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The Case for Targeting the Level of Nominal Spending

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Summary: One way for the Federal Reserve to provide additional stimulus, should that be judged desirable, is by committing to hold down interest rates until some price index or measure of nominal spending reaches a pre-announced target path. This memo argues that a nominal-spending target offers advantages relative to a price-level target, and deserves careful study.

Three Desiderata

There are three general desiderata for a monetary policy rule, roughly corresponding to the three goals for monetary policy set out in the Federal Reserve Act: “maximum employment, price stability, and moderate long-term interest rates.”

- The first desideratum is that the policy rule minimize wasteful underutilization (or, more generally, wasteful misallocation) of resources due to the various frictions that slow the adjustment of money prices and, so, distort relative prices. Such frictions ordinarily interfere with relative-price adjustment only temporarily, so this policy objective is most salient at short-to-medium horizons. The exact character of the relevant frictions remains controversial, and optimal policy design is sensitive to assumptions. In general, however, monetary policy should try to minimize required adjustments to those money prices that are stickiest.
- The second desideratum is that the policy rule imply low and stable long-term inflation expectations. This requirement is not controversial in the abstract. Practical success hinges on institutional arrangements and the will to resist political pressures.

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- The third desideratum is that the policy rule promote financial stability. While promoting financial stability is arguably primarily the responsibility of financial regulatory policy, monetary policy also has a role to play. Monetary policy rules that ignore financial conditions may respond inappropriately to prospective productivity gains, feeding asset-price bubbles (Christiano *et al.* 2010). Also, unexpected price-level changes redistribute real wealth between debtors and creditors. The possibility of such changes may raise the risk premium built into interest rates. Moreover, as noted by Irving Fisher back in the 1930s, a lower-than-expected price level can put financial strain on debtors, triggering loan defaults and/or the distress sale of illiquid assets, creating new financial strains, and so forth, generating dangerous downward momentum.

Currently, the pursuit of all three policy goals is complicated by the fact that short-term interest rates are at (or very close to) their zero lower bounds. The options open to monetary policymakers in these circumstances, should they wish to provide additional stimulus, are limited and their effectiveness uncertain.

One option is to directly support increased government purchases or cuts in taxes through additions to the money supply. While an expansion of total government liabilities (of which high-powered money is one component) may sometimes be required to prevent expectations of deflation from becoming entrenched, by all accounts long-term inflation expectations currently remain well anchored near 2 percent.

A second option is an expansion of the Federal Reserve's balance sheet not tied to changes in fiscal policy. With the economy satiated with liquidity, however, traditional Federal Reserve purchases of short-term Treasuries are useless. Other asset purchases depend for their influence on imperfections in capital markets and/or signaling effects (Eggertsson and Woodford 2003; Curdia and Woodford 2010). Capital markets were badly disrupted at the height of the financial crisis, but at this point have largely normalized. Remaining imperfections are most likely to affect privately issued financial instruments, not Treasury securities. Intervention in markets for privately issued assets would be politically charged and is subject to legal constraints.

Even in the absence of capital-market imperfections, purchases of Treasury bonds might

lower expected future policy rates. Presumably, monetary policymakers would not want to put themselves in a position where they would have to go hat in hand to Congress or the Treasury, seeking recompense for capital losses. So, the purchase of bonds that mature in X years can signal that the monetary authority intends to hold its policy rate at current low levels for at least X years. The problem is the non-contingent nature of the commitment. By purchasing longer-term Treasuries the FOMC signals that it will hold the funds rate down independent of what might happen to inflation, the price level, or real activity. The more bonds they purchase and the further out the yield curve the purchases go, the more that policymakers lock themselves in.

The focus of this memo is on a third stimulus option, which is to commit to holding down short-term interest rates until some price index or measure of nominal spending reaches a pre-announced target path. A path target does not forgive past policy misses in the way that a growth target does. This “history dependence” feature is critical at the zero bound, when current interest-rate policy is constrained (Eggertsson and Woodford 2003). However, the commitment is not for a fixed period of time, independent of the state of the economy. It incorporates an exit strategy.

Since its effectiveness depends on the Federal Reserve being able to affect current private-sector behavior through the promise of future action, targeting the path of a nominal variable is only successful insofar as the promise is believable. It will be more believable the more obviously it is consistent with the three goals of monetary policy, outlined above. In this regard, a nominal-spending target has features that make it worthy of serious consideration as an alternative to a price-level target.

