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Analyzing Economic Variables and their Relationship to Inflation in the USA, Germany and China: Why Empirical Results Demonstrate the Inability to Accurately Assess Economic Policy through Data

Anthony Marino Rosa[1]*

[1]College of distance education and training, USA

*Corresponding author: Anthony Rosa: anthonymarinorosa@gmail.com

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Abstract:

For the past 50 years, economists have principally used the quantity theory of money to explain inflation. Monetarists, like Milton Friedman, view inflation as "everywhere a monetary phenomenon" and cite data comparing the quantity of money per unit of output (Real GDP) with the consumer price index (CPI). Once scaled, the relationship between Real GDP and CPI does appear linear. Critics note that over the past decade, unprecedented action by central banks has not led to inflation. Recent research claims, "rapid money supply growth does not cause inflation...neither do rapid growth in government debt, declining interest rates, or rapid increases in a central bank's balance sheet." I test claims about the causes and predictability of inflation through a cross-country examination of different policies and their correlation with countries' inflation rates. The study of inflation and its causes is important as the price mechanism is considered the mudsill of a functioning market, and countries aim to minimize large, unpredictable changes like hyperinflation (rapidly rising prices generally exceeding 50% per month) or deflation (decreasing prices). I examine empirical data from 1991-2020 in the United States through a multivariate linear regression model and then compare this with data from Germany 1991-2020 and China 1996-2016 as global references. I demonstrate the theoretical contradiction that personal spending and personal savings both correlate with inflation while monetary injections do not. I also demonstrate two key findings. First, interest rates appear to react to inflation rather than cause it.

Second, there are no predictable causes of visible inflation in a global market. My results are inconclusive; yet the puzzling nature of their indications is evidence against broad monetary claims in general.

Keywords: Economic variables, Inflation, Economic policy

Introduction

Populations have understood basic mechanisms of inflation for hundreds of years. Historically, rulers incorporated non-precious metals into their bullion; this devalued the integrity of the coinage and enabled the creation of more coinage, since less precious metals were needed per unit [1]. Thus, basic knowledge that increasing monetary supply decreases monetary value is ancient [2]. The concept that debasing currencies increases general prices also followed. Such ideas echoed into later epochs as Carl Menger postulated the theory of marginal utility: that greater supply equates to less perceived value [3].

Mercantilist nations demonstrated knowledge of inflation and its links to interest rates. Countries sought to maximize their collection of bullion (high supply) to ensure adequate liquidity for investments (low interest), which led to price acceleration (increased demand for goods as saving became less beneficial) [4]. John Maynard Keynes famously argued for increasing monetary supply to reduce interest rates and increase income, as displayed by the Keynesian Liquidity Preference Model [5]. Classical economists and later monetarists believe the income increase spurs demand, shifting the supply and demand curve right to a higher price equilibrium, resulting in inflation [6]. Modern Keynesian economists, like Paul Krugman or John Harvey, tend to disagree, believing that "printing money in a depressed economy isn't inflationary" [7] or that it is impossible to increase monetary supply without corresponding demand [8].

Previous studies of inflation tend to test isolated time periods with restrictive categorization of what constitutes "high inflation" or "high M2." [9]. Others restrictively focus on theoretical equations to discuss inflation [10] or focus on a particular variable [11]. What is more useful is an analysis of how different instruments affect inflationary tendencies together, across economies and timespans. I do this by incorporating a 30-year dataset in the US and Germany, testing seven covariates. In China, a 20-year period is utilized with seven covariates measured; the time period is adjusted to account for reliable data limitations. Despite what formulas appear to show [Federal Reserve Board's "$\Delta p^*(t)=\Delta p^*(t-1)+v(t)$" [12] vs Friedman's "Md/P: f (Yp <+>, rb−r m<−>, rs−rm <−> , πe−rm<−>)"], what is important is what empirically materializes. Nonetheless, the theoretical mechanisms behind inflation warrant a cursory review.

One common misconception of monetary policy is that central banks flood markets with newly printed money, thereby accelerating monetary supply and debasing currencies. In actuality, funds enter the market through banks as lendable funds; therefore, any increase in supply must necessitate a proportional increase in demand [13]. This is one reason why inflation is not concurrent with M2 increases (although more important variables exist, such as CPI composition and unemployment). Central banks are in fact manipulating interest rates when

they set about increasing monetary supply, so M2 increase is a result of monetary policy, not a causal factor. With interest rates lower than their natural equilibrium, lowering the price of money, the demand curve shifts right, increasing investment and production, and eventually raising prices to a new level of equilibrium. The economy has grown and stabilized in the process. However, the economy has reorganized around artificially cheap money. Once central rates go up, the economy will necessarily deflate, as demand will regress. Even if the central bank maintains a constant low rate, since the economy has reorganized around low rates, and misallocation of capital is inevitable in any economic system, busts will come unless rates are constantly reduced. This is inhibited by "the lower bound, [where] it is not possible for the central bank to provide further stimulus to the economy by lowering the rate" [14].

