

# Should we reject the natural rate hypothesis?

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## Abstract

50 years ago, Milton Friedman articulated the natural rate hypothesis. It was composed of two sub-hypotheses: First, the natural rate of unemployment is independent of monetary policy. Second, there is no long-run trade-off between the deviation of unemployment from the natural rate and inflation. Both propositions have been challenged. The paper reviews the arguments and the macro and micro evidence against each. It concludes that, in each case, the evidence is suggestive, but not conclusive. Policy makers should keep the natural rate hypothesis as their null hypothesis, but keep an open mind and put some weight on the alternatives.

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## 1. Introduction

Fifty years ago, Milton Friedman (1968) delivered his Presidential address “The Role of Monetary Policy at the December meetings of the American Economic Association, and articulated what became known as the “natural rate hypothesis.” It was a joint hypothesis, composed of two sub-hypotheses:

The first was that there was a natural rate of unemployment, independent of monetary policy. To quote Friedman (p. 8): “The ‘natural rate of unemployment [...] is the level that would be ground out by the Walrasian system of general equilibrium equations, provided there is imbedded in them the actual structural characteristics of the labor and commodity markets, including market imperfections, stochastic variability in demands and supplies, the cost of gathering information about job vacancies and labor availabilities, the costs of mobility, and so on.”

The second was that monetary policy could not sustain unemployment below the natural rate without leading to higher and higher inflation, a proposition that became known as the “accelerationist hypothesis”. Again, to quote Friedman (p. 11): “There is always a temporary trade-off between inflation and unemployment; there is no permanent trade-off. The temporary trade-off comes not from inflation per se, but from unanticipated inflation, which generally means, from a rising rate of inflation. The widespread belief that there is a permanent trade-off is a sophisticated version of the confusion between “high” and “rising” that we all recognize in simpler forms. A rising rate of inflation may reduce unemployment, a high rate will not.”

For the sake of clarity, in the rest of the paper, I shall refer to the joint hypothesis as the “natural rate hypothesis,” and the two separate sub-hypotheses as the “independence hypothesis” and the “accelerationist hypothesis.” Note that they are separate hypotheses. The implications will be different if either one fails separately, or if both fail.

Notice also that, while Friedman referred to unemployment, he clearly had in mind output more generally. The natural rate hypothesis can be recast in terms of output: that is, potential output is independent of monetary policy, and there cannot be sustained deviations of output above potential without increasing inflation. Thus, in this paper, I shall look at the evidence for both unemployment and for output.

Together, the two hypotheses have very strong implications. If inflation is to remain stable, periods during which output exceeds potential output must be offset by periods during which output is below potential; in other words, booms must be fully offset by slumps. Monetary policy cannot do more, and indeed should not try to do more, than smooth fluctuations around the independent path of potential output.

While the natural rate hypothesis was controversial at the time, it quickly became widely accepted, and has been the dominant paradigm in macroeconomics ever since. It is embodied in the thinking and the models used by central banks, and it is the basis of the inflation targeting framework used by most central banks today.

There were always grumblings about the extent to which this hypothesis fully characterized the world, about whether potential output was really independent of monetary policy, and about whether there really was no long-run trade-off between inflation and output. In the 1980s in particular, the natural rate of unemployment in Europe appeared to increase following every recession, and the idea that high actual unemployment might cause an increase in the natural rate became more popular. Hysteresis, which refers to the theory that changes in the natural rate of unemployment can be path-dependent (an idea which could be traced at least to Phelps (1972)), Larry Summers and I argued, could be the explanation for this increase (Blanchard and Summers (1986)). But after a while, as the so-called Great Moder-

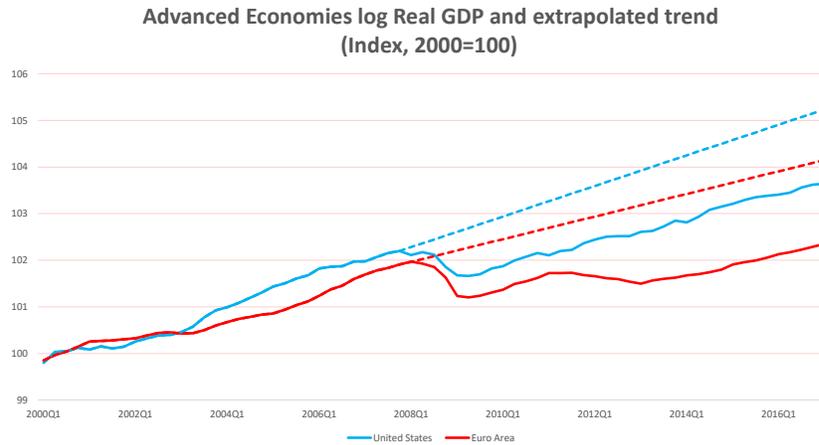


Figure 1:

ation took place from the mid-1980s up to about 2007, research on hysteresis largely disappeared.

Recently however, grumblings have increased (for example, Coeuré 2017). This is for two reasons, both linked to the Great Financial Crisis and the accompanying recession. First, the level of output appears to have permanently been affected by the crisis and its associated recession. This is shown in Figure 1, which plots the evolution of log GDP since 2000 for both the United States and in the European Union, both normalized to equal 100 in 2000. In both cases, it appears as if the output path has shifted down and is now increasing along a lower trend line than before the crisis (The two trends are based on the average quarterly growth rates over 2000 to 2007). This pattern led Summers (2014) to state: “Any reasonable reader of the data has to recognize that this financial crisis has confirmed the doctrine of hysteresis more strongly than anyone could have anticipated.”

Second, in contrast to the accelerationist hypothesis, very high unemployment did not lead to lower and lower inflation, but rather just to ongoing low inflation. In both the United States and the European Union, except for the large decline in inflation in 2009, there does not appear to be any relation between the unemployment rate and the change in inflation in the last two decades. We appear to have returned instead to a relation between the unemployment rate and the rate of inflation, rather than the rate of change of inflation.

Neither fact is by itself a clear rejection of the natural rate hypothesis. It could be that the decrease in output relative to trend reflects a decrease in the underlying trend, or strong and persistent effects of the financial crisis on the supply side of the economy, rather than adverse, hysteretic effects of lower output perpetuating itself. If so, the outcome of the Great Financial Crisis might carry no implication for the effects of monetary policy shocks. Moreover, the Lucas critique of the Phillips curve has told us that expectations matter, and the lack of apparent relation between the unemployment rate and changes in the rate of inflation does not imply that there is an exploitable trade-off. Yet, these facts, and the 50th anniversary of Friedman's (1968) AEA presidential address, suggest that it is a good time to review the available evidence.

