

# Keynesian Economics, Monetary Policy and the Business Cycle - New and Old

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## 1 Introduction

Macroeconomics has undergone substantial methodological developments and swings since the heydays of Keynesianism in the sixties. At that time the view that output is largely demand determined and that the price level can be taken, to a first approximation, as fixed was widely accepted by both academics and policymakers. The great inflation of the seventies revived the classical-monetarist view that output is determined mainly by productive capacity, that prices are flexible, and that changes in demand and in monetary stance mainly affect the price level, at least after a while. This was followed by the emergence of real business cycle models. Starting from preferences, technology, individual dynamic optimization under perfect competition and the premise that prices are flexible this body of research attributed business cycle fluctuations mainly to technology shocks, changes in preferences, taxation and other real reasons. During the last decade, temporarily sticky prices have been resuscitated by incorporating them, along with monopolistic competition into real business cycle models. This opened the door for a more explicit treatment of monetary policy within real business cycle models and produced the recent

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body of research known as New Keynesian economics.<sup>1</sup>

After a brief review of the evolution of macroeconomic thought since the sixties to present days this paper compares and contrasts the Keynesian economics of the sixties with the New Keynesian economics of the last decade or so. A revolutionary idea of New Keynesian economics, also referred to as a "New Neoclassical Synthesis" is that the output gap should be defined by reference to the level of output that would have been produced under fully flexible wages and prices rather than, as traditionally done in the past, as the deviation between actual output and a statistically smooth version of output. The paper compares and contrasts the traditional and the new views of the output gap and of the corresponding versions of potential and of the target levels of output. A remarkable result of this new literature is that, to maximize welfare, policymakers should take the level of output under flexible prices as a target.<sup>2</sup> Notably, this concept may be more volatile than the level of output under sticky prices implying that policymakers subscribing to New Keynesian policy recommendations would, in some cases, have to allow output to fluctuate more than under sticky prices.

It is the judgement of this author that, even if they had been able to get a measure of output under flexible prices, most central bankers would be unlikely to embrace wider fluctuations in output in order to attain this target. Given this premise one may wonder whether this is a mistake on their part or whether existing new models abstract from some factors that policymakers pay attention to? Obviously, both answers may be right. The paper explores the second possibility more precisely by producing a microfounded illustration with sticky nominal wages in which output and consumption are less volatile and leisure is more volatile when prices are sticky than when they are flexible.<sup>3</sup> The example implies that a virtual shift from a sticky prices economy to a flexible prices economy involves a tradeoff between the variability of consumption and the variability of leisure. Consequently, when consumers are sufficiently more risk averse with respect to consumption than they are with respect to leisure, a sticky prices

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<sup>1</sup>A recent survey appears in Clarida, Gali and Gertler (1999).

<sup>2</sup>An early formulation of this principle appears in Goodfriend and King (1997) and is a main result of chapter 6 in Woodford (2003). The basic logic underlying it is that price stickiness causes relative price distortions that are non existent when prices are flexible. Hence, a monetary policy aimed at replicating the flexible price allocation, in the presence of sticky prices, eliminates those distortions.

<sup>3</sup>Wages are normally believed to be more sticky than most prices (Friedman (1999)). A recent detailed study of individual price adjustments in Belgium is consistent with this view (Aucremanne and Dhyne (2004)).

equilibrium is preferable on ex ante welfare grounds to a flexible price equilibrium.

The paper is organized as follows. Section 2 briefly surveys major developments in macroeconomic thought during the last forty years and compares new with old Keynesian economics. Section 3 compares and contrasts new and old notions of potential output, of the output gap and of the corresponding implications for monetary policy. Section 4 utilizes a conventional model of differentiated products with sticky wages to show that consumption and production are less volatile under sticky prices than under flexible price and identifies conditions for which expected welfare is higher under sticky than under flexible prices. This is followed by concluding reflections.

## **2 New Keynesian economics versus the Keynesian consensus of the sixties**

I have chosen the sixties as a point of departure against which to compare the recent body of research dealing with macroeconomic fluctuations and monetary policy known as New Keynesian Economics (NKE) because the sixties are commonly believed to be the heydays of Keynesianism in the US. My discussion will be deliberately brief. Fuller accounts of NKE appear in Clarida, Gali and Gertler (1999), Gali (2003) and Woodford (2003).

### **2.1 Macroeconomic thought from the sixties to the present - A bird's eye view.**

As a first pass, a student of macroeconomics during the sixties would have been told that the behavior of the economy differs depending on whether prices and wages are sticky downward or whether they are fully flexible. In the first case, if aggregate demand happens to be lower than productive capacity (or potential output), economic activity is demand determined and the price level is fixed. In the second, classical case, economic activity is determined by supply or productive capacity and changes in demand only affect the price level. The appearance of the Phillips curve (Phillips (1958)) replaced those polar benchmark cases with a, more continuous, negatively sloped empirical relation between inflation and unemployment. Within a couple of

years this empirical relation was interpreted as reflecting a **stable** tradeoff between those two variables. The policy implication was that, by being more or less restrictive, monetary policy could position the economy at a point of its choice along this tradeoff (Samuelson and Solow (1960)).

