many experts, the most puzzling breakdown of the QTM and the PC started in the aftermath of the GFC. In October 2008, the Federal Reserve started its Quantitative Easing (QE) program with the objective of bringing down long term interest rates and spur private investment. The monetary base almost cuadrupled in a year. In early 2010 a number of conservative scholars from very respectable institutions wrote a public letter to Ben Bernanke, then Chairman of the Fed, in which they argued that "the Federal Reserve's large-scale asset purchase plan (so-called "quantitative easing") should be reconsidered and discontinued" because it could trigger "currency debasement and inflation" and would not achieve the Fed's objective of promoting full employment (Asness et al, 2010). By May 2011, the Fed had already tripled the size of its balance sheet, an unprecedented move in its hundred year history. Another Nobel Prize warned:

> For most of the last 25 years, the quantity theory of money has been sleeping, but during the last year, unprecedented growth in central banks' balance sheets has

> prompted us to worry because the quantity theory has slept before, only to reawaken (Sargent and Surico, 2011, 110).

In a *Newsweek* column, British historian Niall Ferguson claimed that "double-digit inflation" was back but not yet visible because the Bureau of Labor Statistics was tampering with the CPI. "Pretty soon you'll be able to figure out the real inflation rate just by moving the decimal point in the core CPI one place to the right" he wrote (Ferguson, 2011).

Despite these dire warnings, QE continued, and by mid 2013, the monetary base had expanded by another 30%. At this time, another prominent monetarist, explained that inflation had "so far remained subdued" because banks were "not using their swelling reserves to expand credit and increase liquidity" (Melzter, 2013). According to this interpretation, the Fed's policies "hindered employment growth" (in the previous twelve months the unemployment rate had averaged close to 8%).

In its April 2013 *World Economic Outlook*, the IMF pointed out that inflation had remained remarkably stable in the wake of the Great Recession even though unemployment had significantly increased. IMF's analysts were surprised that deflation hadn't occurred given the high levels of cyclical unemployment (2013, p.87). Therefore, instead of a "missing inflation" puzzle, there was a "missing deflation" puzzle. The IMF staff tested two alternative hypotheses. The first suggested that much of the rise in unemployment during the Great Recession was structural and, consequently, continued high levels of unemployment exerted less of an influence on wages and prices than in the past. The second suggested that inflation had become less volatile and less responsive to changes in economic slack than in the past due to the increased credibility of major central banks. The IMF report concluded that "the recent stability of inflation is consistent with the prevalence of ongoing economic slack and a more muted response of inflation to cyclical conditions" and predicted that "ongoing monetary accommodation" would not have significant inflationary consequences, as long as inflation expectations remain anchored." The latter, in turn, required that central banks remained independent (2013, p. 79).

These conclusions became increasingly irrelevant in the ensuing months, as the labor market continued to strengthen. By April 2014, the unemployment rate had dropped to 6.7%, almost a full percentage below the level of a year earlier. In the following twelve months it declined further to

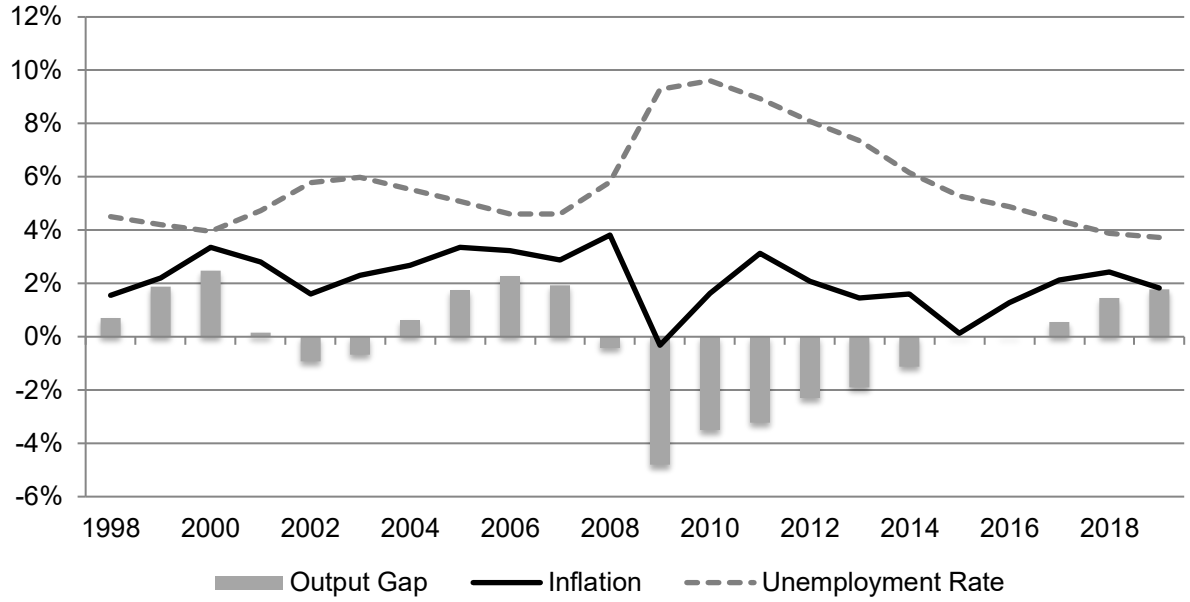
5.4%. Meanwhile, the Fed's balance sheet expansion continued until October 2015, having almost quintupled since the start of QE. In early 2016, Niall Ferguson again warned that high inflation would return to the US economy by the end of the year. "The inflection point is happening, but it will only be visible in about a year, and is barely perceptible to most people now" (Chinnery, 2016).

