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ABSTRACT

The Natural Rate Hypothesis: An idea past its sell-by-date*

Central banks throughout the world predict inflation with new-Keynesian models where, after a shock, the unemployment rate returns to its so called 'natural rate'. That assumption is called the Natural Rate Hypothesis (NRH). This paper reviews a body of work, published over the last decade, which is critical of the NRH. I argue that the NRH does not hold in the data and I provide an alternative paradigm that explains why it does not hold. I replace the NRH with the assumption that the animal spirits of investors are a fundamental of the economy and I show how to operationalize that idea by constructing an empirical model that outperforms the new-Keynesian Phillips curve. I model animal spirits with a new fundamental that I call the belief function.

JEL Classification: E00, E24 and E58
Keywords: inflation, natural rate hypothesis and unemployment

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Submitted 23 July 2013

Six years after the onset of the Great Recession, Western economies are still underperforming by historical standards. There have been calls from prominent academics, politicians and policy makers for a rethink of the foundations of macroeconomics. But what would that mean? This article explains how a radical restructuring of macroeconomic theory, based on models of multiple equilibria, can help us to understand the crisis.

To make my case, I summarize and synthesize results from my recent books and academic articles. This body of work (Farmer 2002, 2006, 2008, 2010a,b 2012a, 2013a, 2014) reconciles Keynesian and classical ideas in a new way. Instead of assuming prices are sticky, I develop a new paradigm to explain why high unemployment persists.

In my work, I use search theory to provide a new foundation to Keynesian economics. Unlike theories based on Samuelson's neo-classical synthesis, I explain why the data do not display a natural rate of unemployment.

I replace the Natural Rate Hypothesis with the assumption that the animal spirits of investors are a fundamental of the economy and I show how to operationalize that idea by constructing an empirical model that outperforms the new-Keynesian Phillips curve. I model animal spirits with a new fundamental that I call the belief function.

A brief history of macroeconomic thought

From Hume to Phillips

Classical economists from David Hume, through Adam Smith, David Ricardo and John Maynard Keynes' contemporary, Arthur Pigou, viewed the economy as a self-regulating mechanism.[1] In modern parlance the classical vision was of an economy with a unique, stable, steady-state equilibrium.

Smith's idea of the 'invisible hand' was formalized in the nineteenth century by Léon Walras (1874) and Vilfredo Pareto (1896). They envisaged an economic system that today we would describe as Pareto Efficient.[2]

Writing in 1936, following a U.S. stock market collapse and an unemployment rate in excess of 20%, Keynes provided a different vision. He saw high persistent unemployment as a different kind of steady state equilibrium.

Keynes' view was rejected by his followers, notably Paul Samuelson (1955). In the third edition of his undergraduate textbook, Samuelson replaced Keynes' notion, of high unemployment as an equilibrium, with a new idea: the neo-classical synthesis.[3] According to that idea, the Keynesian high unemployment equilibrium is only temporary. It applies in the short run, when prices and wages are sticky, but in the long run, when all wages and prices have had time to adjust, the economy reverts to a classical equilibrium with full employment.

Soon after Samuelson introduced the neo-classical synthesis, the theory was provided with empirical support. In an important 1958 article, A. William Phillips demonstrated that there had been a structurally stable relationship between unemployment and the rate of change of money wages in a century of U.K. data. His article was influential because it filled a theoretical hole in Keynesian theory. **Box 1** shows the original Phillips curve and the methodology used to construct it.

Keynesians and monetarists

Milton Friedman is a central figure in the development of macroeconomics in the latter part of the twentieth century. In his1948 article, "A Monetary and Fiscal Framework for Economic Stability", he developed the thesis that policy makers should provide a stable framework in which private agents can operate.

Active monetary and fiscal policy has no role in Friedman's analysis since he assumed that markets work well to allocate resources efficiently to competing ends.[4] Because of the central role of the money supply in Friedman's thought, his ideas are known as **monetarism**.

In 1970, Friedman explained the theoretical framework that guided his policy advice. By that time, the Phillips curve had appeared in print and

[1] Hume (1742), Smith (1776), Ricardo (1817), Pigou (1928).

[2] In the language of modern general equilibrium theory, an equilibrium is Pareto Efficient if an omniscient social planner could not rearrange the allocation of goods, including the allocation of time spent in paid employment, to make any single person better off without making some other person worse off.

[3] For a discussion of the influence of Samuelson's textbook on economic thought, see the enlightening piece by Pearce and Hoover (1995).

[4] For a competing view of why markets do not work well, see the recent piece by Farmer, Nourry and Venditti (2012), which won the inaugural 2013 Maurice Allais Prize in Economic Science.

Box 1: Estimating the first Phillips curve

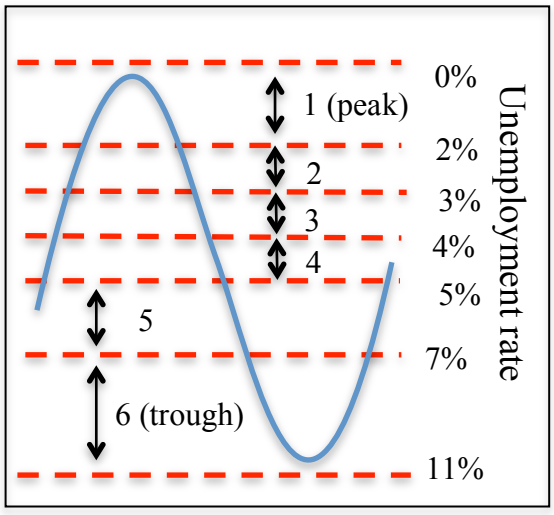
Phillips estimated the first Phillips curve using U.K. data on wage inflation and unemployment from 1861 through 1957.

