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Keynesian Economics, Monetary Policy and the Business Cycle – New and Old

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Abstract: *After a brief review of the main differences between New and Old Keynesian economics from the sixties this paper focuses on a tension between traditional sluggish measures of potential output commonly used by policymakers and the New Keynesian (NK) notion of this variable which conceptualizes it as the level of output that would have been produced under perfect competition had all prices and wages been flexible. The paper shows that, under monopolistic competition, NK potential output is often more volatile than the level of output produced under sticky prices and wages implying either of the following. Real life policymakers mistakenly target smooth versions of output or (since actual economies are monopolistically rather than perfectly competitive) the flexible price and wage equilibrium does not necessarily maximize welfare. The paper shows, that depending on the shape of the utility function and of the distribution of productivity shocks either case is possible and proposes a criterion for discriminating between them.* (*JEL* E3, E4, E5, E6)

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

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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 body of research known as New Keynesian economics.[1]

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 and wages as a target. 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 and wage stickiness causes relative price distortions that are non existent when those nominal variables are flexible. Hence, a monetary policy aimed at replicating the flexible price and wage allocation, in the presence of stickiness in those nominal variables, eliminates those distortions.

A main result of this paper is that, under reasonable circumstances, this output level may be more volatile than the level of output under sticky prices and wages implying that policymakers subscribing to this New Keynesian policy recommendation would have to allow output to fluctuate more than under sticky prices and wages. This result is obtained within a microfounded illustrative framework by comparing the equilibria obtained in the case in which prices and nominal wages are fully flexible with the case in which they are sticky. It is a reality judgement of this author that, even if they had been able to get a measure of output under flexible prices and wages, most central bankers are currently unlikely to embrace wider fluctuations in output in order to attain the (more volatile) level of output under flexible prices and wages. As a matter of fact practically all existing empirical measures of potential output, starting with those produced by Burns and Mitchell for the US, are designed, at least implicitly, towards the smoothing of output rather than towards increasing its volatility.

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[1] A survey appears in Clarida, Galí and Gertler (1999).

Acceptance of this premise raises an important policy relevant question about the source of the discrepancy between the New Keynesian policy recommendation and actual policy practice. One possibility is that existing policy procedures are badly structured and should be revised. Another possibility is that New Keynesian models abstract from some factors that policymakers rightly pay attention to. For example, the flexible price and wage equilibrium may not be a first best to start with, due to reasons beyond those caused by sticky prices and wages. In such a case the general principle of the second best may imply that the addition of a distortion caused by sticky prices and wages actually improves matters.[2]

The illustration in the paper allows the flexible price and wage equilibrium to be distorted by recognizing that there is a monopolistic competition distortion that is not offset by appropriate taxes and subsidies.[3] A main result is that, frequently, output and consumption are less volatile and leisure more volatile when prices and wages are sticky than when they are flexible. Thus, a virtual shift from an economy with sticky prices and wages to one in which those nominal variables are flexible often involves a tradeoff between the variability of consumption and the variability of leisure. Hence, when consumers are sufficiently more risk averse with respect to consumption than they are with respect to leisure, an equilibrium with sticky nominal variables may, at least in principle, be preferable on ex ante welfare grounds to an equilibrium in which nominal variables are fully flexible.

To establish such a possibility beyond reasonable doubt a search over alternative specifications of economic conditions has been conducted and the levels of welfare under sticky prices and wages have been compared to their levels when those nominal variables are flexible. Although this search, which was limited by tractability considerations, produced more cases in which expected welfare is higher under flexible than under sticky prices and wages, cases in which the opposite was true also arose. The paper presents a particular example in which expected welfare is higher under sticky than under flexible prices and wages and proposes a more general criterion for distinguishing economies in which sticky prices and wages are preferable from economies in which the opposite is true.

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2 Obviously, those possibilities are not mutually exclusive.

3 By contrast the early New Keynesian literature often assumes, for simplicity, that any pre-existing steady state distortion is fully offset by an appropriate system of subsidies cum taxes (Rotemberg and Woodford 1997; Erceg, Henderson and Levin 2000; and chapter 6 of Woodford 2003). Benigno and Woodford (2004) consider the more realistic case in which such subsidies are absent.

The paper is organized as follows. Section 2 briefly surveys major developments in macroeconomic thought during the last fourty 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 to show that consumption and production are often less volatile under sticky than under flexible prices and wages. Section 5 attempts to discriminate between circumstances in which sticky prices and wages are ex ante welfare superior to flexible prices and wages from circumstances in which the reverse is true. The concluding section offers a broader discussion and a review of open questions raised by the analysis in the paper.

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, Galí and Gertler (1999), Galí (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.[4] 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 alias, 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 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 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).[5] 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.

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

5 For more recent work that also features empirics see Rotemberg and Woodford (1997).

2. Contrary to old Keyensian models (OKM) prices in NKM are sticky only temporarily.[6] When the appropriate time comes the individual firm's price is reset at an optimal level that takes into consideration the fact that reseting 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 reseting 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.[7] 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. The firm then sets its price so as to maximize its expected profits. This formalism is widely used in NKM to evaluate the costs of inflation and to draw conclusions for optimal monetary policy.[8]

Sticky prices and wages have also been modeled by assuming that prices and wages in a given period are preset in the previous period. This alternative modeling approach has been followed particularly in international macroeconomics. A prominent example is the Obstfeld and Rogoff (1995) redux paper.

