Multiple objectives and central bank trade-offs under flexible inflation targeting*

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Abstract

Many inflation targeting central banks are facing calls to expand their list of policy goals. I discuss how recent research provides new insights into the goals of policy and the trade-offs presented by multiple goals. I focus particular attention on the role of unemployment and labor market frictions, but I also discuss the role of currency misalignment in affecting policy objectives in open economies. Current models often find that price stability is close to the optimal policy, even when, in theory, the central bank should care about multiple goals. I offer some ideas about why this might be the case.

1 Introduction

This year marks the 15th anniversary of the adoption of inflation targeting by the Banco Central do Brazil. It also marks the 25th anniversary of the Reserve Bank of New Zealand Act of 1989, the basis for the very first formal inflation targeting regime. (I believe Charles Goodhart was among the economists consulted by the New Zealand Labour government when the Act was written.) Since inflation targeting premiered in New Zealand, it has spread widely, with close to 30 countries now classified as inflation targets. As Andy Rose has emphasized, inflation targeting has proven to be a very stable policy regime.

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With the exceptions of Finland and Spain, who both dropped inflation targeting to join the euro, no inflation targeter has subsequently abandoned it.

Certainly the inflation experience of Brazil since adopting inflation targeting represents quite a contrast with its experience during the 15 years prior to its adoption. Table 1 compares mean annual average inflation rate and its standard deviation for 1990-1999 and 2000-2013 for Brazil, all of Latin America, the ASEAN-5 economics, and the advanced economies. Brazil was not alone in achieving a marked improvement. The twenty years following the introduction of IT in New Zealand witnessed successful disinflations in many countries, and these successes were broadly similar in both inflation targeters and non-inflation targeters. Not surprisingly, there is an active empirical literature that attempts to assess what role, if any, inflation targeting played in reducing inflation and, equally importantly, contributed to maintaining low and stable inflation and stability in real economic activity.[1]

Inflation Experiences

	Mean		Std. Dev.	
	1985-1999	2000-2013	1985-1999	2000-2013
Brazil	747.26	6.58	932.843	2.661
Latin America	146.60	6.89	133.964	1.421
ASEAN-5	11.37	5.23	5.358	1.825
Advanced	3.26	1.99	1.238	0.754

Source: IMF WEO

Inflation targeting certainly has its critics, and it faces serious challenges in the post-financial crisis environment. Criticism has come from both sides – some have argued that IT hasn't really mattered, others argue it has mattered too much. That the macroeconomic experiences of inflation targeters and non-targeters have been similar and that IT adversely resulted in policy makers focusing too much on inflation while neglecting financial stability and other important macroeconomic objectives such as growth and employment. Calls for ITs abandonment, or at least for its reform, are common. Calls

[1] For example, for evidence generally supportive of IT, see Schmidt-Hebbel (2009), Walsh (2009a), Walsh (2009b), Gürkaynak, Levin and Swanson (2010), Brito and Bystedt (2010), Rose (2013) and the references they contain.

for reform have focused on three types of changes: 1) expanding the list of policy goals assigned to the central bank, 2) retaining IT but raising the target inflation rate, and 3) dropping inflation in favor of an alternative nominal target such as price level targeting or nominal GDP targeting.

In my talk today, I will focus on the first of these potential reforms. Specifically, I want to focus on what modern economic theory says about the goals of monetary policy and whether the gains from deviating from price stability to pursue other goals are worth the cost.

2 Distortions and deviations from strict inflation targeting

> The key principles underlying flexible inflation targeting are credibility, predictability and transparency of decision-taking, and they will remain the cornerstone of successful monetary policy in the future. King (2012), p. 12.

> How to summarize these conclusions (about lessons from the financial crisis for central banks)? Simply: *flexible* inflation targeting is the best way of conducting monetary policy. Stanley Fischer, "Introduction: Central Bank Lessons from the Global Crisis," in *The Great Recession: Lessons for Central Bankers*, edited by Jacob Braude, Zvi Eckstein, Stanley Fischer, and Karnit Flug, The MIT Press, 2013. Quote appears on page 14.

Mervyn King's list of key cornerstones of successful monetary policy are facilitated by inflation targeting, in part because the target provides a structure to policy debates and a means of communicating policy to the public. But emphasizing a single macroeconomic measure – the rate of inflation – does raise the potential that the central bank will ignore other measures of economic health. Stan Fischer emphasizes that the best monetary policy is flexible inflation targeting, with the flexibility indicating that the inflation rate is not the only macroeconomic outcome of relevance. And while the evidence is clear that inflation targeters are *flexible inflation targeters* in practice, a communications strategy focused solely on the inflation rate may lead the public to believe that is all the central bank really cares about.

But what else should monetary policy makers care about?

The modern theory of monetary policy says that central banks should care about many things. Economies are characterized by many frictions that prevent efficient adjustment in the face of economic disturbances. If monetary policy has the ability to affect the real economy, and if the monetary authority is able to offset economic distortions that hinder efficient adjustment, then policy should – at least in principle – sacrifice some price stability to improve overall macroeconomic outcomes.

It is useful to think of decomposing some measure of macroeconomic health – I'll call it social welfare W_t – into components due to different real and nominal frictions. Let W_t^* be the first best outcome – the social planner's allocation, and let W_t^{opt} be welfare under an optimal monetary policy. If we let W_t^{sp} denote welfare achievable when prices are stable – what would be achieved by a strict inflation targeter – we can write

$$W_t^* - W_t^{opt} = (W_t^* - W_t^{ps}) + \left(W_t^{ps} - W_t^{opt}\right) \geq 0. \tag{1}$$

The gap $W_t^* - W_t^{opt}$ reflects the difference between the planner's allocation and best that can be achieved under an optimal monetary policy. This can be, in turn, expressed as the sum of two gaps. $W_t^* - W_t^{ps}$ is the gap between the first best and the equilibrium under price stability. This difference is normally positive due, for example, to imperfect competition in goods markets or other real frictions. The term $W_t^{sp} - W_t^{opt}$ measures the difference in welfare between the equilibrium with stable prices and the level of welfare achievable under an optimal policy that (potentially) deviates from price stability. (1) implies

$$\sigma^2_{W^*-W^{opt}} = \sigma^2_{W^*-W^{ps}} + \sigma^2_{W^{ps}-W^{opt}} + 2\sigma_{(W^*-W^{ps})(W^{ps}-W^{opt})}.$$