However, in October 2017, Janet Yellen, then Chair of the Federal Reserve, admitted that the "biggest surprise in the U.S. economy this year has been inflation." But she meant low inflation. The deflationary worries of early 2013 had now completely disappeared. Yellen also predicted that this situation was unlikely to persist and as labor markets "strengthened" the inflation rate would increase (Yellen, 2017). However, by the end of 2018, the unemployment rate had dropped to 3.9% (compared to 4.1% at the time of Yellen's speech) while the annual inflation rate slowed down to 1.9% from 2.1% a year before.

This unusual trend continued during 2019. The unemployment rate dropped even further to 3.5% while the money supply, as measured by M2, increased by almost 7% and the inflation rate remained anchored around 2% a year. The IMF's October 2019 *World Economic Outlook* highlighted that the "the broad synchronized global expansion from mid-2016 through mid-2018 helped narrow output gaps, particularly in advanced economies, but did not generate sustained increases in core consumer price inflation" (2019, pp.3-4). In fact, the sign of the NKPC's slope seemed to have reversed. In the US, the unemployment rate declined from almost 10% in December 2009 to 3.5% in December 2019, while the annual inflation dropped from 2.8% to 1.5% in the same period. During the same period the output gap increased from minus 4.8% to a positive 1.8%.

Based on a econometric analysis of US unemployment and inflation data for the period 1949-2018, Hopper, Mishkin and Sufi (2019) concluded that "reports of the death of the Phillips curve may be greatly exaggerated". In their view, the flattening of its slope since the mid 1980s was caused by a combination of slack in labor markets, an endogenous monetary policy and an "anchoring" of inflation expectations. In their view a commitment to stabilize inflation by the Fed underlied all three factors and a departure from this policy "would likely lead to a steepening of the Phillips curve" (p.54).

Chart 5: Inflation, Unemployment and the Output Gap in the US (1998-2019)



Source: IMF WEO Database October 2019.

This conclusion was in line with that Sargent and Surico (2011) had reached a few years earlier. In their view, what had put the predictions of the QTM "to sleep" was a monetary policy that responded aggresivelly to inflationary pressures. What would likely reawaken it would be a monetary policy rule "that accedes to persistent movements in money growth by responding too weakly to inflationary pressure" (2011, p.110). It is a commonly held view that an important factor in explaining global disinflation is greater credibility of monetary policy to a great extent supported by greater central central bank independence, a greater prevalence of more conservative anti-inflation oriented central bankers, better communications strategies, and improved monetary control capabilities (Rogoff, 2004). Inflation targeting regimes based on Taylor rules have improved central bank credibility and helped anchor inflationary expectations (IMF, 2013).

What could lead to a change in the monetary policy stance? As in previous apparent breakdowns of the QTM, new theories have emerged that directly challenged its influence over policymakers. One that has received increasing media attention is known as Modern Monetary Theory (MMT), which is loosely based on Lerner's functional finance theory according to which "the absolute size of the national debt does not matter at all" because however large the interest payments they don't constitute "a burden on society" (Lerner, 1947, p.47). The key tenet of MMT is that it is possible

to use expansive monetary policies "to finance large fiscal deficits and create a 'jobs guarantee' program that will ensure full employment and good jobs for everyone" (Edwards, 2019). Advocates of MMT reject the QTM and assert that "no simple proportionate relationship exists between rises in the money supply and rises in the general price level." In their view, the problem of inflation is "intrinsic to the power relations between workers and capital (class conflict), which are mediated by government within a capitalist system" (Mitchell, Wray, and Watts, 2019, p.13, 15, 263 and 255). In its proposed explanation of inflation, MMT resembles the "structuralist" theory that was popular in Latin America in the 1960s and 1970s. According to structuralism, what generates inflation are structural bottlenecks and "distributive conflicts" that generate chronic upward pressures on prices (see Olivera, 1960 and Ros, 1989). Therefore "income" policies are needed to reduce inflation. Interestingly no country in Latin America has been able to reduce its inflation rate with such policies. What has worked very effectively is the trinity of central bank independence, fiscal rules and inflation targeting. Chile, which in the 1960 and 1970s had inflations in excess of 100% a year, provides the clearest evidence. As Edwards (2019) has pointed out, MMT's policy prescriptions have already been tried in a number of emerging market and developing economies. Mostly in Latin America but also in Turkey, Israel and in France briefly during the early years of the presidency of Mitterrand. In Latin America, almost all experiments in which the central bank financed fiscal expansions took place under populist regimes "and all of them ended up badly, with runaway inflation, huge currency devaluations, and precipitous real wage declines" (Edwards, 2019, p.3). The same results are likely if the US or the UK adopt MMT's policy proposals.

As mentioned earlier, from a strictly monetarist perspective there has been no breakdown in the QTM; money demand simply increased (i.e., velocity dropped). Consequently, explaining disinflation in the face of significant growth of M2 requires explaining what is behind this increase. No definitive answer to this question has emerged yet from academia. However, there are several factors besides subdued inflationary expectations that contributed to an increase in the demand for money.