The paper assesses what we know and do not know. I begin by revisiting the logic of the independence hypothesis and looking at the macroeconomic and microeconomic evidence. I then turn to the evidence on the accelerationist hypothesis. Finally, I consider potential policy implications and concludes. To anticipate the answer to the question in the title: I see the macroeconomic and the microeconomic evidence as suggestive but not conclusive evidence against the natural rate hypothesis. Policy makers should keep the natural rate hypothesis as their null hypothesis, but also keep an open mind and put some weight on the alternatives.

## 2. On the independence hypothesis: Persistence versus permanence

The first step must be to recast the discussion. That discussion has largely taken the form of a choice between what appear to be two sharply different classes of models, “standard models” where monetary policy does not affect potential output, and “hysteresis models”, where monetary policy has permanent effects on potential output. The seeming dichotomy between these models is misleading. Even in the most standard models, monetary policy is likely to affect potential output for some time. And in most hysteresis models, the effects of monetary policy are likely to be persistent, but not necessarily permanent. The issue is thus about the size and persistence of the effects of monetary policy on potential output, not their existence nor their permanence. Let me spell out these points more precisely.

The discussion must start with a definition of “potential output”. I define potential output as the level of output which would obtain if, given actual history, nominal rigidities were lifted from now on. I define the natural rate of unemployment in the same way. Potential output is sometimes defined as the level of output which would obtain if nominal rigidities had always been absent, both in the past and in the future. Potential output, defined this way, would be tautologically independent of monetary policy. But this is not a useful definition as what matters is what output can be today, as opposed to what it could have been in some hypothetical world.

Now take any “standard model” in which, because of nominal rigidities, monetary policy does affect output for some time. Suppose that tighter monetary policy triggers a recession and a decline in output. This decline in output is likely to come with a decline in investment. Thus as output declines, the capital stock is lower for some time, and by implication, so is po-

tential output. The same may be true of other factors of production. For example, if matching frictions prevent employment to quickly return to its pre-recession level, then both factors of production are quasi-fixed. Thus, potential output, the output that would prevail if all nominal rigidities were suddenly lifted, may be fairly close to actual output, and be affected for some time by monetary policy.

Figure 2 shows for example the behavior of actual and potential output, as well as the behavior of the actual and the natural unemployment rate, in a model by Christiano et al (2016) that allows, in addition to capital accumulation, for matching frictions in the labor market, frictions which prevent unemployment from quickly returning to its long run natural rate. After an adverse monetary policy shock, potential output follows a path similar in shape to that of actual output, but with an amplitude of about half. When actual output reaches its trough of -0.12%, potential output also reaches its trough, at about -0.07%. Fifteen quarters out, potential output is still -0.05% lower than before the shock. In other words, even if all nominal rigidities were removed at that point, output would still be -0.05% lower than absent the monetary policy shock. A similar pattern holds for the natural and actual unemployment rates.<sup>1</sup>

Now consider the channels which have been emphasized in “hysteresis models”. Some of these channels may indeed imply a permanent effect of monetary policy. For example, if a recession leads to lower research and development for some time, and if total factor productivity depends in part on the accumulation of past research and development efforts, then total factor productivity may indeed be permanently be lower than it would have

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<sup>1</sup>The magnitudes are small, for two reasons: The monetary shock is small, and the effects of monetary policy on actual output in the model are small as well. These aspects are however not relevant to the point made in the text. I am thankful to Mathias Trabandt for performing these simulations. The original paper does not show the path of potential output or the path of the natural rate.

### Impulse Responses to a Contractionary Monetary Policy Shock (50 Annual Basis Points)

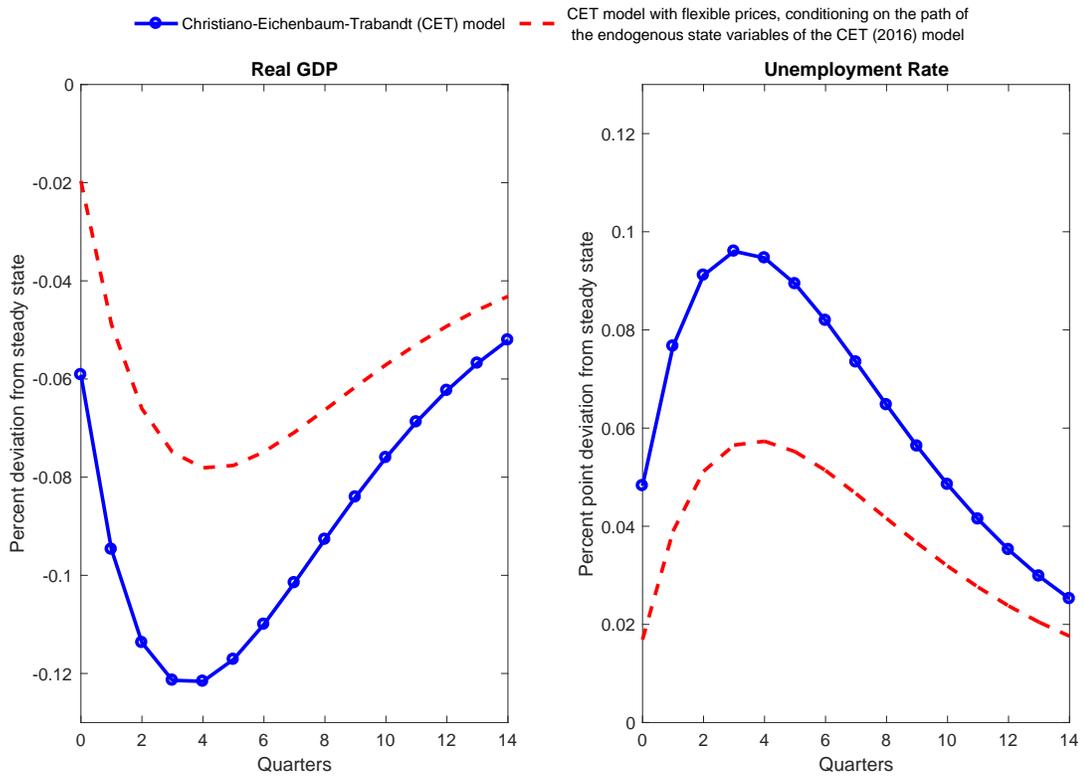


Figure 2:

been absent the recession. But some of the channels which have been studied suggest persistent effects, rather than permanent ones. For example, if some of the long-term unemployed become unemployable, the effect will eventually disappear as these workers reach the age at which they would have stopped working anyway.

In short, all relevant models imply an effect of monetary policy on potential output and on the natural rate lasting for some time.<sup>2</sup> The goal of the empirical work must be, at the macro level, to assess the degree of persistence of the effects, and, at the micro level, to identify and examine specific channels of persistence.