When unemployment was high, he argued that there was an excess supply of labour that put downward pressure on money wages. When unemployment was low, he argued that there was an excess demand for labour, leading to upward pressure on money wages.

To substantiate these claims, he separated his data into three sub-periods and demonstrated that the same relationship held in all three of them. Phillips' first sub-period began in 1861 and ended in 1913 with the onset of WWI. The second contained data for the interwar period and the third began in 1948 and ended in 1957. The Phillips curve was estimated on data from the first sub-sample using an averaging method to remove the influence of changing unemployment on the steady state relationship that he hoped to uncover.

Phillips divided the raw data into six groups based on where an observation occurred over the business cycle. He grouped the pre-WWI data into six and a half cycles and he assigned the unemployment data for each cycle to one of six regions; the peak, the trough and four intermediate regions (see **Chart 1**).

Chart 1: How Phillips grouped the pre-WWI Data



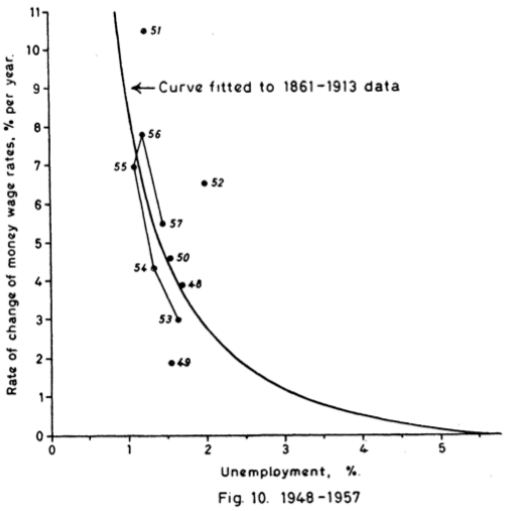
Source: Author

For each of the six and half cycles, the data for unemployment and wage inflation for each region were averaged. That procedure led to six values for average wage inflation and average unemployment to which Phillips fit a nonlinear equation. By grouping data in this way, he hoped to remove the effects of changing inflation and unemployment on the steady state relationship.

The resulting curve connecting unemployment and wage inflation proved to be remarkably resilient. Phillips showed that raw data for each of the six and half cycles in the pre-WWI period lay closely around a curve that had been fit to cycle averaged data.

Chart 2, reproduced from Phillips' original article, illustrates the data for 1948 to 1957. Notice how closely the 1950s data conforms to the pre WWI curve.

Chart 2: Fitting post-WWII data to the pre WWI Phillips curve



Source: Phillips (1958) Used by permission.

Phillips' contemporaries saw the conformity of data from the 1950s, with a curve estimated from nineteenth century data, as evidence that the Phillips curve was a fundamental structural relationship that characterizes the wage adjustment process. The stability of the Phillips curve in a hundred years of data made them sit up and pay attention.

Friedman was able to adopt it as the 'missing equation' that connects the Keynesian short run with the classical long run.

When Friedman explained his framework in 1970, the gap between classical and Keynesian economics was as small as it had ever been: Keynesians and monetarists had adopted a common theoretical framework and Samuelson's neoclassical synthesis had become part of the economic lexicon. For both schools of thought, Keynes' idea of unemployment as a steady state equilibrium had been relegated to the dustbin of history and Friedman could assert without fear of contradiction from Keynesians like Paul Samuelson or Robert Solow that:

> 'Keynes's *error* consisted in neglecting the role of wealth in the consumption function…' (Friedman 1970, p 206, my emphasis)

As a consequence of this alleged error, Friedman argued that Keynes was incorrect to model persistent unemployment as one of many possible long run equilibria since

> '…there is no fundamental "flaw in the price system" that makes unemployment the natural outcome of a fully operative market mechanism.' Friedman (1970, p 207)

Keynesians and monetarists alike adopted the Phillips curve as the missing equation that explains the transition from the short run to the long run. By accepting that point of view, macroeconomists abandoned one of the most important insights of Keynes' General Theory: the existence of high unemployment as a persistent long run steady-state equilibrium.

Unemployment and inflation

The inception of the Natural Rate Hypothesis

In the 1970s we entered an era of stagflation, characterized by simultaneously high unemployment and high inflation. These new facts were inconsistent with the Phillips curve, which predicted that high unemployment should be accompanied by low inflation.

Edmund Phelps (1967) and Friedman (1968) argued independently that stagflation was not inconsistent with the neo-classical synthesis, since we should not have expected to observe a stable trade-off between *money* wage inflation and unemployment. They asserted, instead, that the true relationship is between *real* wage inflation and unemployment. Their work explained why the Phillips curve had disappeared.

To understand the disappearance of the Phillips curve, Friedman introduced the concept of the **natural rate of unemployment**, which 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.'