5. Like RBC models on which they are anchored, NKM features 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.

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

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

8 Examples appear in Galí (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). Endogenous price adjustment decisions have recently been integrated into NKM by Dotsey and King (2005).

6. The dynamics of inventory accumulations and decummulations 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 Keynsian 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 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 (see Artis et. al. 2003).

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.[9] 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 flex nominal variables 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 and wages, welfare would be enhanced. But, in the presence of monopolistic competition the flex nominal variables equilibrium is not a first best. To focus on the distortions due to stagerring in isolation Woodford (2003) postulates the existence of other instruments (like corrective subsidies and taxes) which assure that the flex nominal variables equilibrium is a first best. Under this condition deviations of actual from the flexible prices and wages 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 flex nominal variables equilibria.

In light of this the main part of 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

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9 An early formulation of this principle appears in Goodfriend and King (1997), Rotemberg and Woodford (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 lay their analysis on a RBC core.

flexible prices and wages.[10] 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 wages, 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 relatively more efficiently (temporary distortions of relative prices).[11]

3.3 Is there a connection between traditional potential output and the flexible price and wage 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 and wage 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 it is likely that real life policymakers would not be inclined to conduct monetary policy in a manner designed to attain the flexible price and wage equilibrium.

First, real life flexible price and wage equilibria are contaminated by various distortions including, inter alias, the monopolistic competition distortion stressed in NKM. As a consequence the flexible price and wage equilibrium need not be a first best.[12] Second, as demonstrated below, output in the flexible price and wage equilibrium may be more volatile than output in the sticky price and wage equilibrium (see also Galí 2002). An implication of such situations is that monetary policymakers adopting the flexible price and wage equilibrium as a target would have to conduct monetary policy in a manner that would lead to *wider* output fluctuations than under sticky prices. Casual observation suggests that most policymakers would not be willing to adopt

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[10] The main part of the chapter compares equilibrium outcomes when prices are sticky with those outcomes when prices are flexible given that nominal wages are *flexible in both cases*. Drawing on Erceg, Henderson and Levin (2000) the latter part of the chapter contains an extension in which there is stickiness and staggering in both wages and prices.

[11] 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 misalignements 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). The idea of "sticky information" has recently been revived in the context of NKM by Mankiw and Reis (2002).

[12] Benigno and Woodford (2004) characterize optimal monetary policy in the presence of a monopolistic competition distortion.

such a course of action. Most policymakers, including central bankers appear to prefer less volatile to more volatile levels of output. As a matter of fact, to date, the practical implementation of "potential output" surveyed above is based on the notion that this concept is a smooth version of actual output implying, at least implicitly, that policymakers aim at reducing, rather than increasing, fluctuations in output.

How should we interpret these diametrically opposing views about the desirable objectives of policy? A priori, there are two possibilities. One is that real life policymakers are mistaken and that, once they master the impeccable logic underlying the desirability of the flexible price equilibrium (assuming it is undistorted), they will adopt it as a target for monetary policy. Another possibility is that, due to the existence of distortions other than the one caused by sticky prices and wages the flexible price and wage equilibrium is not a first best to start with. In such cases it is conceivable, although not necessary, that a less volatile level of output under sticky prices and wages may be preffered to a more volatile output under flexible prices and wages. This is one instance of the general principle of the second best.

This section takes a more precise look at those issues by producing a precise example in which, *there is* a monopolistic competition distortion. The example is used for two purposes. First to show that under flexible prices and wages output is often more volatile than under sticky prices and wages, and to identify the economic mechanism responsible for this result. Second, to examine whether the presence of a monopolistic competition distortion can produce cases in which an equilibrium with sticky prices and wages welfare dominates a flexible price and wage equilibrium. The results from those two experiments are then assembled to draw more general tentative conclusions about the widely established practice of using monetary policy to smooth output.

4 Flexible prices and wages may lead to more volatile output than sticky prices and wages – an illustration

The formal example in this section is meant to illustrate that with sticky nominal wages and prices, output, and therefore income and consumption, are often less volatile when prices and wages are sticky than when prices and wages are flexible. On the other hand leisure is often more volatile under sticky than under flexible nominal variables. Those two regimes thus involve a tradeoff between the volatility of output and consumption on one hand and the volatility of leisure on the other. This is demonstrated within a framework in which the economy is hit by transitory productivity shocks, and in which

equilibrium employment, production and consumption fluctuate randomly due to those shocks.

The relatively stabler behavior of production in the sticky price and wage equilibrium (SPE) is due to the fact that in the flexible price and wage equilibrium (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, in many cases, the volatility of leisure.

