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# The Macro-Share Economy and Nominal GDP Targeting

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## Abstract

Using the Pareto criterion and competitive microfoundations, this paper challenges the consensus' focus on inflation control as the goal of monetary economic policy. It is the price level, not inflation per se, that determines whether a borrower or lender gains or loses. Pareto efficiency suggests that the goal of monetary policy should be to minimize, not inflation risk, not even price-level risk, but rather share risk. Share risk is the risk that a predetermined payment as a share of the whole economy will differ from expectations. We conclude that to minimize share risk, central banks should target nominal GDP. Minimizing share risk also helps to minimize employment risk. We show this latter result using a tautological relationship between three variables: 1) hours of employment, 2) the average wage share of the economy, and 3) the percent of nominal GDP going to employee compensation. We use US data on these three variables before, during, and after the 2007-2008 Financial Crisis to study this relationship.

## Keywords

Component, Formatting, Style, Styling

## 1. Introduction

The monetary goals of most central banks include the goal of price stability[1]. Nevertheless, most central banks focus on inflation control. This paper relies on

[1]The primary objective of the European Union is price stability as stated in the Treaty on the Functioning of the European Union, Article 127 (1). http://www.ecb.europa.eu/mopo/intro/objective/html/index.en.html. The U.S. Federal Reserve's dual mandate, which includes price stability as well as maximum employment, is stated in Section 2A of the Federal Reserve Act [12 USC 225a] as amended in 1977, 1978, 1988, and 2000. (http://www.federalreserve.gov/aboutthefed/section2a.htm, and http://www.frbsf.org/publications/federalreserve/monetary/goals.html).

the findings of literature concerning monetary policy's role in optimal risk sharing including Eagle and Domian [1] and Koenig [2]. Using the Pareto criterion, we argue that the risk that monetary policy should try to minimize is not inflation risk, is not even price-level risk, but rather is share risk.

Section 2 discusses the existing literature's confusion between price stability and inflation control. Section 3 uses the Pareto Criterion to argue the appropriate risk to minimize is share risk. Section 4 shows that the way for a central bank to minimize share risk is to target nominal GDP (NGDP). The rest of the paper discusses share risk in various other contexts. Section 5 discusses share risk in the context of labor markets. Section 6 discusses quasi-real indexing, which is a form of insurance against a central bank not meeting its NGDP target. Section 7 concludes and reflects upon this paper's conclusions.

## 2. Inflation Risk vs. Price-Level Risk

Many economists and central banks use the terms "inflation control" and "price stability" interchangeably. This has led to at least two perversions. First, many central banks embrace inflation targeting (IT). Second, economists have embedded inflation into their ad hoc social-loss functions. This section explains the distinction between "inflation risk" and "price-level risk". The mistaken interchangeable use of these two terms has led to much confusion in monetary economics. Inflation targeting (IT) has grown out of that confusion.

Central banks and monetary economists want to control inflation to minimize "inflation risk". The left side of Table 1 describes the generally-accepted view of inflation risk involving risk-averse parties of a nominal, fixed-payment loan[2]. The true risk is not "inflation risk" per se but is rather "price-level risk". A more precise statement of the risk would be if we have replaced "inflation" with "price level" as we did in the right side of Table 1. An example brings this point out clearly and unequivocally:

Table 1. Inflation risk vs. price-level risk.

| Inflation Risk Statement | Price-Level Risk Statement |
|---|---|
| When **inflation** is greater than expected, then the real value of the nominal-loan payment will be less than expected, making the borrower better off and the lender worse off. On the other hand, when **inflation** is less than expected, then the real value of the nominal loan payment will be greater than expected, making the borrower worse off and the lender better off. A priori, both the borrower and lender, being risk averse, would be better off without this **inflation** risk. | When **price level** is greater than expected, then the real value of the nominal-loan payment will be less than expected, making the borrower better off and the lender worse off. On the other hand, when **price level** is less than expected, then the real value of the nominal loan payment will be greater than expected, making the borrower worse off and the lender better off. A priori, both the borrower and lender, being risk averse, would be better off without this **price-evel** risk. |

[2]See Doepke and Schneider [3] for a similar statement based on the values of loans rather than of loan payments.

Suppose that the central bank announces a 2% inflation target. This central bank aims for this inflation rate, over the medium term, which it defines as three years. Assume the public expects the price level to rise on average over the next three years by this 2% rate. For simplicity, assume the current price level is $P_0$ = 100. Consider a loan of €100,000 for ten years with a fixed nominal interest rate of 5.4% p.a., compounded monthly. The constant fully amortized monthly nominal payment would be €1080.31. Both the borrower and lender expect the price level in three years to be E $[P_3]$ = 106.12 = $100(1.02)^3$. Both the borrower and lender expect[3] the real value of the monthly loan payment at time 3 to be €1018.00 = 1080.31/1.0612.