Would a Nominal-Spending Target Anchor Long-Term Inflation Expectations?

As long as policymakers have a good grasp of the economy’s long-run real growth potential, a target path for nominal spending can be chosen so as to achieve any desired long-run average inflation rate. If the estimated long-run growth rate of potential real GDP is 2.5 percent per year, for example, and the desired long-run average inflation rate is 2.0 percent, policymakers would specify a target path for the level of nominal spending that includes a $2.5 + 2.0 = 4.5$ -percent-per-year growth trend. If the estimate of potential real growth were subsequently revised downward to, say, 2.25 percent per year, the trend built into the target

spending path would be revised downward to 4.25 percent per year in a “technical adjustment”.²

Recent research suggests that U.S. real GDP *per capita* is trend stationary variable over the post-WWII period, except for one break (Perron and Wada 2009). This result implies that by targeting the path of nominal spending policymakers would not only anchor the long-run average inflation rate, but also make the price level a trend-stationary variable. The only difference between nominal-spending targeting and price-level targeting is that under the former, deviations of the price level away from trend are systematically related to deviations of real output away from trend. As a practical matter, a nominal-spending target gives policymakers the flexibility to tolerate above-normal inflation in the near term if output growth is weak, or if output has fallen below trend. This near-term flexibility is pertinent, today.

Charts 1 and 2 show the log-levels of nominal GDP and nominal PCE. Trend lines (the dashed lines in the charts) are fitted through data from 2001:Q1 through 2007:Q4—*i.e.*, through data that extends from business-cycle peak to business-cycle peak. Both of these fitted trends show growth of 5.4 percent per year. Both series were very nearly on trend as the economy slipped into the 2008-2009 recession.

From 2007:Q4 forward, the fitted trend lines are replaced by hypothetical 4.5-percent growth paths (the dotted lines in the charts). As noted above, 4.5-percent spending growth guarantees 2.0-percent long-run average inflation if the economy’s long-run average real growth potential is 2.5 percent. Currently, nominal GDP and nominal PCE are 9.6 percent and 8.5 percent below their respective reference paths, and the gaps are widening. If either reference path were adopted as a target, the message from the charts would be that recent policy has failed badly at keeping spending on a path consistent with long-run price stability.

Chart 3 is the core-PCE-price-index counterpart of Charts 1 and 2. (Results for the headline PCE price index are quite similar.) It shows the chain-weight price index for personal consumption expenditures excluding food and energy, along with a fitted trend (the dashed line) and a reference 2.0-percent growth path (the dotted line). Note that the fitted trend line rises at

² Similarly, if it is expected that (say) slowing population growth will gradually lower the economy’s real growth potential, an identical slowing could be incorporated into the target path for nominal spending.

the same 2.0-percent annual rate as the reference path, so that the latter is simply an extension of the former. If the trend/reference line were adopted as a target path for the price level, the message for monetary policy would be very different from that implied by Charts 1 and 2. Chart 3 says that monetary policy has been basically on track: the recent recession has simply returned the price level to target after a period during which it was running on the high side. All that is needed, now, is a modest course correction to keep the price index from slipping significantly below the target path.

The FOMC could, of course, pursue a different price path than that displayed in Chart 3. It could, for example, announce that it will target a price path with a growth rate above 2.0 percent for a time. Rationalizing such a relaxation of its professed inflation objective could prove to be challenging, however, and the departure might erode confidence in the Committee's commitment to long-run price stability. The flip side is that insofar as people *do* have confidence in the Committee's commitment to price stability, they may doubt the Committee will be willing to suspend pursuit of that objective for long enough to get the economy moving again.³ An advantage of a nominal-spending target is that it *automatically* relaxes the implicit near-term inflation objective when such relaxation is warranted and *automatically* tightens the implicit near-term inflation objective as the real economy improves, yet guarantees long-term price stability. No temporary suspension of the target need be announced or justified.

Would a Nominal-Spending Target Help to Maintain Full Employment?

As noted above, the sluggish adjustment of prices raises the possibility that resources will be misallocated, in the near term, as compared with an economy in which prices adjust instantly to fully reflect available information. Several different models of nominal frictions have been explored in the professional literature. In some of these models, agents' information sets are continuously updated, but it is expensive or time consuming to change prices to reflect the new information. In other models, changing prices is costless, but information sets are updated with a

³ The same objections apply to the Reifschneider-Williams (2000) variant of the Taylor rule. (Reifschneider and Williams suggest raising the inflation target built into the Taylor rule when policy is constrained by the zero bound.)

lag. Generally, the prescription that emerges from this literature is that monetary policy should try to minimize movement in the market-clearing levels of those prices that are stickiest. A key task, then, is the identification of markets where price adjustment is especially sluggish.

