Brookings Papers
ON ECONOMIC ACTIVITY

BPEA Conference Draft, September 15–16, 2016

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August 29, 2016

1 Introduction

Over the past forty years, a broad consensus has developed among academic macroeconomists that policymakers' choices should closely track pre-determined rules.[1] This consensus is perhaps strongest in monetary economics. It can be traced back to two key papers. From a theoretical perspective, Kydland and Prescott (1977) showed nominal rigidities created a challenging time consistency problem for monetary policymakers. Given this problem, it was welfare-improving to require monetary policymakers to follow a pre-determined rule. From a practical perspective, Taylor (1993) demonstrated that the Federal Reserve's monetary policy choices could, in fact, be well-approximated by a simple feedback rule (from publicly observed economic conditions to interest rates) and that rule was associated with good macroeconomic outcomes. These two papers have had enormous influence in both academic and policy circles.

*Prepared for Brookings Papers on Economic Activity, Fall 2016. I thank Sam Schulhofer-Wohl and Kei-Mu Yi for their comments. I also thank Alan Blinder, Janice Eberly, and Lars Svensson for their comments on an earlier draft.

[1]Taylor (1993, p. 197) writes, "If there is anything about which modern macroeconomics is clear however - and on which there is substantial consensus - it is that policy rules have major advantages over discretion in improving economic performance." His words go back nearly a quarter century but are probably now even more widely viewed as being true. Thus, three Nobel Laureates joined Taylor in signing this letter in support of Congress' requiring the Fed to explain any deviations from the Taylor Rule: `http://financialservices.house.gov/uploadedfiles/020916_taylor_letter_with_signatories_.pdf`.Rules enjoy considerably less support among those who actually have the responsibility of making policy, as evidenced in this open letter from Chair Janet Yellen to Representatives Pelosi and Ryan: `http://www.federalreserve.gov/foia/files/ryan-pelosi-letter-20151116.pdf`.

Most academic papers in monetary economics treat policymakers as mere error terms on a pre-specified feedback rule. Most modern central bank staffs model their policymaker bosses in exactly the same way.

The purpose of the current paper is to re-visit the consensus that favors the use of rules over discretion in the making of monetary policy. I do so in two ways. The first is empirical. I use information in the transcripts[2] from 2009-10 Federal Open Market Committee (FOMC) meetings to argue that the FOMC pursued a relatively slow recovery, in which unemployment was anticipated to take five years to return to its long-run level and inflation was expected to take even longer to return to the Committee's long-run target.[3] I trace this lack of aggressiveness to the FOMC's unwillingness to deviate greatly from the recommendations of the Taylor Rule[4], because it provided a good approximation to the Committee's pre-2007 policy reaction function.[5] I document too that Brunner and Meltzer (1968) arrive at a similar conclusion about the Great Depression: the Federal Reserve's poor performance in 1929-30 was attributable to its excessive reliance on its pre-1929 policy framework.

The empirical analysis is a reminder that monetary policymakers are forced to choose rules based in large part on their past historical performance, and those estimated rules can give rise to poor outcomes if conditions change sufficiently. However, the analysis leaves open the possibility that there is some other rule out there, yet to be found, that would dominate discretion. In the second part of the paper, I explore this question theoretically using the delegation model of Holmstrom (1984). The main trade-off in the theoretical framework is that the central bank may desire a different level of inflation than does society, but the central

[2]The Federal Open Market Committee publicly releases transcripts of its meetings, along with supporting staff materials, with a five to six year lag. The transcript from the December 2010 meeting is the latest one that has been released so far.

[3]I served on the Federal Open Market Committee from October 2009 through October 2015. My comments about the FOMC's policy perspectives in 2009-10 apply with at least as much force to my own during that time frame.

[4]The term "Taylor Rule" is used to refer to a wide class of monetary policy rules. Throughout the paper, I use the term to refer specifically to the interest rate rule originally described in Taylor (1993) or to the FOMC staff's version of that rule (which uses Okun's Law to substitute an unemployment gap for the Taylor Rule's output gap).

[5]I made a similar argument in Kocherlakota (2015b).

bank also has information about the future evolution of inflation that is impossible to write into a rule. Here, I have in mind that the central bank sees a large number of possible factors, with time-varying factor loadings, that help it forecast inflation. For example, suppose a large European financial institution suddenly closes three investment funds.[6] How will the central bank respond to that shock? The appropriate response will depend on a host of details that would be hard to write into any pre-determined rule.

I compare two possible institutional setups: discretion, under which the central bank can choose any level of monetary accommodation that it wishes, and a rule, under which the central bank's decision is a fixed function of some publicly observable information.[7] The benefit of the former institutional framework is that the central bank has the ability to offset shocks that can't be encoded into a rule, but would otherwise generate highly variable inflation. The cost of the former framework is that inflationary outcomes will be systematically different from the socially optimal level, because of the central bank's inflation bias. Correspondingly, I show that, in terms of ex-ante welfare, discretion generates better outcomes for society as long the central bank has a sufficiently small inflation bias relative to the magnitude of non-rulable inflationary shocks. (Here, I use two notions of ex-ante welfare: quadratic loss and a min-max robustness criterion as in Hansen-Sargent (2007).) I use evidence from the past the past two decades to argue that the Federal Reserve does not have a material pro-inflation bias (meaning, at most, a quarter percent).[8]

The empirics and the theory both suggest that, contrary to conventional wisdom, monetary policy rules impede central bank performance. Central banks will achieve better outcomes if they are given discretion - that is, if on an ongoing basis, they make choices based on all available information to keep inflation or employment close to target. Importantly, this recommendation does hinge on the inflationary bias of the central bank being small. That

[6]Readers will recognize this as a description of BNP Paribas' decision on August 9, 2007.

[7]My terminology mirrors that in Kydland and Prescott (1977). However, others prefer a broader notion of rules: what I call discretion in this paper, Bernanke has called a rule: `http://blogs.wsj.com/economics/2015/03/02/bernanke-says-fed-already-follows-policy-rule/.`

[8]See Kocherlakota (2015a) for a related discussion.

seems to be an accurate description of the Federal Reserve in the past twenty years, but I provide no guidance about how to ensure that it continues to be true going forward.

My analysis is closely related to much prior work. In terms of the empirics, during the 2009-10 time period, many observers critiqued the FOMC for providing insufficient levels of accommodation. My contribution here is that my use of internal Committee documents (only released over the last couple years) sheds new light on how the FOMC's pre-crisis framework contributed to this under-provision of accommodation. In terms of the theory, Canzoneri (1985) illustrates a similar tension between central bank bias and central bank private information. Svensson (2003) makes similar points to mine about how discretion allows central banks to use judgment so as to achieve better macroeconomic outcomes.[9]

2 The Not-So-Great Recovery and the Taylor Rule

In this section, I discuss the actions of the Federal Open Market Committee (FOMC) during the beginning of the recovery from the 2007-09 Great Recession. The Committee and its staff viewed the Taylor Rule as providing a good approximation to the Committee's pre-2007 reaction function. I argue that, as a result, the FOMC's choices in 2009-10 were heavily influenced by the prescriptions of that particular rule. I document that this rule-based framework led the Committee to pursue a relatively slow recovery in both prices and employment. I briefly parallel the Federal Reserve's reliance on the Taylor Rule in 2009-10 with the Federal Reserve's (considerably more disastrous) reliance on the Riefler-Burgess framework during the 1929-30 time frame.

[9]Throughout the paper, I compare outcomes under rules to outcomes under complete discretion, so that the central bank can choose any amount of accommodaiton. In a dynamic version of the problem that I study, Athey, Atkeson, and P. Kehoe (2005) prove that the optimal delegation game is either a rule or has *bounded* discretion (which is what I term constrained discretion). In their benchmark parametric example, they prove that, as the central bank's private information becomes increasingly large, the optimal delegation game converges to one without any constraint on discretion.