Suppose that the actual price level at time 3 is $P_3$ = 102 instead of 106.12. This implies an inflation rate of 0.66%, significantly less than the targeted and expected rate of 2%. The real value of the monthly loan payment at time 3 is therefore €1059.13 = 1080.31/1.02. This real payment is over 4% greater than the borrower's and lender's initial expectation of €1018. Hence, in real terms, the borrower is worse off and the lender is better off than initially expected.

Moving forward in time, assume that the price level at time 6 is €112.62. This implies an average inflation rate between time 3 and time 6 of 3.36% (=(112.62/102)^(1/3) − 1). Hence, the inflation rate between time 3 and time 6 was significantly greater than the targeted 2% inflation rate. Nevertheless, the real value of the monthly payment is the same as the borrower and lender expected at time 0 when they initially entered into their loan agreement. This is because the actual price level at time 6 turned out being the same as the borrower and lender initially expected (Note: 112.62 = $100(1.02)^6$). This example makes it obvious that the true risk facing the borrower and lender is not inflation risk, but rather price-level risk. As long as the price level ends up as expected, the real value of the nominal loan payment will be the same regardless of the more recent experience with inflation.

Many economists may say that they all along understood this distinction between "inflation risk" and "price-level risk". Nevertheless, the current fad in central banking is inflation targeting (IT), which can exasperate price-level risk rather than mitigate it. To see this, assume that when the price level at time 3 equals $P_3$ = 102, the central bank responds by "letting bygones be bygones" and aims only to get the future inflation rate to be consistent with their 2% inflation target. Assume they succeed in meeting their inflation target between time 3 and time 6. Then the price level at time 6 would be $P_6$ = 108.24 = $102(1.02)^3$. Then the real value of the monthly loan payment at time 6 would be €998.08 =

[3]While this paper computes the expected loan payment by taking the known nominal loan payment and dividing by $E[P_t]$, technically, we should multiply the nominal loan payment by $E[1/P_t]$, and $E[1/P_t]$ does not always equal $E[P_t]$. We could avoid this technicality by instead of using $E[P_t]$, we could assume individuals have expectations of $E[1/P_t]$ consistent with the inflation target. However, for the broad audience, this would just create confusion and hence result in less understanding. Hence, we do just divide by $E[P_t]$, recognizing that this is not technically correct, but that this technicality is really not very important in this context.

1080.31/1.0824. However, the borrower and lender initially expected the real value of this monthly loan payment to be €959.28 = 1080.31/1.1262 where 112.62 = $100(1.02)^6$. The actual real value of this loan payment is over 4% greater than what the borrower and lender initially expected.

Let this example continue to time 9. Assume the central bank again succeeds in meeting its inflation target from time 6 to time 9. Then the price level at time 9 will equal $P_9$ = 114.87 = $102(1.02)^6$ = $108.24(1.02)^3$. The real value of the monthly loan payment will equal €940.47 = 1080.31/1.1487. However, when they initially entered into their loan agreement, both the borrower and lender expected the price level to be E [$P_9$] = 119.51 = $100(1.02)^9$. Both the borrower and lender expected the real value of their monthly loan payment to be €903.96 = 1081.31/1.1951. The realized real value of the monthly payment of €940.47 will be over 4% greater than what both the borrower and lender initially expected.

The above example illustrates how inflation targeting (IT) "holds the loser down while they are down". When IT misses its target, one party loses and the other gains. By "letting bygones be bygones," IT tries to make permanent the percentage that the real value of the loan payment differs from its initial expected path.

The preceding discussion may lead some economists to argue that central banks should target the price level rather than inflation. In fact, many such as Svensson [4], Kahn [5], and the Bank of Canada [6], have looked at price-level targeting. However, section 3 of this paper finds that the risk we should minimize for Pareto efficiency is not inflation risk, it also is not price-level risk. Instead, for individuals with average relative risk aversion, the risk we should minimize for Pareto efficiency is "share risk".

Another way that the confusion between "inflation risk" and "price-level risk" has led to confusion in economic analysis has been the ad hoc incorporation of inflation into loss functions used by central banks, macroeconomists, and monetary economists in their economic modeling (See, for example, Equations (3.1) and (3.2) on p. 5 in Woodford [7]). Including such an inflation term into these loss functions biases a solution in favor of inflation targeting (although Svenson [4] and others have found that even then, price-level targeting sometimes is superior to inflation targeting). Microeconomists have warned us that ad hoc assumptions concerning social welfare or loss functions can interject a researcher's biases into the analysis. Clearly, by incorporating inflation rather than the price level into these ad hoc loss functions, economists have contributed to the inflation-targeting debacle.

Instead of using social loss or welfare functions, microeconomists advocate using the Pareto criterion to help avoid embedding a researcher's biases into an analysis. The next section relies on research that uses that criterion with diverse consumers. We chose not to use models with representative consumers because the risk of a borrower losing or a lender losing is absent when there is only one consumer.