Friedman (1968) disputed this view on the ground that the tradeoff lasts only as long as inflation is unanticipated. Following the oil shocks of the seventies and Lucas' (1972, 1973) work the view that the tradeoff is temporary became widely accepted. This led to a reconsideration of the relative importance of monetary and of real factors in the generation of business cycles. Monetary and financial factors were deemphasized and real factors like productivity and taste shocks were propelled into the center of macroeconomic investigations of the real business cycle (RBC) of the eighties and nineties.<sup>4</sup> Interestingly both Lucas' work as well as most RBC models till the mid nineties postulated flexible prices and competitive markets. But during the last decade sticky prices and monopolistic competition were gradually integrated into some RBC models. As a matter of fact the integration of those factors into RBC frameworks is a major distinguishing feature of NKE as illustrated, inter alia, by the work of Goodfriend and King (1997).

## 2.2 New versus old Keynesian models

I turn now to a more systematic comparison of the old (circa 1960) and the new Keynesian models.

1. A major factor that is common to both frameworks is that, within some range, prices and/or nominal wages are sticky and economic activity is demand determined. In the old version the microfoundations of this process are not explicitly specified and, at least in its polar version, old Keynesian thinking admits of one of the two following alternative regimes. One in which output adjusts fully to satisfy demand while the price level does not respond at all to demand shocks. In the other "full employment" regime output does not respond and all the burden of adjustment to demand shocks is borne by the price level. In New Keynesian models (NKM) there are explicit microfoundations based on monopolistic competition due to product

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<sup>4</sup>At the methodological level, the RBC literature insisted on the explicit formulation of individual dynamic optimization and of preferences and technology.

differentiation and sticky prices that are motivated by costs of price adjustments. An early theoretical formulation of such a framework appears in Blanchard and Kiyotaki (1987).<sup>5</sup> Due to the temporary stickiness of prices and the existence of positive profits it is optimal for firms to accommodate demand shocks by means of higher production within some range.

2. Contrary to old Keynesian models (OKM) prices in NKM are sticky only temporarily.<sup>6</sup> When the appropriate time comes the individual firm's price is reset at an optimal level that takes into consideration the fact that resetting the price again in the future is costly. As a consequence current price setting behavior is a function of current inflationary expectations. This requires the explicit modeling of inflationary expectations which are normally specified as being model consistent expectations. The optimal resetting of prices and the influence of inflationary expectations on this activity are absent in the OKM.

3. Asymmetries in upward versus downward adjustments of nominal variables is an important element of OKM. In particular OKM postulate that prices, and particularly nominal wages, are more sticky downward than upward.<sup>7</sup> By contrast in NKM the degree of nominal stickiness is independent of the direction of pressure for price change.

4. All firms in the economy normally do not adjust their prices simultaneously. OKM are silent on this issue. An attractive feature of NKM is that they attempt to evaluate the positive and normative consequences of price staggering. For tractability reasons the costs of price adjustment are not modeled explicitly. Following a suggestion by Calvo (1983) it is postulated instead that each firm can reset its price in any given period with a constant probability that is smaller than one. As a consequence, when a firm gets the opportunity to reset its price it takes into consideration that it might not be given such an opportunity again for a number of periods to come. This formalism is widely used in NKM to evaluate the costs of inflation and to draw conclusions for optimal monetary policy.<sup>8</sup>

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<sup>5</sup>For more recent work that also features empirics see Rotemberg and Woodford (1997)

<sup>6</sup>In the old models there is no explicit mention of the length of time over which prices are sticky.

<sup>7</sup>Recent evidence for the US supports the view that nominal wages are particularly sticky downward (Bewley (1999)).

<sup>8</sup>Examples appear in Gali (2002), Chapter 3 of Woodford (2003), Schmitt-Grohe and Uribe (2004). Explicit modeling of the consequences of costs of price adjustments for **endogenous** price setting decisions have been extensively studied during the eighties at the micro level. A collection of relevant articles appears in Sheshinski and Weiss (1993). As far as I know such endogenous price adjustment decision have not been integrated into NKM.

5. Like RBC models on which they are anchored, NKM feature explicit dynamic optimization at the level of the individual economic unit. For the most part OKM of the sixties were static and did not incorporate micro based consequences of those dynamics like intertemporal substitution in consumption.

6. The dynamics of inventory accumulations and decumulations play an important role in Keynes original thinking and in some of the large scale econometric models of the sixties. To this point NKM did not incorporate inventories into the analysis.