Research has shown that to get realistic persistence in the economy's response to nominal shocks, one needs either *ad hoc*, rule-of-thumb indexing of product prices to lagged inflation or a labor-market friction like wage stickiness or labor immobility. The latter approach is as plausible as the former.⁴ More generally, sticky wages are no less plausible than sticky product prices. The early frictions literature focused almost exclusively on sluggish wage adjustment.

If it is primarily money wages that are sticky, not product prices, then it will be optimal for monetary policymakers to try to avoid surprise changes in the market-clearing money wage and let product prices move up or down as needed to clear the labor and product markets. In an economy in which the principal real disturbances are shocks to productivity, this policy is equivalent to targeting a geometric weighted average of real output and the price level (Koenig 1995, 2004). In the special case where the income and substitution effects that productivity shocks have on employment are offsetting—a reasonable rough approximation—then the optimal wage policy is equivalent to targeting the level of nominal spending.⁵

⁴ Chari, Kehoe, and McGratten (2000) demonstrate the lack of persistence in the most common model of sluggish product-price adjustment. Koenig (2000) and Edge (2002) note that the Chari *et al.* result can be overturned if labor is immobile between firms or, equivalently, if there is sluggish money wage adjustment. [Mankiw and Reis (2002), for example, adopt the former assumption in a model where product pricing is delayed due to “sticky information”. Their model is isomorphic to Koenig’s (1999) model of sticky-information wage adjustment.] Alternatively, researchers who construct empirical dynamic general equilibrium models with sticky product prices often assume that firms who at a particular moment are unable to re-optimize their price are able to costlessly index to lagged inflation (Christiano, Eichenbaum and Evans 2005). Ambler (2009) comments: “The rule-of-thumb price-setting rules in current models provide a convenient shortcut that helps to generate the degree of inflation persistence observed in the data; they are also the least theoretically satisfactory feature of New Keynesian models. It is unclear whether policy recommendations should be based on *ad hoc* modelling (sic) assumptions that are as vulnerable to the Lucas critique as previous generations of macroeconomic models.”

⁵ Suppose that the aggregate production function is Cobb-Douglas with an elasticity of real output, Y , with respect to employment, L , equal to β . Then the real wage must satisfy $W/P = \beta Y/L$ as long as firms are on their labor-demand curves, and the nominal wage is related to nominal GDP and employment by $W = \beta PY/L$. Thus, holding nominal GDP to a pre-announced path is equivalent to holding the market-clearing money wage to a pre-announced path provided the price level is flexible and the market-clearing level of employment is unaffected by real shocks to the economy. In an economy

Why not avoid approximations and target the path of the nominal wage directly? The main reason is that, precisely because wages *are* sticky, spending is likely to move in advance of wages, giving early warning that policy is moving off track. **Charts 4 and 5** illustrate this tendency for ECI wage inflation, using nominal GDP and nominal PCE, respectively, to measure spending. In both charts, the correlation between wage growth and spending growth is maximized when the latter is shifted forward by 4 quarters. Then, correlation coefficients are 0.74 and 0.78, respectively.⁶ So, movements in nominal spending have, indeed, given advance warning of movements in wage inflation.⁷ It's possible, of course, that these correlations and leads would change if controlling spending became the focus of Federal Reserve policy.

In any case, the assessment of current policy implied by the recent behavior of wages is similar to that implied by Charts 1 and 2: policy has “fallen behind the curve” since the financial crisis deepened in late 2008. The evolution of the “wage gap” is displayed in **Chart 6**, which is similar in construction to Charts 1-3. The fitted trend path of wages from 2001:Q1 to 2007:Q4 rises by 2.8 percent per year. However, assuming 1.5-percent trend productivity growth (matching the average growth rate of GDP per worker over the past 20 years), wage growth could rise to 3.5 percent per year without jeopardizing price stability, defined as 2.0-percent long-run average price inflation. Accordingly, Chart 6 extends the fitted trend wage line using a

with fixed capital, it is easy to verify that the latter condition is satisfied if the utility function of the representative household takes the form $\log(C) - L^{1+\lambda}/(1+\lambda)$, where C is household consumption and $\lambda > 0$ is the inverse of the wage elasticity of labor supply. Then, households are on their labor-supply schedules if, and only if, the real wage satisfies $W/P = CL^\lambda$. Combine this condition with the labor-demand condition derived above and impose $C = Y$, and one finds that the market-clearing employment level is constant at $\beta^{1/(1+\lambda)}$. The variable-capital case is considerably more complicated, because the link between C and Y is loosened.