### **3. Macro evidence on the independence hypothesis: Monetary policy, recessions, unemployment, and output**

The independence hypothesis is a hypothesis about the effects of monetary policy shocks on potential output. Thus, the first issue is how to identify monetary policy shocks. One approach would be to use a vector autoregression (VAR) methodology with identified monetary policy shocks, trace their dynamic effects on output or unemployment, and assume that, as the horizon increases, these increasingly reflect their effects on potential output and the natural unemployment rate. Given the well-known difficulties of identifying those monetary shocks, and the statistical uncertainty associated with

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<sup>2</sup>Put more formally, all realistic models will have a number of state variables, some of them affecting potential output. Thus, even if all nominal rigidities were suddenly removed during a recession, potential output would be different from what it would have been absent the shock. One can think of hysteresis models as models focusing on those mechanisms potentially leading to long-lasting, or, in the limit, permanent effects on some of these state variables, and by implication on output and unemployment.

impulse responses, this approach does not look very promising. A meta-study of VAR studies by De Grauwe and Costa Storti (2004) finds the mean effect of a 1 percent interest rate shock on output to be -0.15 percent after five years. However, the distribution of estimates however has a standard deviation of 0.27 percent, so a zero effect is not far from the middle of the distribution.

A more promising approach is to look at recessions associated with intentional disinflations. The shocks are clearly monetary shocks; they are large; and they are plausibly largely exogenous, reflecting more a change in policy rather than the response of policy to other shocks. This approach which has been pursued by a number of authors, in particular Laurence Ball in a number of contributions (for example Ball (2009), (2014)). It is the approach I shall follow here, building on Blanchard, Cerutti, Summers (2015). Details are given in the appendix, but the general approach is as follows.

I look at 22 advanced economies over the last 50 years, and, using a simple algorithm looking at peaks and troughs (based on Harding Pagan 2002), I identify 122 recessions. I then classify recessions according to their proximate cause – such as intentional disinflations, oil price increases, financial crises, and so on – and focus first on the 22 recessions associated with intentional disinflations. (I shall return to whether and how one can use information from the other recessions later.) I then compute the average unemployment rate over various time intervals both pre-recession and post-recession, and take the difference between the post- and the pre-recession periods. As discussed in Blanchard et al, there is a trade-off in looking at averages over different time intervals. The longer the length of the post-recession period for example, the more the average can tell us about persistence, but the more the average is affected by other shocks than the disinflation.

The results are shown in Figure 3. The different bars correspond to the different time intervals used to compute pre-recession and post-recession

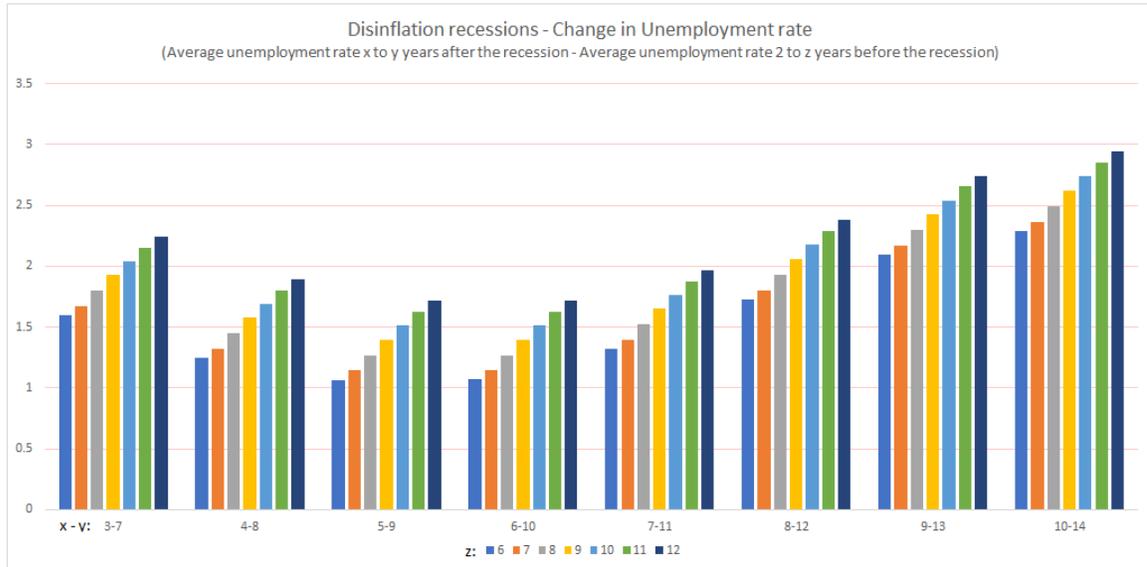


Figure 3:

averages. Each set of bars corresponds to a given post-recession average, but different pre-recession averages. Thus, the first set gives results for the post-recession average computed over 3 to 7 years after the end of the recession, and pre-recession averages computed over 2 to 6 years before the beginning of the recession for the first bar, 2 to 7 years for the second bar and so on (In all cases, I leave out the 2 years before the recession in case there was a cyclical boom). The second set of bars gives the results for the post-recession average computed over 4 to 8 years, and so on. The visual impression is fairly clear, with, on average, large and very persistent increases in unemployment after those recessions, with differences ranging from 1 to 3 percent depending on the combination. As shown in the appendix, the results are very similar if the prime-age male unemployment rate is used instead of the overall unemployment rate.

Three caveats are in order. First, the majority of recessions took place around the same time in the early 1980s, so the results may, to some extent,

reflect common time effects. Second, the averages hide some heterogeneity. For the combination of time intervals which gives the smallest increase, only 15 out of the 22 recessions are associated with increased unemployment; for the combination of time intervals which gives the largest increase, the number increases to 19. Third, the figure shows the changes in the actual unemployment rate, not necessarily the changes in the natural unemployment rate. While it is plausible that the two may converge, as we look at longer and longer intervals pre- and post-recession, one may worry that this is not the case. This is where, in principle, the behavior of inflation can offer more information. During the 1980s and early 1990s when these recessions took place, the evidence (reviewed later in this paper) is that the accelerationist Phillips curve gave a good characterization of the data, so we can look at the change in inflation as a signal of the distance between actual and natural unemployment rates. The average annual change in the inflation rate over the various pre-recession time intervals ranges from 0.04 to 0.12 percent. The average annual change over the various post-recession intervals ranges from -0.40 to 0.12 percent. These are small numbers and suggest that the change in the actual unemployment rate can be interpreted mostly as a change in the natural rate.