According to Friedman,

> 'A lower level of unemployment [than the natural rate] is an indication that there is an excess demand for labor that will produce upward pressure on real wage rates. A higher level of unemployment is an indication that there is an excess supply of labor that will produce downward pressure on real wage rates.' (Friedman 1968)

The NRH provided a tidy explanation both for the existence of the Phillips curve in nineteenth and early twentieth century data, and for its disappearance in the 1960s and 1970s. According to this explanation, in the period before WWII, inflation expectations were anchored by the gold standard. Price inflation would never be too high or too low because the price level is determined, in the long run, by the stock of money. That, in turn, was linked to gold production.

A new concept: the expectations-augmented Phillips curve

When the U.S. left the gold standard in 1971, the quantity of money could expand without limit and price expectations lost their natural anchor. Phelps and Friedman argued that the Phillips curve shifted because households and firms began to expect higher price inflation.

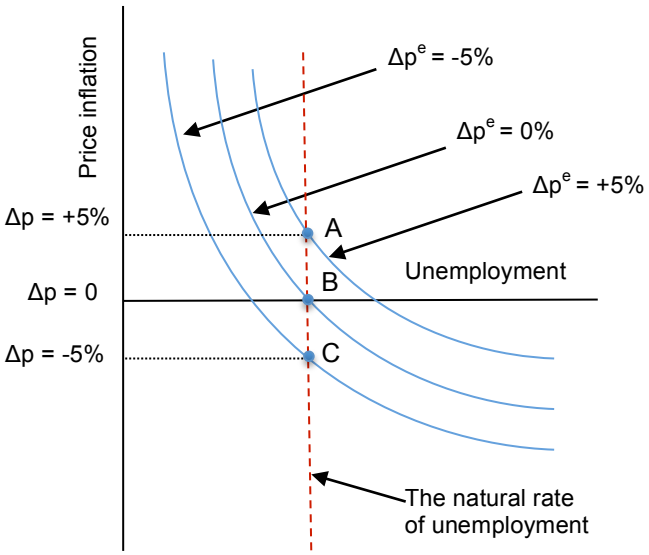
Phelps and Friedman believed that firms and workers care about real wages, not money wages, and they claimed that the expected rate of price inflation becomes written into wage contracts. If price inflation is forecast correctly, unemployment will equal its natural rate. Since forecasts of price inflation will often be wrong, unemployment, in the short run, will differ from its natural rate. The work of Phelps and Friedman led to the development of a new concept, the **expectations-augmented Phillips curve**.

According to this theory, realized price inflation replaces wage inflation on the vertical axis of the Phillips curve graph and there is a different Phillips curve for every value of expected price

inflation: expected price inflation shifts the curve. Importantly, unemployment can only differ from its natural rate when expected inflation is different from actual inflation.

Chart 3 illustrates this idea. The chart plots the realized rate of price inflation, in any given month, against the realized value of the unemployment rate. Each of the three Phillips curves on this graph is associated with a different rate of expected price inflation, denoted by Δp^e on the chart. The vertical dashed red line represents the natural rate of unemployment. For each of the points A, B and C that lie on the NR line in **Chart 3**, inflation expectations (shown for each curve) are equal to realised price inflation (shown on the y axis). For example, actual and expected inflation are both equal to 5% at point A.

Chart 3: The expectations augmented Phillips curve



Source: Author

How do agents form expectations about economic variables such as inflation? Early theoretical papers that used the NRH assumed a theory of **adaptive expectations**. According to that theory, next period's expected inflation rate is formed by taking a weighted average of this period's actual inflation rate and last period's expected inflation rate.

The combination of NRH and adaptive expectations implied that, if the unemployment rate were held below its natural rate by expansionary fiscal or monetary policy, the outcome would be an inflationary spiral. Similarly, if policy makers were to keep unemployment above its natural rate, there would be a deflationary spiral. For that reason, the natural rate of unemployment is sometimes called the non-accelerating inflation rate of unemployment (NAIRU).

The fact that inflationary expectations can influence actual inflation implies that managing expectations is critical. The NRH implies that, once high inflation becomes expected, it will persist, even when unemployment is at its natural rate. That is why inflation targeting is thought to be such an important tool for anchoring expectations. It provides an anchor to inflationary expectations; a role that was previously played by the gold standard.

The rise of rational expectations

When Phelps and Friedman wrote their seminal articles on the NRH, they were simply acknowledging the logical implications of the neoclassical synthesis. If the neoclassical synthesis is correct then the economy will always return to full employment as wages and prices adjust to clear markets. Unemployment cannot differ permanently from its natural rate and Keynes' original vision of high unemployment, as a persistent steady state, must be fatally flawed.

Keynes had argued that most unemployment is 'involuntary,' in the sense that households are not 'on their labour supply curves.' He meant that, at the prevailing wages and prices of the 1930s, most unemployed people would have preferred to be working. Franco Modigliani famously described the counterfactual: If unemployment were indeed voluntary, the Great Depression must have been caused by a 'sudden attack of contagious laziness'.

The orthodox view in the 1960s was that Keynes was right about this point but that involuntary unemployment is a temporary situation that occurs because there is a friction that prevents wages and prices from adjusting to clear all markets. Writing in 1968, Phelps and Friedman both accepted this orthodox view.

In 1972, Robert E. Lucas Jr. published an influential piece that shaped the course of macroeconomics for the next forty years. He argued that labour markets are always in equilibrium and that the concept of involuntary unemployment, introduced by Keynes in the General Theory, is not a useful one. The idea that the demand and supply of labour are always equal is called **continuous market clearing**.