⁶ When first-release GDP growth estimates are used in place of today's data, the correlation between spending growth and wage growth drops slightly, to 0.68, but the lead remains at 4 quarters. Similarly, the correlation between first-release PCE growth and wage growth drops to 0.74, and the lead shrinks to 3 quarters. (The correlation at 4 quarters is 0.72.)

⁷ Nominal GDP and PCE growth also lead the Dallas Fed's trimmed-mean measure of trend PCE inflation. The leads are 4 quarters and 5 quarters, respectively, and the correlations are 0.62 and 0.70. First-release PCE growth also strongly leads trimmed-mean PCE inflation, with a 0.64 correlation and a 5-quarter lead. However, the link between nominal GDP growth and trimmed-mean PCE inflation weakens substantially when first-release spending growth estimates are used: the correlation drops to 0.55, and the lead falls to only 2 quarters. (At a 4-quarter lead, the correlation drops to 0.46.)

3.5-percent, post-2007:Q4 reference growth path. Against this reference path wages have fallen short by 3.3 percent.⁸

Nominal-Spending Targeting, Financial Stability, and the Distribution of Risk

Many financial obligations—such as loan payments, corporate pension liabilities, and lease payments—are fixed in nominal terms.⁹ The existing literature emphasizes the vulnerability of those with fixed nominal obligations to price-level-induced adverse shocks to their net worth—adverse shocks that are a potential barrier to the extension of credit and, insofar as they lead to defaults, also a potential threat to the smooth functioning of credit markets. Some analysts have cited these vulnerabilities as a reason for central banks to adopt price-level targeting (Crawford *et al.* 2009). However, such analyses are incomplete. Debtors with fixed nominal payments are exposed to stress whenever current or prospective nominal revenue flows deteriorate, independent of whether the deterioration is due to lower-than-expected inflation or to lower-than-expected real revenue growth.¹⁰ Purely random variation in the price level is surely undesirable, but that fact doesn't mean that price-level variation can't be a good thing provided it helps reduce unexpected variation in nominal revenue. An appendix to this memo presents a formal analysis suggesting that a nominal-income target for monetary policy distributes risk more efficiently across debtors and creditors than does a price-level target. Both policies eliminate purely random price-level variation, but a price-level target puts all of the risk due to aggregate real shocks onto debtors and none onto creditors. A nominal-income target, in contrast, distributes aggregate-output risk across debtors and creditors in the same way that actuarially fair private insurance would, if it were available.

Currently, a majority of households expect their money incomes to decline over the next

⁸ The wage gap is 2.1 percent if a 1.0-percent productivity trend is assumed.

⁹ “If one thinks about the important sets of contracts in the economy that are set in nominal terms, and which are unlikely to be implicitly insured or indexed against unanticipated price-level changes, financial contracts (such as debt instruments) come immediately to mind.” –Bernanke (1995)

¹⁰ This observation is consistent with Bernanke (1995), who notes: “Similarly, a household whose current nominal income has fallen relative to its debts may be barred from purchasing a new home, even though purchases is justified in a permanent income sense.”

six months—a situation that is extraordinary (**Chart 7**). Anecdotally, uncertainty about future income is high. This pessimism and uncertainty contribute to households’ hesitancy to take on debt to finance new purchases. A monetary policy publicly committed to keeping nominal income on a 4.5-percent growth track would help change consumer attitudes to the better.

A Generalization of Nominal-Spending Targeting: *Flexible Price-Level Targeting*

Finding the optimal way to conduct monetary policy in an economy where short-term interest rates may become constrained by the zero bound is a non-trivial task. A basic principle, though, is that the more binding the zero-bound constraint has been, the more relaxed people must expect that policy will be once the constraint has lifted. Policy must make up for past misses, not just be set on the basis of current and expected future conditions. Neither policies which try to hit a fixed near-to-medium-term inflation target nor similar policies that target the growth rate of nominal spending have the necessary “history dependence”. Policies that target the price level or the level of nominal spending do have this property.