2.1 The Summary of Economic Projections

My discussion relies heavily on the *Summary of Economic Projections* (SEP). Beginning in 2007, FOMC participants (all twelve Presidents of the regional Reserve Banks and the members of the Federal Reserve's Board of Governors) have submitted their forecasts for key macroeconomic variables four times per year. These submissions make up the SEP. Importantly, as the description of the SEP clearly states, a given participant's forecast is "based ... on each participant's assumptions about factors likely to affect economic outcomes, including his or her assessment of appropriate monetary policy. 'Appropriate monetary policy' is defined as the future path of policy that the participant deems most likely to foster outcomes for economic activity and inflation that best satisfy his or her interpretation of the Federal Reserve's dual objectives of maximum employment and stable prices." A given participant's assessment of the appropriate stance of monetary policy may well differ from their forecast of what the Committee would actually do. As a result, these so-called projections should not be seen as reflecting participants' forecasts for the actual course of the economy. Rather, beyond the usual one to two year lag associated with monetary policy, a participant's projection is best viewed as a description of his or her monetary policy *goals* for the evolution of the relevant macroeconomic variables.

After the relevant meeting, the FOMC releases summary statistics from the SEP to the public. However, when the FOMC releases the meeting transcript (five plus years later), it also releases the full set of SEP submissions. The full SEPs provide valuable information, as they link participants' relatively detailed and standardized assessments of the economy and policy with their forecasts.[10] I exploit all of this public information heavily. Hence, my discussion will focus on the SEP from the years 2009-10, since the full SEP from later years have not been released. As well, I restrict attention to the fourth quarter SEPs from those years because they have a longer forecast horizon than SEPs from earlier in the year.

[10]Unfortunately, the submissions remain anonymous for another five years. As a result, it is impossible to link a participant's submissions at one meeting to his/her submissions at another until a decade after both meetings.

2.2 The FOMC's Limited Ambitions

According to the Federal Reserve Act, the FOMC is charged by Congress to make monetary policy so as to promote price stability and maximum employment. The Committee has translated the former objective into a goal of 2% for Personal Consumption Expenditure (PCE) inflation. In terms of the latter objective, it tracks progress using a number of metrics, but tends to put the most weight on the unemployment rate. In principle, the two mandated objectives could conflict with one another, and that conflict did shape the SEP submissions of some participants. However, most saw no conflict between the two goals during this time frame between the two mandates: inflation was expected to be too low and unemployment was expected to be too high.

The first table documents the intentions of the median FOMC participant in the fourth quarter of 2009 and 2010 for the evolution of the unemployment rate over the medium term.

Table 1: Median Fourth Quarter SEP Projections for the Unemployment Rate

	Current	2 Years Ahead	3 Years Ahead	Long Run
2009	9.8	8.3	7.0	5.0
2010	9.5	8.0	7.1	5.3

The median FOMC participant believed that, under appropriate monetary policy, the unemployment rate would fall to about 8% in 2 years and to about 7% in 3 years. Obviously, these figures were well below the unemployment rate that prevailed at the time that the forecasts were made. At the same time, though, the Committee was aiming for a relatively slow recovery in employment, in the sense that the unemployment rate in three years' time remained well above its long run level.

As noted above, though, the FOMC has two objectives. It could be that the Committee was aiming for a measured recovery in the unemployment rate in order to guard against inflation. The second table documents the Committee's intentions in the fourth quarters of 2009 and 2010 for the evolution of the PCE inflation rate over the medium term.

Table 2: Median Fourth Quarter SEP Projections for Inflation

	Current	2 Years Ahead	3 Years Ahead	Long Run
2009	-0.5	1.5	1.5	2.0
2010	1.3	1.4	1.5	2.0

The median FOMC participant believed that, under appropriate monetary policy, the inflation rate would rise to about 1.5% in both 2 years and 3 years, well short of the median long-run target of 2%. In both years, and at both horizons, *at most one* FOMC participant saw above 2% inflation as being appropriate.[11] In 2009 and 2010, the FOMC was aiming to use its monetary policy tools to foster a recovery that would return both inflation and unemployment to their long run levels relatively slowly.

2.3 Why Were the FOMC's Aims so Modest?

The transcripts suggest that the staff's forecasts were key to informing the FOMC's assessment of appropriate monetary policy in 2009-10, The staff based its forecasts on the assumption that the FOMC would follow the Taylor Rule with respect to the fed funds rate (while respecting the constraint that the target range fed funds rate would never fall below zero).[12] The staff made this assumption on empirical grounds: their analysis suggested that the Taylor Rule had served as a good approximation to the Committee's pre-crisis behavior. But most FOMC participants apparently also felt that the Taylor Rule was a useful normative guide to policy.

For example, on page 19 (20) of the November 2009 (2010) Summary of Economic Projections, meeting participants are asked to comment on any differences between their assumptions about the appropriate evolution of monetary policy, and the evolution of policy

[11]The FOMC did not adopt an official long-run target until January 2012. Even so, in 2009 and 2010, no FOMC participant believed that inflation should be above 2% in the long run. However, in 2009, five participants said that it would be appropriate for inflation to converge to less than 2% in the long run. Interestingly, one year later that number had grown to seven. Discarding these "sub-2%" participants moves the various medians by at most 0.1 percent.

[12]See footnote 4, October 2009 Greenbook Part I and footnote 3, October 2010 Tealbook Part A. In October 2010, the staff assumed that the FOMC held the fed funds rate at zero slightly longer than would be implied by the Taylor (1993) Rule.

assumed by staff (the Taylor Rule). Several participants did project that, under appropriate monetary policy, the fed funds rate should rise more rapidly than the staff expected.[13] However, these participants largely trace their preference for higher interest rates to their expectations that inflation would rise more rapidly than anticipated by staff. They don't say that they favor a different rule, in the sense that they would prefer a different fed funds rate target, conditional on the same inflation and unemployment rate realizations.[14]

This suggests that FOMC participants viewed the Taylor Rule - the Committee's pre-crisis reaction function - as being a key guide to their policy choices during the early part of the economic recovery. We can see how this reliance on the Taylor Rule affected the FOMC's medium-term macroeconomic goals by looking at the staff's long-term outlook (which was based on the Taylor Rule) in the fourth quarters of 2009 and 2010.

[13]No participant in either November 2009 or November 2010 pointed to a more gradual increase as being appropriate.

[14]In November 2009, a couple participants (5 and 16) stated in their SEP submissions that they favored a higher fed funds rate than implied by the Taylor Rule because they felt that historically low interest rates could lead to imbalances and undue risk-taking. No participant in either the November 2009 or November 2010 meetings specifically favored a lower interest rate path than that described by the Taylor Rule. (I should note that a key shortcoming of the 2009-10 SEPs is that participants did not submit quantitative forecasts for the evolution of the fed funds rate.)

It may be surprising that more participants did not mention financial stability concerns as a reason to tighten policy faster than recommended by the Taylor Rule. It's important to keep in mind that I'm discussing a period in which the unemployment rate was generally well above 9%. It was hard to see any signs of "overheating" or "froth" in financial markets. Much of the Committee's discussion was about the magnitude of the downward pressures on inflation generated by economic slack. (See December 2009 FOMC meeting for a particularly thorough staff briefing along these lines.) The situation was quite different in, say, mid-2013 when the FOMC publicly began to discuss its plans for tapering asset purchases.