Saving (2016) has shown that the massive increase in the monetary base following the GFC did not have the expected impact on the money supply and inflation for two reasons: 1) the Fed started paying interest on bank reserves, which significantly grew during this period, 2) money velocity

fell dramatically as a result of historically low interest rates. The Fed sterilized the growth in its asset base "by making reserves a Federal Reserve short-term liability." In essence, the Fed engaged in a massive and very profitable carry trade, which also contributed to reduce the interest burden of a growing fiscal deficit.

There is another factor that needs to be incorporated into the analysis of the Fed's policy since the GFC: the significant drop in the ratio of M2 to total reserves (i.e., the money multiplier). Lower velocity and a lower multiplier broke the established relationship between money, output and employment. As Selgin (2020) correctly pointed out "the old connection between growth in bank reserves and growth in broad money measures has been severed for more than a decade."

Following Friedman, Teijeiro (2020) has argued that the discrepancies between nominal GDP growth and growth in monetary aggregates in the last decade in the US are mainly due to two factors: a) a lower opportunity cost of holding idle balances due to declining nominal interest rates to historical lows, and, b) an increase in the proportion of US dollars held by non-residents from 48% in 2009 to around 60% by 2016 (see Judson, 2017, Rogoff, 2017 and Haasl et al, 2018 for estimates of foreign holdings of US dollars). The first factor was reinforced after GFC when interest rates reached historical lows. Although applicable to the US experience, the second factor however does not explain what happened in the UK, where the increase in money demand was more significant than in the US.

There is a third factor that may have contributed to the increase in the demand for money that has not received much attention from monetary experts: changes in portfolio managers' cash allocations. The total market value of bond and stocks has increased from 177% of GDP in 1990 to 349% of GDP in 2018. Such increase had significant impact on the demand for cash balances by portfolio managers. Such demand is a function of the opportunity cost of cash, transaction costs, changes in the regulatory framework for the banking system and securities markets and investor uncertainty. The latter can be measured by the risk premia (the spread between yields on Baa corporate bonds and 10-year Treasury bonds) or the expected volatility of the stock market (VIX). Evidence from the first two decades of the 21st century suggests that as interest rates declined steadily towards historical lows, expected stock market volatility became an increasingly important driver of those allocations. Between 2007 and 2008 while the VIX index increased from

17.5% to 32.7% US private pension funds increased their cash allocation from 3.6% to 4.4% (SIFMA, 2019). Cash allocations of money market mutual funds showed a similar behavior: they increased from 25.7% to 39.8% of the total. After analyzing data for the US, the Euro area, Switzerland and the UK in the aftermath of the 2001 crisis, Bellike and Tollet (2011) concluded that "drastic changes in stock market volatility indeed appear to have been accompanied by a growing demand for money" (p.114). Anderson, Bordo and Duca (2016) developed a model that tracked changes in money velocity in the US since 1929 by incorporating risk premia a measure "of financial market participants' perceived risk."

Finally, another important factor that has contributed to an increase in the demand for money has been the explosive growth in the derivatives markets, which require counterparties to post cash collateral. According to the International Swaps and Derivatives Association (ISDA) the collateral posted on outstanding derivative contracts amounted to approximately $1 trillion in 2019, of which almost 73% was in cash (ISDA, 2019).[11] The impact of this factor on money demand deserves more attention from scholars.

By increasing the demand for money, all the factors mentioned above would have an impact on the left hand side of the QTM's equation of exchange. Other forces may have had an impact on the right hand side, and consequently also on the measured slope of the PC. First, a persistent mismeasurement of inflation would alter any conclusion regarding the validity of the QTM. On this point two separate arguments have been made. First, based on the work of Williams (2009), Ferguson (2011) argued that the CPI is "a bogus index" that underestimates the real inflation rate: if the Bureau of Labor Statistics (BLS) used the methodology of a few decades ago, the annual inflation rate would have been estimated at close to 10%. One of Williams' key objections to the CPI is that instead of holding the cost-of-living basket unchanged for long periods, the BLS makes frequent changes to its composition. Some changes occur due to technology (e.g., CDs been replaced by Spotify) or changes in quality while others due to changes in relative prices. The latter imply a substitution effect: if the price of meat increases relative to the price of chicken, consumers will eat more of the latter than the former. Maintaining the original weights would ignore this effect. As Dolan (2010) has pointed out, "if we did not account for changed consumption patterns

[11] ISDA does not provide details about currency composition of this collateral but it is safe to assume that the US dollar predominates.

in response to changed prices… we would overstate the cost of maintaining a constant level of satisfaction". Also, the BLS weighs each item in the CPI basket based on regular household surveys that provide information about buying habits, income, and other household characteristics. In general, the hypothesis that the CPI underestimates inflation is not taken seriously by mainstream economists. Moreover, a study by the Boskin Commission in 1996 found that the effects of these biases overstate rather than understate the inflation rate (Boskin et al, 1996).

The second mismeasurement argument is based on the idea that the "theoretically correct" inflation index should measure the prices of both current and future consumption. Alchian and Klein (1973) were the first to argue for the inclusion of asset prices in any measure of inflation. As Issing (2001) explained, "asset prices are claims on future consumption and can be used as measures of future prices." (2001, p.193). Based on this idea, Cechetti et al (2000) built an intertemporal cost of living index that included the prices of consumer goods and services (those commonly included in the CPI), equities and housing. They concluded that equity prices contain "too much noise to be useful in inflation measurement" but housing prices "contain significant information regarding aggregate price inflation". Even though central bankers resist this approach, an inter-temporal CPI could improve the QTM's predictive power. However, the overall conclusion remains unchanged: a) at least in the US and the UK, money supply currently seems to have less influence on prices that at any time in the last three decades, b) even adjusting for real GDP growth, the discrepancy between money growth and prices implies a structural change in the demand for money.