The economic mechanism producing those results can be understood roughly by comparing the behavior of firms and of the economy in the face of productivity shocks under flexible prices and wages with their behavior under sticky prices and wages. In the first case firms adjust their prices following productivity shocks to maintain their profit maximizing markups in the face of a nominal wage that adjusts to clear a competitive labor market. As a consequence the real wage goes up and down with productivity. By contrast, in the sticky nominal variables case the real wage does not adjust to productivity shocks. *In both cases*, when productivity goes down profits go down triggering, a negative pure income effect on leisure which increase the supply of labor and mitigates the decrease in production due to the decrease in productivity. Under flexible prices there is, additionally, a decrease in the real wage that normally reduces labor supply. This reduces the mitigating effect of the decrease in profits on the decrease in output due to the productivity decrease, making output volatilility in the FPE larger than under 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.[13] 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 ($u'(.)$ and $v'(.)$ posi-

[13] The model is a variant of the one in Goodfriend (2002).

tive and $u''(.)$ and $v''(.)$ negative). The consumption aggregator and the corresponding ideal price index, P, are given by

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

and

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

Here $c(i)$ is the quantity of variety i, $p(i)$ is the price of this variety and η is the constant (across different pairs of goods) elasticity of substitution between different varieties. P is the minimum cost of achieving the utility level defined by the aggregate 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

$$l + n = 1 . \tag{4}$$

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

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

Labor productivity, a, is subject to serially uncorrelated stochastic fluctuations, and possesses a time invariant mean, $Ea_t = \bar{a}$, and a variance σ^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

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

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 characterize the behavior of the economy and to draw implications for the relative volatilities of output, consumption and related variables under two alternative scenarios. One, in which prices and wages are flexible in the sense that they are set *after* the realization of labor productivity in each period. In the second case prices and wages are sticky in the sense that they are set *prior* to the realization of labor productivity for each period. In both cases nominal wages are taken to be fixed at an exogenous

level, W. 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

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

Here $w \equiv \frac{W}{P}$ and π 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

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

and it 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 and wage 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.

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

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

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 and W 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

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

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

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

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

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

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

(13) $$y = C.$$

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. Market clearing in the (competitive) labor market implies

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

where n_f is equilibrium labor input under flexible prices and wages. 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

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

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

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

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

Thus, the real wage depends only on labor productivity and on the profit maximizing markup of firms since, for any given nominal wage, W, firms always adjust their prices to obtain the profit maximizing markup, μ^*.[14] Given this real wage, clearing of the labor market is assured by equation (15) that combines the first order condition of a representative individual with labor market clearing. Essentially, labor market clearing is assured by the requirement that the marginal utility of labor supplied is equal to the real wage multiplied by the marginal utility of the consumption that is produced with this labor.

4.4 The sticky price and wage equilibrium (SPE)

Sticky prices and wages are characterized by the requirement that the nominal wage and prices are set *prior* to the realization of labor productivity. As a consequence the real wage is invariant to productivity shocks while the markup, which was invariant to those shocks under flexible prices and wages, 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

The typical firm takes the general price level, total expenditure on consumption and the nominal wage as given and sets its price so as to maximize the expected value of profits for the period. The markup is uncertain now 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

[14] As a consequence the nominal wage is inconsequential and can be taken as an arbitrary numeraire. Put differently, the equilibrium in the text pins down the real wage but not the nominal wage and the price level.

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

where the term to the right of the equality sign is obtained by using equations (9) and (14). 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

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

where the second equality follows from the definition o μ^* in (12). The third equality reflects the fact that all firms set the same price. 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.

$$(19)\qquad \frac{W}{P}=\frac{EC}{En}\frac{1}{\mu^*}\equiv w_s\,.$$

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

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

Similarly to the case of flexible prices and wages, 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

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

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

Equations (15) 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

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

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 wages and raises it under flexible prices and wages as well if the degree of relative risk aversion in consumption (γ) is larger than one.

(ii) When γ is larger than one employment and leisure under sticky prices and wages are more volatile than under flexible prices and wages.

(iii) When $\gamma \leq 1$ a decrease in productivity lowers (or does not change) employment under flexible prices and wages.[15]

Proposition 2 In the neighborhood of a_0 consumption and output are positively related to productivity under both flexible and sticky prices and wages but it fluctuates more widely in the first case.

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 and wages, the real wage does not adjust to changes in productivity, whereas it changes directly with productivity under flexible prices and wages. But in both cases profits (which individuals take as given) go up and down with productivity. As a consequence, in the case of sticky

[15] In this case a drop in productivity leads to a drop (if $\gamma < 1$) in employment under flexible prices and wages, exacerbating the effect of the decrease in productivity on consumption and to no change in it when $\gamma = 1$.

prices and wages, the decrease in productivity, by reducing profits, triggers only a (positive) wealth effect on employment.

In the case of flexible prices and wages the decrease in productivity *also* reduces the real wage triggering additionally the familiar negative substitution and positive income effects of a change in the real wage on employment. If the degree of relative risk aversion in consumption is sufficiently large $(\gamma > 1)$ the positive wealth and income effects dominate the negative substitution effect and employment moves to partially offset the effect of the productivity decrease on consumption also under flexible prices and wages.[16] Due to the positive correlation between the real wage and productivity under flexible prices and wages 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 and wages offsets the drop in consumption to a lesser extent than under sticky prices and wages.[17] As a consequence, consumption and output fluctuate more and, for $\gamma > 1$, employment and leisure fluctuate less under flexible prices and wages.