Table 3: FOMC Staff's Projections

	2009:IV proj. for UR	2009:IV proj. for core π	2010:IV proj. for UR	2010:IV proj. for core π
2010:IV	9.5	1.1	9.7	1.1
2011:IV	8.2	1.0	9.0	1.0
2012:IV	6.1	1.1	7.9	1.0
2013:IV	4.9	1.4	7.1	1.2
2014:IV	4.7	1.6	6.1	1.3
2015:IV	NA	NA	5.2	1.5

This outlook features a slow decline in the unemployment rate, coupled with an even slower increase in the inflation rate (back to, in this case, the staff's assumed target of 2%). While there are differences (notably with the 3-year-ahead unemployment forecast in 2009), this staff outlook is broadly similar to the median projections of the FOMC participants. This similarity is consistent with the perspective that the FOMC saw a slow recovery in unemployment and inflation as being appropriate because the Taylor (1993) Rule - a good approximation to the FOMC's pre-crisis reaction function - implied that kind of slow recovery.

Why did the Taylor Rule imply such a slow recovery? The Taylor Rule is designed to eliminate gaps between inflation gaps (between current inflation and a 2% target) and output/unemployment gaps. However, the Rule constrains the size of the FOMC's response to these gaps; in particular, it precludes the FOMC from rapidly cutting interest rates until all gaps are eliminated.[15] In this sense, the Taylor Rule represents a constraint on the FOMC's interest rate response to inflation and activity gaps.

Mathematically, we can think of the Taylor Rule as putting weight on an implicit objective of keeping the fed funds rate close to its historically normal level. To be more concrete, suppose that the central bank has a quadratic loss function with weight on both inflation gaps

[15]Here, I assume (as is true in New Keynesian models among others) that the FOMC's current interest rate choices have *some* effect on current outcomes. In contrast, Svensson (1997) assumes that current monetary policy choices have no impact on macroeconomic outcomes for two years.

and interest rate gaps. Suppose as well that the current inflation rate is (well-approximated by) an affine function of the current interest rate. Then the bank's optimal interest rate choice would set the interest rate equal to an affine function of the inflation gap. It is readily shown that the slope in this relationship converges to infinity as the weight in the objective on interest rate gaps converges to zero.

2.4 Could the FOMC Have Done Anything Differently?

As of November 2009, the FOMC had already lowered the target range for the fed funds rate to near zero and had bought a large amount of long-term assets. What else could the Committee have possibly done to stimulate inflation and employment? The staff analysis at the time suggested two answers to this question: asset purchases and forward guidance. The two answers are conceptually quite different. By buying longer-term assets, the Committee intended to push up their price and incentivize spending on the part of those who would normally hold those longer-term assets. Through forward guidance, the Committee intended to change private sector beliefs about the future course of short-term interest rates - that is, about the likely pace of the removal of accommodation. I'll discuss each of these tools in turn.

2.4.1 Asset Purchases

The FOMC relied heavily on long-term asset purchases as a form of monetary stimulus during the recovery. The staff regularly presented possible options to the Committee that featured more aggressive use of this tool. For example, in November 2009, the staff presented a policy option to the FOMC according to which the Committee would have lengthened the duration of an ongoing asset purchase program. The staff argued that doing so would allow the FOMC to accelerate the economy's return to full employment, guard against downside risks, and raise unduly low inflation. No participant spoke in support of this policy option.[16]

[16]From October 2009 Bluebook, p. 41: "The Committee may view the staff's economic outlook, with its very protracted return to full employment, as producing unacceptably poor outcomes given the Committee's

After the November 2010 meeting, the FOMC announced that it would purchase $600 billion of long-term assets in a policy action that became known as QE2 (to refer to a second round of "quantitative easing"). However, within the meeting, staff presented a policy option under which the Committee would have bought $1 trillion of long-term assets. Again, they argued that this step would allow the Committee to accelerate the pace of the recovery in both inflation and employment. No participant supported this policy option.[17]

There were a number of reasons behind the Committee's reluctance to undertake a larger asset purchase program. In a non-routine October 2010 FOMC meeting about potential forms of additional accommodation, I pointed out that the theoretical literature offered little support for the use of asset purchases as way to provide accommodation.[18] I also suggested five immediate risks associated with the use of asset purchases:[19]

- There was likely to be huge market uncertainty about the eventual stock of our purchases (which, according to the FOMC, was what mattered for the stimulus).

- Other large holders of long-term Treasuries could offset the FOMC's policy action by

dual mandate. Or participants might believe there remains a non-negligible risk that the economy could suffer a relapse and fall back into recession next year when some of the lending facilities and other government programs wind down. Policymakers may also be troubled by continued inflation readings well below the inflation objectives implicit in the majority of their longer-run projections. For these reasons, they may judge that additional monetary stimulus would be appropriate. The Committee might conclude that an effective way to provide such stimulus would be to expand the amount of agency MBS purchases and to extend the timeframe for conducting agency MBS and agency debt transactions (thereby allowing a higher amount of agency debt to be bought without causing market disruption)."

[17]From October 2010 Tealbook B, p. 18: "Policymakers may believe that without fairly aggressive policy action soon, both employment and inflation will likely be below the Committee's objectives for these variables for a very substantial period. Moreover, they may be worried that very low inflation poses significant risks to the recovery. If so, the Committee may wish to provide more substantial policy accommodation at this meeting, as in Alternative A [which involved purchasing $1 trillion of long-term assets, rather than $600 billion]. Committee members may, like the staff, expect the economic recovery to remain quite gradual, even with the additional $600 billion expansion of the Federal Reserve's balance sheet envisioned in Alternative B. In the staff's baseline projection, the unemployment rate does not fall below 9 percent until 2012, and inflation remains below levels that the Committee sees as consistent with its objectives for much longer. Members may see such outcomes as unacceptable."

[18]See pp. 19-22 of the October 2010 FOMC transcript. I focus on my own remarks for what should be obvious reasons. I was certainly not the only participant at the meeting to express concerns about the downside risks aassociated with asset purchases.

[19]I certainly wasn't alone in seeing risks associated with asset purchases. In December 2009, Chairman Ben Bernanke expressed his concern that additional asset purchases could destabilize inflation expectations or lead to undesirably sharp upward movements in commodity prices. Arguably, the latter actually did come to pass in the first half of 2011 after the FOMC launched QE2.

markedly reducing their positions.

- There could be an untoward response in the value of the dollar relative to other currencies.
- If the Federal Reserve's balance sheet ever grew to be $3 trillion to $4 trillion in size, the FOMC might not have the tools necessary to raise rates when desired.
- The Fed is taking duration risk onto the balance sheet of taxpayers. They might not be too pleased about the Fed's doing so.

I would say that, six years later, the risks that I mentioned have largely proven to be manageable or insubstantial. (The last issue seems still up in the air.) But I would still argue that, as of late 2010, the downsides of asset purchases seemed large when the baseline economic theory suggested their upside was near zero.[20]

2.4.2 Forward Guidance

The second tool available to the FOMC, forward guidance, had a much stronger theoretical basis and represented (as I said at the same October 2010 FOMC meeting) a relatively low-risk alternative to asset purchases. Throughout the November 2009-November 2010 time frame, the Committee provided a qualitative form of forward guidance, saying that it anticipated that the fed funds rate would remain extraordinarily low for "an extended period." As William Dudley, vice-chair of the FOMC noted, this phrase was widely understood as meaning that "no tightening was likely for more than six months."[21] The Committee was

[20]The baseline economic theory that I have in mind is Eggertsson and Woodford (2003), which builds on the work of Wallace (1981). In these papers, through a Ricardian Equivalence argument, long-term asset purchases have no impact on long-term yields. There is much empirical work based on central bank asset purchase programs (both here and elsewhere) that suggests that, in fact, the purchases did lead to a decline in long-term yields. As Woodford (2012) points out, it is a distinct question whether this decline in long-term yields was associated with an increase in economic activity. I would guardedly endorse Bernanke's (2012) conclusion that, "Overall, however, a balanced reading of the evidence supports the conclusion that central bank securities purchases have provided meaningful support to the economic recovery while mitigating deflationary risks."