7. Both old and new Keynesian models largely abstract from supply constraints when dealing with the effects of demand on economic activity. This is usually assumed explicitly in the old models. In the new models this is done by implicitly assuming that the demand shocks are not too large so that total demand facing a typical firm is smaller than the level of output at which the firm's marginal cost of production becomes larger than its temporarily fixed price. In the absence of this assumption actual economic activity would have to be specified as the minimum between that level of output and demand.

In summary, the main distinguishing feature of NKM is that they incorporate sticky prices and monopolistic competition into RBC frameworks. In that they build a bridge between neoclassical and Keynesian frameworks in which economic activity is demand determined. But, it seems that one could have, with equal justification, characterized the body of research under the NKM heading as a New Neoclassical Synthesis (NNS) that, introduces sticky prices into a RBC core. This, equally plausible, characterization is reflected in the title of Goodfriend and King (1997) paper. Titles aside, an attractive byproduct of this synthesis is that it makes it possible to recognize the effects of inflationary expectations on current price setting behavior.

### **3 Potential output - traditional versus new**

#### **3.1 Traditional measures of potential output and of the output gap**

Central bankers and other policymakers conceive and measure the business cycle in terms of the deviation of actual output from some smooth version of output that is normally referred

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to as potential output. There is little doubt that monetary policy in most Western economies is affected by the perceptions of their central banks about potential output. Various methods have been used to measure potential output by practitioners. Some are based on the production function approach, sometimes in combination with measures of capacity utilization. Other methods are based on various statistical smoothing devices like the Hodrick Prescott filter or polynomial smoothers. The output gap is then defined as the difference between actual output and potential output as measured by one of those methods. All these methods share two basic features. First, they do not possess very explicit conceptual foundations. Second, they all imply that potential output is a substantially more sluggish variable than actual output. Those features also characterize the business cycle chronology of the NBER, as well as recent attempts to develop a business cycle chronology for Europe.<sup>9</sup>

### **3.2 Potential output as a flexible price equilibrium**

Perhaps the most intriguing innovation of the NNS/NKE is based on the notion that the level of output to be targeted by monetary policy should maximize welfare. Under some conditions this criterion implies that monetary authorities should try to steer the economy as near as possible to the level of output that would have been produced under flexible prices and wages.<sup>10</sup> The intuition underlying this policy recommendation originates from staggering in the setting of prices by firms. In the presence of staggering some prices respond to previously unanticipated shocks and other do not. As a consequence some firms produce more than the amount that they would have produced had all prices been flexible while other firms produce less than this benchmark.

In the absence of other distortions the flexible price equilibrium is a first best. Provided this condition is satisfied, if monetary policy could induce firms to produce at (or nearer to) the levels of output they would have chosen under fully flexible prices, welfare would be enhanced.

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<sup>9</sup>See Artis et. al. (2003).

<sup>10</sup>An early formulation of this principle appears in Goodfriend and King (1997) and is a basic result of chapter 6 in Woodford (2003). In some cases this principle leads to the optimality of complete price stability. See also King and Wolman (1999) and Goodfriend and King (2001). Initial Neo-Keynesians (as opposed to New-Keynesians) largely adhered to traditional concepts of potential output because they did not put a RBC core into their models.

But, in the presence of monopolistic competition the flexible price equilibrium is not a first best. To focus on the distortions due to staggering in isolation Woodford (2003) postulates the existence of other instruments (like corrective subsidies and taxes) which assure that the flexible price equilibrium is a first best. Under this condition deviations of actual from the flexible prices level of output creates distortions that are due only to staggering. The Calvo formalism makes it possible to characterize those distortions within a RBC framework and to demonstrate, using quadratic approximations, that welfare is a decreasing function of the distance between the sticky and the flexible price equilibria.

In light of this chapter 6 in Woodford (2003) proposes to conceptualize the output gap as the difference between the level of output in the presence of sticky prices and staggering, and the level of output under fully flexible prices. Characterization of the gap in this way implies, at least implicitly, that "potential output" is conceptualized as the level of output that would have been produced in the economy under fully flexible prices, and in the absence of distortions. This notion of potential output has two attractive features. First, it is welfare based. Second it is particularly suited as a target for monetary policy since it directs attention to the distortion that monetary policy can handle (temporary distortions of relative prices) and abstracts from those, like the monopolistic competition distortion, that monetary policy cannot handle.<sup>11</sup>

### **3.3 Is there a connection between traditional potential output and the flexible price equilibrium?**

The short answer to the question posed in the title of this subsection is that, to the extent there is a connection between the two concepts, it is tenuous at best and most likely non existent. Getting reliable measures of the flexible price equilibrium level of output is a non trivial task that, at best, is in its infancy. But even if the profession had already been at a stage in which this practical difficulty had been resolved I believe there may exist a range of cases in which real life policymakers would not be inclined to conduct monetary policy in a manner designed to

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<sup>11</sup>Similar relative price distortions have been modeled in the literature of the seventies and the early eighties as being due to "sticky information" (as in Lucas' island models) rather than to sticky prices. In this literature distortion arising from misalignments of relative prices were characterized by means of the distance between output under imperfect information and output under full information. A survey of this earlier literature appears in Cukierman (1983).

attain the flexible price equilibrium. The reasons for such doubt are elaborated in what follows.