Intuitively, the advantage of a price-level target over an inflation target is that the prospect of higher future inflation lowers current and future real market interest rates even if current policy is constrained by the zero bound. However, equally effective at increasing current stimulus would be the prospect of higher real growth, which raises current and future *equilibrium* real rates. A nominal-spending target path allows stronger real growth prospects to substitute for higher inflation expectations. Rules which allow this substitution have the advantage, relative to simple price-level rules, that they are transparently consistent with the Federal Reserve’s mandate to promote full employment as well as price stability. This property adds to their credibility.

Nominal-spending targeting imposes a 1-for-1 substitution between output and the price level. A more general specification takes the form:

$$p(t) + \alpha y(t) = p^* + \alpha E_{t-s}[y^*(t)], \quad (1)$$

or, equivalently,

$$[p(t) - p^*] + \alpha[y(t) - E_{t-S}[y^*(t)]] = 0, \quad (1')$$

where $p(t)$, $y(t)$, and $y^*(t)$ are the (logarithms) of the period- t price level, real output, and real potential output; respectively, $\alpha > 0$ is a fixed parameter that measures the weight given output in policy deliberations; p^* is the target price level (or, more generally, target price path); and $E_{t-S}[y^*(t)]$ is the mathematical expectation of $y^*(t)$ conditioned on information available in period $t - S$. The monetary authority adjusts its policy instrument(s) so as to try to keep a weighted average of the price gap and an output gap equal to zero. Hall (1984) calls this approach to policy an “elastic price standard”. One might also call it “flexible price-level targeting”. Flexible *inflation* targeting takes much the same form, but with $p(t - 1)$ in place of p^* .

Again, nominal-spending targeting is the special case in which $\alpha = 1$. S is how far in advance the nominal-spending target is announced. The target is chosen so that if the economy is expected to be at potential, then the price level will be expected to be at p^* . Koenig (2005) argues that S ought to be the amount of time it takes for wages and prices to fully adjust following an aggregate shock, so that $E_{t-S}[p(t) - p^*] = E_{t-S}[y(t) - y^*(t)] = 0$ if policymakers are successful in obeying Equation 1.

Eggertsson and Woodford (2003) show that a policy rule of the same form as Equation 1, but with $S = 0$, performs well in a stripped-down sticky-product-price model that is subject to a zero lower interest-rate bound. The Eggertsson-Woodford model—lacking the rule-of-thumb inflation indexation, labor-market frictions, and habit persistence needed to generate plausible dynamics—can’t be taken seriously as a framework for policy evaluation. Nevertheless, the finding that flexible price-level targeting performs well in an economy with nominal price frictions suggests that rules like Equation 1 deserve serious consideration.

Precedents

Sweden implemented a version of price-level targeting in the early 1930s, but the experiment was abandoned quickly once the deflation threat eased. Thus, the new policy was announced in September, 1931; but implemented only after it received approval by the Riksdag in May, 1932; and it was replaced by an exchange-rate peg (to the British pound) in July, 1933 (Berg and Jonung 1998).

The closest thing to a precedent for nominal-income targeting in the U.S. was the adoption of money-growth targeting in 1979. (Targeting the money supply is equivalent to targeting nominal income if the velocity of money is stable or, more generally, predictable.) Policymakers' concerns were very much the opposite of their concerns today: the FOMC could not seem to raise short-term market interest rates quickly enough to keep pace with increases in the natural rate, with the result that inflation expectations were high and rising. Formally, the FOMC adopted not a target money path but a target for money *growth*. However, there was active debate over which approach was more appropriate.

Potential Problems

If price adjustment is governed by an accelerationist Phillips curve, according to which inflation is a function of lagged inflation and economic slack, nominal-income targeting is destabilizing (Ball 1997). McCallum (1997) demonstrates that this result is very sensitive to the Phillips-curve specification. If price setting is at least partly forward looking—*i.e.*, if current inflation depends partly on lagged expectations of current inflation or on current expectations of future inflation—the instability problem disappears. The former specification (current inflation depends on lagged expectations of current inflation) is implied by “sticky information” frictions models, in which changing prices is costless, but new information filters only gradually through the economy (Koenig 1999; Mankiw and Reis 2002). The latter specification (current inflation depends on current expectations of future inflation) is implied by Calvo-style models of nominal frictions, in which information is updated immediately, but one's ability to respond to new information is subject to delays (Roberts 1995). Strikingly, the price-adjustment assumptions that ensure that nominal-income targeting is stable are the same as the assumptions needed to ensure that price-level targeting outperforms inflation targeting (Ambler 2009).