[21]November 2009 FOMC transcript, p. 168. See also the results of the primary dealer survey reported on p. 5 of December 2009 transcript.

concerned throughout this period that this forward guidance would be regarded as a commitment, while it was only meant as a forecast.[22]

In November 2010, staff presented a policy option under which the FOMC would adopt a stronger form of forward guidance (along with the larger $1 trillion asset purchase program noted above). According to this guidance, the FOMC would state that it intended to keep the fed funds rate extraordinarily low until mid-2012. The proposed guidance came with a number of escape clauses, designed to prepare the public for the possibility that the FOMC might raise the fed funds rate more rapidly. No one at the meeting spoke in favor of this more specific form of forward guidance.

Actually, the staff's analysis at the two November meetings supported the adoption of much more aggressive forms of forward guidance. The staff routinely provided forecasts of the optimal path of fed funds rate target choices that were based on the benchmark FRB-US model.[23] In both November 2009 and November 2010, these optimal control exercises resulted in interest rate paths that stayed at a quarter percent until the unemployment rate fell to about 5%.[24] This delay in the initation of interest rate increases provides considerably more monetary accommodation than results from following the recommendations of the Taylor Rule.

Interestingly, these 2009-10 optimal control prescriptions are both relatively close to what the FOMC actually ended up doing: it did not raise the fed funds rate target range from its 2008 level until the unemployment rate was 5%. But the policy is much more stimulative in the model because people know well in advance that the Fed intends to keep interest rates low until the unemployment rate hits 5%. They did not have that knowledge in the real

[22]See, for example, Bernanke, p. 119 of March 2010 FOMC transcript: "... this is clearly not a fixed time commitment. It is a conditional statement .... I would just ask ... that everybody emphasize in talking about this publicly that it is conditional and that we are tying our policy to the state of the economy."

[23]The term "optimal" refers to minimizing a loss function that puts equal weight on squared deviations of inflation from 2%, squared deviations of the unemployment rate from the natural rate, and squared interest rate changes. The last term is motivated by the staff's desire to capture the FOMC's apparent aversion to interest rate changes. See Svensson and Tetlow (2005) for an extensive analysis of the optimal policy projections made by FOMC staff.

[24]This is a description of the relevant graphs on p. 25 of the November 2009 Bluebook and p. 3 of Part B of the November 2010 Tealbook.

world: In late 2009, Blue Chip forecasters expected that the FOMC would first raise interest rates when the unemployment rate was near 10%.[25]

Over two years later, in December 2012, the FOMC implemented a new kind of forward guidance that committed to keeping the fed funds rate extraordinarily low at least as long as the unemployment rate stayed above a particular numerical threshold (and as long as inflation and inflation expectations stayed under control). The staff analysis available at the November 2009 and 2010 meetings suggests that their forecasts for both unemployment and inflation would have been considerably more optimistic had the FOMC chosen to implement an aggressive form of threshold-based forward guidance at either of those meetings. More specifically, suppose that the FOMC had announced sometime in 2010 that its intention was to keep the fed funds rate extraordinarily low at least until the unemployment rate reached 5% (as long as inflation and inflation expectations stayed under control). According to the staff's optimal control exercises in late 2009 and in late 2010, this aggressive forward guidance would have brought the unemployment rate back to pre-crisis levels about one year earlier than under the staff's benchmark outlook, while the inflation rate would have returned to target within the forecast horizon.[26] To the extent that one views asset purchases as being stimulative, this forecast underestimates what the FOMC could have expected to achieve using its tools.[27]

[25]Bernanke (2012, fn. 25). This timing of the removal of accommdation is much earlier than is implied by the Taylor Rule.

[26]Like the staff's baseline FRB-US model, this comparison abstracts from the possibility that a faster recovery would have had permanent positive effects on the long-run level of economic activity. Chairman Ben Bernanke discusses this benefit of additional stimulus in some detail on page 99 of the November 2010 transcript.

[27]There is another, more subtle, reason why the forecast underestimates what the FOMC could achieve in terms of unemployment and inflation. In the optimal control exercise, the staff uses a loss function that puts substantial weight on interest rate changes. That loss function leads the FOMC to begin to raise rates too early and too slowly, relative to the optimal path under a loss function that doesn't put any weight on interest rate changes.

2.4.3 Summary

Staff analysis in November 2009 and November 2010 made clear to the Committee that it did have ways available to provide additional stimulus to the economy. These stimulative steps received essentially no support within the FOMC. In terms of asset purchase, one can trace at least some of the FOMC's hesitancy to the risks of the tool itself. However, in terms of forward guidance, the FOMC's reluctance seems in no little part due to its unwillingness to commit to a pronounced deviation from the prescriptions of its pre-2007 policy framework - that is, the Taylor Rule. I believe that Chairman Bernanke summarized the sentiments of almost all meeting participants when he said at the *December 2009* FOMC meeting[28], "... it's good for confidence and good for predictability for us to begin to *normalize* policy, to begin to operate in a way that people are more familiar with." (italics mine).

2.5 An Aside on the Brainard Principle

In a well-known (1967) paper, William Brainard considered the problem of a policymaker who is choosing an action designed to keep the economy close to a target, but is uncertain about the effects of the policy action. Brainard's analysis shows that it is optimal for that policymaker to only partially offset shocks to the economy. Why doesn't the policymaker aim instead to offset a larger fraction of the shocks to the economy? Being more aggressive has little impact on the policymaker's performance if the policy action turns out to be ineffective. But being more aggressive will lead the policymaker to miss by a lot if the action turns out to be highly effective. This last consideration deters the policymaker from seeking to engage in more complete offset.

Was this kind of uncertainty responsible for FOMC policymakers aiming for a modest recovery? To me, the evidence in the transcripts from 2009 and 2010 suggests not.[29] Several FOMC principals did express concern that monetary policy might not be all that effective

[28]Page 136 of the December 2009 FOMC meeting transcript.
[29]See Williams (2013) for a countervailing perspective.

relative to historical norms (and I say as much above when I discuss asset purchases). In light of this risk, Brainard's results imply that it would have been appropriate for the FOMC to undershoot its inflation and employment objectives. However, Brainard's analysis also implies that the risk of policy ineffectiveness should have led Committee members to favor unusually high levels of accommodation (just not high enough to hit inflation and employment targets). But, as we have seen, the Committee was loath (during this period) to adopt a more accommodative stance than the historically based prescriptions of the Taylor Rule.

2.6 An Analogy: The Fed's Great Depression Policy Error

In this subsection, I briefly recapitulate Brunner and Meltzer's classic (1968) analysis of the Federal Reserve's policy error during the early part of the Great Depression. My basic point is that, just as in 2009-10, the Federal Reserve's decision-making in 1929-30 was overly influenced by its pre-downturn decision framework. (To be clear, the the policy error in 1929-30 led to a macroeconomic catastrophe compared to what happened in 2009-10 and thereafter.)