First, real life flexible price equilibria are contaminated by various distortions including, inter alia, the monopolistic competition distortion stressed in NKM. Second, as a theoretical matter, output in the flexible price equilibrium may be more volatile than output in the sticky price equilibrium.<sup>12</sup> One implication of such situations is that monetary policymakers adopting the flexible price equilibrium as a target have to conduct monetary policy in a manner that would lead to **wider** output fluctuations than under the sticky price equilibrium. I doubt that many policymakers would be willing to adopt such a course of action. Most policymakers, including central bankers seem to prefer stabler to more volatile levels of output. Conditional on accepting this reality judgement one may further ask what could be the reasons for such an attitude. Obviously one possibility is that such policymakers are making a mistake and that, once they master the logic underlying the desirability of the flexible price equilibrium (assuming it is undistorted), they will see the light and adopt it as a target for monetary policy. Another possibility is that existing versions of NKM abstract from some factors that affect welfare, but to which practical policymakers are not insensitive. The next section illustrates such a possibility by developing a precise example of such a case.

## 4 Sticky prices and wages may be welfare superior to flexible prices - an illustration

The formal example in this section is meant to illustrate the following main points. With sticky nominal wages, output, and therefore income and consumption, are in many cases less volatile when prices are sticky than when prices are flexible. On the other hand leisure is more volatile under sticky than under flexible prices. Those two regimes thus involve a tradeoff between volatility of consumption and volatility of leisure. As a consequence the expected welfare of individuals who are sufficiently more risk averse in consumption than in leisure is higher under sticky than under flexible prices. This is demonstrated within a framework in which the economy is hit by transitory productivity shocks, and in which equilibrium production and consumption

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<sup>12</sup>The next section provides an illustration of such a case. See also Gali (2002).

fluctuate randomly due to those shocks.

Essentially, by rendering consumption streams less volatile in the face of productivity shocks, a sticky price equilibrium (SPE) provides more stable consumption streams to individuals than a flexible price equilibrium (FPE). The relatively stabler behavior of production and of consumption in the SPE is due to the fact that in the FPE, markups are constant implying that the real wage goes up and down with transitory productivity shocks. By contrast in the SPE the real wage is constant creating a, relatively stronger, inverse relation between employment and productivity than in the FPE. This mitigates the effect of productivity shocks on the volatility of consumption but raises the volatility of leisure. Since the first effect raises expected welfare while the second effect reduces it, expected welfare may in general be higher or lower in the SPE. When individuals are sufficiently more risk averse in consumption than in leisure, the smoother consumption streams produced in the SPE more than compensate individuals, in expected utility terms, for the higher volatility of leisure generated by the SPE.

## 4.1 Model

The economy consists of a continuum of individuals on the  $[0, 1]$  interval and of a continuum of firms also on the  $[0, 1]$  interval, with each firm producing a particular differentiated good.<sup>13</sup> The utility function of a typical individual is given by

$$u(C) + v(l) \tag{1}$$

where  $C$  is a Dixit and Stiglitz (1977) constant elasticity-of- substitution aggregator of differentiated goods,  $l$  is leisure and each of the two components of utility displays positive but decreasing marginal utility ( $u'(\cdot)$  and  $v'(\cdot)$  positive and  $u''(\cdot)$  and  $v''(\cdot)$  negative). The consumption aggregator and the corresponding ideal price index,  $P$ , are given by

$$C = \left[ \int_0^1 c(i)^{\frac{\eta-1}{\eta}} di \right]^{\frac{\eta}{\eta-1}} \tag{2}$$

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<sup>13</sup>The model is a variant of the one in Goodfriend (2002).

and

$$P = \left[ \int_0^1 p(i)^{1-\eta} di \right]^{\frac{1}{1-\eta}}. \quad (3)$$

Here  $c(i)$  is the quantity of variety  $i$ ,  $p(i)$  is the price of this variety and  $\eta$  is the constant (across different pairs of goods) elasticity of substitution between different varieties.  $P$  is the minimum cost of a unit of the aggregate defined in (2). Each individual is endowed with one unit of time in each period, which he can allocate to either leisure or work,  $n$ . Thus

$$l + n = 1. \quad (4)$$

The typical firm is endowed with a constant return to scale technology that transforms labor input into output of the  $i$ 'th variety according to

$$y(i) = an(i), \quad i \in [0, 1]. \quad (5)$$

Labor productivity,  $a$ , is subject to serially uncorrelated stochastic fluctuations, and possesses a time invariant mean,  $Ea_t = \bar{a}$ , and a variance  $\sigma^2$ . It can be shown (Dixit and Stiglitz (1977)) that, for a given budget, maximization of utility from consumption implies that, at given prices, the individual demand for variety  $i$  is

$$c^d(i) = \left( \frac{p(i)}{P} \right)^{-\eta} C \quad (6)$$

and that  $C$  is equal to the total real budget allocated to consumption. Since the mass of consumers is one equation (6) also represents total demand for variety  $i$ .