In the world of Blanchard and Galí's divine coincidence (Blanchard and Galí (2007)), $W_t^* - W_t^{ps}$ is a constant, so $\sigma^2_{W^*-W^{ps}} = 2\sigma_{(W^*-W^{ps})(W^{ps}-W^{opt})} = 0$ and $\sigma^2_{W^*-W^{opt}}$ is then minimized by minimizing $\sigma^2_{W^{ps}-W^{opt}}$, i.e., by ensuring price stability.[2]

But this is a special case. If there are real frictions arising from, for example, markup shocks in product and/or labor markets, or nominal rigidities such as wage stickiness in addition to price stickiness, then $W_t^* - W_t^{ps}$ is a welfare cost that varies over time. In this case, the central bank can improve macro outcomes by deviating from price stability to create a negative correlation between $W_t^* - W_t^{ps}$ and $W_t^{sp} - W_t^{opt}$, i.e, so that $\sigma_{(W^*-W^{ps})(W^{ps}-W^{opt})} < 0$. Allowing inflation to rise somewhat in the face of an

[2] Since in this case, $W_t^{ps} = W_t^{opt}$ and $\sigma^2_{W^*-W^{opt}} = 0$.

adverse supply shock, for instance, helps cushion the contraction in economic activity and improves overall welfare. Strict inflation targeting will not be optimal. This point is not new. The fact that price rigidities may improve welfare relative to the flexible price equilibrium arises because they mean monetary policy can offset partially other distortions.[3][4]

Of course, the fact that $W_t^* - W_t^{ps}$ is volatile does not necessarily imply policy can generate welfare gains by deviating from price stability. The negative correlation must more than offset the volatility introduced into $W_t^{sp} - W_t^{opt}$ if welfare is to be improved. If it is necessary to generate large movements in $W_t^{sp} - W_t^{opt}$ to produce a negative correlation with $W_t^* - W_t^{ps}$, then sticking to a policy of price stability may be close to optimal. That is, are the costs of the inflation volatility that is needed to reduce $W_t^* - W_t^{ps}$ may be too large to justify the required deviations from price stability.

3 Inefficient fluctuations and trade-offs

The literature has investigated many potential reasons economies experience distortions that would call for deviating from price stability. First generation new Keynesian models assumed that price markup shocks in goods markets caused inefficient fluctuations in inflation and output. Optimal policy trades off some volatility in output in an attempt to prevent these shocks from creating volatility in inflation. In this environment, optimal policy (under discretion) follows the Qvigstad rule, named for Norges Bank Deputy Governor Jan Qvigstad who described it in Qvigstad (2006) – if inflation is above target, the output gap should be negative and vice versa.[5] If inflation is above target and the output gap is also positive, then policy is too loose; if inflation is below target and the output gap is negative, policy is too tight. If inflation relative to target is plotted against the output gap, observations should fall into quadrants II and IV. Points in quadrant I indicate policy that is too loose; points in quadrant III indicate policy is too tight. Figure **??** shows such a plot for the U.S.

A Qvigstad plot provides a simple but rough assessment of monetary policy, similar to

[3] Adao, Correia, Teles (2003) discuss a model with multiple distortions and nominal price rigidity where this intuition applies.

[4] Staggered price setting may improve welfare relative to the flexible price equilibrium since it provides monetary policy the opportunity to offset partially other distortions. Adao, Correia, Teles (2003) discuss a model with multiple distortions and nominal price rigidity where this intuition applies.

[5] Qvigstad (2006).

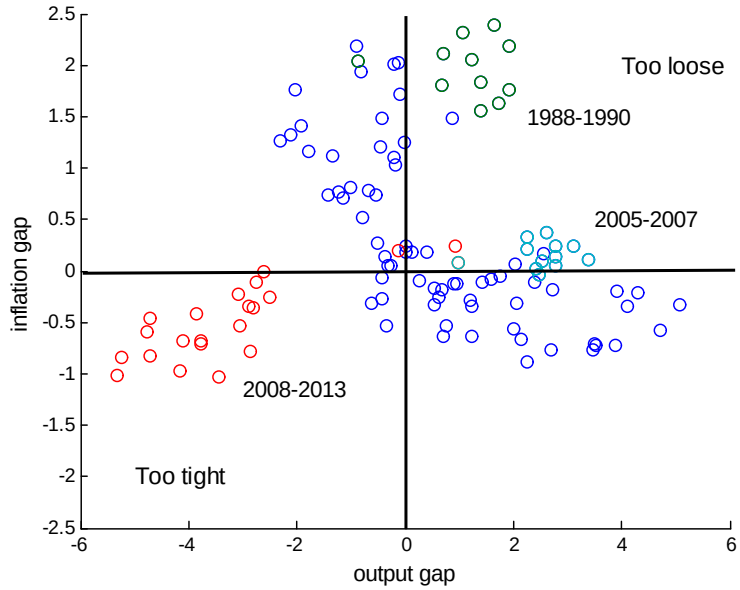

Figure 1: A Qvigstad plot of the U.S. output gap and inflation gap inflation relative to 2%)

exercises that compare the policy interest rate to the predictions of a Taylor rule. It has the advantage of focusing on the things we care about – inflation and real activity – rather than on the setting of the policy instrument. It gives a general sense of the balancing act the central bank has had to make, but it doesn't tell us whether the outcomes are consistent with an optimal policy.

To get a sense of what theory implies about optimal policy, at least under discretion, we can use a simple graph to analyze the case of serially uncorrelated markup shocks. Equilibrium, shown in figure 2, is represented by the intersection of two curves – the Phillips curve, linking inflation and the output gap, and a policy curve showing the way the central bank balances fluctuations in these two variables.

The curves shown are not arbitrary – they reflect commonly used parameter values for linear approximations to the basic new Keynesian model.[6] The key point is that the

[6] The policy curve is defined by $\kappa\pi + \lambda x = 0$, where κ is the elasticity of inflation with respect to the output gap and λ is the relative weight on output gap stabilization in the central bank's objective function. In terms of tructural parameters, $\lambda = \kappa\left(\sigma + \eta\right) / \left[\left(1 + \eta\theta\right)\theta\right]$ where is the elasticity of product demand faced by firms. The slope of the policy curve is $-\lambda/\kappa = \left(\sigma + \eta\right) / \left[\left(1 + \eta\theta\right)\theta\right]$. The figure assumes log utility ($\sigma = 1$), $\eta = 2$, and $\theta = 11$. The value of θ is consistent with an average markup of 10%.