While Friedman's (1968) natural rate hypothesis focused on unemployment, along with much of the research on hysteresis, his arguments clearly were meant to apply to output as well. Thus I use a similar methodology to look at whether output returns to its pre-recession level after recessions triggered by intentional disinflations. More specifically, I estimate a log-linear trend for output over some pre-recession time interval, extrapolate it post-recession and compute the resulting output gap as the average difference between actual and extrapolated output over some post-recession time interval. One delicate empirical issue is that output growth has declined in

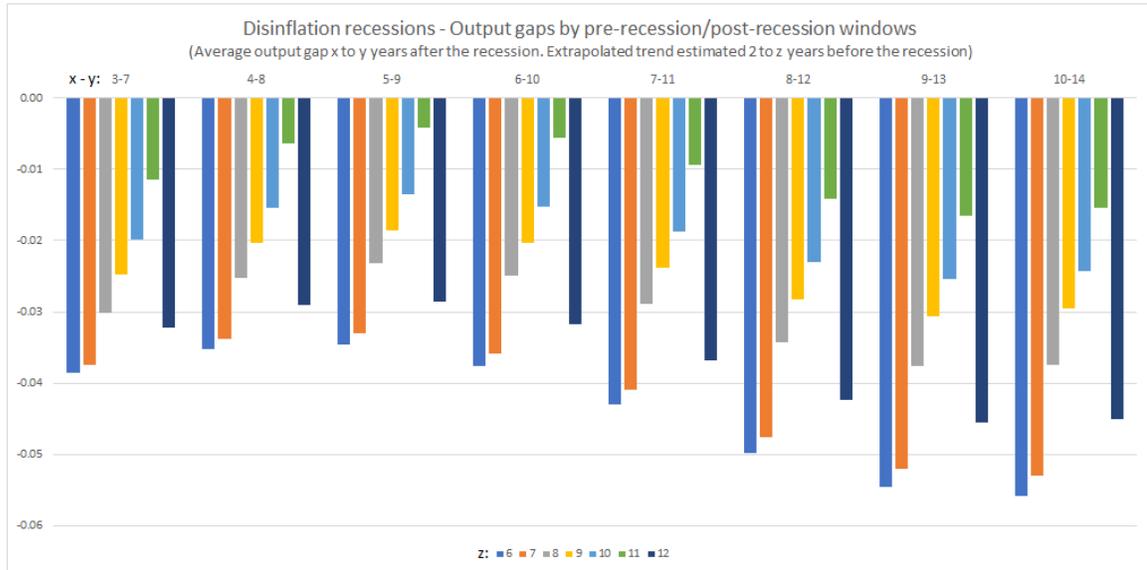


Figure 4:

most advanced countries over the sample period; thus the extrapolation of a log-linear trend over any pre-recession time interval will tend to overpredict post-recession output, and lead to an estimated negative output gap, even in the absence of any hysteresis. Thus, I correct for this decrease in the underlying trend when extrapolating the pre-recession trend. (How this is done is described in the appendix).

The results are shown in Figure 4 for the various pre-recession and post-recession time intervals. The average output gaps are typically negative, but the results are less consistent than for unemployment, and are more sensitive to the time intervals used to estimate the pre-recession gap. Also, the averages hide substantial heterogeneity. While the average gaps are negative, the proportion of negative output gaps over all time intervals is only 55 percent, which offers only weak support for the hysteresis hypothesis.

An obvious question is how to reconcile the unemployment and the output results. To make progress, I decompose the log output gap between a

log employment gap and a log productivity gap, using for each the same methodology as for log output, so the sum of the two gaps is equal to the output gap. The results (reported in the appendix) lead to three main conclusions: The employment gaps are consistently negative, largely insensitive to the choice of time interval, and close to the unemployment gaps reported above. The productivity gaps are, perhaps surprisingly, often positive, and are sensitive to the choice of pre-recession time interval. A tentative explanation for this sensitivity is, again, that most disinflation episodes took place around the same time, and one unusual pre-recession year can affect the results quite strongly.

Can the evidence from the other 100 recessions, those not caused by explicit disinflation efforts, be used to learn about persistent effects of monetary policy shocks? The answer is yes, but only if one is willing to make further assumptions. If, for example, one assumes that long run labor supply is inelastic – be it individual labor supply or the relation between the wage and unemployment derived from matching-bargaining models – then if one finds persistent effects of non-monetary shocks on unemployment, this suggests the presence of channels relevant for monetary shocks also.

For an example, consider the case of recessions brought on by oil price increases. To the extent that such shocks are persistent, they imply a decrease in real consumption wages relative to trend; but if long run labor supply is inelastic, this should eventually have no effect on unemployment. What about output? Theory suggests that, while oil shocks should not have a direct effect on productivity (as productivity is the ratio of value added—which, if correctly measured, is unaffected—to employment), they may have an indirect effect on productivity growth. For example, to the extent that technological progress is directed by shifts in economic incentives, a change in oil prices may well lead to a temporary slowdown in productivity growth

as firms have to explore technologies corresponding to the new configuration of relative prices. If so, the productivity level may be lower in the long run than it would have been, absent the increase in the oil price.

Or take the case of recessions brought on by financial crises. By the same argument, if long-run labor supply is inelastic, one would not expect them to lead to a permanent increase in unemployment. But to the extent that they have persistent effects on financial intermediation, be it because of changes in behavior or changes in regulation, they may well also have persistent adverse effects on productivity. For example, banks may become more risk averse, financing projects with lower risk but also, by implication, a lower expected rate of return.

This suggests focusing on unemployment rates, in the same way as I did earlier. The method of classification and the results are described in the appendix, and can be summarized as follows. Looking at the 33 oil-related recessions (all of them taking place from the mid-1970s to the early 1980s) or the 19 recessions brought on by financial crises (12 of them taking place in the late 2000s), the evidence in both cases is of large, highly persistent, increases in unemployment, consistent across pre-recession and post-recession time intervals. The same caveats apply however as for disinflation triggered recessions before: In particular, the oil price related recessions all happen around the two episodes of large oil price increases in the mid and late 1970s, and thus the results could reflect common time effects. The same is true for the majority of financial crisis related recessions. Nevertheless, the fact that most recessions are associated with a positive unemployment gap is quite striking.

For the reasons discussed above, results for output cannot be used to test the independence hypothesis, as the effects on output may well reflect the persistent effects of the specific shocks, and thus would not be present for monetary shocks. They are still worth reporting briefly, with more details

given in the appendix. Output gaps associated with oil price related recessions are negative, large, and consistent across time intervals. In contrast to the disinflation related recessions, they reflect mostly productivity gaps. Output gaps associated with financial crisis related recessions are smaller, but also consistent across time intervals. They reflect mostly employment gaps rather than productivity gaps. The current case of the United States stands as an exception. As shown in Figure 1, output remains far below its pre-crisis trend, but the unemployment rate is back to its pre-crisis level. It also shows the limits of the method I have used: There is fairly wide agreement that, at least in the US, the productivity growth slowdown started in fact a few years before the crisis (for example Fernald 2014). If so, the methodology I have used attributes this decrease in productivity (and by implication the decrease in output) incorrectly to the recession.

To summarize: I read the macroeconomic evidence as suggestive of persistent effects of monetary policy on the natural unemployment rate and potential output. But the evidence is not overwhelming. Moreover, looking just at recessions has its limits: It cannot answer whether there are symmetrical effects of booms and recessions, which is a crucial issue for the design of policy. In this context, a closer look at potential channels of persistence and more microeconomic evidence may help to assess potential nonlinearities or asymmetries between recessions and booms.