Another potential problem is data revisions. At any given date it might look like nominal spending is on track, but the picture could change as new spending estimates become available. Of course, the same concern arises for price-level targeting. To get a handle on the size of revisions to prices and spending, **Table 1** compares first-release, 16-quarter inflation and spending growth estimates to the corresponding estimates as they appeared 4 years later. The inflation and growth rates are *not* annualized. After 4 years, all these data have undergone a

complete set of annual revisions. Consequently, the errors reported in the table give a good sense of by how much data revisions might shift the price level or spending level relative to a pre-set target path.

The upper half of the table, which covers the period from 1996:Q1 to 2006:Q1, indicates that initial estimates of both price and spending have understated the data as they appeared four years later.¹¹ The bias ranges from about 0.1 percent for the core PCE price index to 0.4 percent for nominal GDP. The bias in initial estimates of nominal PCE is greater than that for the core PCE price index, but less than that for the GDP price index. Mean absolute revisions are in the 0.55-to-0.75-percent range except for nominal GDP, where the mean absolute revision is 1.03 percent. In general, then, early nominal GDP estimates are least reliable, and early core PCE price estimates are most reliable, with GDP price and nominal PCE estimates in the middle.

The bottom half of the table covers the period from 1966:Q1 to 1997:Q4, which facilitates comparison with an analysis of output-gap revisions conducted by Orphanides and van Norden (2002). Revisions to nominal PCE are larger over this early sample than they were over the late sample, but remain smaller than the revisions to nominal GDP. GDP price revisions are of about the same size over both samples. Judging by root-mean-square errors, data revisions are indeed potentially more problematic for a nominal-spending target than for a price-level target, but they are even more of a problem for any rule that depends on accurate real-time output-gap estimates.

Summary and Concluding Remarks

The main impact of a Treasury-bond purchase program is likely to come through the signal it sends that policymakers are planning to hold down short-term policy rates. While a commitment to hold down policy rates may be needed in present circumstances—given the weak recovery, lower-than-desired inflation, and binding zero-bound constraint—not all commitments are equally compatible with the mandated goals of the Federal Reserve or are likely to be equally efficacious. In this regard, the contingent commitment provided by a price-level or nominal-

¹¹ The sample period is determined by the availability of real-time estimates of the core PCE price index and by the 4-year revision requirement.

spending target is preferable to the non-contingent commitment signaled by purchases of Treasury bonds. A level target for nominal spending, in turn, offers enough potential advantages relative to a simple price-level target that it deserves careful study. Most obviously, the price index that the Committee has identified as its primary inflation gauge has not yet dropped significantly below its 2.0-percent trend path, making it difficult to use price-level targeting to justify further stimulus at this time. More generally, a simple price-path target would elevate one component of the Federal Reserve's triple mandate (price stability) above the other two (full employment and financial stability) even in the short run. A level target for nominal spending, in contrast, would currently indicate that further stimulus is desirable. It would automatically mandate that stimulus be scaled back if either inflation or real growth were to pick up. It imposes long-term price stability, while providing short-run flexibility. In addition, risk would be distributed more efficiently between debtors and creditors under a nominal-spending target than under a simple price-level target.

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APPENDIX: Formalization of the Risk-Sharing Argument

Consider a 2-period endowment economy with equal numbers of each of two types of household. The types are distinguished by the timing of their endowments. Each household of type 1 receives real income of $y(1) > 0$ in period 1 and no endowment in period 2. Each household of type 2 receives no endowment in period 1 and real income of $y(2) > 0$ in period 2. The period-2 endowment is random (with known distribution). Finally, the utility of a type- i household is $U(c_i(1)) + U(c_i(2))$, for $i = 1, 2$, where $c_i(1)$ and $c_i(2)$ are consumption in periods 1 and 2, respectively. I assume that $U'(\bullet) > 0$, $U''(\bullet) < 0$, and $U'(c) \rightarrow \infty$ as $c \rightarrow 0$.