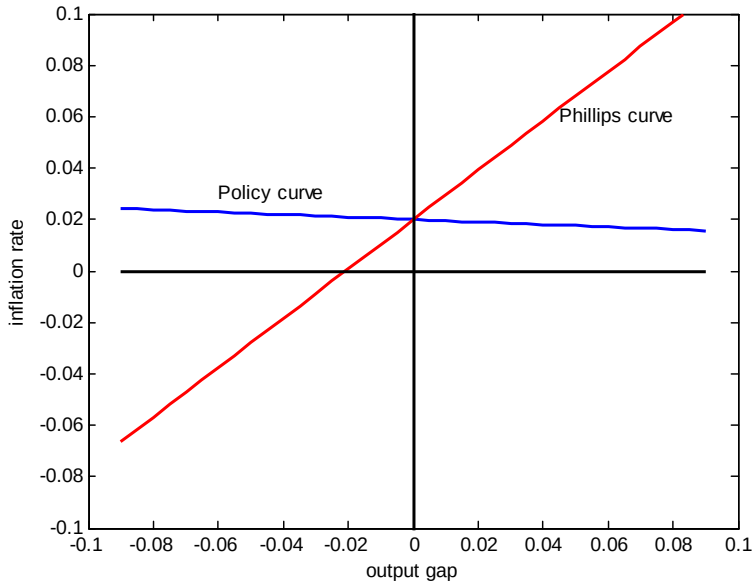

Figure 2: Simple new Keynesian model: optimal discrectionary policy.

policy curve is very, very flat. Figure 3 illustrates what happens when there is a positive markup shock. Output rise and the output gap falls, but given the flat policy curve, the rise in inflation is very small. Under a policy of pure price stability, the policy line would be completely flat. It almost is, so optimal policy is close to price stability.

The basic new Keynesian model, therefore, implies that, while in theory central banks should care about stabilizing both inflation and the output gap, in practice, or at least if one takes the model seriously, optimal monetary policy is pretty much strict inflation targeting (price stability).

3.1 Currency misalignments

The previous example came from a very basic model. Do the conclusions change if one begins to incorporate more sources of potentially inefficient fluctuations that might call for deviating from price stability? One case in which this might occurs arises from currency misalignment.

Assuming a smaller value of θ (a larger average markup) would increase the absolute value of the policy curve slope.

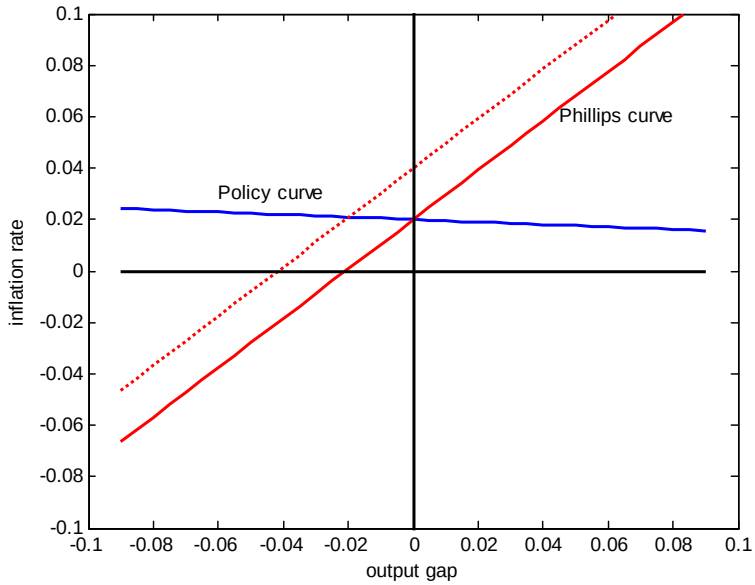

Figure 3: Effects on inflation and the output gap of an inflation shock.

Early extension of the new Keynesian model to the environment of a small open economy such as Clarida, Gali and Gertler (2001) and Clarida, Gali and Gertler (2002) concluded the small open economy was essentially isomorphic to the closed economy. While the parameter values relevant for an open economy would differ from those for a closed economy, that was the only difference. And importantly, optimal policy called for stabilizing domestic goods prices, not a consumer price index. This was an important finding as all inflation targeting central banks actually define their target in terms of a consumer price index.

The key distortion in the Clarida et al. (2002) model was due, as in all new Keynesian models, to relative price distortions that arise when firms adjusted prices in a staggered, nonsynchronized fashion. Relative price dispersion causes a shift in demand away from firms with relative high relative prices and towards those with relative low relative prices. These shifts in demand and production across firms, shifts due solely to inflation variability combined with sticky prices, result in an inefficient allocation of labor across firms. Since it is the allocation of labor across domestic firms that is responsible for the inefficiency, stabilizing domestic prices is the answer.

These early open economy models, however, ignored many important frictions that characterize open economies. For example, they assumed uncovered interest parity held; pass-through was complete, and the law of one price held. They also assumed the domestic consumption bundle consisted entirely of tradeable goods. Empirical models of open economy have had to relax all these aspects to match the data.

Consider the following two additions to the basic model of Clarida et al. (2002): nontraded goods and local currency pricing by domestic firms engaged in exporting. The first extension (to incorporate nontraded goods) is developed in Wren-Lewis and Leith (2006). Demand and supply in the market for nontradeables must be equal, and the same must hold for the demand and supply of domestically produced tradeables. Equilibrium in the nontradeable goods sector requires

$$Y_N = V_N C_N \Rightarrow C_N \leq Y_N,$$

where V_N is a measure of relative price dispersion across firms in the nontradeables sector. Equilibrium in the domestic tradeables goods producing sector, which arises from both domestic consumers and foreign consumers, requires

$$Y_H = V_H \gamma S C^* \left[(1 - \alpha) \varepsilon + \alpha \right]$$

where C^* is world consumption, ε is a shock to the UIP condition, S is the terms of trade (the price of foreign produced tradeables relative to domestically produced tradeables), and V_H is a measure of relative price dispersion among domestic tradeable goods producing firms.

Not surprisingly, with sticky prices in both sectors of the economy, output gaps in both sectors matter for social welfare, as does inflation in the price indexes of both sectors. Because output gaps in both sectors are relevant, one cannot replace them with a single output gap measure – the sectorial composition of output matters.

Of course, the two output gaps can be replaced by gaps in aggregate output and another gap that captures the sectorial composition effects. Wren-Lewis and Leith (2006) show that a central bank objective function defined in terms of an aggregate output gap would also need to incorporate a terms of trade or real exchange rate objective as well.