Once this lower bound is met, policies tend to shift towards Quantitative Easing (QE) where assets are purchased, raising the funds possessed by banks in relation to the reserve requirement, effectively lowering the interest rate [15]. QE is a form of manipulating interest rates to affect demand. There is an ongoing debate about the process and efficacy of QE. Assets are not only purchased from banks, they are bought from pension funds and insurance companies whose intermediary is a bank. This increases the asset owner's cash balance, enticing them to rebalance into higher yielding assets [16]. Asset prices rise with increased demand. Additional money allocated to banks in this process is cancelled out by the additional liability created by pension fund deposits [17]. In this perspective, the increased consumer demand originates from alterations of the cost of raising money; higher asset prices from QE allow business to expand, which in turn increases spending in the economy [18]. Although increased supply production does lead to inherent increased demand [19] there is no evidence that it is equivalent to the balance increase from higher asset prices. Prices can fall in certain sectors which expand, while asset and supply-side productive prices simultaneously rise. Empirically, the dichotomy of simultaneous price increases and decreases in a low interest rate market was observed in the early 2000s; housing prices rose as renting prices decreased [20]. While this may seem unsurprising, given the tradeoff of homeownership and rentership, many landlords experienced a decreased income, and a likely decrease in consumer demand. How all of these intricate results of monetary policy affect inflation in aggregate is not well understood.

Thus, the two most common monetary stimulus programs are derivations of interest rate alteration, which indicates the root of inflation as increasing demand. Proponents of monetary stimulus, while arguing against probabilities of hyperinflation, still acknowledge their inflationary tendencies as the policies are intended to curb deflation [21].

My study tests inflation against multiple facets of demand. I analyze taxes, M2, interest rates, savings rates, personal spending rates, government real spending, and personal savings rate and their correlation to month over month inflation rates. I expect to see low interest rates, high M2, high government spending, and high personal spending correlate with increased inflation, and high taxes and savings rates to correlate with less inflation.

Limitations

There are many limitations in my study of inflation, common to inflationary studies in general. First, there are multiple measurement techniques used to

study inflation, all of which focus on different goods and/or services. It is common for one metric to indicate inflation and another to indicate deflation, clouding our knowledge of present conditions [22]. In the US, CPI is the most commonly used, and therefore will be analyzed, though the problems with CPI are shared across all inflation indices.

Items that constitute the CPI change over time, which means it measures prices of different goods across time periods [23]. Videocassette recorders were included in CPI at one point, whereas they are not presently included [24]. How can it be said that we are truly measuring inflation if older, cheaper technology is replaced by newer, more expensive items? Just as some goods deflate as production becomes simplified or the technology becomes outdated, some goods increase in quality and thus price. Cars produced in 2020 have many additional features not present in cars in 1950, however the increased quality, and accompanying price, is only measured as inflation by CPI. A more stark example is how home purchases were used in CPI measurements until 1983, making data before and after this time period difficult to compare [25]. Change in measurement techniques is one reason why the time period analyzed is shorter than that of the available data.

CPI also changes from country to country. In market economies, specialization occurs amongst trade. Since different goods have different demand elasticity, economic change will affect economies differently. In a hypothetical global recession, pretend that Germany primarily produces cars and the US primarily produces wheat. As it is much easier to take public transportation or carpool than it is to stop eating a staple food, wheat may retain its demand while car sales decrease. Therefore, the same economic phenomenon, in this case a general demand glut, has different national effects. The extension of this argument applies to policy. If demand is stimulated through government spending, the car industry will react differently than the wheat industry, and it is not possible to determine the aggregate effects of such policy on millions of prices [26]. There are intrinsic limitations in studying inflation since inflation metrics are inherently distorted.

The expanse of my datasets (30 years) is problematic in some ways. Societies change over time, and things that were not included in the market become included. For example, the proportion of females in the workforce increased almost 3% from 1990 to 1999, and the domestic services they conducted outside of the recorded economy are now measured [27]. This gives the impression of rising GDP even though it is only a rise in measurement [28]. Conversely, recent female labor force participation has fallen to its 1990 levels, giving the impression of a sinking GDP, even though services may still be provided, they are just not recorded.