4.6 A reinterpretation of the analysis

This subsection argues that the analysis presented so far can also be reinterpreted as a comparison between sticky and flexible prices given that the nominal wage is sticky in *both* cases. Such a reinterpretation is useful because wages are normally believed to be more sticky than most prices {see Friedman 1999 for example}. 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 prices appear to be generally more flexible than nominal wages.[18] It is therefore of some interest to contrast the behavior of the economy under sticky and under flexible prices given a sticky nominal wage.

To establish the claim at the beginning of this subsection we only need to show that the equilibrium obtained in the case of flexible prices and wages is identi-

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[16] In the special case $\gamma = 1$ the positive substitution effect and the sum of the negative income and wealth effects exactly offset each other so that a change in productivity does not affect employment under flexible prices and wages.

[17] As a matter of fact when $\gamma < 1$ this effect is even stronger since a decrease in productivity reduces employment under flexible prices and wages exacerbating the decrease in consumption due to the decrease in productivity.

[18] See also Bewley (1999) for the US. A survey of recent models in which prices are more flexible than nominal wages appears in Cukierman (2004).

cal to an equilibrium in which the nominal wage is preset at some arbitrary level prior to the realization of productivity and in which prices are set after productivity is revealed to firms.[19] This follows in turn from the observation that, independently of whether the nominal wage is preset or is determined after the realization of productivity, firms always adjust prices under flexible prices so that the profit maximizing markup is μ^*. It follows, from equation (12) that, whatever the nominal wage, the real wage is given by equation (16). Competitive clearing of the labor market implies that equation (14) holds and equilibrium in the goods' market implies equation (13) again. Substituting those relations into the consumer – worker first order condition in equation (8) leads again to equation (15) which yields the same general equilibrium level of employment as in the case of flexible prices and wages. The other equations then also produce identical levels of production and profits.

Thus the main comparison in which the real equilibrium under sticky prices and wages is contrasted with the equilibrium under flexible values of those variables is equivalent to the case in which it is compared to a benchmark with flexible prices and a sticky nominal wage.

5 Implications for relative welfare under sticky and under flexible prices and wages

A widely used criterion for the exante evaluation of welfare is expected utility. Risk averse individuals 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 (for $\gamma > 1$) leisure is less volatile under flexible than under sticky prices and wages. Hence, the welfare comparison between sticky and flexible prices and wages 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.

It can be shown that the first best level of expected welfare is obtained under flexible prices and wages in the absence of the monopolistic competition distortion. More precisely under a benevolent social planner expected welfare is maximized when employment is determined by equation (15) and the

[19] The sticky price and wage equilibrium is obviously the same.

markup is zero $(\mu^* = 1)$. Formally, the exante socially optimal employment level is determined from

(23) $$au'(an_o) - v'(1 - n_o) = 0$$

where n_0 is the socially optimal level of employment. The resulting, productivity contingent, vector of employment levels welfare dominates the state contingent employment vectors in both the FPE\ with positive markup, and the SPE by construction.

However in the presence of a positive markup $(\mu^* > 1)$ cases in which the SPE welfare dominates the FPE cannot be ruled out apriori since none of those equilibria represents a first best. In particular expected welfare under sticky prices and wages would be higher than under flexible prices and wages if, taking the FPE as a benchmark, the lower welfare due to the higher variability of leisure in the FPE is more than compensated for by the smoother level of consumption delivered in the SPE. It would appear that 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.[20] However the welfare ranking is complicated by the fact that the relative degrees of risk aversion also determine the difference between the variabilities of consumption and of leisure under the two regimes and those are hard to characterize in general.

5.1 Towards a relative welfare ranking of the FPE and the SPE

There generally are realizations of productivity for which the FPE dominates the SPE and other realizations of productivity for which the opposite is true. This can be illustrated by taking the productivity level, a_0, at which the real wage in both cases is identical as a point of departure. Equations (19) and (22) imply that a_0 is determined by the relation

(24) $$a_0 = \frac{EC\left(a, \frac{a_0}{\mu^*}\right)}{En\left(a, \frac{a_0}{\mu^*}\right)} = Ea\left(\frac{n\left(a, \frac{a_0}{\mu^*}\right)}{En\left(a, \frac{a_0}{\mu^*}\right)}\right)$$

[20] The local nature of the result in proposition 2 implies that, strictly speaking, this argument holds provided the distribution of productivity is sufficiently concentrated in a neighborhood around a_0.

where $C\left(a, \frac{a_0}{\mu^*}\right)$ and $n\left(a, \frac{a_0}{\mu^*}\right)$ are the, productivity dependent, equilibrium levels of consumption and of employment in the SPE and where the notation highlights the fact that they depend on both a and a_0.[21] Equation (24) implicitly determines the critical productivity level a_0. The extreme right hand side of the equation shows that a_0 is a weigthed average (with positive weights that sum up to one) of the $a's$ implying that a_0 is strictly within the support of the distribution of a.