## 3. Pareto Efficiency and Share Risk

Microeconomists have long recognized the pitfalls of assuming an ad hoc social welfare or loss function. Doing so can embed one's own preconceived biases into an analysis. Instead, we rely on the Pareto criterion to see how under optimal risk sharing, an individual's consumption as a share of the economy should vary over different states of the economy or nature. We assume a pure-exchange economy with no storage. Consumers are diverse, but each has average relative risk aversion. In such an economy, Eagle and Domian [1], Koenig [2], Eagle and Christensen [8], and Eagle [9] find that an individual's Pareto-efficient consumption is a constant share of the economy. By constant, we mean across different states of the economy, not over different time periods.

The basic intuition behind these findings is as follows: Assume that real aggregate supply falls by 10%. Since there is no storage, a drop of aggregate supply by 10% requires that aggregate consumption must also fall by 10%. This also implies that average consumption must also fall by 10%. If individual A's consumption falls by less than 10%, then there must exist an individual B, whose consumption falls by more than 10%. That could be justified if individual A was more risk averse than average and individual B was less risk averse than average. In essence individual A would be transferring some of her risk to individual B through some form of risk-transfer agreement. However, if both A and B have the same level of relative risk aversion, then Pareto efficiency requires that their individual consumption change by the same proportion. For example, assume A's share is ten billionths of the economy and B's share is five billionths. As long as A and B have the same relative risk coefficient, then Pareto efficiency requires that A's share remain at 10 billionths and B's share remain at five billionths of the economy regardless what happens to the state of the economy.

Prearranged nominal contracts naturally provide this constant share as long as NGDP remains as expected. To see this, remember that the equation of exchange is $MV = N = PY$, where $M$ is the money supply, $V$ is velocity, $P$ is the price level, and $Y$ is real aggregate supply; we have interjected $N$, NGDP, into the middle part of the equation. If we concentrate on the $N = PY$ part of this equation and solve for $P$ we get $P = N/Y$. Let $B_t$ be a future prearranged nominal payment at time $t$. Then the real value of this payment equals

$$\frac{B_t}{P_t} = \frac{B_t}{N_t} Y_t$$

where $\frac{B_t}{N_t}$ is the share of the economy that this payment represents. Since the prearranged future nominal payment $B_t$ is known in advance, then the necessary and sufficient condition for this share to be known in advance would be for NGDP ($N_t$) to be known in advance. For example, if NGDP remains the same across all states of nature or states of the economy, then if real aggregate supply ($Y_t$) decreased by 10%, then the price level must increase by approx-

imately 10%[4], causing the real payment to decline by 10%.

However, if NGDP changes, then nominal contracts no longer work well at keeping this share constant. Hence, if the goal of monetary policy is to minimize share risk, then monetary policy should try to keep NGDP from varying from its expected path. That is exactly what NGDP targeting aims to do.

If we look at the population without prejudice as we design monetary policy, we should presume that borrowers are neither more risk averse or less risk averse than lenders. Instead, we should assume both groups have the same level of risk aversion. More specifically, it seems appropriate for us to gear our monetary policy to serve people with average relative risk aversion.

One of the published reasons the ECB has for price stability is to reduce the need for hedging (http://www.ecb.europa.eu/mopo/intro/benefits/html/index.en.html). A central bank can reduce the need for risk-transfer instruments by gearing monetary policy to better serve individuals with average relative risk aversion, leaving the need to transfer aggregate risk only for those individuals with relative risk aversion that is much higher or much lower than the average. To do so, monetary policy should be geared to minimize share risk.

## 4. Share Risk, NGAP, and NGDP Targeting

Suppose an individual *j*'s consumption in state *i* at some future date *t* is given by the following equation:

$$c_{jit} = \tilde{y}_{jit} + B_t / P_{it}$$

where $\tilde{y}_{jit}$ is j's endowment in state *i* at time *t* after any endowment-sharing[5] payment aimed to offset any endowment risk individual j faces. For an individual with average relative risk aversion, the endowment-sharing insurance should result with $\tilde{y}_{jit}$ being a constant share of real GDP[6]. Hence, a necessary and sufficient condition for j's consumption to be a constant share of real GDP, is that the real value of the payment $B_t / P_{it}$ should also be a constant share of real GDP. Replace $P_{it}$ with $N_{it} / Y_{it}$ to get that the real value of this payment should be $\left(B_t / N_{it}\right) Y_{it}$. The ratio $B_t / N_{it}$ is the share of the economy that the predetermined nominal payment $B_t$ represents. Hence, a necessary and sufficient condition for the real value of this payment to be a constant share of the economy is for NGDP at time *t* to be the same no matter what the state of nature. That is in essence what NGDP targeting tries to do.