The main objective of this section is to compare and contrast the behavior of the economy and to draw implications for the level of welfare under two alternative scenarios. One, in which prices are flexible in the sense that they are set **after** the realization of labor productivity in each period. In the second case prices are sticky in the sense that they are set **prior** to the realization of labor productivity for each period. The first case is labelled FP (for flexible prices) and the second SP (for sticky prices). In both cases nominal wages are taken to be fixed at an

exogenous level,  $W$ .<sup>14</sup> In both cases production, consumption and employment decisions in each period are made after the realization of labor productivity for the period.

## 4.2 Consumers

The problem of a typical consumer is to pick  $C$  and  $n$  so as to maximize utility in (1) subject to the time constraint in (4) and the budget constraint

$$y \equiv \pi + wn = C. \quad (7)$$

Here  $w \equiv \frac{W}{P}$  and  $\pi$  are the real wage and the profits that the individual obtains from his share of firms' ownership. The individual consumes all his income. All profits are distributed to individuals but they take them as given when choosing labor supply and consumption. Note that since the mass of consumers is one, equation (7) represents the income, the consumption and the functional income shares of a single individual, as well as the aggregate values of those variables. The first order condition for the consumer problem is given by

$$wu'(\pi + wn^s) - v'(1 - n^s) = 0 \quad (8)$$

and implicitly determines labor supply,  $n^s$ . It restates the conventional result that the individual works up to the point at which the marginal utility of an additional unit of time allocated to work equals the marginal utility of leisure.

## 4.3 The flexible price equilibrium (FPE)

The distinguishing feature of the FPE is that individual firms set their prices for each period **after** the realization of labor productivity for the period.

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<sup>14</sup>Recent evidence from a detailed study of the Belgian CPI during the nineties suggests that more than fifty percent of individual prices have a duration lower than one year (Figure 1 in Aucremanne and Dhyne (2004)). Since the duration of nominal wage contracts is normally at least a year the assumption in the text is not inconsistent with reality.

### 4.3.1 Firms

The typical firm takes the general price level, total expenditure on consumption in (2) and (3) and the known realization of productivity as given and sets its price so as to maximize the value of profits. Real profits of each firm are given by

$$\frac{p(i)c^d(i) - Wn^d(i)}{P} = \frac{C}{P^{1-\eta}} \left[ (p(i))^{1-\eta} - \frac{W}{a}(p(i))^{-\eta} \right]. \quad (9)$$

Here  $n^d(i) = \frac{c^d(i)}{a}$  is the firm's derived demand for labor needed to satisfy product demand at level  $c^d(i)$ . Technically, the term to the right of the equality sign follows by using (5) and (6) to substitute  $c^d(i)$  and  $n^d(i)$  out. Since the single firm takes  $C$  and  $P$  as given maximization of (9) with respect to  $p(i)$  is equivalent to maximization of the term in brackets on the right hand side of this equation with respect to this variable. The solution to this problem yields

$$p(i) = \frac{\eta}{\eta - 1} \frac{W}{a} \equiv \frac{\eta}{\eta - 1} mc \quad (10)$$

implying, as is standard in models of monopolistic competition based on a Dixit-Stiglitz utility, that the individual price is a constant markup,  $\frac{\eta}{\eta-1}$ , over the marginal cost,  $\frac{W}{a}$ . Since the marginal cost is the same for all firms they all set the same price so that

$$p(i) = P, \quad i \in [0, 1]. \quad (11)$$

Thus, under flexible prices, the profit maximizing markup is the same across firms, does not depend on productivity, and is given by

$$\frac{P}{mc} = \frac{\eta}{\eta - 1} \equiv \mu^*. \quad (12)$$

As a consequence each firm produces the same quantity of its differentiated product so that  $c^d(i) = C$  for all  $i \in [0, 1]$ . Equilibrium in the commodity market implies that quantity demanded is equal to total production so that

$$y \equiv C. \quad (13)$$

Furthermore, combining (10) and (11), the real wage under flexible prices is a constant multiple of labor productivity and is given by

$$w \equiv \frac{W}{P} = \frac{a}{\mu^*} = \frac{\eta - 1}{\eta} a. \quad (14)$$

From the production function in (5) and from (13) demand for labor by the  $i$ 'th firm is  $n^d = \frac{C}{a} = \frac{y}{a}$ . Since the mass of firms is one this is also aggregate labor demand. Equilibrium in the labor market implies

$$n^d = \frac{C}{a} = n^s \equiv n_f \quad (15)$$

where  $n_f$  is equilibrium labor input under flexible prices. Using this condition along with commodity market equilibrium ((13)) in the consumer's first order condition (equation (8)) and taking note of (7), we obtain

$$\frac{a}{\mu^*} u'(an_f) - v'(1 - n_f) = 0. \quad (16)$$

This relation implicitly determines the general equilibrium level of employment under flexible prices.