Since in both types of equilibria the real wage generally differs from the socially optimal real wage, a, the first best benchmark is not attained in either case. To a first order approximation the loss of welfare relatively to this benchmark is proportional to the difference between a and the real wage determined in each type of equilbrium. For the FPE and the SPE those difference are given by

$$d_f(a) \equiv a - w_f(a) = \frac{\mu^* - 1}{\mu^*} a \tag{26}$$

and

$$d_s(a) \equiv a - w_s = a - \frac{a_0}{\mu^*} \tag{27}$$

respectively. At a_0 the welfare losses in both types of equilibria are the same by construction. Since the slope of $d_s(a)$ is larger than that of $d_f(a)$,and since both slopes are positive, it follows that, to a first order approximation, welfare is higher in the SPE than in the FPE when $a < a_0$ and that the opposite holds when $a > a_0$. Since the difference in expected welfare between the SPE and the FPE is a probability weighted average of such differences for given values of a it would appear that there generally exist utility specifications and probability distributions for which this difference may be of either sign. However experimentation with several alternative specifications of utility limited by the requirement that employment levels are solvable explicitly from the appropriate first order conditions revealed that, at least within this set, there

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[21] Since $w_s = \frac{a_0}{\mu^*}$ this can be written equivalently as

$$w_s = \frac{EC(a, w_s)}{En(a, w_s)}. \tag{25}$$

is a predominance of cases in which expected welfare is higher under the FPE. Details appear in Subsections 5.3 and 5.4 below.

Those findings raise two questions. One concerns the very existence of cases in which the SPE delivers a higher level of welfare than the FPE. The other concerns the derivation of conditions that allow a sharper discrimination between cases in which expected welfare in the SPE is higher than in the FPE from cases in which the opposite is true. The next subsection produces a case in which the SPE welfare dominates the FPE implying that the set of cases in which sticky prices and wages provide a higher level of expected welfare than flexible prices and wages is non empty. The subsequent subsection derives conditions on utilities and on probability distributions of productivity shocks that provide a sharper perspective on some of the factors that determine which of the two types of equilibria is welfare superior.

5.2 Demonstration that the set of cases in which expected welfare in the SPE is higher than in the FPE is non empty

Let

(28) $$\Delta(a) \equiv u(C_s(a)) + v(l_s(a)) - \{u(C_f(a)) + v(l_f(a))\}$$

where $C_s(a) = C\left(a, \frac{a_0}{\mu^*}\right)$ and $l_s(a)$ are equilibrium consumption and leisure in the SPE and $C_f(a)$ and $l_f(a)$ are equilibrium consumption and leisure in the FPE. Expected welfare under a SPE is higher if and only if

(29) $$E\Delta(a) > 0 .$$

The following subsection presents a specific numerical example in which this is the case.

5.2.1 A particular numerical example

Consider the case in which the utility function in equation (1) is specialized to

$$BC - \frac{\rho}{2}C^2 + ql, \quad C < \frac{B}{\rho}$$

where B, ρ and q are positive parameters. This specification builds in some risk aversion with respect to consumption and risk neutrality with respect to

leisure. The first order conditions for internal maxima in the FPE and the SPE (15) and (21) now become

$$\frac{a}{\mu^*}(B-\rho C)-q=0$$
$$w_s(B-\rho C)-q=0$$

implying that

$$C_f(a)=\frac{1}{\rho}\left(B-\frac{q\mu^*}{a}\right),\quad l_f(a)=1-\frac{1}{\rho a}\left(B-\frac{q\mu^*}{a}\right)$$
$$C_s(a)=\frac{1}{\rho}\left(B-\frac{q}{w_s}\right),\quad l_s(a)=1-\frac{1}{\rho a}\left(B-\frac{q}{w_s}\right). \tag{30}$$

Consider the particular set of parameters $B=\rho=q=2,\ \mu^*=3$ and let the distribution of productivity shocks contain two points; $a_1=4$ and $a_2=8$ with respective probabilities $p_1=\frac{1}{3}$ and $p_2=\frac{2}{3}$. Using those values in equation (30) yields

$$C_f(4)=\frac{1}{4},\quad C_f(8)=\frac{5}{4},\quad l_f(4)=\frac{30}{32},\quad l_f(8)=\frac{27}{32}$$
$$C_s(4)=C_s(8)=\frac{1}{2},\quad l_s(4)=\frac{28}{32},\quad l_s(8)=\frac{30}{32} \tag{31}$$

and $w_2=2$. Consumption is substantially more variable in the FPE than in the SPE.[22] Substituting those values into equation (28) yields

$$\Delta(4)=\frac{3}{16},\quad \Delta(8)=-\frac{5}{64}$$

which implies that

$$E\Delta(a)=\frac{1}{96}>0.$$

Thus the SPE, with its relatively smoother levels of consumption and of output, welfare dominates the FPE. Continuity considerations and simulations (not shown) suggest that this case is not an isolated one.

[22] Leisure is also slightly more variable in the FPE but this is of no consequences for the welfare ranking since the individual is risk neutral with respect to leisure.