Define $NGAP_t$ to be the percent deviation of NGDP from expected NGDP at

[4]Taking the natural log of both sides of $P = N / Y$ gives $\ln(P) = \ln(N) - \ln(Y)$. Taking the total derivative with respect to a change in the state of nature gives $\dot{P} = \dot{N} - \dot{Y}$, where the dot over the variable indicates its percentage change. When NGDP remains the same, then $\dot{N} = 0$, implying that $\dot{P} = -\dot{Y}$. Hence, if $\dot{Y} = -10\%$ then $\dot{P} = 10\%$.

[5]See Eagle [4]. This endowment sharing payment is assumed to not interject any moral hazard or adverse selection, which is a reasonable assumption with observable endowments, but may not be reasonable if instead of endowments it was income. Unemployment insurance is similar to endowment sharing insurance, but would face moral hazard and adverse selection issues.

[6]See Eagle [4] for a proof as to why Pareto efficiency requires these endowment-sharing payments.

time $t$. In other words, $NGAP_t \equiv \left( \frac{NGDP_t - E[NGDP_t]}{E[NGDP_t]} \right)$. Next, define the symbol $\alpha_t$ to be the reciprocal of the share of the economy that the fixed nominal payment $B_t$ represents at time $t$. Hence, $\alpha_t \equiv \frac{N_t}{B_t}$. Then the percentage deviation of the actual value of $\alpha_t$ from its expected value equals:

$$\frac{\alpha_t - E[\alpha_t]}{E[\alpha_t]} = \frac{\frac{N_t}{B_t} - E\left[\frac{N_t}{B_t}\right]}{E\left[\frac{N_t}{B_t}\right]} = \frac{N_t - E[N_t]}{E[N_t]} = NGAP_t \quad (1)$$

Squaring each side and taking expectations of each side gives:

$$E\left[\left(\frac{\alpha_t - E[\alpha_t]}{E[\alpha_t]}\right)^2\right] = E\left[\left(NGAP_t\right)^2\right] \quad (2)$$

The left side of (2) is a measure of share risk. Equation (2) shows that the way to minimize this share risk is to minimize the variance of NGAP. This is exactly what NGDP targeting tries to do. First, by formally announcing a NGDP target, the central bank helps the public formulate its expectations concerning NGDP. Second, under NGDP targeting, the central bank tries to minimize the deviation of actual NGDP from to its NGDP target, *i.e.*, minimize the NGAP. Sheedy [10] has also discussed the importance of NGDP targeting to help financial markets deal with incomplete markets with fixed nominal debt.

## 5. Share Risk and the Labor Markets

As Mankiw [11] states, for both Keynesian and Monetarist economic theories, the reason the economy suffers from aggregate-demand-caused recessions is because wages and/or prices are sticky; these wages and/or prices do not change immediately when nominal aggregate spending falls. In classical (Pre-Keynesian) macroeconomic models with flexible wages and prices, a drop in nominal aggregate spending would ceteris paribus be accompanied by a proportional drop in wages and prices leaving the real characteristics of the economy the same as before the drop in nominal aggregate spending. This proportional drop in wages and prices would return aggregate production and unemployment to their "full employment" levels and consumers would receive the same level of real income and consume the same level of real goods and services as before the drop in nominal aggregate spending.

While Keynes [12] acknowledged the truth of the classical macroeconomic models in the long run ("when we are all dead"), he argued that wages and/or prices are sticky in the short run especially in the downward direction. With sticky wages and prices, a drop in nominal aggregate spending will lead to a reduction in the demand for final goods and services, layoffs, and reduced production and increased unemployment. Keynesian economists have advocated fiscal

stimuli—tax cuts and increased government spending—to boost nominal aggregate spending back to a level to be consistent with those sticky wages and prices.

In this section, we present a tautological relationship between employment, wage levels, and NGDP that is consistent with the sticky wage viewpoint. This relationship implies that in order for employment not be affected by economic downturns, wages payments as a share of the economy should be constant.

Let $e$ represent the aggregate number of hours worked in the economy. Also, let $W$ be the average level of employment compensation per hour, which we can think about as the wage rate. Furthermore, let $N$ be NGDP and $k$ be the fraction of NGDP that is for employee compensation. Then,

$$eW = kN \tag{3}$$

For example, in the fourth quarter of 2007 in the US, our rough estimate of $e$ was 263,002,656 hours worked, $W$ was \$34.6 per hour, so $eW$ equaled \$7.9793 trillion, which was the total wage and salary compensation from the US National Income Accounts for 2007[7]. $N$ was \$14.3379 trillion, so $k$ was 7.9793/14.3379 = 55.65%.

Equation (3) is what we call the Fundamental EWN Equation. EWN stands for the relationship between Employment, Wages, and NGDP. For now, consider $k$ to be a constant. If nominal aggregate spending ($N$) declines, then so must nominal income and so must aggregate employee compensation. If the wage rate remains constant, then the number of hours worked must decrease leading to greater unemployment. The decline in the number of hours worked will be even larger if there are positive cost of living adjustments (COLAs) that are based on previous inflation.