## 4.4 The sticky price equilibrium (SPE)

Sticky prices are characterized by the requirement that firms set prices **prior** to the realization of labor productivity so that prices are invariant to realizations of productivity. As a consequence the real wage is invariant to productivity shocks while the markup, which was invariant to those shocks under sticky prices, varies with the realization of productivity. But, production, employment and consumption decisions are still made after the realization of each period's shock.

### 4.4.1 Firms

Within each period the typical firm takes the general price level and total expenditure on consumption as given and sets its price so as to maximize the expected value of profits for the period. Profits for the period are now uncertain since the firm has to commit to a nominal price prior to the realization of labor productivity. The firm picks its price at the beginning of each

period so as to maximize

$$E \frac{C}{P^{1-\eta}} \left[ (p(i))^{1-\eta} - \frac{W}{a} (p(i))^{-\eta} \right] = \frac{1}{P^{1-\eta}} [EC(p(i))^{1-\eta} - WE(n)(p(i))^{-\eta}]. \quad (17)$$

Note that at the time  $p(i)$  is chosen  $C$  and  $n$  are stochastic variables since they depend on the yet unknown realization of labor productivity for the period. The solution to this problem is

$$p(i) = W \frac{E(n)}{EC} \frac{\eta}{\eta - 1} = W \frac{E(n)}{EC} \mu^* = P, \quad i \in [0, 1] \quad (18)$$

where the second equality follows from the definition of  $\mu^*$  in (12). The third equality reflects the fact that all firms set the same price in both periods. Rearrangement of (18) provides an expression for the real wage in terms of the, shock invariant, expected values of consumption and of employment, and of the profit maximizing markup.

$$\frac{W}{P} = \frac{EC}{E(n)} \frac{1}{\mu^*} \equiv w_s. \quad (19)$$

Since both prices and wages are sticky the real wage remains at  $w_s$  even after the realization of productivity for the period implying that markups move up and down with productivity. The precise relation is given by

$$\mu(a) = \frac{a}{w_s}. \quad (20)$$

Similarly to the case of flexible prices, the equilibrium conditions in the commodity and the labor markets, along with the consumer's first order condition in equation (8) imply that equilibrium employment under sticky prices,  $n_s$ , is determined implicitly from the relation

$$w_s u'(an_s) - v'(1 - n_s) = 0. \quad (21)$$

## 4.5 Comparison of economic behavior under sticky and under flexible prices

Equations (16) and (21) above can now be used to find the main differences between the behavior of equilibrium employment under flexible and under sticky prices. Comparison of those equations

suggests that the only difference between them concerns the real wage. Under flexible prices the real wage changes directly with productivity according to the relation  $w_f = \frac{a}{\mu^*}$  while, under sticky prices it is fixed at  $w_s$ . Clearly, for the particular productivity realization at which those two real wages are equal the levels of employment in the two regimes are identical ( $n_f = n_s \equiv n$ ). Denoting by  $a_0$  this particular level of productivity,  $a_0$  is determined by the relation

$$w_s = \frac{a_0}{\mu^*} \equiv w_f(a_0). \quad (22)$$

I turn next to the implications of the difference in real wage behavior for the behavior of employment and of consumption. The following two propositions summarize the main results

**Proposition 1** *In the neighborhood of  $a_0$ ;*

(i) *A decrease in productivity raises employment under sticky prices and may either raise or reduce employment under flexible prices.*

(ii) *When, following a given drop in productivity employment under flexible prices goes up, it always goes up by less than the increase in employment under sticky prices.*

(iii) *A decrease in productivity raises employment under flexible prices if and only if the degree of relative risk aversion in consumption ( $\gamma$ ) is larger than one.<sup>15</sup>*

**Proposition 2** *In the neighborhood of  $a_0$  consumption is positively related to productivity under both flexible and sticky prices but it fluctuates more widely under flexible than under sticky prices.*

The proofs of the propositions are in the appendix.

Intuitively, the basic reason for the differences between the two regimes is that, under sticky prices, the real wage does not adjust to changes in productivity, whereas it immediately changes directly with productivity under flexible prices. As a consequence, following an unanticipated decrease in productivity the real wage goes down under flexible prices causing a stronger drop in employment than under a sticky prices regime in which the real wage is constant. If the degree of relative risk aversion in consumption is sufficiently large, employment moves to partially offset the effect of the productivity decrease on consumption with both flexible and

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<sup>15</sup> *When  $\gamma$  is smaller than (or equal to) one a drop in productivity leads to a drop (no change) in employment under flexible prices, exacerbating the effect of the decrease in productivity on consumption.*

sticky prices. However, due to the positive correlation between the real wage and productivity under flexible prices the offset is smaller in this case. The second proposition is a corollary of the first. The relatively smaller increase in employment following a decrease in productivity under flexible prices offsets the drop in consumption to a lesser extent than under sticky prices. As a consequence, consumption and output fluctuate more under flexible prices.