Brunner and Meltzer argue that, during the 1920s, the Federal Reserve developed a framework to guide its decision-making about monetary policy that was sketched in the Board of Governors' tenth annual report (for the year 1923). A core element of this framework is that the presumption that banks only borrowed reserves from the Fed when they needed those reserves to meet large deposit outflows. This presumption allowed policymakers to use borrowed reserves as a signal about the relative tightness of monetary policy. High amounts of borrowed reserves, especially if interest rates were high, signaled that money demand was high relative to supply, and the stance of policy was tight. Low amounts of borrowed reserves, especially if interest rates were low, signaled that money demand was low relative to supply, and the stance of policy was easy. In his magisterial history of the Federal Reserve, Meltzer summarizes this framework as saying that "if borrowing and interest rates were low,

policy was easy; if the two were high, policy was tight."[30] Brunner and Meltzer refer to this framework as the Riefler-Burgess doctrine, in honor of two Federal Reserve staff economists[31] who played a key role in its development.[32]

Brunner and Meltzer argue that Federal Reserve decision-makers turned to the Riefler-Burgess doctrine during the early part of the Depression to help guide their thinking about monetary policy. For example, toward the end of 1930, member bank borrowing from the Federal Reserve was low relative to historical norms, even though interest rates were also unusually low. These metrics led many Reserve Bank leaders to conclude that monetary policy was easy - so easy, that in September 1930, the Federal Reserve strongly considered *selling* securities as a way to tighten monetary policy during a period of rampant deflation.

Meltzer (2003) summarizes the Federal Reserve's thinking in the 1929-30 period as follows, "People see most clearly what they are trained or disposed to see. The Riefler-Burgess ... doctrine ... was not a mechanical formula directing Federal Reserve policy, but it directed attention to member bank borrowing and market interest rates as measures of tightness and ease. In 1929-30, most members of the Federal Reserve Board and governors of the reserve banks accepted this framework. They believed that they had acted decisively to ease credit conditions, and on their measures they had."[33] This description, with the obvious substitutions, seems apt for the 2009-10 period as well.

3 Modeling Rules versus Discretion

In the preceding section, I described how the FOMC could have achieved its inflation and employment objectives more rapidly if it had been willing to deviate more from its pre-crisis reaction function, as proxied by the Taylor Rule. Of course, the Taylor Rule is only one

[30] Meltzer (2003, p. 164).

[31] More specifically, Winfield Riefler (a Board staff economist) and W. Randolph Burgess (a Federal Reserve Bank of New York staff economist)

[32] Meltzer (2003, p. 161) notes that Benjamin Strong, the first governor of the Federal Reserve Bank of New York, also contributed to the development of the Riefler-Burgess framework.

[33] Meltzer (2003, p. 403).

possible rule. In this section, I describe a simple model that will allow for a more general comparison of central bank discretion with central bank rules.

3.1 Environment

Consider the following three stage environment, in which the stages are indexed 0, 1, 2. In the final stage 2, inflation π is realized. It is the sum of four components:

$$\pi = x_R + x_{NR} + a + \varepsilon$$

The first component (x_R) is a signal that is revealed at the beginning of the intermediate stage 1 that is rulable - that is, it can be encoded into a policy rule. The second component (x_{NR}) is a signal that is observed (at least by the central bank and possibly to others) at the beginning of stage 1, but is non-rulable (cannot be written into a rule). The third component (a) is the level of accommodation determined by the central bank in stage 1. The final component (ε) is a random shock to inflation that is realized in stage 2.

It is common knowledge in stage 0 that the continuous density of x, over its support X_R, is given by g. For now, I will assume that it is also common knowledge in stage 0 that, conditional on x_R, (x_{NR}, ε) are mutually independent mean zero random variables with respective supports X_{NR} and E. Their respective continuous densities, conditional on x_R, are represented by $f(.|x_R)$ and $h(.|x_R)$. I assume that (X_R, X_{NR}, E) are all intervals in the real line.

The objective function of the central bank is defined over inflation and is known to be:

$$-(\pi - \pi_{CB})^2$$

The objective function of society over inflation is known to be:

$$-(\pi - \pi_{SOC})^2$$

These objective functions allow for the possibility that the central bank's inflation target π_{CB} is distinct from that society's inflation target π_{SOC}.

3.2 Interpretation of the Environment

There are three main attributes of the environment. The first is that the central bank has information x_{NR} available that is useful in forecasting inflation, but cannot be used as the basis of a policy rule. The idea behind y being non-rulable is that it is a complicated function of possibly many time-varying factors on inflation (thus, $x_{NR} = \theta'\beta$, where θ and β are both very long vectors). This emphasis on the importance of non-rulable information is consistent with the fact that most central banks base their inflation forecasts on objects like potential output and the natural rate of interest that are complex functions of observable and unobservable data (like staff judgments of various kinds). I view this modeling as being a simple way to formalize Svensson (2003)'s observation that "central banks have developed very elaborate and complex decision-making processes, where large amounts of information are collected, processed, and analyzed, and where considerable judgment is exercised."

The second is that the central bank's objective for inflation could differ from that of society's. There are many possible reasons for this bias, like political economy effects of various kinds. However, it could simply be that the central bank's horizon is short-run, while society's is long-run. In this way, the model can capture the effects of time inconsistency.[34]

The final attribute of import is that society has no way to offer outcome-contingent rewards or punishments to the central banker. In elegant work, Walsh (1995) showed how such rewards/punishments can be used to align a central banker's incentives with society's. However, it does seem challenging to implement such schemes in reality (at least in the US).

[34]To be a little more precise: this one-period model is meant to capture the central bank's decision problem *after* the private sector has made its decisions that feed into inflation within the current period. This timing means that the central bank's objective in this decision problem does not include the impact of its reaction function on the private sector's expectations - exactly the time consistency problem highlighted originally by Kydland and Prescott (1977).

3.3 Delegation Games

My results are about *delegation* games, in which the central bank can directly choose the level of accommodation from a set of possibilities. In this subsection, I show that any equilibrium outcome of any game played by the central bank in this environment is an equilibrium outcome of a delegation game.

I define a game to be a pair (C, α). Here, the first component C is a correspondence from the set X_R of realizations of the rulable signal into some set Γ of actions for the central bank. The game component α is a continuous outcome function that maps $(\Gamma \times X_R)$ into the real line; given the rulable signal, it describes the accommodation resulting from the central bank's choice of γ. The set of equilibria $EQM(C, \alpha)$ to the game (C, α) consists of all functions $\gamma^* : X_R \times X_{NR} \to \Gamma$ such that γ^* is the central bank's best response as a function of the rulable and non-rulable signals (x_R, x_{NR}) about inflation:

$$\gamma^*(x_R, x_{NR}) \in argmax_{\gamma \epsilon C(x_R)} - \int_{\varepsilon \in E} (\alpha(\gamma, x_R) + x_R + x_{NR} + \varepsilon - \pi_{SOC})^2 h(\varepsilon | x_R) d\varepsilon$$

I define a *delegation* game to be a game (C, α) in which the range Γ of the correspondence C is a subset of the real line and the outcome function $\alpha(\gamma, x_R) = \gamma$. In a delegation game, the central bank directly chooses an accommodation level from a set of possibilities that can vary with the rulable information x_R.

The following proposition shows that there is no loss in generality in restricting attention to the equilibrium outcomes of delegation games.