One may ask what is required for employment not to be affected by an economic downturn. To answer this question solve (3) for $e$ to get:

$$e = k\frac{N}{W} \tag{4}$$

This shows that if $k$ is constant, then in order for $e$ to remain the same, the ratio $N/W$ must be constant. Please note that the inverse of $N/W$ is $W/N$, the share of the economy that the average wage represents. Hence, if $k$ is constant, then a necessary and sufficient condition for employment to remain the same is for the average wage rate to be a constant share of the economy.

Table 2 shows how $k$ varied in the USA around the time of the Financial Crisis of 2007-2008. The share of NGDP that was employee compensation between 2007-IV and 2009-II was relatively constant and that share decreased slightly between 2007-IV and 2009-IV. The beginning of the recession in the USA began in December 2007, but it was not until the end of 2008 that the worst of the recession was felt. The 2009-II quarter is of interest because that is the quarter for which NGDP had fallen the most from 2007-IV. The 2009-IV quarter is also of interest because it had a higher unemployment rate than did 2009-II.

[7]We computed $W$ by dividing the total wage and salary compensation from the U.S. National Income Accounts by our rough estimate of $e$.

Table 2. Employee compensation as a ratio of NGDP in the USA before and during the Financial Crisis of 2007-2008.

| | 2007-IV | %NGDP | 2009-II | %NGDP | 2009-IV | %NGDP |
|---|---|---|---|---|---|---|
| Nominal GDP | 14,337.9 | 100.00% | 14,151.2 | 100.00% | 14,453.8 | 100.00% |
| less: Depreciation | −1792.8 | −12.50% | −1864 | −13.17% | −1857.7 | −12.85% |
| Other Adjustments | 90.3 | 0.63% | −69 | −0.49% | −163 | −1.13% |
| National Income | 12,635.4 | 88.13% | 12,218.2 | 86.34% | 12,433.1 | 86.02% |
| less: Bus. Taxes | −986.8 | −6.88% | −964.6 | −6.82% | −973.8 | −6.74% |
| Bus. TP & Gov. CS | −101 | −0.70% | −136.6 | −0.97% | −121.7 | −0.84% |
| NI less taxes | 11,547.6 | 80.54% | 11,117 | 78.56% | 11,337.6 | 78.44% |
| Net Interest Income | 798.9 | 5.57% | 784.4 | 5.54% | 782.6 | 5.41% |
| Corporate Profits | 1499.4 | 10.46% | 1226.5 | 8.67% | 1467.6 | 10.15% |
| Proprietors' Income | 1102.1 | 7.69% | 1028 | 7.26% | 1060.3 | 7.34% |
| Rental Income | 168 | 1.17% | 262 | 1.85% | 286.7 | 1.98% |
| Empl. Compensation | 7979.3 | 55.65% | 7815.9 | 55.23% | 7740.6 | 53.55% |
| | 11,547.7 | 80.54% | 11,116.8 | 78.56% | 11,337.8 | 78.44% |

The primary difference between NGDP and nominal National Income is depreciation. Since depreciation is already set by previous years' investments, when NGDP decreased, depreciation as a percent of NGDP increased from 12.50% in 2007-IV to 13.17% in 2009-II. Since depreciation is an expense to businesses not workers, the net effect of depreciation should be close to zero on the share that employee compensation is of NGDP. Note that if employee compensation were to increase as a share of NGDP, then some other component of nominal national income must decrease as a share of NGDP. In the case of the 2007-2009 USA recession, corporate profits did decrease as a share of NGDP. However, rental income to persons increased significantly from a 1.17% share of NGDP in 2007-IV to a 1.85% share in 2009-II and to a 1.98% share in 2009-IV. Given the downturn in the real estate market, this rental income probably occurred because many people unable to sell their homes chose to rent their homes instead.

In the USA since 1948, the ratio of employee compensation to NGDP has ranged from a low of 52% to almost 60%, a range of 8%. Over this long period of time, the share that employee compensation is of NGDP has not been constant. However, that 8% range is much greater than the changes in this share that occur over the time span of a recession. To learn more how this share has behaved in USA recessions since 1948, we conducted a paneled event study. Our first step in doing the paneling was to identify the quarter we would call quarter 0. We did this by identifying where NGDP first dropped by over 1.7% relative to the trend NGDP (except for the 2001 recession where we identified quarter 0 as when GDP dropped by the largest percentage). Table 3 reports those quarters, along with the percent change in NGDP less the previous' trend percent change in NGDP.