Similarly, policy needs to stabilize inflation is both sectors. Policy objectives can be defined in terms of an aggregate measure of domestic price inflation, but in this case,

an exchange rate or terms of trade measure also should appear in the central bank's objective function.

But how important are these additional objectives? Wren-Lewis and Leith (2006) show for a calibrated version of the model that the improvement of the optimal policy under commitment over a policy of strict output price inflation targeting is just 0.001% of steady-state consumption. There is almost no gain from optimally balancing the need to stabilize multiple output, terms of trade, and inflation gaps.

Let me mention briefly one further example from the open economy literature. Engel (2011) examines a variant of the Clarida et al. (2002) model which includes local currency pricing by domestic export firms. Now sticky prices that create dispersion among the relative prices of domestically produced tradeables in the domestic market also create a dispersion of relative prices for these exporting firms in foreign markets. This affects the demand facing these firms and leads to an inefficient allocation of labor among domestic firms.

How important are these distortions? What are the costs of deviating from price stability, defined either in terms of domestic tradeables output or nontradeables output prices?

Engel (2011) shows, in a model in which all goods are tradable and local currency pricing characterizes pricing of export goods from the domestic economy, that an optimal policy attempts to stability output gap measures, inflation in both domestic prices and prices changed abroad by domestic firms, and a measure of currency misalignment, all measured relative to their efficient levels. Currency misalignment is related to the average foreign price of domestic tradeables to their average price in the home market.

But how big are the relative weights on these different policy objectives? Using standard values ($\sigma = \phi = 1$, $\xi = 11$, $v = 2/3$, the weight on currency misalignment is only 1/8 the weight on the price dispersion terms that are linked to inflation volatility.

In a related paper, Kirsanova, Leith and Wren-Lewis (2006) derive the social welfare function for a small open economy and find that, relative to inflation (at annual rates), the coefficient on terms of trade volatility, using Engel's calibration, is zero. Assuming instead that $\sigma = 0.5$, the relative weight on terms of trade volatility relative to inflation volatility is 0.007.

So while multiple distortions argue for multiple objectives in principle, standard open economy models imply that the central bank should focus overwhelming on stabilizing domestic price inflation. The costs of deviating from price stability are large relative to

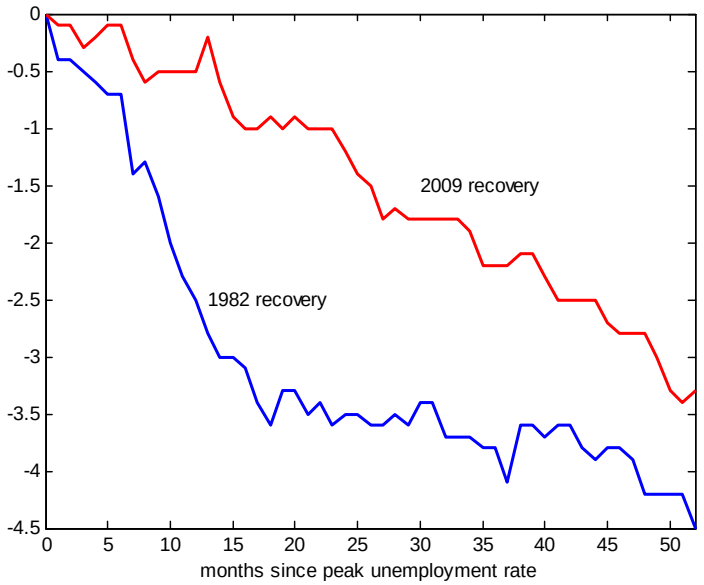

Figure 4: Decline in unemployment rate from peak level (unemployment.m). Unemployment peaked at 10.8% in December 1982 and 10% in October 2009.

the gains to be had from trying to deal with other distortions.

3.2 Labor market distortions

Unemployment has been of major concern in the U.S. and therefore for Federal Reserve, so let me now turn to a labor market example.

Not only did the 2008-2009 Great Recession see the highest peak unemployment rate since the Volcker disinflation of the early 1980s, but unemployment has remained stubbornly high since the recovery began. Because of the large social costs of elevated levels of unemployment, especially when that unemployment persists for extended periods of time, the health of the labor market has loomed large in Federal Reserve policy discussions. This is entirely consistent with the Fed's dual mandate of maintaining price stability and maximum sustainable employment.

Starting in Fall 2012, the Fed began to link future interest rate increases to develop-

ments in the labor market.[7] The September 13, 2012 FOMC statement indicated that quantitative easing policies, in this case purchases of mortgage-backed securities, would continue "if the outlook for the labor market does not improve substantially." In its December 12, 2012 statement, the FOMC adopted a more quantitative measure of labor market health, stating that

> In particular, the Committee decided to keep the target range for the federal funds rate at 0 to 1/4 percent and currently anticipates that this exceptionally low range for the federal funds rate will be appropriate at least as long as the unemployment rate remains above 6-1/2 percent, inflation between one and two years ahead is projected to be no more than a half percentage point above the Committee's 2 percent longer-run goal, and longer-term inflation expectations continue to be well anchored. ..... In determining how long to maintain a highly accommodative stance of monetary policy, the Committee will also consider other information, including additional measures of labor market conditions, indicators of inflation pressures and inflation expectations, and readings on financial developments.

On March 31, in her first formal speech as Chairwoman of the Federal Reserve, Janet Yellen focused on the continued weaknesses of the labor market, sending a signal that policy would remain accommodative for some time.[8]

3.2.1 A model of the labor market

Standard new Keynesian models are not well suited to analyze the role unemployment should play in the design of monetary policy. There is a simple reason for this – most such models still do not have any unemployment. They incorporate fluctuations in labor hours, but they do not include any actual fluctuations in the number of individuals who are seeking work but who do not currently have jobs. Fortunately, there is now a standard theory of unemployment based on the Nobel Prize winning work of Peter Diamond, Chris Pissarides, and the late Dale Mortensen that can be incorporated into monetary policy models.[9] A large literature has developed over the past decade, both theoretical and

[7] See section 2.3, p. 46 of Woodford (2013) for relevant dates and quotations from FOMC statements.

[8] The rapid fall in the U.K. unemployment rate in early 2014 lead the Bank of England to quickly reverse its use of a numerical value for unemployment in conveying forward guidance.

[9] This so-called DMP model was first incorporated into a new Keynesian model of nominal rigidities in Walsh (2003), Walsh (2005) and Trigari (2009).