## 4.6 Implications for expected welfare under sticky and under flexible prices

A widely used criterion for the ex ante evaluation of welfare is expected utility. Since they are risk averse consumers prefer stable consumption and stable leisure to fluctuating values of those variables. The two propositions above imply that (in the neighborhood of  $a_0$ ) consumption is more volatile, and leisure is less volatile under flexible than under sticky prices. Hence, the welfare comparison between sticky and flexible prices involves a tradeoff between the stability (or variability) of leisure and the stability (or variability) of consumption. The FPE yields one point along this tradeoff and the SPE yields another. Depending on the relative degrees of risk aversion in consumption and in leisure the first or the second point along this tradeoff may be welfare superior.

In particular expected welfare under sticky prices is higher than under flexible prices if, taking the FPE as a benchmark, the lower welfare due to the higher variability of leisure under sticky prices is more than compensated for by the smoother level of consumption delivered by sticky prices. This is more likely to be the case, the higher the degree of risk aversion in consumption, in comparison to the degree of risk aversion in leisure. Although the local nature of the results implies that, strictly speaking, this argument holds for sufficiently concentrated distributions of productivity, the result is likely to be more general since the "locality" requirement is sufficient but not necessary. (This can be seen from the structure of the proofs in the appendix).

## 4.7 Discussion and caveats

Under traditional measures of potential output, a policymaker who aims at stabilization of the output gap invariably reveals a preference for a smoother level of economic activity. By contrast the New Keynesian conception of output gaps may imply that policy should allow economic activity to be more volatile than under sticky prices.

The illustration in this section suggests that this "preference for smoothing" on the part of policymakers is, in some cases, consistent with maximization of expected welfare. The reason is that, in the absence of complete markets, sticky price equilibria provide, in some cases, a better overall allocation of consumption and of leisure risks over the business cycle than flexible price equilibria. Although in the illustration cycles are driven only by productivity shocks, it is likely that similar factors will operate in the presence of demand and of other shocks as well.

By assuming that all prices are set at the beginning of each period I have abstracted from the welfare costs associated with asynchronization in price setting. Since staggering in price setting is one of the main reasons for the New Keynesian recommendation to take the more volatile level of output under flexible prices as a target, the illustration is biased in favor of a preference for smoothing. Obviously, a fuller analysis should incorporate both the better insurance of business cycle risks provided by sticky prices, as well as the relative price distortions associated with staggering. However it is likely that there will be, even in the extended framework, plausible cases for which less volatile sticky price equilibria will be welfare superior to more volatile flexible price equilibria.

For simplicity I have abstracted from dynamic elements by utilizing a one period model. However, additional work (not shown) suggests that the main result of this section, that with a sufficiently high degree of risk aversion in consumption relatively to leisure expected welfare in the SPE is larger than in the FPE, carries over to multiperiods frameworks.

## 5 Concluding reflections

After a survey of the main differences and similarities between old and New Keynesian concepts this paper focusses on a tension between sluggish traditional measures of potential output used by policymakers and the recent New Keynesian proposal to identify potential output with a

notional flexible price equilibrium that is often relatively more volatile.

Casual observation suggests that monetary policymakers gear their actions to partially offset traditional measures of the output gap in which the potential or target level of output is a relatively smooth version of actual output. The paper has shown that such a preference for stable output is consistent, in some cases, with a welfare superior allocation of consumption risks over the business cycle. The reason is that the levels of output and of consumption are less variable under sticky than under flexible prices but leisure is more variable creating a tradeoff between smooth consumption and smooth leisure. The paper identifies conditions under which the benefits of smoother consumption outweigh the costs of more variable leisure so that the sticky price equilibrium dominates the flexible price equilibrium in terms of expected welfare.

The illustration in the paper suggests that targeting the flexible price equilibrium (as recommended by Woodford (2003, chapter 6)) might be abstracting from welfare considerations that are beyond the relative price distortions featured in recent NKM.<sup>16</sup> One may wonder about the origin of the difference between this recommendation and the result in this paper. Woodford derives his result under the assumptions that there is in place a system of taxes cum subsidies that offset the monopolistic competition distortion and that the degree of stickiness in wages and prices is similar.

By contrast, the illustration in this paper investigates the relative welfare desirability of sticky versus flexible prices **in the presence** of the monopolistic competition distortion and with sticky nominal wages under both sticky and flexible prices implying that - in the second case - wages are more sticky than prices. This probably explains the difference between his result and mine. Perhaps more importantly this suggests that, in the absence of a system of taxes cum subsidies designed to offset the monopolistic competition distortion and in the presence of universally sticky nominal wages, the flexible price equilibrium is not always an appropriate target for monetary policy.