I am limited in comparable data from all countries utilized. The United States abandoned fixed value gold exchange rates in 1971 and Germany adopted the EURO in 2002. Different currencies and governance systems make it difficult to accurately examine data across these time periods. However, omitting data reduces the sample size and erases important measurements. If certain policy decisions have predictable effects, then we should see them turn out in aggregate, even if specificity is sacrificed through measuring multiple systems. Germany and China have also maintained relatively stable income tax rates at 45% for decades. Without changing rates, it's not possible to analyze their effect through correlative data.

Another issue is with multivariate regression models. I am only able to study correlation; any inference to causal effects is misplaced. Issues with interpreting

the correlative results are further examined in the analysis section. Additionally, these biased results can include the correlation itself, an important point to consider when drawing conclusions based on this method.

Data

US: For the US case-study, I examined data from January 1991 - March 2020. Column 2 comes from the St. Louis Federal Reserve and shows month by month M2 calculated into trillions. Column 3 is my calculations of the month by month change in M2 extrapolated from the same data. Column 4 is the inflation rate month over month from the US Bureau of Labor Statistics. It measures consumer price increases from one month to the next. Column 5 shows personal spending as a month over month change; the data originates from the US Bureau of Economic Analyses. Column 6 shows the personal savings rate month by month and originates from the US Bureau of Economic Analyses. Column 7 shows government spending to GDP and GDI growth originating from the US Bureau of Economic Analyses and US Federal Reserve. For example, entry number one is 13.887705. This means that for every dollar of GDP growth, $13.88 was spent by the government. While combining GDP and GDI risks multicollinearity, and our analysis of other predictors, this metric is used instead of absolute spending values to account for the proportional impact of government spending relative to consumer power in a growing/shrinking economy. Column 8 shows the highest historical marginal tax rates originating from the Tax Policy Center. The effects of tax rates are difficult to measure for multiple reasons. It is well known that higher taxes incentivizes storing income in tax free utilities. In four different circumstances in the past century higher tax revenues followed decreases in marginal tax rates [29]. So, it is difficult to correlate high rates with large amounts of taxed income. Additionally, brackets of income which are taxed at certain rates changes over time; measuring the tax rates of a certain bracket in one decade might be defined differently in another. This is why the highest rate was chosen for use. While who it pertains to is still fluid, it has always applied to the wealthiest segment of Americans. Lastly, column 9 shows the federal funds rate originating from the St. Louis Federal Reserve. The federal funds rate was chosen as it is the means by which the US central bank manipulates money injection in the economy. While the dataset spans 60 years, a 30-year period was used for analysis for a comparable cross-national time period while excluding problematic CPI changes, like home purchases.

Germany: For the German case-study, I examined data from January 1991 - March 2020. Column 2 comes from the Deutsche Bundesbank (DB) and shows month by month M2 calculated into trillions. Monetary policy by individual European central banks is subject to scrutiny over the influence of the European Central Bank (ECB). This is mitigated by omitting variables which are contentiously influenced by the ECB, such as bond rates. Germany is the ideal choice for studying national inflation in the eurozone, as the ECB is modeled off the DB, all of the DB's demands were agreed to in the forming of the ECB, and the DB remains the largest and most influential central bank in Europe [30]. Column 3 is my calculations of the month by month change in M2 extrapolated from the same data. It measures consumer price increases from one month to the next. Column 4 shows consumer spending in trillions; the data originates from the Federal Statistical Office. Column 5 shows the personal savings rate month by month and originates from the Deutsche Bundesbank. Column 6 is

government quarterly spending converted to trillions and originates from the Federal Statistical Office. I divided each entry by three to achieve average quarterly spending by month. Column 7 is the inflation rate month over month from the Federal Statistics Office. Column 8 shows government spending to GDP and GDI growth originating from the Federal Statistical Office. Column 9 shows the 90-day interbank rates and yields originating from the Federal Reserve Bank of St. Louis.

China: For the Chinese case-study, I examined data from February 1996 - December 2016. Column 2 comes from the People's Bank of China and shows month by month M2 calculated into trillions. Column 3 is my calculations of the month by month change in M2 extrapolated from the same data. Column 4 is the inflation rate month over month from the National Bureau of Statistics of China. It measures consumer price increases from one month to the next. Column 5 shows the household savings rate month by month and originates from the OECD. Column 6 shows consumer spending in trillions; the data originates from the National Bureau of Statistics of China. Column 7 is government yearly spending converted to monthly in trillions and originates from the National Bureau of Statistics of China. Column 8 shows government spending to GDP and GDI growth originating from the Federal Reserve Bank of St. Louis. Column 9 is the real annual interest rate originating from the World Bank.