In the same paper, Lucas introduced the concept of **rational expectations**, the idea that peoples' expectations about the future paths of key economic variables are subject to random errors but are correct on average. The introduction of continuous market clearing and rational expectations had important implications for monetary economics.

What's wrong with the NRH?

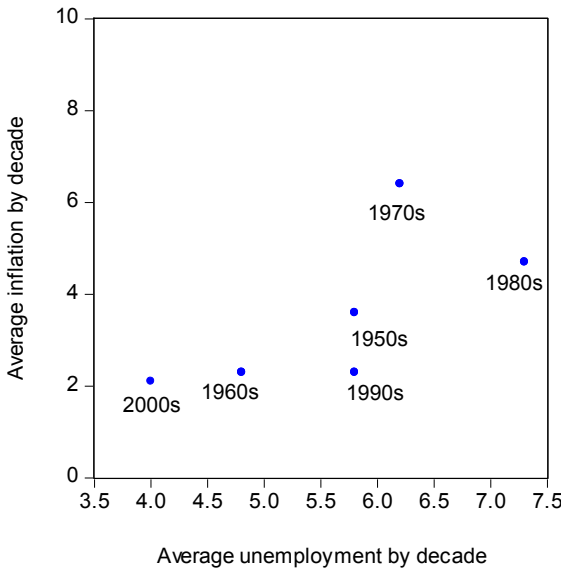
The data rejects the NRH when combined with rational expectations

When the NRH was first proposed, Friedman assumed that expectations are adaptive. The combination of adaptive expectations and the NRH led to a theory where variations in the unemployment rate are caused, primarily, by incorrect expectations. In this theory, households and firms forecast price inflation and their forecast determines which Phillips curve prevails in the period. Expected price inflation feeds into wages, and, through mark-ups, into realized inflation.

According to the NRH, unemployment differs from its natural rate only if expected inflation differs from actual inflation. If expectations are rational, we should see as many quarters when inflation is above expected inflation as quarters when it is below expected inflation. **That suggests the following test of the NRH.**

Because a decade contains forty quarters, the probability that average expected inflation over a decade will be different from average actual inflation should be small. If the NRH and rational expectations are both true simultaneously, a plot of decade averages of inflation against unemployment should reveal a vertical line at the natural rate of unemployment. **In Chart 4**, **I show that this prediction fails dramatically.**

Chart 4: Average inflation and unemployment by decade



Source: Author's calculations

There is no tendency for the points to lie around a vertical line and, if anything, the long run Phillips curve revealed by this chart is upward sloping, and closer to being horizontal than vertical. **Since it is unlikely that expectations are systematically biased over decades, I conclude that the NRH hypothesis is false.**

Defenders of the natural rate hypothesis might choose to respond to these empirical findings by arguing that the natural rate of unemployment is time varying. But they have not provided us, in advance, with a theory of how the natural rate of unemployment varies over time. In the absence of such a theory the NRH has no predictive content. **A theory like this, which cannot be falsified by any set of observations, is closer to religion than science.**

The development of new-Keynesian economics

Real Business Cycle theory and the birth of DSGE models

Soon after Lucas developed the theory of rational expectations, Edward Prescott (1980) and John B. Long Jr. and Charles Plosser (1983) introduced the – then radical – idea that business cycles can be explained by shocks to productivity. That theory of real business cycles began with simple equilibrium models where 'random shocks' to the level of technological innovation are the sources of swings in growth and employment. It soon developed into a much more ambitious programme.

In real business cycle theory there is no unemployment since RBC theorists assume that the demand and supply of labour are always equal to each other. There is continuous market clearing. They argue that unemployment is not a useful concept and that instead, we should represent labour market activity by the number of hours spent in paid employment by a representative household.

If there is no unemployment, how can there be a natural rate of unemployment? There too, RBC theory has a response. According to RBC economists, there is a natural rate of *employment,* which represents the hours of paid employment of a representative worker when productivity is at its average level over the business cycle.

Starting in the 1980s, the tools of rational expectations and continuous market clearing swept the profession. Classical ideas spread outwards from the Universities of Chicago and Minnesota and soon prominent graduate economics programmes throughout the world were training their students to study the macroeconomy using classical tools. This new approach was called Dynamic Stochastic General Equilibrium (DSGE) theory.

Putting sticky wages and prices into the RBC model

Keynesian economists were initially resistant to the classical tools of rational expectations and continuous market clearing but their resistance did not last long. They began to use classical techniques, but they amended them by putting back sticky prices using Samuelson's neoclassical synthesis as an organising principle. With the publication of an influential volume of readings in 1991, edited by N. Gregory Mankiw and David Romer, new-Keynesian economics was born.[5]

Gradually, new Keynesian researchers incorporated frictions and additional shocks into their models. These included sticky prices, shocks to confidence, monetary disturbances and news shocks. By the onset of the financial crisis in 2007, macroeconomists had developed mathematical equations that captured the ideas of 1920's classical business cycle theories described by Pigou (1928).[6]

There is no involuntary unemployment in the new-Keynesian model

Classical and new-Keynesian economists both use DSGE models. The twin hallmarks of the DSGE agenda are the assumptions of continuous labour market clearing and rational expectations. These assumptions were made in the first RBC models of Prescott (1980) and Long and Plosser (1983) and were incorporated into almost every DSGE model since. That includes almost all of the work on new-Keynesian economics that predates the 2008 crisis.