Proposition 1. *Consider a game* (C, α) *in which* $\gamma^* \in EQM(C, \alpha)$. *Then, let* $\Gamma' = \cup_{x_R \in X_R} \cup_{x_{NR} \in X_{NR}}$

$\alpha(\gamma^*(x_R, x_{NR}), x_R)$. *Define the delegation game (C',α') by*

$$C'(x_R) = \cup_{x'_{NR} \epsilon Y} \alpha(\gamma^*(x_R, x'_{NR}), x_R)$$
$$\alpha'(\gamma, x_R) = \gamma$$

Then γ' is an equilibrium to (C', α'), where:

$$\gamma'(x_R, x_{NR}) = \alpha(\gamma^*(x_R, x_{NR}), x_R) \, \forall (x_R, x_{NR}) \in (X_R \times X_{NR})$$

Proof. For any x_R in X_R and any x_{NR} in X_{NR}, we know that $\gamma^*(x_R, x_{NR}) \in C(x_R)$. If the central bank observes rulable information x_R and non-rulable information x_{NR}, then the central bank weakly prefers the action $\gamma^*(x_R, x_{NR})$ to the action $\gamma^*(x_R, x'_{NR})$ for any x'_{NR}, so that for any (x_R, x_{NR}, x'_{NR}) :

$$\begin{aligned} &- \int_{\varepsilon \in E} (x_R + x_{NR} + \varepsilon + \alpha(\gamma^*(x_R, x_{NR}), x_R) - \pi_{SOC})^2 h(\varepsilon | x_R) d\varepsilon \\ \geq &- \int_{\varepsilon \in E} (x_R + x_{NR} + \varepsilon + \alpha(\gamma^*(x_R, x'_{NR}), x_R) - \pi_{SOC})^2 h(\varepsilon | x_R) d\varepsilon \end{aligned}$$

This inequality implies that for any (x_R, x_{NR}, x'_{NR}) :

$$\begin{aligned} &- \int_{\varepsilon \in E} (x_R + x_{NR} + \varepsilon + \alpha'(\gamma'(x_R, x_{NR}), x_R) - \pi_{SOC})^2 h(\varepsilon | x_R) d\varepsilon \\ \geq &- \int_{\varepsilon \in E} (x_R + x_{NR} + \varepsilon + \alpha'(\gamma'(x_R, x'_{NR}), x_R) - \pi_{SOC})^2 h(\varepsilon | x_R) d\varepsilon \end{aligned}$$

Equivalently:

$$\begin{aligned} &- \int_{\varepsilon \in E} (x_R + x_{NR} + \varepsilon + \alpha'(\gamma'(x_R, x_{NR}), x_R) - \pi_{SOC})^2 h(\varepsilon | x_R) d\varepsilon \\ = &\, max_{\gamma \in C'(x_R)} - \int_{\varepsilon \in E} (x_R + x_{NR} + \varepsilon + \alpha'(\gamma, x_R) - \pi_{SOC})^2 h(\varepsilon | x_R) d\varepsilon \end{aligned}$$

This proves the proposition's claim that γ' is an equilibrium to the delegation game (C', α').

□

Proposition 1 is, essentially, an application of the revelation principle in this setting. In keeping with Proposition 1, I will focus on delegation games in the remainder of the paper. I will pose the rules versus discretion question as being about the nature of the restrictions embedded in the correspondence C.

3.4 Kinds of Delegation Games

In light of Proposition 1, we can restrict attention to delegation games. There are three possible kinds of delegation games. The first kind are *rules* that restrict the central bank's choice to depend only on the rulable information x_R about future inflation.

Definition 1. Suppose (C,α) is a delegation game. The game is said to be a *rule* if $C(x_R)$ is a singleton for almost all x_R in X_R.

In a rule, the public knows exactly what the central bank will do as a function of the rulable variable x_R

The second kind of delegation game features discretion, in the sense that the central bank is always allowed to choose any level of accommodation.

Definition 2. Suppose (C, α) is a delegation game. The game is said to feature *discretion* if $C(x_R)$ is the entire real line for almost all x_R in X_R.

All other delegation games are said to feature *constrained discretion.*

Definition 3. Suppose (C, α) is a delegation game. The game is said to feature *constrained discretion* if, for some set of x_R in X_R that has positive measure, $C(x_R)$ is a proper subset of the real line and if, for some set of $x'_R \in X_R$ with positive measure, $C(x'_R)$ is not a singleton.

I will largely be interested in comparing outcomes under rules with outcomes under games that feature discretion. The following result will help in that investigation. Define the stage 0

social welfare associated with any rule (C, α) to be the expected value of the social planner's objective implied by that rule:

$$-\int_{x_R \in X_R} \int_{x_{NR} \in X_{NR}} \int_{\varepsilon \in E} (x_R + x_{NR} + C(x_R) + \varepsilon - \pi_{SOC})^2 h(\varepsilon|x_R) f(x_{NR}|x_R) g(x_R) d\varepsilon dx_{NR} dx_R$$

Proposition 2. *Consider the rule (C^*, α) such that $C^*(x_R) = \pi_{SOC} - x_R$ for any $x_R \in X_R$. No other rule has higher stage 0 social welfare.*

Proof. Rewrite the stage 0 welfare associated with a rule (C, α) as:

$$\begin{aligned}-\int_{x_R \in X_R} \int_{x_{NR} \in X_{NR}} \int_{\varepsilon \in E} [(x_R + C(x_R) - \pi_{SOC})^2 + (x_{NR} + \varepsilon)^2] h(\varepsilon|x_R) f(x_{NR}|x_R) g(x_R) d\varepsilon dx_{NR} dx_R \\ -2\int_{x_R \in X_R} \int_{x_{NR} \in X_{NR}} \int_{\varepsilon \in E} (x_R + C(x_R) - \pi_{SOC})(x_{NR} + \varepsilon) h(\varepsilon|x_R) f(x_{NR}|x_R) g(x_R) d\varepsilon dx_{NR} dx_R\end{aligned}$$

Recall that:

$$\int_{x_{NR} \in X_{NR}} \int_{\varepsilon \in E} (x_{NR} + \varepsilon) h(\varepsilon|x_R) f(x_{NR}|x_R) d\varepsilon dx_{NR} = 0 \text{ for all } x_R \text{ in } X$$

Hence, the stage 0 welfare can be expressed as:

$$\begin{aligned}-\int_{x_R \in X_R} (x_R + C(x_R) - \pi_{SOC})^2 g(x_R) dx_R \\ -\int_{x_R \in X_R} \int_{x_{NR} \in X_{NR}} \int_{\varepsilon \in E} (x_{NR} + \varepsilon)^2 h(\varepsilon|x_R) f(x_{NR}|x_R) g(x_R) d\varepsilon dx_{NR} dx_R\end{aligned}$$

and this expression is maximized by setting the first integrand to zero - that is, setting $C(x_R) = \pi_{SOC} - x_R$. □

The best rule is to offset the inflationary pressures embedded in the rulable signal x_R.

This rule provides stage 0 social welfare equal to:

$$\begin{aligned} V_{rule}^{opt} &= -\int_{x_R \in X_R} \int_{x_{NR} \in X_{NR}} \int_{\varepsilon \in E} (x_{NR} + \varepsilon)^2 h(\varepsilon|x_R) f(x_{NR}|x_R) g(x_R) d\varepsilon dx_{NR} dx_R \\ &= -\int_{x_R \in X_R} \int_{x_{NR} \in X_{NR}} x_{NR}^2 f(x_{NR}|x_R) g(x_{NR}) dx_{NR} dx_R - \int_{x_R \in X_R} \int_{\varepsilon \in E} \varepsilon^2 h(\varepsilon|x_R) g(x_R) d\varepsilon dx_R \\ &= -Var(x_{NR}) - Var(\varepsilon) \end{aligned}$$

Here, I use the notation $Var(.)$ to refer to the variance of the relevant random variable, as of stage 0. The stage 0 social welfare is the negative of the sum of two components: the variance of the non-rulable inflation shock x_{NR} and the variance of the ex-post inflationary shock ε.

4 Main Theoretical Results

We can now use the theoretical model described in the prior section to assess whether rules are superior to discretion, or vice-versa. The answers to this question generally trade off two quantities: the magnitude of central bank bias versus the variance reduction gains associated with allowing the central bank to offset shocks to inflation that are hard to encode in rules.

Suppose first that there is no non-rulable information and no inflation bias. Then, discretion is equivalent to the best possible rule.