5.3 The class of utilities functions $u(C)+v(l)=\frac{C^{1-\gamma}}{1-\gamma}+ql$

Here $u(C)$ is a CRRA in consumption and γ and q are positive parameters. This is a convenient case since its equilibrium can be obtained explicitly from the first order conditions in equations (15) and (21). The equilibrium values of consumption and of leisure under flexible and under sticky prices are given respectively by

$$C_f=\left(\frac{a}{q\mu^*}\right)^{\frac{1}{\gamma}},\quad l_f=1-\left(\frac{1}{q\mu^*}\right)^{\frac{1}{\gamma}}a^{\frac{1-\gamma}{\gamma}}$$

$$C_s=\left(\frac{w_s}{q}\right)^{\frac{1}{\gamma}},\quad l_s=1-\left(\frac{w_s}{q}\right)^{\frac{1}{\gamma}}\frac{1}{a}$$

where

$$w_s=\frac{1}{\mu^* E\frac{1}{a}}.$$

Proposition 3 For the family of utility functions, $u(c)+v(l)=\frac{C^{1-\gamma}}{1-\gamma}+ql$, expected welfare under flexible prices and wages is larger than expected welfare under sticky prices and wages for all possible markups and distributions of productivity shocks.

The proof of the proposition appears in Cukierman and Shapir (2005).

5.4 The cases $u(C)+v(l)=ln\,C+ln\,l$ and $u(C)+v(l)=-\frac{1}{C}+ln\,l$

Those cases too lead to explicit analytical solutions which can be used to calculate expected welfare in both regimes as functions of basic parameters for given distributions of productivity shocks. An extensive grid search over alternative combinations of the markup with uniform, triangular and truncated normal distributions of productivity shocks with varying supports indicate that, in all cases, expected welfare under flexible prices and wages is higher than under sticky prices and wages.

5.5 A necessary and sufficient condition for the welfare dominance of the SPE

Condition (24) for the determination of a_0 may be rewritten as

$$\sum_i p_i Q(a_i, a_0) = 0$$

where

$$Q(a_i, a_0) \equiv n\left(a_i, \frac{a_0}{\mu^*}\right)(a_i - a_0)$$

and p_i is the probability that shock a_i realizes. Since a_0 belongs to the interior of the support of a, $Q(a, a_0)$ is negative for all $a < a_0$ and positive for all $a > a_0$. Let[23]

$$\psi(a, a_0) \equiv \frac{\Delta(a)}{Q(a, a_0)}.$$

Let $H(a)$ be the subset of all $a's$ in the range $a > a_0$ such that $\psi(a, a_0) > k$ for some arbitrary k and let $L(a)$ be the subset of all $a's$ in the range $a < a_0$ such that $\psi(a, a_0) \leq k$. The following proposition provides a criterion for discriminating cases in which the FPE welfare dominates the SPE from cases in which the reverse is true.

Proposition 4 There exist probability distributions of productivity shocks such that expected welfare under the SPE is higher than under the FPE $(E\Delta(a) > 0)$ if and only if there exists a real number k such that each of the sets $H(a)$ and $L(a)$ is non empty.

The proof appears in Cukierman and Shapir (2005). Intuitively, the non emptiness of $H(a)$ and $L(a)$ means that there is at least one value of a in the range $a > a_0$ such that $\psi(a, a_0)$ at this value of a is larger than $\psi(a, a_0)$ for at least one value of a in the range $a < a_0$. When this condition is satisfied cases for which $E\Delta(a) > 0$ can be constructed by appropriate allocations of all the probability mass to the union of the sets $H(a)$ and $L(a)$ with some probability mass allocated to each one of those sets. But cases in which $E\Delta(a) > 0$ may

[23] $\Delta(a)$ indirectly depends on a_0. This dependence is subsumed into the functional form to economize on notation.

exist in this case even if not all the mass is allocated to only those two sets. When the sets $H(a)$ and $L(a)$ are empty the maximum value of $\psi(a, a_0)$ in the range $a > a_0$ is smaller than the minimal value of $\psi(a, a_0)$ in the range $a < a_0$ and there do not exist probability distributions for which $E\Delta(a) > 0$ implying that expected welfare in the FPE is larger than in the SPE. Further details appear in Cukierman and Shapir (2005).

6 Concluding reflections

Following a survey of the main differences and similarities between old and New Keynesian concepts this paper focuses 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 and wage equilibrium. This is done by showing that under reasonable conditions output and consumption are often more volatile under flexible than under sticky prices and wages. To a first pass this may be construed as a criticism of conventional measures of the output gap since those measures rely on a potential or target level of output that is a relatively smooth version of actual output.

However, in the presence of a positive markup, the flexible price equilibrium itself is not a first best. This opens the possibility that such a preference for stable output may, in some cases, provide a welfare superior allocation of consumption risks over the business cycle. One reason is that, as shown in the paper, the levels of output and of consumption often are less variable under sticky than under flexible prices and wages while leisure is more variable, creating a tradeoff between riskier consumption and riskier leisure. It is therefore conceivable that, if individuals are sufficiently more risk averse with respect to consumption than with respect to leisure a sticky price-wage equilibrium may dominate its flexible counterpart in the presence of a positive markup. To show that this set is non empty the paper produces an example in which this is the case.

An alternative way to conceptualize the origins of a non monotonic welfare ranking of sticky and flexible nominal price regimes is to note that in both of them the average renumeration to labor is too low in comparison to the first best. But, since the real wage is fixed in the first case and variable in the second, the first regime welfare dominates the second for some realizations of productivity shocks while the opposite is true for other realizations.