## **4. Micro evidence on the independence hypothesis: Channels for high persistence**

Persistent effects of monetary shocks on output may come either from employment or from productivity.

Starting with employment, the initial mechanism emphasized by Blan-

chard and Summers (1986) focused on wage formation. In its simplest form, the argument was straightforward. Suppose that employed workers (or the unions representing them) set wages, and did not care about the unemployed. Unemployment would then play no role in wage setting, and would follow a random walk, with no tendency to return to any particular value. After an adverse shock and a recession, it would remain higher. After a boom, it would remain lower. (A modern treatment along these lines, in a micro-founded New-Keynesian model with insiders and outsiders, is given by Gali (2016), and shows the long term effects of monetary shocks.)

The argument correctly emphasized the power of insiders in wage formation, but it was too strong. Even if the employed workers do not care about the unemployed, they should care about their own situation, were they to become unemployed. The higher the unemployment rate, the more willing they should be to accept a lower wage. Also, wages are not set unilaterally by workers (or by unions), but rather unilaterally by firms or by a process of bargaining between firms and workers. In this case, wages will reflect the option of firms to hire the unemployed. The higher the unemployment rate, the larger the pool of potential hires, the stronger the firms will be in bargaining. For both reasons, even with selfish insiders, unemployment will matter.

One of the major research developments of the 1980s and 1990s was the development of a framework capturing these aspects, based on matching and bargaining, with the basic framework now known as the DMP model, for the work by Diamond, Mortensen, and Pissarides. It gives a better way to think about the effect of unemployment on wages, and how the strength of the effect depends on the structure of the labor market and on labor market

institutions.<sup>3</sup>

For example, consider the potential role of employment protection. The higher the firing cost, the smaller the risk for an employed worker to become unemployed (leaving the risk of bankruptcy and firm closure aside), the smaller the effect of unemployment on the wage. The higher the hiring cost, the smaller the risk for an employed worker of being replaced by an unemployed worker, and thus the smaller the effect of unemployment on the wage. In the limit, with high hiring and firing costs, unemployment may indeed have little effect on the wage, and lead to highly persistent effects of monetary policy shocks on the natural rate of unemployment. This analytical framework suggests that high persistence is more likely in countries with high employment protection, more generous unemployment benefits, stronger unions. An in-depth analysis, both theoretical and empirical, of the effect of such cross-country differences on the persistence of shocks on the natural rate and potential output remains however largely to be done.<sup>4</sup>

A subsequent explanation focused on the effect of high unemployment on labor market institutions, and by implication, on the natural unemployment rate. Indeed, the high unemployment rate triggered by the two oil shocks of the 1970s led to an increase in employment protection and in the generosity of unemployment benefits in most European countries (Blanchard and Wolfers 2000). While these measures were taken to limit the initial increase in unemployment and make it less painful, it is likely that they increased the natural rate. However, this explanation is specific to those recessions, and does not provide for a general channel of high persistence.

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<sup>3</sup>Indeed, the model by Christiano et al. used to generate Figure 2 above incorporates a formalization of the labor market reflecting matching and bargaining. Unemployment is a state variable, leading to a persistent, but not permanent, effect of monetary policy shocks on the natural rate.

<sup>4</sup>In Blanchard and Wolfers (2000), we took a first pass at it, by looking at the interaction of shocks and institutions in determining effects of shocks on unemployment. But much remains to be done.

Yet another channel, and at this point probably the most popular one among researchers, has focused on the effect of high unemployment on the morale, skills, and employability of the long-term unemployed.

It has long been known that the probability of becoming employed decreases with the duration of unemployment. For example, based on data from the Current Population Survey for 1994-2016, the average probability of becoming employed in the following month decreases from 28 percent if unemployed for less than 27 weeks to 14 percent if unemployed for more than 27 weeks. At the end of 2009, when the U.S. unemployment rate reached a high of 10 percent, the probability of reemployment in the following month was 18 percent if unemployed for less than 27 weeks, but only 10 percent if unemployed for more than 27 weeks.

While these comparisons are suggestive, they do not prove however that the long-term unemployed become less employable. It may be instead that the workers who are the most employable are hired first, and thus the longer the duration, the less employable is the remaining pool. However, two recent papers suggest that hysteresis – in this case, the effect of unemployment duration on employability – might be at work. First, Krueger et al (2014) use the time structure of the Current Population Survey (in the sample for four months, out for eight months, back in for four months) to look at the more relevant longer transition probabilities, and confirm the message from monthly probabilities. On average, for the period 1994 to 2012, the average probability of being employed 15 months later was 55 percent for those unemployed for less than 27 weeks, but only 40 percent for those unemployed for more than 27 weeks. Second, Abraham et al. (2016) link data from the Current Population Survey and the unemployment benefit register, and look at the employment history of the long-term unemployed. They find that the probability of being employed eight quarters earlier is roughly similar for the short-term and the long-term unemployed. If we think of this probability as

a proxy for workers' characteristics, this suggests that the long-term unemployed have roughly the same characteristics as the short-term unemployed, and that their lower probability of becoming employed is primarily caused by the duration of their unemployment rather than by their unobservable characteristics.

One more step is needed to prove the case for hysteresis. It could be that the decreased probability reflects mostly the fact that firms, when they have the choice, often give priority in hiring to those who have been unemployed the least time (a decision rule that Diamond and I (1994) have called "ranking".) If this is the case, so long as unemployment is high and firms get many applicants, the long-term unemployed will be less likely to get a job. But as unemployment decreases and the number of job applicants declines, the long term unemployed will be more often at the front of the line, and see their relative probability of employment increase. What might appear like hysteresis in the short-term will fade away over time. While this hypothesis can be formally tested by looking at relative probabilities of employment as a function of overall unemployment, I have not seen it done. The regressions of transition probabilities for short-term and long-term unemployed on the overall unemployment rate by Krueger et al (see their Table 2) indicate that the relative probabilities do not vary much with the state of the labor market. If so, the data can be seen as providing some evidence for hysteresis.

To the extent that decreased employability is a source of hysteresis, one can then explore non-linearities and asymmetry between recessions and booms. As shown in Figure 5, leaving aside short-run dynamics (which lead to countercyclical loops), the ratio of long-term unemployment to total unemployment is strongly increasing in unemployment. Put another way, the long term unemployment rate is convex in the unemployment rate. If we think of the number of workers who become unemployable as roughly proportional to the number of long-term unemployed, this implies that hystere-

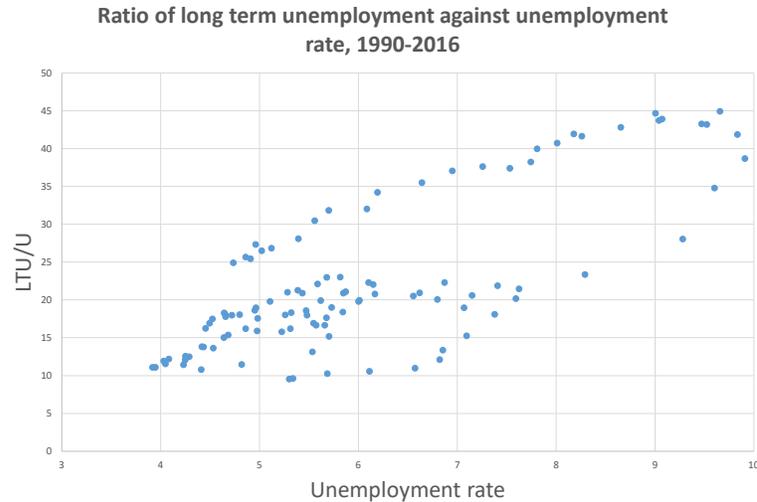


Figure 5:

sis is asymmetric, being more relevant in recessions than in booms.