Proposition 3. *Suppose $X_{NR} = \{0\}$, so that there is no non-rulable information, and $\pi_{CB} = \pi_{SOC}$, so that the central bank is unbiased. There is a unique equilibrium outcome to any delegation game with discretion and its stage 0 social welfare is equal to the stage 0 social welfare implied by the best possible rule.*

Proof. Consider any delegation game (C, α). Then, in stage 1, the central bank solves the problem:

$$max_{a \in C(x_R)} -\int_{\varepsilon \in E} (x_R + \varepsilon + a - \pi_{SOC})^2 h(\varepsilon|x_R) d\varepsilon$$

which can be rewritten as:

$$max_{a \in C(x_R)}[-\int_{\varepsilon \in E} \varepsilon^2 h(\varepsilon|x_R)d\varepsilon - (x_R + a - \pi_{SOC})^2]$$

Suppose the delegation game features discretion, so that $C(x_R)$ is the entire real line. Then the unique solution to this problem would be to set:

$$a = \pi_{SOC} - x_R.$$

The stage 0 welfare associated with this equilibrium is easily seen to be V^{opt}_{rule}. □

The proposition demonstrates that, without any non-rulable information or bias, the best rule is equivalent to discretion.

At this point, it is worth noting something obvious that is often ignored. Many economists will airily say that, "Rules are better than discretion." The above proposition makes clear how sloppy this language is. In the context without bias or non-rulable information, any rule other than the best one provides less stage 0 welfare. Hence, it is not true that rules are as good as discretion. What's true is that there is exactly one (carefully chosen) rule that does as well as discretion.

Suppose next that the central bank's information about inflation is all rulable and and that the central bank is biased. Then, discretion is worse in terms of stage 0 welfare than the best possible rule.

Proposition 4. *Suppose $X_{NR} = \{0\}$, so that all available information about inflation is rulable, and $\pi_{CB} \neq \pi_{SOC}$, so that the central bank has an inflation bias. There is a unique equilibrium outcome to any delegation game that features discretion and its stage 0 social welfare is less than V^{opt}_{rule} (the social welfare implied by the best possible rule).*

Proof. Consider any delegation game (C, α). Then, in stage 1, the central bank solves the

problem:

$$max_{a \in C(x_R)} - \int_{\varepsilon \in E} (x_R + \varepsilon + a - \pi_{CB})^2 h(\varepsilon | x_R) d\varepsilon$$

which can be rewritten as:

$$max_{a \in C(x_R)} [- \int_{\varepsilon \in E} \varepsilon^2 h(\varepsilon | x_R) d\varepsilon - (x_R + a - \pi_{CB})^2].$$

Suppose the delegation game features discretion. Then the unique solution to the central bank's stage 1 problem is:

$$a = \pi_{CB} - x_R.$$

The stage 0 welfare associated with this equilibrium outcome is given by:

$$- \int_{x_R \in X_R} \int_{\varepsilon \in E} \varepsilon^2 h(\varepsilon | x_R) g(x_R) d\varepsilon dx_R - (\pi_{CB} - \pi_{SOC})^2$$

which equals:

$$V_{rule}^{opt} - (\pi_{CB} - \pi_{SOC})^2$$

□

In the case in which all information is rulable and the central bank is biased, discretion is strictly worse than the best rule. The sign of the bias doesn't matter for this result.

The case considered in Proposition 4 is the one that most macroeconomists have in their mind when they think about the issue of rules versus discretion. The central bank is biased in its decision-making (because of time consistency and political economy considerations). Because of this bias, it is best to constrain the central bank by a rule.

However, in this paper, I explicitly allow for the possibility that the central bank has information about inflation that cannot be written into a rule. As above, the problem with discretion is that the central bank will systematically aim to generate suboptimally high inflation. But there is a benefit to discretion: the central bank can use this flexibility to

offset the impact of inflationary pressures that can't be encoded into a rule. . Intuitively, if the bias is sufficiently small, then the benefit of discretion outweighs the relevant cost. The following proposition provides the precise way to do the comparison when the relevant objectives are quadratic.

Proposition 5. *Suppose:*

$$Var(x_R) > (\pi_{CB} - \pi_{SOC})^2$$

Then the unique equilibrium outcome implied by a delegation game with discretion has higher stage 0 welfare than the best rule.

Proof. Consider a delegation game with discretion. In stage 1, the central bank observes (x_R, x_{NR}) and then solves the problem:

$$max_{a\in\mathbb{R}} - \int_{\varepsilon\in E} (x_R + x_{NR} + a + \varepsilon - \pi_{CB})^2 h(\varepsilon|x_R) d\varepsilon$$

The maximand in this problem can be rewritten as:

$$-\int_{\varepsilon\in E} \varepsilon^2 h(\varepsilon|x_R) d\varepsilon - \int_{\varepsilon\in E} (x_R + x_{NR} + a - \pi_{CB})^2 h(\varepsilon|x_R) d\varepsilon$$

The solution is to set $a = \pi_{CB} - x_R - x_{NR}$. The stage 0 social welfare associated with this equilibrium is given by:

$$-\int_{x_R\in X_R} \int_{\varepsilon\in E} \varepsilon^2 h(\varepsilon|x_R) g(x_R) d\varepsilon dx_R - (\pi_{SOC} - \pi_{CB})^2$$

which can be rewritten as:

$$V^{opt}_{rule} + \int_{x_R\in X_R} \int_{x_{NR}\in X_{NR}} x^2_{NR} f(x_{NR}|x_R) g(x_R) dx_{NR} dx_R - (\pi_{SOC} - \pi_{CB})^2$$

which proves the proposition. □

The next proposition shows that the reverse is true: in terms of stage 0 welfare, the best

possible rule is better than discretion if the bias is sufficiently large in absolute value.

Proposition 6. *Suppose:*

$$Var(x_{NR}) < (\pi_{CB} - \pi_{SOC})^2$$

Then the unique equilibrium outcome implied by any delegation game that features discretion has lower stage 0 welfare than the best rule.

Proof. Same as the proof of Proposition 5. □

The proposition shows that, if the bias is sufficiently large relative to the non-rulable information available to the central bank about inflation, then the best possible rule is better than discretion. (Again, I want to stress that the proposition only applies to the best possible rule (and to a set of rules in the neighborhood of the best possible rule). It does not apply to all possible rules.)

The above propositions all assume that, in stage 0, society was able to form a prior distribution over possible realizations of the central bank's non-rulable information However, given the nebulous nature of that information, it may well be more reasonable to assume that society wants to formulate a delegation game that is robust to extreme outcomes of the central bank's non-rulable information. To be more precise, suppose that a game has an equilibrium outcome given by $a^*(x_R, y_{NR})$. Then define the *robust social welfare* from that outcome to be:

$$min_{x_{NR} \in X_{NR}} - \int_{x_R \in X_R} (x_R + x_{NR} + a^*(x_R, x_{NR}) - \pi_{SOC})^2 g(x_R) dx_R - \int_{x_R \in X_R} \int_{\varepsilon \in E} \varepsilon^2 h(\varepsilon | x_R) g(x_R) d\varepsilon dx_R$$

It is simple to show that, with respect to robust social welfare, discretion is better than any rule as long as the largest possible non-rulable inflation shock is larger in absolute value than the central bank's inflation bias.

Proposition 7. *Suppose* $X_{NR} = [-M, M]$ *and* $|\pi_{CB} - \pi_{SOC}| < M$. *Then, the robust so-*

cial welfare implied by any rule is less than the robust social welfare implied by the unique equilibrium outcome of a delegation game that features discretion.