Thus targeting the flexible price and wage equilibrium (as recommended in the main part of Woodford (2003, chapter 6)) might be abstracting from welfare

considerations that go beyond the relative price distortions featured in recent NKM. One may wonder about the origin of the difference between this view and the discussion in this paper. Woodford derives his result under the assumption that there is in place a system of taxes cum subsidies that offset the monopolistic competition distortion. By contrast, the framework of this paper compares a regime featuring sticky nominal variables with its flexible counterpart *in the presence* of a monopolistic competition distortion.[24]

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

The paper also briefly discusses more general necessary and sufficient conditions for a sticky price and wage equilibrium to welfare dominate its flexible counterpart. These conditions in conjunction with some additional examples indicate that the set of cases in which the flexible price and wage equilibrium dominates its sticky counterpart is likely to be larger than the set for which the opposite is true. Thus, although the welfare dominance of sticky nominal variables cannot be excluded, there are important classes of cases in which flexible prices and wages welfare dominate sticky prices and wages in spite of the presence of a monopolistic competition distortion.

Finding a sharper demarcation line between those two sets is left for future work.

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[24] Benigno and Woodford (2004) have recently extended the analysis of optimal monetary policy to the case in which *there is* a monopolistic competition distortion. Khan King and Wolman (2003) characterize optimal monetary policy in the presence of monopolistic competition, price stickiness and costly conversions of wealth into goods.

References

Artis, M., M. Marcellino and T. Proietti (2003), "Dating the European Business Cycle", *CEPR Discussion Paper* No. 3696.

Aucremanne, L. and E. Dhyne (2004), "How Frequently Do Prices Change? Evidence Based on the Micro Data Underlying the Belgian CPI", Paper presented at the May 2004 ESSIM, Tarragona, Spain.

Benigno, P. and M. Woodford (2004), "Optimal Stabilization Policy When Wages and Prices are Sticky: The Case of a Distorted Steady State", Manuscript.

Bewley, T. (1999), *Why Wages Don't Fall During a Recession*, Harvard University Press, Cambridge, Mass.

Blanchard, O. and N. Kiyotaki (1987), "Monopolistic Competition and the Effects of Aggregate Demand", *American Economic Review* 77, 647–666.

Calvo, G. (1983), "Staggered Price setting in a Utility-Maximizing Framework", *Journal of Monetary Economics* 12, 383–398.

Clarida, R., J. Gali and M. Gertler (1999), "The Science of Monetary Policy: a New Keynesian Perspective", *Journal of Economic Literature* 37, 1661–1707.

Cukierman, A. (1983), "Relative Price Variability and Inflation – A Survey and Further Results", in: K. Brunner and A. Meltzer (eds.), *Variability in Employment Prices and Money*, Carnegie-Rochester Conference Series on Public Policy 19, North-Holland, Amsterdam, 103–158.

Cukierman, A. (2004), "Monetary Institutions, Monetary Union and Unionized Labor Markets – Some Recent Developments", in: R. Beetsma., C. Favero, A. Missale, V.A. Muscatelli, P. Natale and P. Tirelli (eds.), *Monetary Policy, Fiscal Policies and Labour Markets: Macroeconomic Policymaking in EMU*, Cambridge University Press, Cambridge and NY, available on the web at: http://www.tau.ac.il/~alexcuk/pdf/milansurvey.pdf.

Cukierman, A. and I. Shapir (2005), "Technical Appendix to: Keynesian Economics, Monetary Policy and the Business Cycle – New and Old", September. Available on the web at: http://www.tau.ac.il/~alexcuk/pdf/cukierman-shapir-tech-app.pdf.

Dotsey, M. and R. King (2005), "Implications of State-Dependent Pricing for Dynamic Macroecononic Models", Working Paper No. 05-2, Federal Reserve Bank of Philadelphia.

Dixit, A. and J. Stiglitz (1977), "'Monopolistic Competition and Optimal Product Diversity", *American Economic Review* 67, 297–308.

Erceg, C., D. Henderson and A. Levin (2000), "Optimal Monetary Policy with Staggered Wage and Price Contracts", *Journal of Monetary Economics* 46, 281–313.

Friedman, B. (1999), "Comment on King and Wolman", in: J. B. Taylor (ed.), *Monetary Policy Rules*, The University of Chicago Press and NBER, Chicago and London, 398–402.

Friedman, M. (1968), "The Role of Monetary Policy", *American Economic Review* 58, 1–17.

Galí, J. (2002), "The Conduct of Monetary Policy in the Face of Technological Change: Theory and Postwar US Evidence", in: *Stabilization and Monetary Policy: the International Experience*, Banco de Mexico, Mexico D. F.,

Galí, J. (2003), "New Perspectives on Monetary Policy, Inflation and the Business Cycle", in: M. Dewatripont, L. Hansen and S. Turnovsky (eds.), *Advances in Economics and Econometrics V. III*, Cambridge University Press, Cambridge and NY, 151–197.

Goodfriend, M. (2002), "Monetary Policy in the New Neoclassical Synthesis: A Primer", *International Finance* 5(2), 165–191.