If some workers become less employable or become discouraged, then the unemployment statistics will fail to capture hysteresis effects fully, because many of these workers will drop out of the labor force. Indeed, a recent question has been whether, in the United States, the high unemployment due to the financial crisis has contributed to the drop in labor market participation from 66 percent in 2007 to 63 percent at the end of 2016. The question is difficult to answer, because there has been a downward trend in the labor force participation rate since about 2000, due to the demography of an aging population. Aaronson et al (2014) conclude that much if not most of the recent evolution of participation can be explained by the trend, rather than by the crisis. . A careful study by Yagan (2017) however reaches a different conclusion. Yagan looks at the employment status of individuals in 2015 as a function of the increase in the unemployment rate in their local market

from 2007 to 2009, controlling for individual characteristics, and concludes that a 1% increase in the local unemployment rate in 2007-2009 led to a 0.4% decrease in the probability of being employed in 2015. His estimates imply that of the 7.2% decrease in the employment rate from 2007 to 2015 of the birth cohorts aged 30-49 in 2007, 4.8% can be attributed to demographics, and 1.8% can be explained by the hysteretic effect of high unemployment during the Great recession.

A complementary approach is to look at the evidence on disability insurance. Evidence on both applications and acceptances is useful: Cyclical variations in applications for disability insurance can give information about the loss of morale among workers as a result of the state of the labor market. And, once people are accepted and start receiving disability payments, terminations are rare, except for infrequent program clampdowns (Autor and Duggan 2006). This implies that, to the extent that recessions lead to increases in disability insurance rolls, they have a hysteretic effect on the labor force.

Figure 6 plots the ratio of the flow of applications to the 25-64 year-old population against the unemployment rate for the period 1965 to 2014. The relation is strong, statistically and economically significant. An increase in the unemployment rate from say 5 to 10 percent increases the disability ratio by 0.3 percent (or about 600,000 workers). If one takes the sum of annual unemployment rates in excess of 5 percent since 2008, which is roughly equal to 20 percent, this implies an additional 2.4 million more disability applications, and given an acceptance rate of about 35 percent, a permanent reduction in the labor force of about 800,000 workers. This channel may be seen as a strong piece of micro evidence in favor of hysteresis, relevant not just for disability insurance, but for the effect of unemployment on labor supply more generally. (In contrast to the previous graph however, there is no ev-

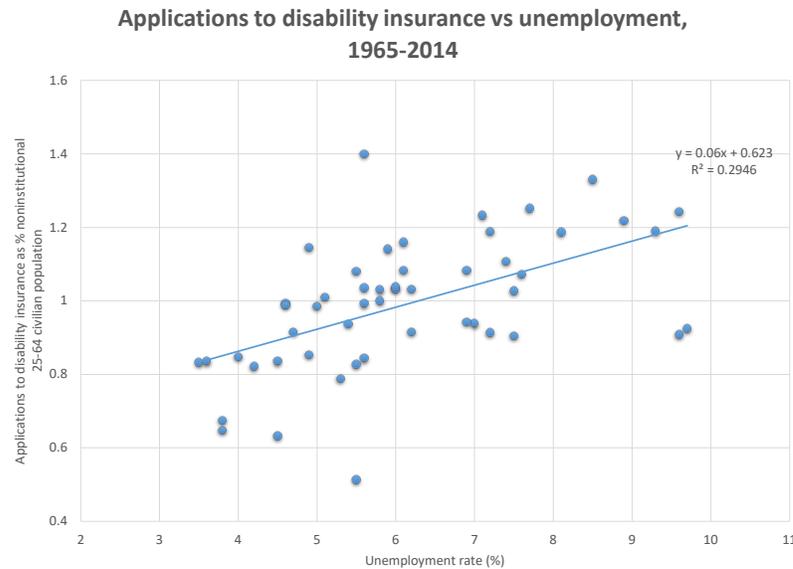


Figure 6:

idence of a convex relation between applications and unemployment, thus no evidence of asymmetry between the effects of high and low unemployment.)

The macroeconomic evidence given earlier, suggested that, at least for disinflation-related recessions, the main channel of persistence was through employment rather than productivity. Nevertheless, it is useful to briefly explore this potential channel as well.

I discussed earlier the role of lower capital accumulation in leading, during the recession, to a decrease in labor productivity given total factor productivity. Rough computations suggest however that the decline in the capital stock during a typical recession, and by implication the effect on labor productivity given total factor productivity, are small. Theory suggests however that recessions could have a permanent effect on total factor produc-

tivity itself and, by implication, on labor productivity. If we think, somewhat simplistically, of total factor productivity as being determined in part by the sum of past spending on research and development, then lower research and development during a recession will lead to permanent lower total factor productivity (and a boom will do the reverse). However, the empirical evidence suggests again limited effects: A regression of the rate of change of research and development spending on the rate of change of GDP for the period 1960-2013 for the United States delivers a low  $R^2$  and a coefficient of about 1 (the regression is given in the appendix). This implies that a 1 percent decrease in GDP is associated with a decrease in research and development spending of 1 percent of itself, a small effect.

Another potential way in which recessions may affect total factor productivity is through their effect on the speed of adoption of inventions. Anzaotegui et al. (2016) look at the effects of (detrended) GDP per person on the speed of adoption of 26 technologies in the United States and the United Kingdom over the period 1947 to 2003. They find that low activity indeed has a negative effect on the speed of adoption. To the extent however that full adoption still eventually takes place, this suggests only a temporary slowdown in productivity growth – persistence rather than permanence of the effects of recessions.

Yet another channel discussed in the literature is the effect of recessions on reallocation, and in turn on productivity growth. The sign of the effect is a priori ambiguous. Recessions may force low productivity firms to close sooner, leading to more creative destruction and an increase in productivity. Alternatively, if the bankruptcy process is inefficient, it may instead force some high productivity firms with high debt to close, leading to a decrease in productivity (for example, see Caballero Hammour (1994).) Looking at past U.S. recessions, Foster et al. (2014) estimate that the effect has been

generally positive and surprisingly large. Other things equal, and with the exception of the recession associated with the financial crisis, the reallocation due to recessions has typically led to increases in productivity growth of 0.4 to 0.8 percent depending on the depth of the recession (a result which fits the finding of often positive productivity gaps in disinflation-induced recessions in the previous section).