The Model

US: The Durbin-Watson analysis is a 1.403 indicating positive autocorrelation slightly outside of a normal range (1.5-2.5). The statistical significance of our results may be overestimated. My residual histogram and Q-Q plot display linearity. We have a correlation of all our covariates and inflation of .376 and 14.1% of inflation's variability is predictable through our variables (R^2=.141). My ANOVA results have a F value of 8.065 and are statistically significant (P<.001) and my seven covariates predicted inflation better than using the mean inflation score. None of our variables are statistically significant except for the federal funds rate and personal spending. For the federal funds rate, every percentage point increase equated to a .019% increase in inflation. For every percentage point that personal spending increased, inflation increased. 137% The federal funds rate and personal spending exercised the strongest effects on the data with respective beta coefficients of .162 and .299. While not statistically significant, higher M2 change was associated with lower inflation.

Germany: The Durbin-Watson analysis is a 2.403 indicating negative autocorrelation within a normal range. My residual histogram and Q-Q plot display linearity. We have a correlation of all our covariates and inflation of .213 and 4.5% of inflation's variability is predictable through our variables (R2=.045). My ANOVA results have a F value of 2.317 and are statistically significant (P=.025) and my seven covariates predicted inflation better than using the mean inflation score. None of our variables are statistically significant. The most significant variable was the 90-day interbank rates and yields (P=.069). It also exercised the strongest effect on the data with a beta coefficient of .264.

China: The Durbin-Watson analysis is a 1.392 indicating positive autocorrelation slightly outside of a normal range. The statistical significance of our results may be overestimated. My residual histogram and Q-Q plot display linearity. We have a correlation of all our covariates and inflation of .177 and 3.1% of inflation's variability is predictable through our variables (R^2=.031). My

ANOVA results have a F value of 1.118 and are not statistically significant (P=.352) so our model is not reliable. None of our variables are statistically significant. The most significant variable was real interest rates (P=.119).

Analysis

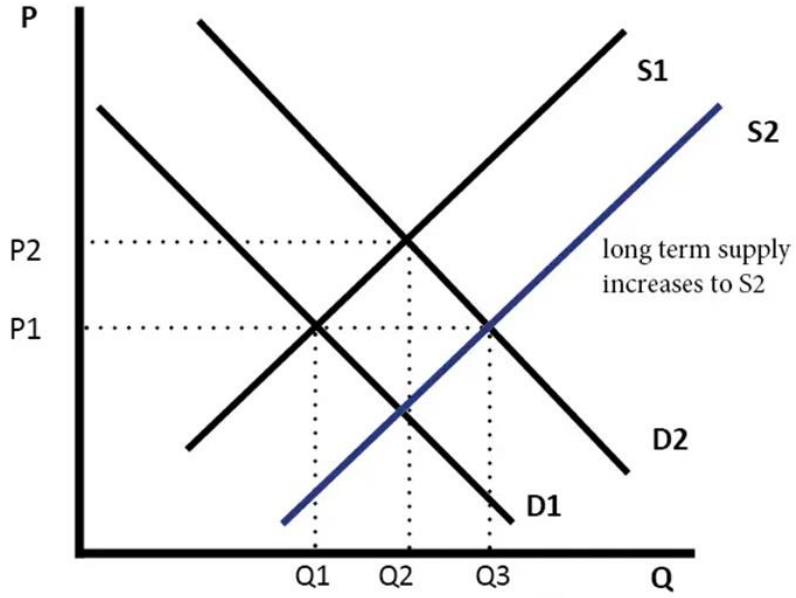
The US case-study provides the clearest results and demonstrates that seven influencers of demand have a weak relationship with inflation. The most important finding was that no variable consistently correlated to inflation with statistical significance. Higher personal spending and interest rates were associated with higher inflation. Higher M2 changes were associated with less inflation. In Germany and China, no variables were significant while interest rates were the most important factor. Interestingly, in these countries, savings rates were correlated with inflation. To some, this might seem odd, as higher savings are typically viewed as inherently deflationary [31]. However, as invested savings and savings deposits are lent or invested elsewhere, they can contribute to aggregate demand [32]. High taxes and interest rates are thought to "cool" the economy by reducing demand and inflation, but no such relationship was observed. Government spending is viewed as a way to bolster demand and prevent deflation, yet no significant relationship appeared here either. So why are the results counterintuitive?