Economists have proposed several other hypotheses to explain the disinflation trend of the last three decades, which to some extent could also explain a temporary breakdown of both the QTM and the PC. These hypotheses can be grouped into five broad categories: 1) credibility of monetary policy, 2) globalization, 3) technological innovation, 4) improved domestic retailing logistics, and 5) declining commodity prices.

Globalization

According to Greenspan (2005), globalization "is patently a key to understanding much of our recent economic history." The growing integration of goods, labour and financial markets over the last three decades and the development of highly efficient global supply or value chains (GSCs) has led to stronger direct and indirect competition that has contributed to global disinflation

(Roach, 2020). China's emergence as a global manufacturing giant has particularly contributed to this trend. Since the early 1980s and first decade of this century China benefited from a massive "Lewisian" demographic dividend. During this period, between 300-400 million people moved from rural to urban areas, representing "the largest mass migration in human history" (Chan, 2013, p.85). This generated an excess supply of labor that put downward pressure on industrial wages and allowed Chinese manufacturers to become increasingly competitive. Although this process seems to be coming to an end in China (Das and N'Diaye, 2013), a similar one –although in a much smaller scale– started to take place in Vietnam, Indonesia and other South East Asian countries that accelerated their industrialization and became more integrated with the rest of the world.

Greenspan (2005) argued that consequent significant additions to world production and trade from China, India and other developing economies "clearly put downward pressure on prices in the United States and in the economies of our trading partners." Rogoff (2007) has argued that although is true that China's low wage workers "place relentless downward pressures on wages and prices elsewhere" this can only affect relative prices. If central banks target inflation in the overall price level "cheap goods from China simply imply that other goods must become more expensive." Following this logic, China is actually "exporting inflation to the other sectors of the global economy" (p.6). On the other hand, Rogoff (2004) recognizes greater competition global competition has weakened the influence of domestic monopolies and labor unions and thus contributed to greater price and wage flexibility. Labor union's weaker bargaining power as a result of globalization and innovation is confirmed by the decline in the share of wages in GDP. Between 1991 and 2014, this ratio declined in twenty nine of the world's fifty largest economies (IMF, 2017). The impact has been particularly sharp for middle-skilled labor.

As a result of all of these trends, "the real effects of unanticipated monetary policy become smaller and more transitory" (p.46). An econometric study by Borio and Filardo (2007) supports the hypothesis that global factors had "become more important relative to domestic factors, and that in some countries the explanatory power of global factors has actually superseded that of domestic output gaps as one of the key determinants of domestic inflation" (p.13).

The deflationary pressures unleashed by globalization not only resulted from greater competition from low labor cost countries such as China but also structural changes in global manufacturing. In recent decades production has been increasingly organized around global supply or value chains (GSC), which different stages of production distributed across different countries. As a result, the share of gross exports consisting of inputs imported from abroad has increased an many countries have specialized in adding value at an intermediate stages of production. (IMF, 2015, p.16). Companies around the world have been able coordinate and track just-in-time (JIT) production through all different stages of production by relying on third party suppliers located in multiple countries. For example, Apple Computer does not own most of the manufacturing plants in its supply chain. The growth of GSCs not only has improved overall productivity and altered global trade patterns but also played an increasingly important role in determining domestic inflation rates (Roach, 2020). Before the coronavirus crisis, a study by Auer, Borio and Filardo (2017) confirmed the hypothesis that by fostering greater direct and indirect competition among economies, the expansion of GSC contributed to making domestic inflation more sensitive to the global output gap. According to their estimates, the sensitivity of domestic inflation to the global output gap – which increased significantly after the GFC– was close to one percent.

Technological Innovation

It is difficult to separate the effects from technological innovation on inflation from those generated by globalization. To some extent both factors have reinforced each other. Globalization provided the scale that made many innovations cost-effective (such as those underlying GSCs). As Greenspan (2005) pointed out "the remarkable technological advances of recent decades have doubtless augmented and fostered the dramatic effect of increased globalization on economic growth." A recent study by Lv, Liu and Xu (2019) explored the joint impact of both forces on inflation and concluded that the impact of the domestic and foreign output gap has weakened in recent years, while the impact of technology has increased.

Moore's law –which states that the number of transistors in a chip doubles every two years– is a power deflationary force. As a result of it, the relative price of technology continuously falls and as manufacturing increasingly relies on technology, production costs are also decline. According to a recent study (Davis, 2017), the amount of technology used in production processes has more than doubled since the late 1990s, from $0.08 per $1 of output to $0.20. The same study estimated

that since 2001, declining prices of computer and electronic products and services reduced the annual inflation rate by 0.5% a year.

A more recent econometric analysis by Csonto, Huang and Tovar (2019) found that digitalization –which is defined as growing pervasiveness of information processing and communications technology in the global economy– had a statistically significant negative effect on inflation in the short and long run in a sample of 36 advanced and emerging market economies. As a proxy for digitalization they used the number of IP addresses per country. Their results show that digitalization not only wass a key determinant of the negative global trend or structural component of inflation but also contributed to reducing short-term inflation, particularly since 2012. The study also showed that digitalization impacted inflation through a direct cost/mark-up channel— associated cost reductions via improved productivity and/or through increased competition— and to a lesser extent an indirect cost channel that has influenced price-setting behaviors. Both channels have contributed to reduce the slope of the PC over the last few years.