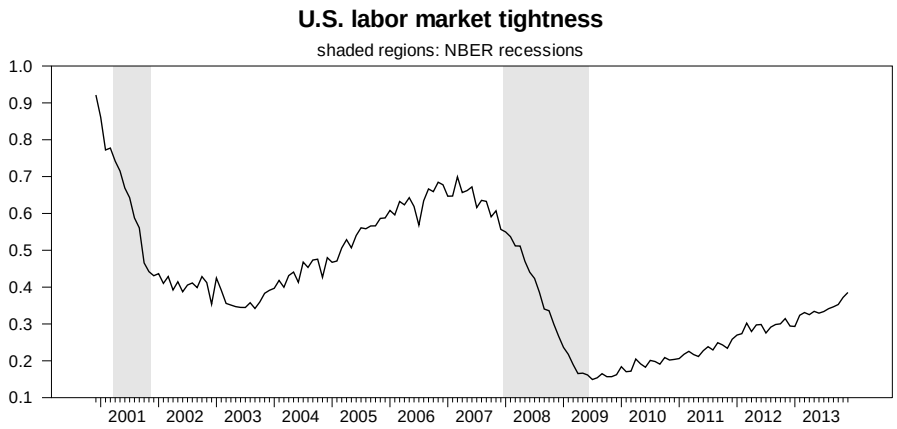

Figure 5: Labor market tightness (vacancies relative to unemployment) in the U.S. (us_labortightness.rpf)

empirical, including important work by Antonnella Trigari (Trigari (2009), Gertler and Trigari (2009), Sala, Söderström and Trigari (2008), and Sala and Trigari (2012)), that imbeds versions of the DMP model into DSGE models that can be used to address issues of monetary policy.

There are two things to note about the NK-DMP model. First, frictions in the labor market give rise simultaneously to unemployment workers and unfilled jobs, so the unemployment rate alone is not sufficient to characterize conditions in the labor market. Instead, these conditions are captured by the ratio of vacancies to unemployment, a measure of labor market tightness (see figure 5).

Second, interest rates have a direct effect on labor demand – that is, monetary policy, to the extent it affects real interest rates, has a supply side effect as well as a demand side effect. Because most employment matches last for several periods, the firm evaluates the present value of the returns to a successful hire when weighing whether to post a new job opening. An interest cut raises the present discounted value of a job match and, ceteris paribus, increases the number of new jobs firms recruit for.[10] Monetary policy has supply side effects and not just standard demand side effects.

[10] For the role of this cost channel for optimal monetary policy, see Ravenna and Walsh (2006). For its role in the Great Recession, see Christiano, Eichenbaum and Trabandt (2014) and Hall (2014).

The current generation of these models has strong implications for monetary policy. Based on the results of Ravenna and Walsh (2011) and Ravenna and Walsh (2012b), Jim Bullard, President of the Federal Reserve Bank of St. Louis, described these papers in a lecture at the 22nd Annual Hyman P. Minsky Conference at the Ford Foundation lecture titled "Some unpleasant implications for unemployment targeters."[11]

So what are these unpleasant implications?

Under the standard DMP assumption that workers and firms engage in Nash bargaining over wages, efficiency requires that their bargaining weights take on specific values given by what is known as the Hosios condition (Hosios 1980). In Ravenna and Walsh (2011), we show that when the Hosios conditions holds, optimal monetary policy should aim to minimize a function that depends on inflation volatility, volatility in a consumption-based output gap, *and* the volatility of the gap between labor market tightness and its efficient level. Thus, the addition of a new distortion calls for not a dual mandate but a triple mandate in which labor market fluctuations play an independent role.

Taking a second order approximation to the welfare of the representative household in the basic NK model yields

$$W_t^{NK} = W_{tip,t}^{NK} - \left(\pi_t^2 + \lambda_0 \tilde{c}_t^2\right),$$

where $W_{tip,t}^{NK}$ captures terms that are independent of policy, while in the NK-DMP model, one obtains

$$W_t^{NKDMP} = W_{tip,t}^{NKDMP} - \left(\pi_t^2 + \lambda_0 \tilde{c}_t^2 + \lambda_1 \tilde{\theta}_t^2\right), \tag{2}$$

where $W_{tip,t}^{NKDMP}$ represents the terms independent of policy. However, for a plausible calibration of the model, it turns out that $\lambda_1 \approx 0.0001$.[12] So for all intensive purposes, optimal policy ignores labor market fluctuations. But under this same calibration, $\lambda_0 \approx 0.0143$, so optimal policy is pretty close to a complete focus on inflation stabilization. We show that this welfare function can be expressed in terms of inflation, the consumption gap, and an unemployment rate gap variable, but again the theoretically implied weight

[11] April 17, 2013, New York.

[12] $\lambda_2 = (1-\alpha)(\delta/\varepsilon)\kappa\bar{V}/\bar{C} \approx (1-0.5)(\delta/6)\,0.01$. With the Calvo parameter $\omega = 0.75$,

$$\delta = \frac{(1-0.75)(1-0.75*0.99)}{0.75} = 0.0858$$

so $\lambda_2 \approx 0.00007$. And $\lambda_1 = \sigma\delta/\varepsilon \approx \sigma \times 0.0143$ so unless risk aversion is very high, λ_1 is also small.

on unemployment is small.

In Ravenna and Walsh (2011), we calibrate this model to assess the welfare costs of ignoring labor market variables. We consider the welfare costs of designing policies to minimize a standard objective function that either ignore labors market frictions or introduce them in an ad hoc fashion. Specifically, we consider two alternatives to the welfare-based loss function. The first alternative simply drops the $\tilde{\theta}_t^2$ term, yielding a loss function that more closely parallels a standard NK quadratic loss function:

$$L_t^{nk} \equiv \pi_t^2 + \lambda_0 \tilde{c}_t^2. \tag{3}$$

In this case, policy aims to stabilize inflation volatility and the volatility of the consumption gap. We employ the welfare-based value of λ_0 since this is equal to the same value that would arise in a standard NK model in which utility depends linearly on hours worked. This loss function ignores the inefficiencies arising from search costs in the labor market.