In new-Keynesian models, there are costs of changing wages and prices. Because of these so called **menu costs**, wages and prices are not always at the levels that would be chosen in their absence. Nevertheless, households are still assumed to be able to find as much employment as they would like at existing wages and prices. **In new-Keynesian DSGE models, just as in RBC models, there is no involuntary unemployment**.

[5] Mankiw and Romer: (1991).

[6] The pinnacle of the NK programme is the model developed by Frank Smets and Rafael Wouters (2007). That model fits pre 2008 data very well by incorporating large numbers of frictions and shocks into a DSGE structure. It is much less successful at explaining the Great Recession. Lakatos (1978) distinguished between a progressive and degenerative research programme. Farmer (2013b) argues that New-Keynesian economics is a degenerative research programme in the sense of Lakatos. It is a programme that must continually modify a set of subsidiary hypotheses in order to explain new data.

We need to bring unemployment back into our models

In the wake of the Great Recession, continuous labour market clearing and rational expectations have both come under attack. In my view, the rational expectations concept is useful and, if applied carefully, can be incorporated into a model that will help us to understand what went wrong in the crisis.[7] But the assumption of continuous labour market clearing is seriously misleading. Based on this assumption, RBC models take account only of *employment,* proxied by the number of hours worked, with no explicit role for the rate of *unemployment*.

The distinction between employment and unemployment is crucial. In this section I draw on U.S. labour market data from the past half-century to argue that the RBC approach is fundamentally flawed, and that any model that aims to explain business cycle fluctuations *must* provide an explicit theory of the unemployment rate.

Hours worked varies for three reasons

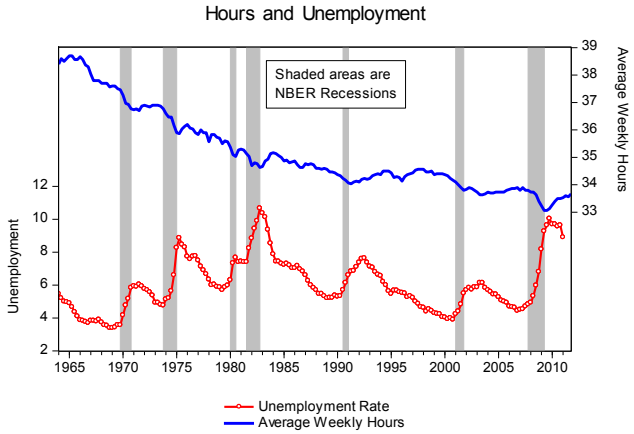
RBC economists use hours spent in employment by a representative agent as their measure of employment. This measure varies for three reasons. First, households decide how many household members will participate in the labour market. Second, each potential worker must find a job. Finally, each employed worker must decide how many hours to work in a given week. Each of these three variables displays very different characteristics.

Average hours worked do not vary much at business cycle frequencies. **Chart 5** plots U.S. unemployment, on the left hand axis and average weekly hours on the right hand axis. Unemployment is measured as a percentage of the labour force, and average weekly hours is a number. The grey shaded areas are recessions defined by the NBER dating committee. **This chart shows that there has been a secular downward drift in average weekly hours but very little movement in hours at business cycle frequencies**.

[7] For an important and interesting counter argument, see the work of Roman Frydman and Michael Goldberg (2011).

Hours worked does not vary much at business cycle frequencies

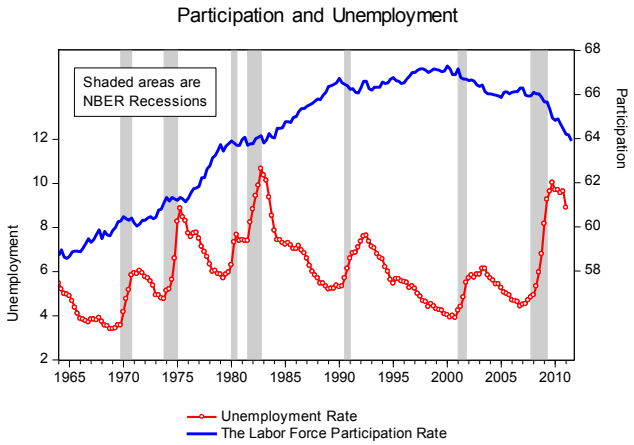
Chart 5: Hours and employment in the U.S.



Source: Author

Chart 6 plots unemployment, on the left axis and the labour force participation rate on the right axis. The participation rate is measured as a fraction of the over-16 non-institutional population. **This chart shows that, like hours, most of the movements in the participation rate are secular. They are not strongly correlated with recessions.**

Chart 6: Participation and unemployment in the U.S.



Source: Author

In both Classical and new-Keynesian theories, employment variation over the business cycle occurs through intertemporal substitution, by rational forward-looking households, of leisure today for leisure tomorrow. In both theories, households can work as many hours as they choose and the demand and supply of labour are continuously equated by adjustments of the money wage. **The facts contradict this assumption.**

Charts 5 and 6 demonstrate that almost all of the variation in hours at business cycle frequencies occurs because of variations in the unemployment rate. If we want to understand the causes of business cycles, we cannot neglect the determinants of the unemployment rate. In spite of this obvious fact, almost all DSGE models, pre 2008, did not contain unemployment.[8]

Modelling unemployment

Using search theory to model unemployment

Although the concept of unemployment disappeared from modern mainstream macroeconomics, it did not disappear from economics entirely. One promising avenue, pursued by theorists, was the incorporation of search frictions into simple models of the labour market. This avenue is called **search theory**.[9]

The main innovation of search theory is the concept of a **matching function**, which models the process of finding a job as a **search technology** with two inputs. Just as a production technology combines labour and capital to produce a commodity, so a search technology combines the search time of an unemployed worker with the search time of the recruiting department of a firm to fill a vacancy.