Table 3. Determination of time-0 quarter for recessions.

| first quarter | %ΔNGDP−Previous %ΔNGDP | | | | | | last quarter | time 0 quarter |
|---|---|---|---|---|---|---|---|---|
| | 1st Q | 2nd Q | 3rd Q | 4th Q | 5th Q | 6th Q | | |
| 1948-IV | −1.95% | −4.31% | −3.79% | −1.89% | −3.32% | | 1949-IV | 1948-IV |
| 1951-III | −2.00% | −-2.77% | −3.10% | −3.80% | −2.24% | −0.46% | 1952-IV | 1951-III |
| 1953-II | −0.67% | −1.86% | −2.99% | -1.81% | -1.41% | | 1954-I | 1953-III |
| 1957-IV | −2.48% | −3.08% | −0.53% | | | | 1958-II | 1957-IV |
| 1960-II | −2.02% | −1.33% | −2.87% | −1.04% | | | 1961-I | 1960-II |
| 1969-IV | −1.46% | −1.02% | −0.71% | −0.59% | −2.07% | | 1970-IV | 1969-IV |
| 1973-IV | 0.33% | −1.60% | 0.02% | −0.68% | −0.05% | −1.56% | 1975-I | 1974-I |
| 1980-I | −0.07% | −2.36% | −0.40% | 2.17% | 2.17% | −1.42% | 1981-II | 1980-II |
| 1981-III | −0.11% | −2.56% | −3.42% | −1.36% | -2.08% | | 1982-III | 1981-IV |
| 1990-III | −0.75% | −1.74% | −1.08% | −0.27% | | | 1991-II | 1990-IV |
| 2001-I | −1.17% | −0.18% | −1.48% | −0.86% | | | 2001-IV | 2001-III |
| 2008-I | −0.95% | −0.34% | −0.86% | −2.57% | −2.38% | −1.39% | 2009-II | 2008-IV |

For each quarter of each recession, we broke down NGDP into five income categories: 1) employee compensation 2) corporate or proprietor's profit plus taxes plus depreciation, 3) rental income of persons, and 4) net interest income of persons, and 5) miscellaneous, which represents everything else.

Next, we computed the share each component was of NGDP. Then we averaged these component shares for each quarter over the recessions we included in our paneled analysis. To make sure we are clear on what this average is, let $x_{ij}$ represent the share the particular component is of NGDP in recession $i$ for quarter $j$, where the quarters were labeled −4, −3, ···, 0, 1, ···, 8. Since quarter 0 is the quarter of the first significant drop in NGDP, quarter-4 is four quarters before that and quarter 8 is eight quarters after. For each quarter $j$, we computed the average of each component's share over all recessions. Where $\overline{x}_{*j}$ is this average,

$$\overline{x}_{*j} \equiv \left(\sum_{i=1}^{n} x_{ij}\right) \Big/ n$$

where $n$ is the number of recessions we studied. Table 4 presents these averages.

To more clearly identify how each component changed over the time span of these recessions, we first computed the average of the first three quarters to establish a prerecession baseline for the component. Where $\tilde{\overline{x}}$ is this baseline, $\tilde{\overline{x}} \equiv \sum_{j=-4}^{-2} \overline{x}_{*j}$. Next, for each quarter, we computed $\overline{x}_j - \tilde{\overline{x}}$, which represents the difference between the ratio of this component for quarter $j$ and the baseline. Table 4 presents the averages of these differences across all USA economic recessions.

**Table 4.** Components of NGDP as share of NGDP by relative quarter to initial quarter of decrease in NGDP.

| quarter | Misc. | Net Interest Income | Rental Income (Persons) | Profit. + taxes + depr | Employee Compensation | Misc. | Net Interest Income |
|---|---|---|---|---|---|---|---|
| −4 | 0.19% | 3.05% | 2.33% | 38.83% | 55.60% | 0.19% | 3.05% |
| −3 | 0.40% | 3.03% | 2.33% | 38.66% | 55.56% | 0.40% | 3.03% |
| −2 | 0.30% | 3.19% | 2.35% | 38.63% | 55.53% | 0.30% | 3.19% |
| −1 | 0.31% | 3.33% | 2.37% | 38.29% | 55.67% | 0.31% | 3.33% |
| 0 | 0.43% | 3.43% | 2.41% | 37.70% | 56.02% | 0.43% | 3.43% |
| 1 | 0.35% | 3.51% | 2.46% | 37.53% | 56.14% | 0.35% | 3.51% |
| 2 | 0.18% | 3.59% | 2.54% | 37.60% | 56.09% | 0.18% | 3.59% |
| 3 | 0.48% | 3.52% | 2.57% | 37.68% | 55.76% | 0.48% | 3.52% |
| 4 | 0.61% | 3.60% | 2.57% | 37.69% | 55.55% | 0.61% | 3.60% |
| 5 | 0.56% | 3.65% | 2.55% | 37.85% | 55.39% | 0.56% | 3.65% |
| 6 | 0.29% | 3.43% | 2.62% | 38.07% | 55.60% | 0.29% | 3.43% |
| 7 | 0.28% | 3.49% | 2.60% | 37.91% | 55.71% | 0.28% | 3.49% |
| 8 | 0.20% | 3.56% | 2.59% | 37.79% | 55.87% | 0.20% | 3.56% |