It is instructive to compare the broad conclusions obtained here with those of Goodfriend and King (1997) and Goodfriend (2002) in their NNS. They postulate that prices are sticky

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<sup>16</sup>But the illustration does not work out the implications of this observation for the optimal target level of output. Such an undertaking would have to combine the distortions that are due to staggering with those that are due to excessive fluctuation in consumption over the business cycle.

but that nominal wages are flexible. As a consequence, an unanticipated productivity shock is equilibrated by changes in the nominal wage and individuals work less in periods of low productivity exacerbating the fall in consumption, due to the reduced productivity. By contrast, as shown here, when both wages and prices are sticky, individuals work more in periods of low productivity. This partially shields consumption from the wider fluctuations produced under flexible prices and sticky wages.

NKM implicitly take the length of time over which nominal wages and prices are fixed to be similar. Yet there is evidence, at least for Europe, that at least fifty percent of prices change at least once within a year (Aucremanne and Dhyne (2004)). Since nominal wage contracts are usually longer than a year it would appear that more attention should be devoted to frameworks which recognize that spells of fixed nominal wages are longer than spells of fixed prices for most prices.<sup>17</sup> A survey of recent models in which prices are more flexible than nominal wages appears in Cukierman (Forthcoming).

## 6 Appendix:

### 6.1 Proof of proposition 1

(i) Applying the implicit function theorem to equations (16) and (21) to evaluate the effects of a change in  $a$  on the equilibrium level of employment in the neighborhood of  $a_0$  yields

$$\frac{dn_f}{da}(a_0) = -\frac{nw_s u''(a_0 n) + \frac{1}{\mu^*} u'(a_0 n)}{a_0 w_s u''(a_0 n) + v''(a_0 n)} \quad (23)$$

$$\frac{dn_s}{da}(a_0) = -\frac{nw_s u''(a_0 n)}{a_0 w_s u''(a_0 n) + v''(a_0 n)}. \quad (24)$$

The denominators of both expressions are identical and (since  $u''(\cdot) < 0$  and  $v''(\cdot) < 0$ ) negative. Since both expressions are preceded by minus signs their signs are determined by the signs of their respective numerators. Hence (since  $u''(\cdot) < 0$ ) the sign of  $\frac{dn_s}{da}(a_0)$  is negative but (since  $\frac{1}{\mu^*} u'(\cdot) > 0$ ) the sign of  $\frac{dn_f}{da}(a_0)$  is generally ambiguous. Hence a decrease in productivity raises

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<sup>17</sup>See also Bewley (1999) for the US.

employment under sticky prices and may either raise or reduce it under flexible prices.

(ii) Comparison of equations (23) and (24) reveals (since  $\frac{1}{\mu^*}u'(\cdot) > 0$ ) that

$$\frac{dn_s}{da}(a_0) < \frac{dn_f}{da}(a_0) \quad (25)$$

implying that, even if employment under flexible prices increases following a drop in productivity, it increases by less than under sticky prices.

(iii) Employment goes up following a decrease in productivity, under flexible prices, if and only if the numerator of equation (23) is negative. Using equation (22) to substitute  $w_s$  out from this numerator this is the case, in turn, if and only if

$$c_f u''(c_f) + u'(c_f) < 0. \quad (26)$$

Rearranging, this is equivalent to

$$(1 - \gamma)u'(c_f) < 0 \quad (27)$$

where

$$\gamma \equiv -\frac{c_f u''(c_f)}{u'(c_f)}$$

is the coefficient of relative risk aversion in consumption. It is easily seen that condition (27) is equivalent to the condition  $\gamma > 1$ .

## 6.2 Proof of proposition 2

The constant return to scale technology in conjunction with equilibrium in the commodity market imply that, for any  $a$ ,

$$C = an(a) \quad (28)$$

where the notation  $n(a)$  highlights the fact that the level of employment depends on productivity.

Differentiating equation (28) with respect to  $a$

$$\frac{dC}{da}(a) = n(a) + a \frac{dn}{da}(a). \quad (29)$$

Substituting  $\frac{dn_s}{da}(a_0)$  into equation (29) and rearranging

$$\frac{dC_s}{da}(a) = \frac{v''(a_0n)}{a_0w_su''(a_0n) + v''(a_0n)} > 0. \quad (30)$$

Thus, in spite of a stronger offsetting effect via employment under sticky than under flexible prices, consumption goes up and down with productivity in the sticky prices case. Using equations (25) and (30) in (29) yields

$$0 < \frac{dC_s}{da}(a) < \frac{dC_f}{da}(a)$$

implying that, under both sticky and flexible prices, consumption is directly related to productivity, and that it fluctuates more widely under the latter.

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