Imagine that the labour force is constant and that every worker works a thirty-five-hour week. Since neither hours not participation varies much at business cycle frequencies, these assumptions are useful approximations if our goal is to understand recessions.

There are approximately 30 million workers in the UK labour force. Let's suppose that 40,000 of them lose their jobs every week, either because they quit voluntarily or because they are laid off. How can we replace those workers in a way that keeps the number of employed people constant?

According to search theory, the matching function connects the number of vacancies posted, the number of unemployed people, and the number of new positions that are filled.

Table 1: The Matching Function

(1)	$J = \frac{1}{10}\left(V^{1/2}U^{1/2}\right)$

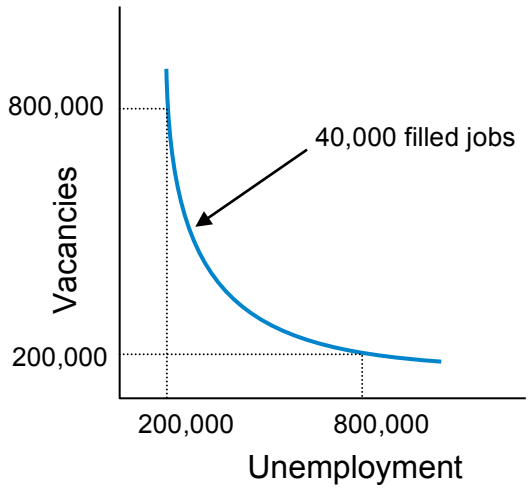
[8] Some notable exceptions are the papers by Merz (1995), Andolfatto (1996) and Hall (2005).

[9] Search theory was recognized, in 2010 with the award of the Nobel Prize in Economics to Peter Diamond, Dale Mortensen and Chris Pissarides. It began with a remarkable collection of papers (Phelps et. al. 1970) that explored the theoretical foundations of the Phillips Curve. Important contributions include Diamond (1982), Mortensen (1970), and Pissarides (1976).

Equation 1 is an example. Here, J represents the number of filled jobs in a week; V is the number of unfilled vacancies that are available that week and U is the number of unemployed people.

Chart 7 illustrates **Equation 1** in a graph. This chart shows that 40,000 new jobs can be created in many different ways. One would be if 200,000 unemployed people searched for 800,000 vacancies. Another would be if 800,000 unemployed people searched for 200,000 vacancies. Those different ways of matching workers with jobs have very different implications for the unemployment rate. To see this, suppose the economy in this example has a labour force of 1 million people. The first case would result in an unemployment rate of 80% and the second in an unemployment rate of 20%.

Chart 7: The Beveridge curve as an isoquant



Source: Author

Chart 7 resembles an empirical relationship, called the **Beveridge Curve**, which characterises the U.K. and U.S. data. According to search theory, the Beveridge curve is analogous to an isoquant in the microeconomic theory of the firm. In the theory of the firm, an isoquant gives different levels of capital and labour that can be used to produce a given amount of physical goods. In search theory, the Beveridge curve gives different combinations of vacancies and unemployed workers that can be used to fill a given number of jobs.[10]

If the theory of the firm can be used to help explain unemployment then perhaps we can also learn from welfare economics, which teaches us that the equilibria of competitive markets are efficient. That turns out *not* to be the case.

Search theory and market efficiency

One way of characterizing the efficiency of markets is to write down a problem that would be solved by a fictitious social planner who knows the technologies available to produce goods and the preferences of all the people in the economy. In our example, the social planner would also know the technology for matching unemployed workers with vacant jobs.

Suppose we ask the social planner to maximize the utility of a representative household by choosing the best possible way of matching unemployed workers with vacant jobs. Microeconomic theory tells us that the decision of the social planner can be achieved anonymously by allocating goods through competitive markets. The idea that markets solve the planner's maximization problem is called the first welfare theorem of economics. **But for the first welfare theorem to hold there must be enough markets and enough relative prices.**

To apply the first welfare theorem to an economy with a search technology, there would need to be a large number of 'matchmaking' firms, as well as the usual assumption of a large number of production firms. Matchmaking firms and production firms would play different roles.

Matchmaking firms would pay unemployed workers for the exclusive right to find them a job. And they would pay the firms that produce commodities for the exclusive right to fill their vacancies. After matching suitable workers with commodity producing firms, the matchmaking firm would sell the match back to the worker-firm pair.

In reality we do not see matchmaking firms that operate in this way because the market would be difficult to police. For the search markets to work well, the matchmaking firms would need to buy the inputs to the search technology in a pair of competitive markets. These firms would, in effect, be paying unemployed workers for being idle. It is easy to see that there is an incentive for these workers to cheat and to refuse to accept a job once it is offered.

Because it would be difficult or impossible to force a matched worker to accept a job, the factor markets in a search model are necessarily incomplete. There are not enough relative prices to send the correct signals to market participants.