Robotization also seems to have had a negative impact on inflationary dynamics. Fueki and Maehashi (2019) used a country level balanced panel dataset and a standard New Keynesian model to empirical verify this hypothesis. The replacement of human labor by robots has allowed firms to adjust their production and increase efficiency. Consequently, marginal costs have become less responsive to changes in economic activity. Their empirical results confirm that as manufacturing becomes more dependent on robots the PC becomes flatter.

Improved Retailing Logistics

Another explanation concerns the effect of increased retail competition on inflation, also known as the "Walmart effect" (Basker 2007, Igan & Suzuki 2012). The entry of Wal-Mart, now the world's largest retailer, into the market exerted a huge amount of downward pressure on the prices of consumer goods directly but also indirectly, as it affected the prices that incumbent competitors charge both in the short-run and long-run (Basker, 2007). Igan and Suzuki examined the contribution of retail competition to inflation in Europe between 2000 and 2004 and found that "a 10% increase in retail competition reduces the inflation rate for goods that are traded on retail by around 0.5 percentage points." Therefore, there is evidence to suggest that retail competition has contributed to the deflationary environment seen in the last two decades.

Once the impact of the "Walmart effect" waned, another retail revolution took place: e-commerce, in turn fuelled by technological innovation. According to US Census data, e-commerce has grown at a compound annual rate of more than 9% since 1992. In the first quarter of 2020 online sales accounted for almost 12% of total U.S. retail sales. Amazon dominates e-commerce with a market share close to 40%. According to one hypothesis, the "Amazon effect" has been a powerful deflationary force (Trainer, 2016; Guatieri, 2019). Amazon not only cuts costs by eliminating middlemen, but also provides an engine for price discovery on broad array of products contributing to increased competition. In 2013, Amazon carried 230 million items for sale in the United States, nearly 30 times the number sold by Walmart. However, according to the available data, the "Amazon effect" on inflation appears to be negligible (Charbonneau et al 2017; McClellan, 2017).

Commodity Price Cycles

Another factor that has contributed to disinflation in spite of monetary expansion has been the reversal of the commodity supercycle. Since early 2012, most commodity prices entered a sustained downward phase. The decline of oil prices –which have historically had a significant impact on consumer prices– was significant and steady. Between its peak of March 2012 and December 2019 the average price of crude fell 43% in nominal terms. The decline was in great part due to a technological revolution –fracking– that allowed the US to rapidly expand production and become the largest oil producer in the world. This in turn led to a decline in the bargaining power of OPEC, disrupting the traditional supply and demand dynamics in the oil market.

5. Conclusion

Economists have not reached yet a consensus about which factors explain the cyclical disinflation trend of the last three decades and the apparent breakdown of the QTM and the PC (in any of their respective versions). A number of structural changes in the world economy have occurred during this period and it is difficult to disentangle the individual impact of each. Undoubtedly globalization and technology have reinforced each other and have played an important role by fostering competition and weakening the bargaining power of labor unions. The increased credibility, independence, managerial competence and technical expertise of the world's main central banks have also contributed to anchor inflation expectations. To which in recent years we

must add global output slack in the aftermath the GFC and a persistent decline of commodity prices since mid 2012.

Of all these factors technological innovation is the one that is most likely to continue to exert a persistent negative influence on inflation. Central bank independence may succumb to political pressures as the coronavirus takes its toll on national economies and global output slack deepens or alternative monetary policy paradigms such MMT become influential. As to commodity prices, in the short term their likely trajectory also seems downward absent a crisis in the Middle East. Finally, the political backlash against globalization that started after the GFC –which seems to have intensified with the spread of the coronavirus– could revive the QTM and bring inflation back. As Roach (2020) has pointed out, "the inflationary risk for the post-coronavirus world" lies in the dismantling of the GSCs. If that were to happen, the world is likely to be heading towards a period of stagflation similar to that of the early seventies. On the positive side, higher inflation rates would help dilute the weight of historically high levels of public debt.

Finally, the experience of Argentina provides ample support to the notion that the QTM is not irrelevant. Wicksell and his modern interpreters may have provided a better theory to explain cyclical movements in the general price level in the case of countries that consistently maintain fiscal and monetary discipline during periods of rapid technological innovation, expanding real output and high levels of trade, labor and financial integration. However, in a scenario of persistently expansionary fiscal and monetary policies (such as those proposed by MMT advocates), diminished central bank autonomy and creeping protectionism, the relationship between money and prices posited by the QTM is likely to reawaken with a vengeance. Hayek, who was very critical of a simplistic application of this theory, warned that "it would be one of the worst things which would befall us if the general public should ever again cease to belive in the elementary propositions of the quantity theory" (1931, p.3).

6. References

Alchian, A.A. and Klein, B. (1973). "On a Correct Measure of Inflation", Journal of Money, Credit and Banking, Vol. 5, No. 1, Part 1 (February), pp. 173-191.

Anderson, R. G., Bordo, M. and Duca, John V. (2016). "Money and Velocity During Financial Crises: From the Great Depression to the Great Recession" NBER Working Paper No. 22100, (March).