A second loss function previously employed in the literature includes inflation and the unemployment gap:

$$L_t^u(\lambda) \equiv \pi_t^2 + \lambda \tilde{u}_t^2. \tag{4}$$

Such a loss function has been employed by Orphanides and Williams (2007) and is used by Sala et al. (2008) in a model with search and matching frictions in the labor market. Because (4) represents an ad-hoc specification of policy objectives, theory offers no guidance as to the value to assign to λ, the relative weight placed on unemployment objectives. For our baseline, we set λ so that the standard deviation of the unemployment gap under commitment is the same when minimizing either (4) or the welfare-based loss function (2). In this case, $\lambda = 0.0035$. Sala, Söderström, and Trigari (2008) derive optimal policy for various values of λ and find that a value of 0.0521 matches the standard deviation of unemployment in their model.[13] Therefore, we also report results for $\lambda = 0.0521$. Since this value of λ is nearly 15 times the one that would deliver the same unemployment gap volatility as the optimal policy, it will imply a very high volatility of inflation in our model. This experiment is useful in providing a measure of the sensitivity of the loss to the relative weight placed on competing objectives. Orphanides and Williams (2007), for example, employ an even larger weight of 0.25 on unemployment in their analysis.

[13] Because they express inflation at an annual rate, the actual value of λ they use is $16 \times 0.0521 = 0.833$.

Table 2—Alternative Policy Objectives: Commitment

	Quadratic loss relative to opt. commitment (percent)	Welfare cost*	σ_π	$\sigma_{\tilde{u}}$	$\sigma_{\hat{\theta}}$	$\sigma_\pi/\sigma_{\tilde{u}}$
Welfare-based loss (1)	0	0	0.24	0.72	11.82	0.33
Std. Loss in π and $\tilde{c}$–gap, $\lambda = \lambda_0$ (2)	4.59	0.0011	0.02	0.75	12.36	0.03
Std. Loss in π and $\tilde{u}$–gap, $\lambda = 0.0035$ (3)	0.34	0.0001	0.22	0.72	11.86	0.32
Std. Loss in π and $\tilde{u}$–gap, $\lambda = 0.0521$ (4)	275.93	0.0683	1.96	0.51	8.27	3.83

*Relative to welfare-based optimal commitment, as percent of steady-state consumption.

Figure 6: Outcomes with different policy objectives. From Ravenna and Walsh (2011).

Results when policy is based on minimizing (under commitment) the alternative loss functions (3) and (4) are reported in Table 6. The first column of the table reports the percentage increase in the welfare-based loss function given by (2) when policy minimizes one of the alternative loss functions. Minimizing (3), for example, increases the loss by 4.59 percent (row 2). When policy minimizes inflation and unemployment volatility, the weight placed on the unemployment gap is crucial; minimizing (4) increases the loss by 0.34 percent (row 3) when $\lambda = 0.0035$ but by 275.93 percent (row 4) when the value $\lambda = 0.0521$ is used.

Consistent with the comparison based on the quadratic loss itself, the welfare costs of deviating from the optimal commitment policy are small in terms of steady-state consumption equivalents except when a large weight is placed on the volatility of the unemployment gap. In fact, when $\lambda = 0.0521$ in (4), performance deteriorates significantly (see row 4, Table 2). With this parameterization, policy is much more aggressive in stabilizing deviations of unemployment from the efficient level; the standard deviation of inflation increases by a factor of eight, while the standard deviation of the unemployment gap falls by about one third. The monetary authority would do much better by

Table 3—Alternative Policy Objectives: Discretion

	Quadratic loss relative to opt. commitment (percent)	Welfare cost*	σ_π	$\sigma_{\tilde{u}}$	$\sigma_{\tilde{\theta}}$	$\sigma_\pi/\sigma_{\tilde{u}}$
Welfare-based loss						
(1)	10.50	0.0026	0.39	0.72	11.93	0.54
Std. Loss in π and $\tilde{c}$–gap, $\lambda = \lambda_0$						
(2)	4.55	0.0011	0.02	0.75	12.36	0.03
Std. Loss in π and $\tilde{u}$–gap, $\lambda = 0.0035$						
(3)	16.75	0.0041	0.45	0.72	12.04	0.62
Std. Loss in π and $\tilde{u}$–gap, $\lambda = 0.0521$						
(4)	1936.12	0.4815	4.83	0.43	7.35	1.13

Relative to welfare-based optimal commitment as percent of steady-state consumption.

Figure 7: Outcomes under discretion. From Ravenna and Walsh (2011).

focusing on stabilizing inflation and ignoring altogether the impact of bargaining shocks on employment, as the second row of Table 2 shows.

Notice that the loss in inflation and unemployment yields a standard deviation for inflation that is essentially the same as that obtained under the fully optimal policy. And the use of the standard loss function (row 2) yields only a slight deterioration in labor market volatility while essentially achieving price stability. Expressed alternatively, there is a large gain in inflation stability at a relatively small cost in terms of greater real economic volatility, even though welfare ends up being somewhat lower.

Of course, these findings are for commitment policies, and it may be more relevant to consider outcomes when the central bank can commit to its objectives but cannot commit to future policy actions. This case is considered in Table 7 which shows that optimal policy employing an incorrect – but standard – objective function is both close to strict inflation targeting and improves over policy that correctly incorporates labor market frictions. But the finding that strict inflation targeting performs well in new Keynesian models is not unique to models that incorporate labor market frictions. As Mervyn King has noted with respect to financial frictions,

> "Although there is a, by now extensive, literature on financial frictions including attempts to incorporate them in New Keynesian models, it turns out that such extensions make little difference to the propagation of shocks, to optimal policy, or to the quantitative conclusions that overwhelmingly the most important objective remains inflation stabilization." King (2012), p. 5.

The same appears to be true for labor market fluctuations and motivates the quotation from Jim Bullard to conclude

> The instinct that many might have–that including search-theoretic unemployment in the [*new Keynesian*] model explicitly would have to mean that the policymaker would want to "put equal weight" on trying to keep prices stable and trying to mitigate the unemployment friction–turns out to be wrong. Optimal monetary policy is still all about price stability.[14]

4 Why is price stability close to optimal?

My labor market example and the example of currency misalignment illustrated how theory implies multiple objectives for the central bank but also implies that at the end of the day, price stability is close to optimal. Optimal monetary policy in these models is pretty much the same as strict inflation.

There are two possible explanations for this result. First, as indicated by the small weight on non-inflation objectives in the welfare approximation, it might simply be the case that volatility in real economic activity or unemployment or the real exchange rate does not really generate very large costs to the economy. Alternatively, fluctuations in the economy may create large welfare costs, but monetary policy may just be an inefficient means of addressing the problem.

So why might this be the case? This question is investigated in Ravenna and Walsh (2012b).