This paneled event study shows that during the average recession, employment compensation initially increases as a share of NGDP when the recession begins. However, as the recession lingers, that share returns to its baseline. This observation would be consistent with the story of firms initially trying to keep their employees even when the firms themselves have lower profits or are losing money. However, eventually the firms must let employees go as their profits continue to be low or negative. Other than the initial rise in this ratio at the beginning of a recession, **Table 4** supports our premise that this ratio is relatively constant during a recession. Given that this ratio $k$ is constant, then by equation (4), we must conclude that a necessary and sufficient condition for employment to remain unchanged by a recession is that the ratio of N/W not change. If W is fixed then N would need not to change. In other words, the central bank should target nominal GDP and would need to be successful in meeting that target.

## 6. Quasi-Real Indexing and the Wage Indexation Literature

Some economists may argue that NGDP targeting is not possible at times in the economy because of the lower zero bound on nominal interest rates. However, Cochrane [13] and Eagle [14] argue that inflation targeting leads to price indeterminacy and that this price indeterminacy manifests itself in getting the economy stuck in a liquidity trap or at a lower zero bound. Eagle [14] argues that NGDP targeting does lead to price determinacy when it follows a sufficiently strong feedback rule for setting interest rates. Thus, NGDP should at least reduce the possibility of the lower-zero bound or liquidity trap, a conclusion con-

sistent with literature on the lower-zero bound or liquidity trap by Krugman [15], Eggerson and Woodford [16], Svenson [17], and Gaspar *et al.* [18].

Nevertheless, the literature cited in the above paragraph may not sufficiently satisfy some economists that a central bank will be able to always keep NGDP close to its targeted level. What this paper argues is that the best a central bank can do with monetary policy is to try to keep NGDP close to its target. If the central bank is unable to do that because of zero-lower bound, liquidity trap, or some other reason; then we have to look beyond monetary policy for a means by which to keep predetermined payments being fixed shares of the economy. Quasi-real indexing as initially presented in Eagle and Domian [19] is aimed at doing just that.

Ideal" Quasi-Real Indexing (QRI) of wages will set the current wage as shown below:

$$W_t = W_0 \frac{N_t}{N_0 (1+g)^t} \tag{5}$$

where $W_t$ is the wage rate and $N_t$ is the level of NGDP in the current period; $W_0$ is the wage rate and $N_0$ is the level of NGDP for the base year of the QRI contract; and $g$ is the expected long-run growth rate in real GDP as explicitly stated in the QRI contract. We can rewrite (3) as:

$$\frac{N_t}{W_t} = \frac{N_0 (1+g)^t}{W_0} \tag{6}$$

This shows that at any particular time t, the ratio $N/W$ is also a constant, and by (4) $e$ will be a constant. Please note that the constancy of the ratio $N/W$ and $e$ is not across different points of time, but across different possibilities at a specific time $t$.

It is important to note that for QRI to work to mitigate recessions, all contracts have to be QRI, not just wage contracts. To understand this, imagine an economy where wages are quasi-real indexed, but mortgages, car loans, rents are not. Then an unexpected drop in nominal aggregate spending would trigger a drop in wage rates, but the workers' mortgage payments, car payments, and rent payments would remain unchanged. These workers would be squeezed between their lower wages and their constant other payments. However, if QRI also applied to mortgages and other loans and rents, then, when nominal aggregate spending falls, the QRI would simultaneously trigger drops in the payments on all these contracts as well as the wage rate, averting the squeeze on employees. Also, if prices fall proportional to the lower employment costs, then the real value of the household's disposable income would be the same after the drop in nominal aggregate spending as before. (See Eagle [14] for a more rigorous presentation of the logic behind this conclusion.) Note that if a landlord's own mortgage is quasi-real indexed, then he/she would want his/her rents to also be quasi-real indexed.

Because this paper focuses on monetary policy, not indexing, we do not want

to spend too much time on quasi-real indexing. However, it is important to note that quasi-real indexing is really insurance against the central bank not meeting its NGDP target (even if it is not targeting NGDP). Also, because this paper is an attempt to synthesize several different ideas into the issue of share risk, we also want to recognize how the wage-indexation literature ties into quasi-real Indexing.

Return again to the tautological equation that $P = N/Y$. This means there are two determinants of the price level: 1) nominal aggregate spending as measured by NGDP, and 2) real aggregate supply. Hence, we can also break down inflation into two components: 1) aggregate-demand-caused inflation and 2) aggregate-supply-caused inflation. Note that by indexing wages, loan payments, or other payments only to NGDP, quasi-real indexing only adjusts for aggregate-demand-caused inflation and not to aggregate-supply-caused inflation. In contrast, conventional cost of living adjustments (COLAs) adjust for inflation no matter the cause.