Asness, C. et al (2010). "Open Letter to Ben Bernanke", [Online] Available at https://www.hoover.org/research/open-letter-ben-bernanke [Accessed on 10 May 2020].

Barro, R. J. (1979). "Money and the Price Level Under the Gold Standard", *The Economic Journal*, Vol. 89, No. 353 (Mar., 1979), pp. 13-33.

Belke, A. and Polleit, T. (2009). *Monetary Economics in Globalised Financial Markets*. Berlin: Springer.

Boskin, M. J., Dulberger, E. R., Gordon, R. J., Griliches, Z. and Jorgenson, D. W. (1996)., ''Toward a More Accurate Measure of the Cost of Living", Final Report to the Senate Finance Committee, December.

Cagan, P. (1956). "The Monetary Dynamics of Hyperinflation." In Friedman, Milton (ed.), *Studies in the Quantity Theory of Money*. Chicago: University of Chicago Press.

Cecchetti, S.G., Genberg, H., Lipsky, J. and Wadhwani, S. (2000). *Asset Prices and Central Bank Policy*, Geneva and London: International Center for Monetary and Banking Studies and Centre for Economic Policy Research.

Chan, (2013). "China: internal migration" in the The Encyclopedia of Global Human Migration, Edited by Immanuel Ness. London: Blackwell Publishing Ltd.

Charbonneau, K. B., Evans, A., Sarker, S. and Suchanek, L. (2017). "Digitalization and Inflation: A Review of the Literature," Staff Analytical Notes 17-20, Bank of Canada.

Chinnery, K. (2016). "Niall Ferguson says GFC stagnation is over and inflation will rise", Financial Review, 16 May, [Online] Available at https://www.afr.com/policy/economy/niall-ferguson-says-gfc-stagnation-is-over-and-inflation-will-rise-20160519-goyolq [Accessed on 10 May 2020].

Csonto, B., Huang, Y. and Tovar, C E. (2019). "Is Digitalization Driving Domestic Inflation?" IMF Working Paper (December).

Das, M. and N'Diaye, P. (2013). "Chronicle of a Decline Foretold: Has China Reached the Lewis Turning Point?" IMF Working Paper (January).

Davis, J. (2017). "Why is inflation so low? The growing deflationary effects of Moore's Law", Vanguard research (October).

Dimand, R.W. (2013). "David Hume and Irving Fisher on the quantity theory of money in the long run and the short run", *The European Journal of the History of Economic Thought*, 20:2, pp. 284-304.

Dolan, E. (2015). "Deconstructing ShadowStats. Why is it so Loved by its Followers but Scorned by Economists?", *The Street*, March 31, [Online] Available at https://www.thestreet.com/economonitor/emerging-markets/deconstructing-shadowstats-why-is-it-so-loved-by-its-followers-but-scorned-by-economists [Accessed on 20 May 2020].

Dornbusch, R. and de Pablo, J.C. (1990). "The Process of High Inflation" in Sachs, Jeffrey A. (Ed.), *Developing Country Debt and Economic Performance*. Chicago: University of Chicago Press, 1990, Vol.22, pp. 77-91.

Dornbusch, R., Sturzenegger, F.A. and Wolf, H. (1990). "Extreme Inflation: Dynamics and Stabilization", *Brookings Papers on Economic Activity*, 2:1990.

Edwards, S. (2019a). "Modern Monetary Theory: Cautionary Tales from Latin America Economics", Working Paper - Hoover Institution.

Ferguson, N. (2011). "The Great Inflation of the 2010s", *Newsweek*, 1 May, [Online] Available at https://www.newsweek.com/great-inflation-2010s-67663 [Accessed on 10 May 2020].

Forbes, K. (2019). "Inflation Dynamics: Dead, Dormant, or Determined Abroad?", NBER Working Paper No. 26496 (November).

Friedman, M. (1956). "The Quantity Theory of Money: A restatement", pp. 3-24, in Friedman, M. (Ed), *Studies in the Quantity Theory of Money*. Chicago: University of Chicago Press.

_____ (1968). "The Role of Monetary Policy", *The American Economic Review,* Vol. 58, No. 1. (Mar., 1968), 1-17.

_____ (1975). "Can Inflation Be Cured... before It Ends Free Society?", address delivered in Sydney on 2 April 1975, in *Milton Friedman in Australia*, 1975, pp. 45-80. Sydney: Constable & Bain and the Graduate Business School Club, 1975.

_____ (1980). *Bright Promises, Dismal Performance An Economist's Protest*. New York: Harcourt Brace and Jovanovich Publishers.

_____ (1987). "Quantity Theory of Money", in *The New Palgrave: A Dictionary of Economics*, edited by John Eatwell, Murray Milgate, and Peter Newman, vol. 4, pp. 3-20. New York: Stockton Press; and London: Macmillan.

_____ (1992). *Money Mischief*. New York: Harcourt Brace and Jovanovich.

_____ (2003). "The Fed's Thermostat", *The Wall Street Journal*, 19 August.

_____ (2005). "Letter to the editor: No Cause to Berate Fed for 'Reigniting Inflation'", *The Wall Street Journal*, 7 April.

Fueki, T. and Maehashi, K. (2019). "Inflation Dynamics in the Age of Robots: Evidence and Some Theory", Bank of Japan Working Paper Series.

Gali, J. and Gertler, M. (1999). "Inflation dynamics: A structural econometric analysis," *Journal of Monetary Economics*, vol. 44(2) (October) pp. 195-222.