Perfect Capital Markets

If capital markets function without frictions, type-2 households will sell shares in their future endowments to type-1 households. Suppose that a full (100 percent) share sells for q units of current output, and that s is the fraction of the future endowment that is sold. Then:

Period 1	Period 2	
$c_1(1) = y(1) - qs$	$c_1(2) = sy(2)$	
$c_2(1) = qs$	$c_2(2) = (1 - s)y(2)$	(1)

Taking q as given, type-1 households maximize utility when:

$$qU'[y(1) - qs] = E\{y(2)U'[sy(2)]\}. \tag{2}$$

Similarly, the first-order condition for a type-2 household is:

$$qU'(qs) = E\{y(2)U'[(1 - s)y(2)]\}. \tag{3}$$

In the case where utility is logarithmic in consumption [$U(c) = \log(c)$], the first-order conditions are easily solved for q and s . One obtains:

$$q = y(1) \qquad s = 1/2. \tag{4}$$

It follows that $c_1(1) = c_2(1) = y(1)/2$ and $c_1(2) = c_2(2) = y(2)/2$. Thus, the period-2 endowment risk is borne equally by type-1 and type-2 households.

As is readily verified, the identical solution holds in the general case provided that

$$E y(2) U'[y(2)/2] = y(1) U'[y(1)/2]. \quad (5)$$

In words, the expected marginal utility value of the endowment received by each type-2 household equals the marginal utility value of the endowment received by each type-1 household.

Nominal Debt Contracts and Optimal Monetary Policy

The allocation derived above assuming a market in shares of future output can also be achieved using nominal debt contracts supplemented with actuarially fair private insurance. Type-2 households with fixed nominal debt obligations will have an incentive to partly insure against adverse shocks to their endowments and also against unexpected declines in the price level, insofar as the price level is uncertain. Type-1 households will have an incentive to sell such insurance. For whatever reason, however, the relevant insurance appears to be unavailable in the real world. Its absence is a key element in the debt-deflation argument for price-level targeting. The point of the analysis that follows is that optimal monetary policy in an economy where debt-deflation is a potential concern (a world with nominal debt contracts and no insurance protection against real-income and price-level risk), does *not* take the form of a price-level target. Instead, it takes the form of a nominal spending target.

Without loss of generality, set the period-1 price level equal to 1. The monetary authority determines the period-2 price level, π , after observing $y(2)$. Let B be the debt issued by each type-2 household in period 1, and let R denote the (gross) nominal interest rate. Then:

Period 1	Period 2	
$c_1(1) = y(1) - B$	$c_1(2) = BR/\pi$	
$c_2(1) = B$	$c_2(2) = y(2) - BR/\pi$	(6)

where the period-2 outcomes assume it is known that the Fed will keep $\pi y(2) > BR$, so that type-2

households are not driven into bankruptcy. Note that this is a condition on the nominal value of output in period 2, relative to principal and interest due on outstanding debt.

We can see, already, that white-noise variation in the price level is an unambiguously bad thing: it introduces noise in the period-2 consumption of both types of household, reducing their expected period-2 utility by Jensen's inequality. Proponents of price-level targeting leap from this result to the conclusion that π should be fixed in advance. With π pre set, however, type-2 households (debtors) bear all period-2 output risk. The monetary authority can spread output risk more evenly across debtors and creditors by varying π *systematically* with $y(2)$, raising π when $y(2)$ is unexpectedly low and lowering π when $y(2)$ is unexpectedly high. The formal argument follows.

Taking R as given, type-1 households maximize utility when:

$$U'[y(1) - B] = R E[U'(BR/\pi)/\pi]. \quad (7)$$

Similarly, the first-order condition for a type-2 household is:

$$U'(B) = R E\{U'[y(2) - BR/\pi]/\pi\}. \quad (8)$$

These two equations determine B and R conditional on the policy rule of the monetary authority and the distribution of period-2 output.

In the special case where utility is logarithmic in consumption [$U(c) = \log(c)$], the first-order conditions reduce to:

$$B = y(1)/2 \quad (7')$$

and

$$1 = E\{1/[\pi y(2)/BR - 1]\}, \quad (8')$$

respectively. Equation 7' says the amount of credit extended in period 1 is independent of monetary policy and the distribution of period-2 output. The amount of credit is such that both types of

household have the same period-1 consumption: $c_1(1) = c_2(1) = y(1)/2$.

Combining 7' and 8', the nominal interest rate must satisfy

$$1 = E\{1/[2(\pi/R)(y(2)/y(1)) - 1]\}, \quad (9)$$

which says, roughly, that the expected real interest rate will equal expected growth in real output.