Any explanation is a practice of postdiction, but important points should still be considered. Economic policies are often reactive. If high rates of inflation occurred and then interest rates were raised to cool off inflation, high rates would be correlated with high inflation. The same can be said of government spending and tax rates. State spending tends to increase in recessionary periods, so high spending correlates to receding prices. Taxes are usually raised in times of economic prosperity, so high taxes correlate with inflation. This is the principal issue of measuring correlative data that cannot be causally linked. After all, if low interest rates and government spending truly led to deflation, they would not be employed.

The issue with any inflationary study is that it is impossible to measure the billions of shifting economic variables that occur every day and across the globe. One example is how I found increases in M2 to correlate with deflation. More money is primed when economies falter, and such actions are taken by governments around the world. If the US raises M2 by 2%, but other nations (China) increase the money stock by 9%, the dollar may deflate as its supply decreases relative to other currencies. Prices tend to fall when the money stock remains stable, [33] so it would be discourse changing if increased M2 actually led to deflation.

Additionally, since price equilibriums have been manipulated for over a century, the demand curve has already shifted right for a long time. When demand is artificially raised, as when interest rates are lowered by a central bank rather than by a free market process, prices rise. If the stimulus is not continuously increased, prices will decline as supply meets the previous demand and demand decreases. Since the increased demand is not accompanied by a proportional increase in personal savings, the demand increase is unsustainable without further stimulus. In theory, an increasing supply would accompany a decreasing demand. Even if supply remained stable, demand would start to fall as stimulus wore off. In this sense, we are experiencing deflationary tension

constantly. If interest rates were allowed to adjust to a free market rate, and the government stopped spending, deflation would quickly set in.



The graph above [34] is a visual demonstration of this process. P1 is the free-market price equilibrium. Stimulus policies shift the demand curve right, increasing prices and/or causing a shortage. Business has an incentive to increase supply to meet this demand, so the supply curve shifts right to establish the price at Q3, which is deflationary. The new supply level is still based on unnatural levels of demand; therefore, if the stimulus recedes, demand returns to its original, or lower, level, establishing prices even lower than their original position. This is the deflationary tension ever present in a manipulated market.

A real world example is housing. People need a certain amount of savings to purchase a house; they need to prove to banks they have sufficient income, save for a down payment, and save for monthly payments among other things. When interest rates are lowered by the Federal Reserve, less savings are needed than under free market rates, and demand increases. That portion of the homebuying community has likely been removed from the market for years. If interest rates are pushed even lower, another segment of the population opens itself to the housing market. However, once more houses are built to meet the rising demand, prices lower to their new equilibrium, resulting in deflation. Since much of the demand was stimulated, and not accompanied by genuine savings, there is no guarantee demand will meet the new supply level, resulting in further deflation. Programs designed to increase home ownership frequently lead to unintended deflationary tension and resulting defaults as people cannot pay back rising loans in a deflationary market. Inflationary intervention lays the foundation for deflation.

While analytical speculation is useful in rationalizing results, the evidence demonstrates the inability of interventionary institutions to isolate one economic metric and predictably alter inflation. In two out of the three countries studied, not one variable was statistically significant in correlation to inflation. A counterargument is that just because we cannot accurately measure the effects of certain fiscal or monetary policy, doesn't mean it has no effect. If we cut interest rates in a recession where prices were falling, CPI might decrease, but probably less so than without the rate cut. In effect, the rate cut caused elusive inflation.

However, this argument is unscientific, as there is no way to differentiate elusive inflation from the policy having no effect, making the claim untestable and unfalsifiable. A plausible explanation is that economic institutions have an understanding of how a policy will generally affect the market (low rates = inflation). However, they lack the capacity to contextualize this knowledge in relation to the billions of price shifts, policy decisions, monetary actions, resource changes, and environmental shifts that occur in 195 different countries, every day. Such constraints of knowledge have long been pointed out by other thinkers, such as F.A. Hayek, who declared "it would be 'absurd' to assume that we could ascertain all the data" required for accurate econometric formulations [35].

Conclusion

In all three of our case-studies, interest rates were the most significant coefficient in predicting inflation. However, in Germany and China, there were 0 statistically significant variables, and only two in the US, providing evidence against the accuracy of studying inflation. With billions of daily market alterations, the issue of reactive economic policy, and manipulated markets, there are simply too many competing variables and changing circumstances to achieve any accuracy of results. Additionally, many issues exist with the measurements used to study macroeconomic phenomena like inflation. My research presents an issue for broad monetarists and economic interventionists. Without empirical evidence for the efficacy of market manipulation, it is difficult to laud such programs as sound policy. Furthermore, studies which claim to identify the inflationary effects of policy must explain why, empirically, there is a low correlation amongst predictors and inflation. More than anything, my research supports the notion that "inflation and what causes it are not very well understood." [36].

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