The Wage Indexation literature starting with Grey [20] [21] and Fischer [22] found that indexing worked optimally when all inflation was caused by aggregate demand. However, when inflation was caused by drops in aggregate supply, this literature found that indexing actually became procyclical. While this literature settled on the imperfect policy recommendation of partial indexing, Fischer [23] stated on p. 43:

> … it is well known that by making the real wage less flexible, indexation worsens the response of the economy to supply shocks: An adverse supply shock raises prices and reduces output more with indexed than with non-indexed wages. It is analytically possible to avoid this difficulty by tying wages to an index that excludes the effects of supply shocks, but such complicated indexation schemes have not yet been introduced.

However, after Fischer's 1984 statement, Eagle and Domian [19] did propose quasi-real indexing, which does meet Fischer's ideal with computations comparable to conventional indexing.

Jadresic [24] points out the problems that can occur when indexing occurs with a significant lag; then the indexing can become procyclical even for aggregate-demand-caused inflation. Hence any implementation of quasi-real indexing should try to minimize this lag effect.

## 7. Conclusion and Reflections

This paper argues against the central bank goal of minimizing "inflation risk," and against central banks following inflation targeting (IT). The "letting bygones be bygones" property of IT and its associated price-level base drift lead to the central banks "holding the losers down when they are down". Instead of minimizing "inflation risk", instead of minimizing "price-level risk," we instead advocate minimizing "share risk," a goal consistent with Pareto efficiency. We also find that goal consistent with maintaining high employment.

We have relied on the finding that Pareto efficiency requires the consumption of an individual with average risk aversion be a constant share of the economy. This finding comes from Eagle and Domian [1], Koenig [2], and Eagle and Christensen [8]. While their finding assumes a pure exchange economy without storage, it is important to note that this paper's relationship (2) is general; it does not depend on assuming a pure-exchange economy; it does not depend on assuming no storage. Relationship (2) relates NGAP to the share of the economy that a payment represents. Thus, our finding is general that in order to minimize share risk, we need to minimize NGAP, which is what NGDP targeting does.

Let us think about a nominal loan again, but in the context of a more general economy, with production, storage, and capital investments. Does it then make sense for us to focus on the share of the economy that a nominal payment represents to shift between borrowers and lenders? Selgin [25] argues yes. However, Koenig [2] on p. 59 found in such an economy that Pareto efficiency requires that the share risk that is minimized involve shares of aggregate consumption rather than of aggregate total spending. The difference is investment, which includes storage. I look at Koenig's work as a first step into investigating more complex and realistic economies. However, I view the issue may be more complicated than even Koenig's analysis. At this point in time, I am struggling to try to shift monetary economists' preoccupation with inflation or inflation risk to share risk. If and when a significant shift takes place, then refining how best to define share risk in a more general economy is what future research should investigate.

Many readers may find similarities between Weitzman's [26] "Share Economy" and the "share risk" we focus on. While the macroeconomic benefits are similar, it is important to note that Weisman's proposal of employees sharing in the profit of the firms they work for is a "microeconomic share" not a "macroeconomic share". Our paper focuses on the macroeconomic share, the share that a nominal payment is of the overall economy, whether that payment is a wage, a loan payment, or some other predetermined payment.

The important difference between a microeconomic share and a macroeconomic share is related to the difference between total risk and aggregate risk. Total risk equals idiosyncratic risk plus aggregate risk. By focusing on macroeconomic shares, this paper is concerned with optimal risk sharing of what financial economists call systematic risk (also called market risk or aggregate risk). This is the risk that the individuals, business, and the whole economy cannot diversify away. The idiosyncratic risk can be diversified away, but that diversification needs to be done by other financial instruments like insurance, not monetary policy or aggregate fiscal policy.

Much literature exists trying to explain why wages are sticky. However, the issue uncovered by Eagle and Domain [9], Koenig [2], and Eagle and Christensen [8] offers a new explanation. It is the presumption that microeconomic theory implies that if wages were flexible, then wages would drop proportional to drops in NGDP making the workers as well off after the drop as before. How-

ever, in a world with predetermined nominal loan payments, rents, etc.; workers would be hurt by those proportional drops because they would be squeezed between these predetermined nominal payments and their wage drops. As a result, to avert the possibility of such a squeeze, workers may demand or "expect" a guaranteed fixed wage to match their fixed mortgage payment, fixed rent, and other such fixed expenses.

While Eagle and Domian [18] introduced the concept of quasi-real indexing in the context of government bonds, their quasi-real-indexed bonds are the same as the Trills proposed by Kamstra and Shiller [27], which is a version of a similar bond proposed by Shiller's [28], although neither Kamstra nor Shiller considered their proposal to be a type of inflation indexing. This paper's focus on the term "share" came from reading Kamstra's and Shiller's writings where they emphasize that their bonds represented a share of the economy.

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