Glasner, D. (1985). "A Reinterpretation of Classical Monetary Theory", *Southern Economic Journal*, 52:1 (July), pp.46-67.

Guatieri, S. (2019). "2021: A Price Oddity", EKONAMIK, 8 February, originally published as a Feature by BMO Capital Markets on 8 February 2019, [Online] Available at http://ekonamik.com/2019/02/2021-a-price-oddity/ [Accesed 20 May 2020].

Haasl, T., Schulhofer-Wohl, S. and Paulson, A. (2018). "Understanding the Demand for Currency at Home and Abroad", *Chicago Fed Letter*, No. 396.

Harberger, A. C., (1978). "A Primer on Inflation", *Journal of Money Credit and Banking*, Volume 10, Issue 4 (Nov. 1978), pp. 505-521.

Hayek, F.A. (1931). *Prices and Production*. London: The Macmillan Company.

_____ (1933). *Monetary Theory And The Trade Cycle*. London: Jonathan Cape.

Humphrey, T.M. (1997). "Fisher and Wicksell on the Quantity Theory", Federal Reserve Bank of Richmond *Economic Quarterly*, Volume 83/4 (Fall), pp.71-90.

_____ (2002). "Knut Wicksell and Gustav Cassel on the Cumulative Process and the Price-Stabilizing Policy Rule", Federal Reserve Bank of Richmond *Economic Quarterly*, Volume 88/3 (Summer), pp.59-83.

Humphrey, T.M. and Keleher, R. (1982). *The monetary approach to the balance of payments, exchange rates, and world inflation*. New York: Praeger.

International Monetary Fund. (2013). *World Economic Outlook April 2013: Hopes, Realities, Risks*. Washington D.C.: IMF.

_____ (2017). *World Economic Outlook April 2017: Gaining Momentum?*. Washington, D.C.: IMF.

_____ (2019). *World Economic Outlook October 2019: Global Manufacturing Downturn, Rising Trade Barriers.* Washington D.C.: IMF.

ISDA (2019). "ISDA Margin Survey Year-end 2019" (April 2020) [Online] Available at https://www.isda.org/a/1F7TE/ISDA-Margin-Survey-Year-end-2019.pdf [Accessed 6 June 2020].

James, E. [1955]. *Historia del pensamiento económico en el siglo XX*. México, D.F.: Fondo de Cultura Económica, 1957.

Jonung, L. (1979). "Knut Wicksell and Gustav Cassel on Secular Movements in Prices" *Journal of Money, Credit and Banking*, Vol. 11, No. 2 (May), pp. 165-181.

_____ (1994). "Swedish Experience under the Classical Gold Standard, 1873-1914", in A Retrospective on the Classical Gold Standard, 1821-1931, Bordo, M.D. y Schwartz, A.J. (eds.), pp. 361-404.

Judson, R. (2017). "The Death of Cash? Not So Fast: Demand for U.S. Currency at Home and Abroad, 1990–2016." International Cash Conference 2017 - War on Cash: Is there a Future for Cash?, 25 - 27 April, Mainau, Germany, Deutsche Bundesbank, Frankfurt a. M..

Keynes, J.M. (1923). *A Tract on Monetary Reform*. London: Macmillan and Co. Ltd.

_____ (1930). *A Treatise on Money*. London: Macmillan and Co. Ltd.

_____ (1936). *The General Theory of Employment, Interest and Money*. London: Macmillan and Co. Ltd.

Kiguel, M. A. and Liviatan, N. (1992). "When do heterodox stabilization programs succeed? Lessons from experience", *The World Bank Research Observer*, vol. 7, no. 1 (January 1992), pp. 35-57.

Laidler, D. (1991). "The Quantity Theory Is Always and Everywhere Controversial –Why?", *The Economic Record*, 67, issue 199, pp. 289-306.

Leijonhufvud, A. (1979). "The Wicksell Connection: Variations on a Theme", UCLA Department of Economics, Working Paper #165 (November).

Lerner, A. (1943). "Functional Finance and the Level of Debt", *Social Research*, Vol. 10, No. 1 (February), pp. 38-51.

Lubik, T. A. and Matthes, C. (2015). "Calculating the Natural Rate of Interest: A Comparison of Two Alternative Approaches", Federal Reserve Bank of Richmond, *Economic Brief* (October).

Lucas, R. E. Jr. (1976). "Econometric Policy Evaluation: A Critique" Carnegie-Rochester Conference Series on Public Policy, 1, pp. 19-46.

_____ (1980). "Two Illustrations of the Quantity Theory of Money." *American Economic Review*, 70(5): 1005.

_____ (1996). "Nobel Lecture: Monetary Neutrality", *Journal of Political Economy*, Vol. 104, No. 4 (Aug., 1996), pp. 661-682

Lv L, Liu Z, and Xu Y. (2019). "Technological progress, globalization and low-inflation: Evidence from the United States". PLoS One. 14(4), (April), [Online] Available at https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0215366 [Accessed on 20 May 2020].

Machlup, F. A., (1983). "The Political Economy of Inflation", *Cato Journal*, Vol. 3, No. 1 (Spring 1983).

Mankiw, N.G. (2019). "A Skeptic's Guide to Modern Monetary Theory". NBER Working Papers 26650 (December).