To summarize: Of the microeconomic channels potentially behind high persistence, the most persuasive one appears to be that high unemployment leads some workers to be less employable or to give up on looking for jobs, increasing unemployment or reducing the labor force, and by implication, leading to a persistent effect on potential output.

## 5. The accelerationist hypothesis

The story of the changing Phillips curve – the relation between inflation and unemployment – has been told many times. Soon after Friedman’s (1968) presidential address, and just as he had predicted, the trade-off between the unemployment rate and the inflation rate which had characterized the 1960s started to weaken, replaced in time by the “accelerationist Phillips curve”, a relation between the unemployment rate and the change in the inflation rate. Put another way, the coefficient on lagged inflation in the Phillips curve steadily increased from a value close to 0 to a value close to 1.

This shift was documented in real time during the 1970s. For example, Perry (1970) estimated the coefficient on lagged inflation to be 0.34, while Perry (1978) estimated the same coefficient as 1.0. Starting in the 2000s however, the coefficient has sharply declined, and appears now to be again close to zero. This is shown in Figure 7, which gives the evolution of the coefficient on lagged inflation in a simple specification regressing CPI inflation on a constant term, itself lagged and the unemployment rate, using annual data

since 1948, and backward-looking rolling samples of 15 years. It shows the increase in the coefficient early on, the long period of stability around 1, and the sharp recent decline. The coefficient today is not significantly different from zero.

A small detour: There is another dimension of change of the Phillips curve which is not directly relevant to the issue at hand, but is much discussed and must be mentioned. Since the mid 1990s, the coefficient measuring the effect of unemployment on inflation has become smaller and less precisely estimated over time (see for example Blanchard et al. 2015, and Miles et al 2017). The origin of this decrease remains largely mysterious. This smaller and imprecise estimate makes it hard to pin down what the natural rate, and raises additional challenges for macroeconomic policy. Some researchers have argued that unemployment no longer has an effect on inflation, at least over some unemployment and inflation range. If it were true, this would have dramatic implications for macroeconomic policy (see for example Farmer 2013), or Dupraz et al (2017) for the implications of strict downward nominal wage rigidity). I find it difficult to believe that a tighter labor market does not lead to more upward pressure on real wages, and in turn, given expected inflation, upward pressure on nominal wage inflation. Indeed, I read the evidence as suggesting that the effect of unemployment on wage determination and in turn on wage inflation, while smaller, remains positive.

Returning to the decrease in the coefficient on past inflation, there can be little doubt that is primarily a change in expectation formation: more specifically, that those setting prices and wages now react less to movements in past inflation. However, as the Lucas critique has made clear, even a zero coefficient does not imply that there is an exploitable trade-off between unemployment and inflation. Thus, the question is what hides behind this change

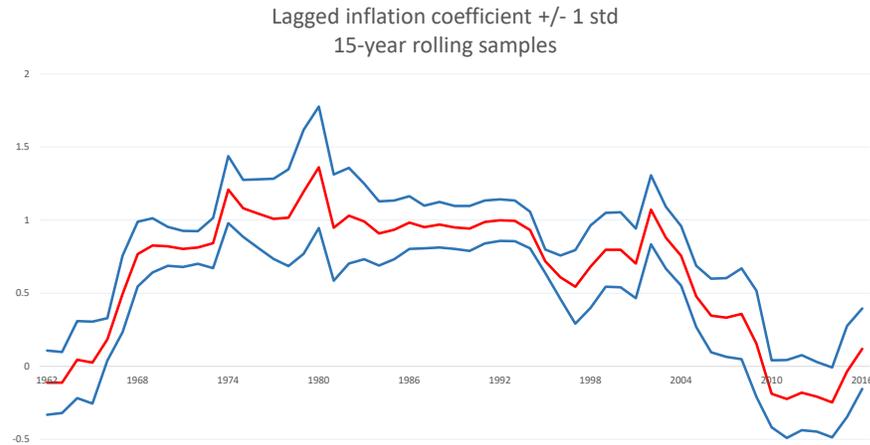


Figure 7:

in expectations.

I can think of two explanations. First, more stable inflation expectations may arise from increased credibility of monetary policy. In turn, monetary policy may be more credible because of the adoption of inflation targeting, a more explicit target for inflation, and the decrease in the standard deviation of inflation. Second, the experience of low and stable inflation may mean that it is no longer salient, and movements in inflation are ignored by wage and price setters. To quote Alan Greenspan (2001): “Price stability is best thought of as an environment in which inflation is so low and stable over time that it does not materially enter into the decisions of households and firms.”

Which of these explanations is more relevant has important implications for the natural rate hypothesis. Under the first explanation, any attempt by the central bank to decrease unemployment below the natural rate and, in

doing so, increase core inflation will decrease credibility and lead to an adjustment of expectations. Under the second, the central bank may be able to decrease unemployment and increase inflation without affecting expectations, so long as inflation remains low enough not to become salient.

How can one tell which of the hypotheses is more relevant? If credibility of the inflation target is the underlying explanation, then inflation expectations should respond more to core inflation, and less to deviations of headline inflation from core. If instead, decreased salience is the reason, one should find that inflation expectations respond little to core, but respond to deviations of headline from core, coming for example from sharp, and thus more salient, changes in gas prices.

Table 1: Regressions of professional and consumers' forecasts of inflation

	1981-3 to 1995-4		1996-1 to 2016-1		
	spf	michigan	spf	michigan	
core	0.498*** [0.038]	0.375*** [0.061]	0.547*** [0.052]	-0.111 [0.125]	
headline minus core	0.125 [0.099]	0.288*** [0.093]	0.077** [0.029]	0.231*** [0.060]	Robust
constant	2.024*** [0.174]	1.873*** [0.267]	1.098*** [0.103]	3.134*** [0.244]	
Observations	58	58	83	83	
R-squared	0.75	0.66	0.60	0.19	

standard errors in brackets. \*\*\* :  $p < 0.01$ , \*\* :  $p < 0.05$ , \* :  $p < 0.1$

Given this motivation, Table 1 shows the results of regressions of inflation expectations on core and headline inflation. It looks at two measures of inflation expectations: the forecast of one-year ahead inflation as reported by the Survey of Professional Forecasters (columns 1 and 3), and the forecast constructed from the Michigan survey of consumers (columns 2 and 4).<sup>5</sup> (One wishes that there was a corresponding series of inflation forecasts held by firms, but such a series does not exist.) The first explanatory variable is a four-quarter moving average of core inflation—the Consumer Price Index excluding volatile energy and food prices. The second explanatory variable is the 4-quarter moving average of headline inflation minus core inflation. The first two columns look at the subperiod 1981-3 to 1995-4, while the last two columns look at the subperiod 1996-3 to 2016-1. The basic results in the table are robust to using 2-quarter to 8-quarter averages, and to dividing the sample at any date in the 1990s.