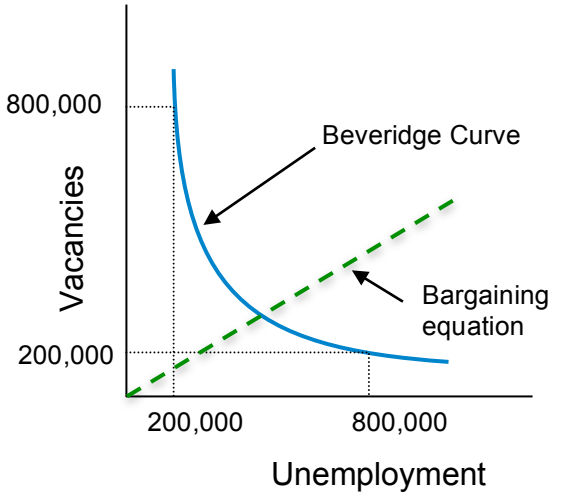
[10] For an interesting link to a real time graph of unemployment and vacancies, see Farmer (2010c).

This lack of enough relative prices leads to a fundamental indeterminacy in the labour market.[11]

Search theory and the Nash bargain

Search theorists recognized that if firms and workers take wages and prices as given, there are not enough equations in a search model to determine all of the unknowns. To complete their model, they assume that when a worker and a firm meet, they bargain over the wage using a theory called Nash bargaining, after the economist John Nash. This assumption adds an additional component to the search model; the **Nash bargaining equation**.

Chart 8: The Beveridge curve and the Nash bargaining equation



Source: Author

The Nash bargaining equation introduces a new parameter to the model: the bargaining weight of the worker. This parameter captures features like the strength of unions relative to firms and it determines how profit-maximizing firms will choose to allocate resources to the activity of recruiting. The Nash bargaining weight picks an equilibrium point on the Beveridge curve.

Chart 8 illustrates this idea. The downward sloping blue curve is the Beveridge curve. This represents the technological possibilities for filling a given number of jobs. The upwards sloping dashed green line follows from the assumption that, when a worker meets a firm, they bargain over the wage. That assumption leads to a unique ratio of vacancies to unemployment with a slope that depends on the bargaining weight of the two parties. Equilibrium occurs at the point where the bargaining equation and the Beveridge curve coincide.

Search theory, closed with the Nash bargaining assumption, is mathematically consistent and has provided several generations of Ph.D. students with elegant problems to solve. But it is not a good description of the data. The Nash bargaining equation picks a unique natural rate of unemployment and reasonable calibrations of standard search and matching models predict that unemployment will quickly converge back to this natural rate. **As I showed in Chart 4, this is not what happens in the real world.**[12]

A new paradigm for macroeconomics

The belief function: A positive theory of animal spirits

If we drop the Nash bargaining equation, as I have done in my work, our economic model will be left without enough equations to determine all of the unknowns. It becomes a model with multiple steady state equilibria. In order to understand what would happen in a model of this kind, we must explain how human beings would react in any given situation.

Whereas standard search theorists close their models in the labour market with an arbitrary bargaining equation, I close my model instead in the asset markets. I capture Keynes' notion of 'animal spirits' by providing an explicit theory of how animal spirits are determined. I model animal spirits as a new fundamental that I call **the belief function**.

The belief function is a mapping, from observations of the past to beliefs about the future. This new fundamental equation plays a

[11] Farmer (2006, 2008, 2010a, 2012a,b) constructs a real model with incomplete factor markets and Farmer (2013b) develops a monetary model with incomplete factor markets where a belief function replaces the assumption that output is exogenous. That model provides a better fit to the data than the New-Keynesian model because it is able to account endogenously for persistence in the unemployment rate.

[12] I am not the only economist who has recognized that we must develop new theories that include unemployment. Since the onset of the Great Recession, new-Keynesian economists have also begun to incorporate unemployment into their models. Notable examples include Gertler et al (2008) and Gertler and Trigari (2009) who introduce more sophisticated bargaining rules into search models in an attempt to provide more persistence to sticky wages. Building on Hall and Milgrom (2008), these new-Keynesian models are closed with versions of the Nash bargaining equation and they cannot account for the failure of the NRH.

similar role to the theory of adaptive expectations: it anchors beliefs.[13]

In models where there are multiple steady state equilibria, the unemployment rate displays what Olivier Blanchard and Lawrence Summers (1987) have labelled hysteresis. In a model with hysteresis, I have shown that the belief function selects a unique path for the unemployment rate. This path wanders across the possible steady state labour market equilibria. Because each of these unemployment rates is itself an equilibrium, so is the non stationary path of unemployment rates that is realized. **The equilibrium in my model is fully consistent with rational expectations.**

The fact that the equilibrium in my model is rational, in the sense of rational expectations, is an important element of the theory that distinguishes it from the popular idea that animal spirits are expressions of 'irrational exuberance'. Because in my model, beliefs are rational, they are correct on average, and no one in the model is consistently fooled when outcomes are realized.

By specifying what variables agents form beliefs about, and by providing a functional form for how those variables depend on present and past observables, I arrive at a complete theory that determines employment, prices, GDP and its components.

Using my new paradigm to explain the data

Putting the belief function through its paces

In my (2013b) paper I ran a horse race of a three equation new-Keynesian monetary model against a "Farmer" monetary model and I showed that the Farmer model, closed with a belief function, does a much better job of explaining the data. Why might that be?