When monetary policy is the only policy instrument available, the competitive equilibrium generally results in an inefficient allocation. Assume policy authorities have a full set of tax instruments that can be used to achieve the first best allocation. We show three instruments are needed: one tax is used to correct any distortions in job creation,

[14] http://www.economicdynamics.org/News281.htm#interview

one tax corrects any inefficiencies in hours worked per employee, and monetary policy is used to ensure price stability. By examining how these tax instruments need to vary in response to shocks, we can infer something about how volatile inflation would need to be if monetary policy were the only instrument available for dealing with the distortions in labor market.

When wages are set by Nash bargaining and the Hosios condition holds (a value of 0.5 for our bargaining share parameter b), the flexible-price equilibrium delivers the planner's level of welfare – employment and hours choices are efficient, and price stability is the optimal monetary policy. This is shown in row 1 of Table 8.

When wages are determined by Nash bargaining but the Hosios condition is violated ($b = 0.7 > 0.5$), row 2 of Table 8 shows that the tax (τ_t^f) to correct for employment distortions must compensate for a large, but basically acyclical, wedge between the efficient and inefficient allocations. This low volatility of the optimal tax means monetary policy aimed at achieving the efficient employment outcome does not need to deviate much from price stability. Monetary policy that aims to achieve efficient employment generates approximately the same level of welfare as price stability (see row 2 of Table 9). In other words, the monetary authority faces a welfare function which is close to flat with respect to the alternative objectives of labor market efficiency and price stability, and so the optimal, efficient employment monetary policy and price stability deliver similar welfare outcomes. The employment inefficiency is large, but most of it – both in terms of the size of the tax needed to correct for inefficiency in vacancy posting and in terms of how this inefficiency translates in welfare loss – depends primarily on the steady state inefficiency, and this steady-state inefficiency cannot be addressed by monetary policy.[15] This explains why previous papers that assume Nash bargaining find that price stability is close to the optimal policy (i.e., Faia (2008), Faia, Lechthaler and Merkl (2009), Ravenna and Walsh (2011)).

Intuitively, the impact of a productivity shock with inefficient Nash bargaining is akin to its impact under the efficient allocation, coupled with a temporary deviation of the

[15] The solution to the optimal policy problem yields a steady-state inflation rate of zero, similarly to the steady state result obtained in models with staggered price adjustment by Khan, King and Wolman (2003) and Adao, Correia and Teles (2003).

Table 4
Intermediate sector optimal tax τ_t^f.

Wage setting	Steady-state tax rate (negative value implies a subsidy)	Volatility	
		σ_τ	σ_τ/σ_y
Nash bargaining			
(1) $b=0.5$	0	0	0
(2) $b=0.7$	−115%	0.08%	0.04
Efficient wage norm			
(3) $\overline{w}=w_{ss}(0.5)$	0	1.69%	0.95
Inefficient wage norm			
(4) $\overline{w}=w_{ss}(0.7)$	−1.64%	1.69%	0.95

Note: Steady-state rate and volatility for subsidy paid to intermediate sector firms. Optimal tax policy implies $1+\tau_t^c=(1-\tau_t^f)/\mu_t$, $\tau^\mu=1-\mu$ and $\mu_t=\mu_t^*=\overline{\mu}=1$. The results in the table are obtained assuming a complete set of policy instruments is available to attain the first best allocation.

Figure 8: Table 4 from Ravenna and Walsh (2012a).

bargaining share from its efficient (Hosios) level. Since workers and firms are concerned with the present value of the match surplus, temporary deviations from efficient bargaining do not have large welfare costs. This argument is closely related to the one made by Goodfriend and King (2001) that the long-term nature of employment relationships reduces the welfare costs of temporary wedges between the marginal product of labor and the marginal rate of substitution between leisure and consumption.

Results change significantly under a wage norm, defined as a fixed wage level. Rows 3 and 4 show that when wages are fixed, the optimal tax needed to correct for labor market inefficiencies is very volatility. Even with a wage norm set at the efficient steady-state level (denoted $\bar{w} = w_{ss}(0.5)$ in the table), the efficient employment monetary policy performs poorly compared to price stability. A monetary policy focused on employment would yield an additional welfare loss equal to 2.33% of steady-state consumption and lead to high inflation volatility (Row 3 of Table 9). When the wage norm is set at an inefficient steady state level (row 4 with $\bar{w} = w_{ss}(0.7)$), implying a larger share of the labor distortion is explained by inefficient cyclical fluctuations as opposed to the steady state loss, row 4 of Table 9 shows that the efficient employment monetary policy delivers

Table 5
Welfare results: efficient employment monetary policy.

Wage setting	Loss relative to price stability λ	Relative inflation volatility σ_π/σ_y
Nash bargaining		
(1) $b=0.5$	0	0
(2) $b=0.7$	0.0003%	0.22
Wage norm		
(3) $\overline{w}=w_{ss}(0.5)$	2.33%	4.11
(4) $\overline{w}=w_{ss}(0.7)$	1.65%	3.28

Note: Welfare results conditional on monetary policy rule $\mu_t=\mu_t^*$ where μ_t^* is defined in Eq. (36). Welfare distances are expressed in terms of λ, the fraction of the expected consumption stream in the reference economy that the household would be willing to give up to be as well off as in the alternative economy.

Figure 9: Table 5 from Ravenna and Walsh (2012a).

a substantial loss, amounting to 1.65% of steady-state consumption, relative to a policy of price-stability.

Why is there so little scope for countercyclical monetary policy? The answers turns out to depend critically on the wage setting process. When wages are Nash-bargained but set at a socially inefficient level, the optimal tax correcting for inefficient hiring is large in the steady state but displays little volatility over the business cycle. The low volatility of the optimal tax implies that there is little role for a cyclical policy to correct labor market inefficiencies. When wages are rigid, however, the optimal tax correcting for inefficient hiring is small in the steady state but very volatile over the business cycle. Monetary policy that attempts to reduce the inefficiency wedge in hiring – that is, attempts to correct for the employment distortion on the extensive margin – generates inefficient price dispersion *and* distorts the intensive hours margin of employment. Thus, the monetary authority faces a very unfavorable trade-off, and price stability does nearly as well as the optimal policy.

As with many other issues in macro, the behavior of wages turns out to be critical.

4.1 Are these results the final word?

Was Jim Bullard right in characterizing these results as "unpleasant implications for unemployment targeters"?