Mankiw, N.G. and Reis, R. (2018). "Friedman's Presidential Address in the Evolution of Macroeconomic Thought" *The Journal of Economic Perspectives* , Vol. 32, No. 1 (Winter), pp. 81-96.

McCallum, B. and Nelson, E. (2010). "Money and Inflation: Some Critical Issues", pp. 97-153, in Friedman, B.M. and Woodford, M. (ed.), *Handbook of Monetary Economics*, Volume 3B. Diego and Amsterdam: North-Holland.

McClellan, M. (2017). "Did Amazon Kill The Phillips Curve?" BCA Research

Meltzer, A. (2013). "Quantitative Quicksand", *Project Syndicate*, 6 June.

Mitchell, W, Wray, L.R. and Watts, M. (2019). *Macroeconomics*, London: Red Globe Press.

Mises, L. [1912]. *The Theory of Money and Credit*. London: Jonathan Cape, 1953.

Olivera, J. (1960). "La teoría no monetaria de la inflación", *El Trimestre Económico*, 27, 108 (4), 626-628.

Poole, W. (1987). "Monetary Policy Lessons of recent Inflation and Disinflation", NBER Working Paper No. 2300 (June).

Rist, C. [1938] *History of Monetary and Credit Theory from John Law to the Present Day*. New York: Augustus Kelley, 1966.

Roach, S. (2020). "A Return to 1970s stagflation is only a broken supply chain away", Financial Times, 6 May, [Online] Available at https://www.ft.com/content/5f4ef4f6-8ad6-11ea-a109-483c62d17528 [Accessed on 10 May 2020]

Rogoff, K. (2004). "Globalization and Global Disinflation" in Federal Reserve Bank of Kansas City, *Monetary Policy and Uncertainty: Adapting to a Changing Economy*, Papers and Proceedings of 2003 Jackson Hole Symposium.

_____ (2007). "Impact of Globalization on Monetary Policy". Paper prepared for symposium sponsored by the Federal Reserve Bank of Kansas City on "The New Economic Geography: Effects and Policy Implications," Jackson Hole, Wyoming, August 24-26, 2006.

_____ (2017). *The curse of cash, updated edition*. Princeton, New Jersey: Princeton University Press.

Ros, J. (1989). "On Inertia, Social Conflict and the Structuralist Analysis of Inflation", Working Paper #128 (August), Kellogg Institute for International Studies.

Samuelson, P.A. (1980). "The World at Century's End" (1980), pp. 58-77, in *Human Resources, Employment and Development, Volume 1, The Issue*s, Shigeto Tsuru (Ed.). London: Macmillan, 1983.

Sargent, T.J. (1982). "The End of Four Big Inflations", in Hall, Robert E. (Ed.), *Inflation: Causes and Effects.* Chicago: University of Chicago Press, 1982), pp. 41-98.

Sargent, T. J. and Surico, P. (2011). "Two Illustrations of the Quantity Theory of Money: Breakdowns and Revivals", *The American Economic Review*, Vol. 101, No. 1 (February), pp. 109-128.

Saving, T.J. (2016). "The Federal Reserve, the Great Recession and the Lost Inflation", Private Enterprise Research Center, Texas A&M University, PERC Study No. 1604, July 2016.

Selgin, G. (2020). "Return of the Inflation Mongers", 27 April, [Online], Available at https://www.alt-m.org/2020/04/27/return-of-the-inflation-mongers/

Shadowstats (2009). "Hyperinflation Special Report", Commentary No.263 [Online] Available at http://www.shadowstats.com/article/hyperinflation-2010 [Accesed 1 May 2020]

SIFMA (2019). *Factbook*. New York: Securities Industry and Financial Markets Association.

Teijeiro, M. (2020). "The Monetary Mystery of the last Decade", UCEMA Working Papers, Nro. 725 (June).

Teles, P. and Uhlig, H. (2013). "Is Quantity Theory Still Alive?" *ECB Working Paper Series*, No. 1605 (November).

Trainer, D. (2016). "How the internet killed inflation" *Forbes*, 28 September, [Online] Available at https://www.forbes.com/sites/greatspeculations/2016/09/28/how-the-internet-economy-killed-inflation/#5b9edd2b788b [Accessed 20 May 2020]

Vegh, C. (1991). "Stopping High Inflation: An analytical overview", *IMF Working Papers*, WP 91/107 (November).

Vera, L. (2013). "Inflación estructural redux", *Ensayos Económicos*, Nro.69 (Diciembre), pp.37-99.

White, M. V. and Schuler, K. (2009). "Who said "debauch the currency": Keynes or Lenin?", *Journal of Economic Perspectives*, Vol. 23, No. 2, Spring 2009, pp. 213–222.

Wicksell, K. [1898] *Interest and Prices*. London: Macmillan and Co. Ltd., 1936.

_____ [1906] *Lectures on Political Economy*, *Volume Two, Money*. London: George Routledge and Sons Ltd., 1935.

_____ (1907). "The Influence of the Rate of Interest on Prices", *Economic Journal*, XVII, pp. 213–220.

Woodford, M. (2003). *Interest and Prices. Foundations of a Theory of Monetary Policy*. New York: Columbia University Press.

Yellen, J. (2017). "The U.S. Economy and Monetary Policy", Speech delivered at the Group of 30 International Banking Seminar, Washington, D.C. (October 15) [Online] Available at https://www.federalreserve.gov/newsevents/speech/yellen20171015a.htm [Accessed on 10 May 2020]