A model that is closed with the Phillips curve implies that the unemployment rate will show a tendency to return, over time, to its natural rate. The data show no such tendency. In contrast, a model where unemployment can wander around a set of possible values provides a better explanation for what we have observed in the last sixty years.

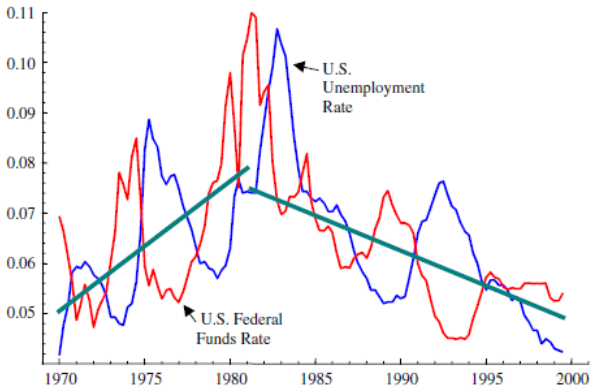
Table 2 describes a parameterized example of the belief function that I used in my 2013b study. Here x_t is nominal GDP, y_t is real GDP and p_t is a price index. All variables are in logs, Δ is the first difference operator and E is the expectations operator.

Table 2: Modelling the belief function

(2)	$x_t = y_t + p_t$
(3)	$E[\Delta x_{t+1}] = \Delta x_t$

The key assumption is **Equation 3.** This asserts that households expect that the growth rate of nominal GDP next period will equal the growth rate this period. When that assumption is inserted into a simple three-equation model of the macroeconomy, as a replacement to the Phillips curve, the resulting system provides a much better fit to data than the canonical new-Keynesian model.

Chart 9: Unemployment and the interest rate in U.S. data



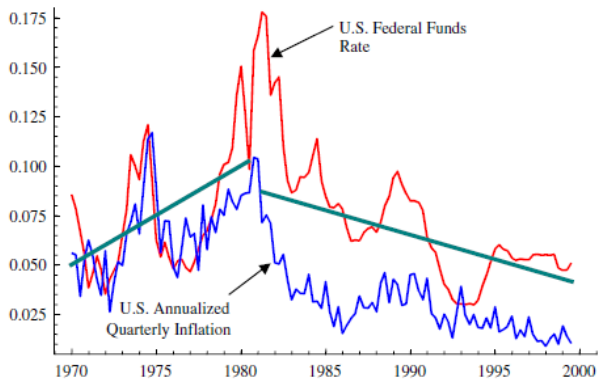
Source: Beyer and Farmer (2007)

To see why that is the case, **Charts 9** and **10** illustrate the behaviour of the data. Data for unemployment and the short-term interest rate are trending up before 1980 and down since then. In joint work, (Beyer and Farmer 2007) Andreas Beyer and I show that unit root tests cannot reject the hypothesis that each individual series is a random walk and that, jointly, the series are connected by two co-integrating equations.[14] It is these facts that the Phillips curve model, an equation that incorporates the NRH, cannot explain.

[13] Adaptive expectations may coincide with rational expectations when there are multiple equilibria. I have explored this idea in a series of books and papers. See Farmer (1999, 2010a, 2012a, 2013b) and Plotnikov (2013). Farmer (2014, forthcoming) compares this work with models that contain multiple dynamic rational expectations equilibria.

[14] A pair of cointegrated random walks is a bit like two drunks walking down the street, tied together by a rope. The drunks can wander apart from each other in the short run, but in the long run they can never get too far apart.

Chart 10: Unemployment and inflation in U.S. data



Source: Beyer and Farmer (2007)

The reason the Farmer model outperforms the new-Keynesian model is because the NK model embodies the natural rate hypothesis. The reduced form of the model consists of three stationary time series that cause the data to cluster around a point in a three dimensional space.

By contrast, the Farmer model contains **Equation 3** as one of its explanatory equations. It does not embody the NRH and instead, the reduced form is a set of cointegrated time series that cause the data to cluster around a line in a three dimensional space.

Conclusion

Friedman (1970) claimed that there is 'no fundamental flaw in the price system'. He was wrong and my work explains why. The stagnation that occurred in the United States during the Great Depression, in Japan during the lost decade of the 1990s and throughout the Western world following the financial crisis of 2008, supports that claim.

9. At the outset of this article I offered not just to provide a critique of macroeconomic theory: but also to provide a constructive alternative with which to rebuild it. That alternative is based on a return to two central ideas of Keynes' General Theory. First, that high involuntary unemployment can persist as an equilibrium of a market economy and second, that the equilibrium that prevails is selected by the animal spirits of market participants.

Economists and central bankers can no longer afford to continue using the NRH. It is an idea that is past its sell-by-date. I have offered a replacement that recovers Keynes' two central ideas and I have shown that this new paradigm outperforms the new-Keynesian model when confronted with data.

By modelling the labour market with a search model where factor markets are incomplete, I have shown how to construct a logical microeconomic foundation to Keynesian economics. And by modelling beliefs as a new fundamental with the same methodological status as preferences, I have shown how to construct a complete DSGE model that provides a coherent explanation of macroeconomic data.

The research agenda that is implied by accepting my ideas is exciting. It raises new questions, answers old ones, and provides new ways of thinking not only about economic theory, but also about policy options.[15] But that is a story for another day.

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