The monetary authority can optimally diversify period-2 output risk by targeting the nominal value of period-2 output, $\pi y(2)$. To verify that nominal-income targeting optimally spreads risk, note that with $\pi y(2)$ set in advance to some number, n^* , Equation 9 reduces to

$$R = n^*/y(1). \quad (9')$$

It follows that $BR = n^*/2$, $BR/\pi = y(2)/2$ (the no-bankruptcy condition is always satisfied), and $R/\pi = y(2)/y(1)$ (the *ex post* real interest rate equals the growth rate of real output). Moreover, from Equation 6, both types of household have exactly the same period-2 consumption: $c_1(2) = c_2(2) = y(2)/2$. Thus, the equilibrium obtained when nominal debt contracts are combined with nominal-income targeting is identical to the equilibrium we found earlier, in an economy with perfect capital markets.

All of the above results carry over to the general case provided Equation 5 holds. The interpretation of this condition is the same as before: it requires that type-1 and type-2 households start off with equal wealth. Then, if the monetary authority chooses π so that $\pi y(2)$ equals a pre-announced target value, n^* , the equilibrium allocation in an economy with nominal debt contracts will give type-1 and type-2 households the same consumption in period 1 and the same consumption in period 2: $c_1(1) = c_2(1) = y(1)/2$ and $c_1(2) = c_2(2) = y(2)/2$. The equilibrium nominal interest rate will be given by Equation 9': $R = n^*/y(1)$. And the equilibrium amount of credit extended will be given by Equation 7': $B = y(1)/2$.

To see that the equilibrium allocation under nominal-income targeting maximizes the *ex ante* expected utility of each household (before households know their type), note that expected period-2 utility, averaged across households, takes the general form

$$\frac{1}{2} E[U(y(2)/2 + x)] + \frac{1}{2} E[U(y(2)/2 - x)]$$

in an economy with nominal debt contracts, where $x \equiv y(2)/2 - BR/\pi$ (*c.f.* Equation 6). Under nominal-income targeting, $x \equiv 0$ and expected utility is $E[U(y(2)/2)]$ for every household.

However, Jensen's inequality says

$$\frac{1}{2}U(y(2)/2 + x) + \frac{1}{2}U(y(2)/2 - x) \leq U(y(2)/2), \quad (10)$$

for any realizations of $y(2)$ and x , with equality if, and only if, $x = 0$. Taking expectations across $y(2)$ and x , it follows that

$$\frac{1}{2} E[U(y(2)/2 + x)] + \frac{1}{2} E[U(y(2)/2 - x)] \leq E[U(y(2)/2)], \quad (11)$$

with equality only if $x \equiv 0$. Thus, nominal-income targeting maximizes *ex ante* expected utility: it optimally spreads risk across debtors and creditors.

Concluding Comments

If agents can buy actuarially fair insurance against fluctuations in aggregate output and the price level, then “money is a veil” as far as the allocation of aggregate risk is concerned: it doesn't matter whether or not the monetary authority allows random variation in the price level and the nominal value of output. If such insurance is *not* available, monetary policy *does* affect the allocation of risk in an economy with nominal debt contracts. A price-level target eliminates one source of uncertainty (price-level shocks), but shifts the other risk (real output shocks) completely on to debtors. A more balanced allocation of risk is achieved by allowing the price level to move opposite to real output. In the stylized model of debt developed above, the risk allocation achieved by a nominal-income target is fully optimal.

TABLE 1. Revisions to Measures of Spending and Prices
 (100X difference between first estimate of 16Q log change and estimate published 4 years later)

1996:Q1-2006:Q1

<u>Series</u>	<u>Mean Revision</u>	<u>Mean Absolute</u>	<u>Root Mean Square</u>
Core PCE Price	-0.096	0.556	0.625
GDP Price	-0.259	0.751	0.838
Nominal PCE	-0.153	0.691	0.873
Nominal GDP	-0.405	1.030	1.255

1966:Q1-1997:Q4

<u>Series</u>	<u>Mean Revision</u>	<u>Mean Absolute</u>	<u>Root Mean Square</u>
Core PCE Price	n.a.	n.a.	n.a.
GDP Price	-0.317	0.659	0.823
Nominal PCE	-0.694	0.891	1.142
Nominal GDP	-0.722	0.998	1.199

Note: HP Output Gap*	0.30	n.a.	1.83
BLT Output Gap**	-0.04	n.a.	1.78

* Revisions to output detrended using the Hodrick-Prescott filter (Orphanides & van Norden 2002).

** Revisions to the difference between output and a broken linear trend (Orphanides & van Norden 2002).