Proof. In a delegation game with discretion, the unique equilibrium outcome is given by $a^*(x_R, x_{NR}) = \pi_{CB} - x_R - x_{NR}$. The robust social welfare is:

$$-(\pi_{SOC} - \pi_{CB})^2 - \int_{x_R \in X} \int_{\varepsilon \in E} \varepsilon^2 h(\varepsilon|x_R) g(x_R) d\varepsilon dx_R$$

In a delegation game that's a rule, the robust social welfare is

$$min_{x_{NR} \in X_{NR}} - \int_{x_R \in X} (x_R + x_{NR} + C(x_R) - \pi_{SOC})^2 g(x_R) dx_R - \int_{x_R \in X} \int_{\varepsilon \in E} \varepsilon^2 h(\varepsilon|x_R) g(x_R) d\varepsilon dx_R$$

The concavity of the objective with respect to x_{NR} means that this robust social welfare can be rewritten as:

$$- \int_{x_R \in X_R} \int_{\varepsilon \in E} \varepsilon^2 h(\varepsilon|x_R) g(x_R) d\varepsilon dx_R + min_{x_{NR} \in \{-M, M\}} - \int_{x_R \in X_R} (x_R + x_{NR} + C(x_R) - \pi_{SOC})^2 g(x_R) dx_R$$

The second term can be rewritten as:

$$-M^2 - \int_{x_R \in X_R} (x_R + C(x_R) - \pi_{SOC})^2 g(x_R) dx_R + min_{x_{NR} \in \{-M, M\}} - 2x_{NR} \int (x_R + C(x_R) - \pi_{SOC}) g(x_R) dx_R$$

The last term is non-positive. Hence, the best rule is to set $C(x_R) = \pi_{SOC} - x_R$ and gives rise to robust social welfare $-M^2$, which is less than the robust social welfare arising from discretion $-(\pi_{SOC} - \pi_{CB})^2$. This proves the proposition. □

As long it is possible that non-rulable inflationary pressures ever exceed the central bank's bias in absolute value, discretion is more robust than any rule.

It is easy to summarize the main theoretical findings. If the bias of the central bank exceeds the standard deviation of the central bank's non-rulable information, then the best possible rule is better than discretion. If the bias of the central bank is lower than the

standard deviation of the central bank's non-rulable information, then all rules are worse than discretion. Perhaps most importantly, if the largest realization of the central bank's rulable information exceeds its bias in absolute value, then discretion is more robust than any rule.

5 Discussion

In this section, I discuss some aspects of the theoretical results derived above.

5.1 Inflationary Bias?

The propositions in the previous section show that rules are dominated by discretion, as long as the central bank's inflationary bias is small in absolute value. In this subsection, I argue that the evidence suggests that the Federal Open Market Committee's inflation bias has been, at most, only modestly above zero over the past two decades.[35]

To make this argument, I need to first establish a benchmark for the socially optimal level of inflation. In many countries (such as Canada and the United Kingdom), elected governments have established what are intended to be long-term targets for inflation. Presumably, these targets can be seen as being relatively good proxies for socially optimal inflation. In the US, no such target has been established. However, in early 2012, the Federal Open Market Committee formally established a long-term goal of keeping PCE inflation[36] at 2%. Congress has, as yet, made no attempt to modify this target. So, I will treat the 2% target as being equivalent to the socially desirable level of inflation (π_{SOC}).

We can gauge the FOMC's inflation bias in two different ways: in terms of the the Committee's inflation objectives and in terms of actual outcomes. In terms of the former, in the

[35]The concerns about bias, both in the media and in the academe, usually focus on the possibility that the FOMC has a positive inflation bias. So, I don't present evidence against the hypothesis that the FOMC's inflation bias was highly negative.

[36]See https://www.federalreserve.gov/monetarypolicy/files/FOMC_LongerRunGoals_20160126.pdf for the most recent version of this statement.

last meeting of each year, the Committee's staff provide inflation forecasts for the upcoming two years. These forecasts are conditioned on the staff's best projection of what the Committee will actually do. Since 1997, the one-to-two year ahead inflation forecasts have only rarely exceeded 2% and have never been as high as 2 1/4 percent. Hence, the staff did not see the FOMC as aiming for inflation well above 2%. Since 2007, the FOMC participants have submitted their own end-of-year inflation forecasts. As discussed earlier, these forecasts are conditioned on each participant's own assessment of appropriate monetary policy. The midpoint of the central tendency of the one-to-two-year ahead PCE inflation forecasts (constructed by discarding the three highest and three lowest forecasts) never exceeded 2% (even during periods of high unemployment).[37]

So, there is little evidence in the FOMC's projections for inflation that the Committee is aiming for inflation to be materially above 2%. If we look at outcomes, we get a similar conclusion. Over the past twenty years, the sixty-month trailing average PCE inflation rate has never been above 3%. Even here, most of the upward misses with respect to inflation can be attributed to the surprisingly large run-up in oil prices in 2008. Over the past twenty years, the sixty-month trailing average core PCE inflation rate (which excludes goods and services related to food and energy) has never exceeded 2 1/4 %.

Of course, inflation rose to unacceptably high levels during the 1970s. However, since that period, much has changed in terms of FOMC practice. Perhaps most notably, both Chairman William Martin and Chairman Arthur Burns interacted relatively closely with the White House compared to Chair Janet Yellen or her immediate predecessors. The Federal Reserve is consequently much more independent of the short-term political pressures that often are argued to have been responsible for at least part of the Great Inflation.[38]

[37] See Kocherlakota (2012).
[38] See Meltzer (2010).

5.2 Communication Challenges with Rules

Over the past two decades, many central banks, including the Federal Reserve, have greatly increased their level of communication about monetary policy. In this subsection, I briefly argue that there is a sense in which rules (or any form of constraint on discretion) make such communication more challenging.

In a world with discretion, the central bank sets the level of accommodation so that:

$$a^*(x_R, x_{NR}) = \pi_{CB} - x_R - x_{NR}$$

The variable x_R is known to the public, but the non-rulable information x_{NR} may or may not be. The choice of accommodation, in and of itself, reveals $(\pi_{CB} - x_{NR})$. If the central bank's bias is known (as I assume above), then the choice of accommodation reveals the non-rulable information x_{NR}.

In contrast, if the central bank is using a rule, the choice of accommodation reveals nothing about x_{NR}. It may well be true, though, that the central bank would like to reveal at least some of its private information about inflation, so as to reduce the private sector's uncertainty about inflation. The central bank would then need to supplement its choice of accommodation with separate communication about x_{NR}. In this sense, rules - or any constraints on central bank accommodation - serve to increase the central bank's communication challenge.

6 Conclusions

There is a broad academic macroeconomic consensus that monetary policy should be constrained by rules. In this paper, I argue instead that there are good reasons to believe that societies will achieve better outcomes if central banks are given complete discretion to pursue well-specified goals. Theoretically, discretion allows central banks to take advantage of information about the macro-economy that is hard to write into rules. Empirically, deviating

more materially from the Taylor Rule would have allowed the FOMC to pursue a more rapid recovery from the Great Recession.

I do show that if central banks have a sufficiently large pro-inflation bias, there exists a set of rules that dominates discretion. (However, it is still not true that *all* rules dominate discretion.) I argue in the paper that, over the past twenty years, the FOMC has shown little if any pro-inflation bias. But this claim would be much less true in other periods in history (like the 1970s). What changes in institutional design have served to reduce the Federal Reserve's inflationary bias to its current low level? I say little about this issue in the paper, beyond referring to increased independence from the White House. However, it is a key question for future work along these lines.

The House of Representatives has passed legislation that would require the FOMC to treat the Taylor Rule as a key benchmark in its decision-making about policy.[39] The analysis in this paper implies that this move by the House is a mistake. It is true that the Taylor Rule was arguably associated with good macroeconomic outcomes during a limited period of US economic history. But so was the Riefler-Burgess framework! Enshrining the Taylor Rule in statute can only hamstring the Federal Reserve's response to currently unanticipated events. The House would be much better off requiring the FOMC to communicate a collective forecast for employment and prices, and to explain clearly why policy is not being used to close any gaps between that forecast and the Committee's ostensible goals. That requirement would incentivize the Committee to pursue more rapid recoveries than they did in 2009-10.

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