The regression results suggest two conclusions. First, professional forecasters put more weight on core than on the deviation of headline from core. In the more recent sample, the weight on core has increased, the weight on the deviation has decreased, suggesting indeed higher credibility of monetary policy.

Second, consumers put instead more weight on the deviation of headline minus core than on core. And in the more recent sample, they appear not to put any weight on core (I have no ready explanation for the negative, but insignificant, coefficient on core), and some weight, although less than before, on the deviation of headline from core. This is suggestive of decreased salience: Consumers now ignore inflation, unless some large change, such

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<sup>5</sup>The questions asked of consumers are: During the next 12 months, do you think prices in general will go up, or go down, or stay where they are? If people answer “up” or “down”, they are then asked: By about what percent do you expect prices to go (up/down) on the average, during the next 12 months? If they give an answer greater than 5%, they are probed to make sure they understood the question. The details of aggregation are given in Curtin (1996)]. What is reported is the median of the distribution.

as a change in gas or food prices, takes place.

To summarize: The econometric relation between unemployment and inflation today is at odds with the accelerationist hypothesis, suggesting that inflation expectations have become largely non-responsive to actual inflation. While increased credibility of policy is clearly a factor, the evidence from consumers' expectations suggests that decreased salience may be at work. To the extent that these expectations, together with those of firms, are the relevant determinants of wage and price decisions, then, so long as inflation remains low enough, there may be an exploitable persistent, if not permanent, trade-off between unemployment and inflation.

## 6. Policy Implications and Conclusions

The policy implications of deviations from the natural rate hypothesis depend very much on the specific channels, the non-linearities, the asymmetries that each of these channels implies. Persistence based on loss of morale or skills by workers may have different welfare implications from hysteresis based on insider-outsider considerations.<sup>6</sup> Persistence based on the effects of long-term unemployment is more likely to be asymmetric than hysteresis based on the effects of activity on R&D and technological progress. It is also more likely to be non-linear with respect to the depth and the length of recessions. At this point, the empirical evidence is just too crude to give us precise guidance.

Yet the basic implications of deviations from either the independence hypothesis or the accelerationist hypothesis, or both, can be shown simply.

Start with the independence hypothesis. Assume that (the log of) poten-

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<sup>6</sup>Gali 2016 gives a full treatment of policy implications in a model where hysteresis is derived from insider-outsider considerations. See also the analysis of optimal monetary policy in an insider-outsider model by Alogoskoufis (2017)

tial output,  $y^*$  follows:

$$y^*(+1) = ay^* + b(y - y^*) \quad (1)$$

Potential output next period depends on potential output today and on the deviation of actual output from potential output today. For notational simplicity, the specification ignores all other shocks which affect potential output, and normalizes long run potential output, if the deviation of output from potential is equal to zero, to be equal to zero.

The parameter  $b$  captures the effect of the output gap on potential output, and the parameter  $a$  captures the persistence of the effect. Under the strict independence hypothesis,  $b$  is equal to zero. Under the strict hysteresis hypothesis,  $b$  is positive and  $a$  is equal to one. I have argued however that these two cases are too extreme. In most models (and in reality...),  $b$  is likely to be positive, and  $a$  to be less than one. We can think of the independence hypothesis as small values of  $b$  and  $a$ , and the hysteresis hypothesis as large values of  $b$  and  $a$ .

Turn to the accelerationist hypothesis. Assume that the relation between inflation and output is given by:

$$\pi = c(y - y^*) + E\pi \text{ where } E\pi = 0 \text{ for } -x \leq \pi \leq x, \pi(-1) \text{ otherwise} \quad (2)$$

Inflation depends on the deviation of output from potential, and on expected inflation. Saliency is captured by the parameter  $x$ . So long as inflation or deflation are smaller than  $x$ , expected inflation is constant, normalized here to zero. If inflation or deflation exceed  $x$ , inflation or deflation become salient, and are assumed to be equal to lagged inflation. Thus, deviations from the accelerationist hypothesis are captured by positive values of  $x$ .

Now, consider the trade-off between inflation and output under different assumptions.

Suppose first that both the independence hypothesis and the accelerationist hypothesis strictly hold, so  $b$  in equation (??) and  $x$  in equation (??) are equal to zero. Consider a one-period increase in the output gap,  $y - y^* \equiv \Delta > 0$ . From equation (??), this one-period increase leads to a permanent increase in inflation of  $c\Delta$ , an unappealing trade-off.

Relax the independence assumption, so  $b$  and  $a$  are now positive. The one-period increase in the output gap now leads to an increase in potential output in future periods, thus a total increase of  $\Delta(1 + b + ab + a^2b + \dots) = \Delta + (b/(1 - a))\Delta$ , where the first term reflects the initial output gap, and the second reflects the sum of the increases in potential output that result from the initial output gap. The increase in inflation is the same as before, thus equal to  $c\Delta$ . In short, failure of the independence hypothesis leads to a more appealing trade-off between output and inflation.

Relax instead the accelerationist hypothesis, so  $x$  is now positive. Assume past inflation to be equal to zero. So long as the output gap is such that inflation does not exceed  $c\Delta$ , the increase in the output gap leads to higher current inflation, but no increase in inflation in future periods. Thus, failure of the accelerationist hypothesis leads to a more attractive trade-off between output and inflation.

Relax both hypotheses, and an increase in the output gap today leads to both a larger increase in future output, and a smaller increase in future inflation, with both effects leading to an even more attractive trade-off between output and inflation.

This toy model can and should be extended in many dimensions, in particular to allow for a richer specification of the response of inflation expectations to actual inflation, for asymmetric effects of recessions and booms, for the presence of shocks, and for uncertainty about the extent of the deviation

from the natural rate hypothesis. The general conclusion is likely to remain the same: Failure of either of the hypothesis leads to a more attractive trade-off between output and inflation, and, in the presence of shocks, suggests a stronger role for stabilization policy. If the independence hypothesis fails, adverse shocks are more costly, and stabilization policy more powerful. If the accelerationist hypothesis fails, there is more room for stabilization policy to be used at little inflation cost.

Where does this leave us? It would be good to have a sense of the values of  $a$ ,  $b$ ,  $c$  and  $x$ , or more generally, a sense of the specific channels at work. The empirical part of this paper has shown that we are still far from it. Thus, the general advice must be that central banks should keep the natural rate hypothesis (extended to mean positive but low values of  $b$  and  $a$ ) as their baseline, but keep an open mind and put some weight on the alternatives. For example, given the evidence on labor force participation and on the stickiness of inflation expectations presented earlier, I believe that there is a strong case, although not an overwhelming case, to allow U.S. output to exceed potential for some time, so as to reintegrate some of the workers who left the labor force during the last ten years.