Goodfriend, M. and R. King (1997), "The New Neoclassical Synthesis and the Role of Monetary Policy", *NBER Macroeconomic Annual*, MIT Press, Cambridge, Mass., 231–282.

Goodfriend, M. and R. King (2001), "The Case for Price Stability", *NBER Working Paper* No. 8423.

Khan, A., R. King and A. Wolman (2003), "Optimal Monetary Policy", *Review of Economic Studies* 70, 825–860.

King, R. and A. Wolman (1999), "What Should the Monetary Authority Do When Prices Are Sticky?", in: J. B. Taylor (ed.), *Monetary Policy Rules*, The University of Chicago Press and NBER, Chicago and London, 349–398.

Lucas, R.E. Jr. (1972), "Expectations and the Neutrality of Money", *Journal of Economic Theory* 4, 103–124.

Lucas, R.E. Jr. (1973), "Some International Evidence on Output-Inflation Tradeoffs", *American Economic Review* 63, 326–335.

Mankiw, G. and R. Reis (2002), "Sticky Information Versus Sticky Prices: A Proposal to Replace the New Keynesian Phillips Curve", *Quarterly Journal of Economics* 117, 1295–1328.

Obstfeld, M. and K. Rogoff (1995), "Exchange Rate Dynamics Redux", *Journal of Political Economy* 103, 624–660.

Phillips, A.W. (1958), "The Relation between Unemployment and the Rate of Change of Money Wage Rates in the UK, 1861–1957", *Economica* 25, 283–299.

Rotemberg, J. and M. Woodford (1997), "An Optimization Based Econometric Framework for the Evaluation of Monetary Policy", in; B. Bernanke and J. Rotemberg (eds.), *NBER Macroeconomic Annua*l, MIT Press, Cambridge, Mass., 297–346.

Samuelson, P.A. and R.M. Solow (1960), "Analytical Aspects of Anti-inflation Policy", *Papers and Proceedings of the American Economic Association 50*, 177–194.

Schmitt-Grohe, S. and M. Uribe (2004), "Optimal Simple and Implementable Monetary and Fiscal Rules", Presented at a conference on Dynamic Macroeconomic Theory, University of Copenhagen, June.

Sheshinski, E. and Y. Weiss (eds.,1993), *Optimal Pricing, Inflation and Cost of Price Adjustment*, MIT Press, Cambridge, Mass.

Woodford, M. (2003), *Interest and Prices: Foundations of a Theory of Monetary Policy*, Princeton University Press, Princeton, NJ.

Appendix

Proof of proposition 1

(i) Applying the implicit function theorem to equations (15) and (21) to evaluate the effects of a change in a on the equilibrium level of employment in the neighborhood of a_0 yields

$$\frac{dn_f}{da}(a_0) = -\frac{nw_s u''(a_0 n) + \frac{1}{\mu^*} u'(a_0 n)}{a_0 w_s u''(a_0 n) + v''(1-n)} \tag{32}$$

$$\frac{dn_s}{da}(a_0) = -\frac{nw_s u''(a_0 n)}{a_0 w_s u''(a_0 n) + v''(1-n)} \tag{33}$$

The denominators of both expressions are identical and (since $u''(.) < 0$ and $v''(.) < 0$) negative. Since both expressions are preceded by minus signs their signs are determined by the signs of their respective numerators. Hence (since

$u''(.) < 0$) the sign of $\frac{dn_s}{da}(a_0)$ is negative but (since $\frac{1}{\mu^*}u'(.) > 0$) the sign of $\frac{dn_f}{da}(a_0)$ is generally ambiguous. Employment goes up following a decrease in productivity, under flexible prices, if and only if the numerator of equation (32) is negative. Using equation (22) to substitute w_s out from this numerator this is the case, in turn, if and only if

(34) $$c_f u''(c_f) + u'(c_f) < 0 .$$

Rearranging, this is equivalent to

(35) $$(1-\gamma)u'(c_f) < 0$$

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 (35) is equivalent to the condition $\gamma > 1$. Hence a decrease in productivity raises employment under both sticky and flexible prices.

(ii) Comparison of equations (32) and (33) reveals (since $\frac{1}{\mu^*}u'(.) > 0$) that

(36) $$\frac{dn_s}{da}(a_0) < \frac{dn_f}{da}(a_0) < 0$$

where the second inequality is implied by part (i) and the condition $\gamma > 1$. Hence employment and leisure are more volatile under sticky than under flexible prices.

(iii) The condition $\gamma \leq 1$ is equivalent to

$$c_f u''(c_f) + u'(c_f) \leq 0$$

which implies, from equation (32), that $\frac{dn_f}{da}(a_0) \geq 0$.

Proof of proposition 2

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

$$C = an(a) \tag{37}$$

where the notation $n(a)$ highlights the fact that the level of employment depends on productivity. Differentiating equation (37) with respect to a

$$\frac{dC}{da}(a) = n(a) + a\frac{dn}{da}(a). \tag{38}$$

Substituting $\frac{dn_s}{da}(a_0)$ into equation (38) and rearranging

$$\frac{dC_s}{da}(a) = \frac{nv''(a_0 n)}{a_0 w_s u''(a_0 n) + v''(1-n)} > 0\,. \tag{39}$$

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 (36) and (39) in (38) 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.