Before leaving you with the impression that Jim Bullard is correct and central banks should ignore labor market distortions, let me point out two modifications of the basic model that point it in the direction of greater realism and also seem to suggest monetary policy needs to pay close attention to labor markets. Both these modifications involve deviation from standard assumptions by introducing heterogeneity and limited access to financial markets.

Heterogeneity is necessary for incorporating a role for financial markets and limitations on market access designed to generate segmented financial markets are important for understanding the effects of such policies as quantitative easing. However, I want to stick to labor markets to argue that heterogeneity and limited access to financial markets are important along two dimensions – for understanding the dynamics of employment adjustment and for understanding the welfare costs of cyclical unemployment.

In Ravenna and Walsh (2012a), we introduce a very simply form of heterogeneity in terms of worker productivity. Imagine there are two types of workers who differ in average productivity. Firms can observe these differences among their existing workers, but they can only observe them in unemployed workers by interviewing a worker. We find that this modest addition of heterogeneity can have significant effects on macroeconomic dynamics. Specifically, we maintain the assuming of random matching as in the DMP model, but we think of these worker-firm meetings as job interviews. Suppose high-efficiency workers are very productive. They always receive a job offer when they are interviewed by a firm. After interviewing a low-efficiency worker, the firm assesses the worker's productivity and then makes a job offer only if the worker's productivity exceeds an endogenous threshold value. This mechanism implies the efficiency of the overall matching process depends on the composition of the unemployed between high and low efficiency workers.

Importantly, the hiring and firing threshold is endogenous to the model and varies over the business cycle. During a recession firms increase the threshold and screen out more job applicants. This reduces the share of unemployed low-efficiency workers who get job offers and increases the share of employed low-efficiency workers who get fired.

Consequently, low-efficiency workers are more vulnerable to business cycle fluctuations, which implies that the share of low-efficiency workers among all unemployed workers is countercylical. If the composition of the pool of unemployed workers shifted more heavily towards low-efficiency workers in a recession, firms have a reduced incentive to post job vacancies, slowing the subsequent recovery of employment. When a contractionary shock is combined with zero lower bound limits on the ability of monetary policy to respond, the recovery of employment can be significantly delayed. This is illustrated in figure 10.

This composition effects results in an externality. Starting from an efficient allocation, firms lay off more workers when the economy is hit by a contractionary shock than is efficient, even if the Hosios condition is satisfied. This additional distortion in the competitive equilibrium may justify larger deviations from price stability to prevent job loss.

Let me mention a second factor that may increase the importance of having monetary policy respond to fluctuations in unemployment. In standard models of labor market frictions, workers face the risk of experiencing unemployment, but they are assumed able to perfectly pool their consumption risk – in fact in some models, the unemployed are actually better off than the employed – they get the same consumption while enjoying more leisure. In fact, unemployed workers suffer declines in consumption. In work in progress with Wolfgang Lechthaler and Federico Ravenna, we are exploring the role that limitations on the ability or individuals to insure against unemployment related consumption volatility may have for the cost of business cycles and the design of optimal monetary policy.

5 Conclusions

Let me conclude with five points:

1. Economies are subject to numerous distortions. This means that strict inflation targeting – policy focused only on inflation – will never be optimal in theory.

2. But strict inflation targeting is close to optimal in many theoretical models – the class of models commonly used for monetary policy analysis imply inflation volatility is very costly, so relatively little weight should be put on other objectives.

3. Price stability could be close to optimal because inflation volatility is very costly,

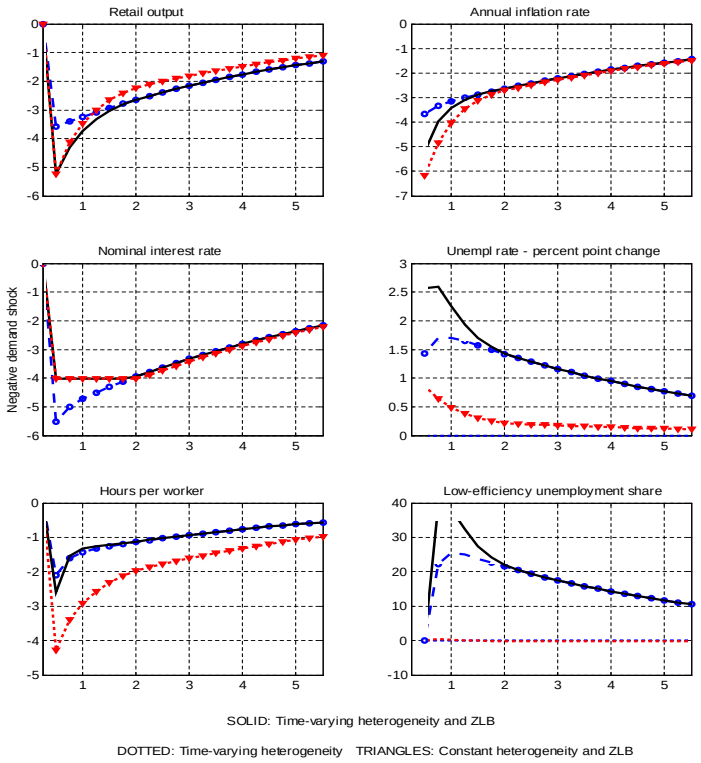

Figure 10: The Great Recession downturn and recovery. Impulse response to a negative demand shock and a discount rate shock leading to the zero lower bound. Comparison shows the time-varying workers heterogeneity economy with and without the zero lower bound, and the constant worker heterogeneity economy with the zero lower bound. Monetary policy set by Taylor rule responding to CPI inflation. AR(1) coefficient of demand shock $\rho = 0.95$. Horizontal axis in years

because fluctuations in real economic activity are relatively costless, or because central banks face a bad trade off in that large increases in inflation variability would be needed to stabilize real activity. I have focused on labor market distortions, and suggested the current generation of models imply the trade offs depend importantly on how wages are set.

4. But this isn't the final word and it may be more revealing about new Keynesian models than about the trade offs central banks face in practice. Heterogeneity and limited ability to insure against consumption risk associated with unemployment are likely to be important.

5. And regardless, while my focus was on how *flexible* inflation targeting central banks should be – none of these factors are likely to call into question the basic structure of inflation targeting. Maintaining low and stable inflation, much like ensuring a stable financial structure, is among the necessary conditions for achieving a successful macroeconomic performance. To close with Stan Fischer's opening quotation,

   > *flexible* inflation targeting is the best way of conducting monetary policy.
   > Fischer (2013)

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