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Why Does Money Affect Output? A Survey

by

Olivier Jean Blanchard

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Why Does Money Affect Output ? A Survey

Olivier Jean Blanchard\*

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Much of the research on economic fluctuations has focused on the effects on nominal money on output. This is not because money is the major source of movements in output : it is not. Rather, it is because economic theory does not lead us to expect such effects. Indeed it holds that, with flexible prices, money should be approximately neutral, with changes in nominal money being reflected in nominal prices rather than in output.

Of course we know that, even with competitive markets, full information and flexible prices, the neutrality proposition is only an approximation. Any anticipated change in nominal money must lead to anticipated changes in the price level, and thus introduce a wedge between the opportunity cost of holding money and the cost of capital ; in all cases this will affect utility and, in most cases, is likely to affect capital accumulation as well (see Fischer [1979] and Chapter 8). Even unanticipated changes, if they are the result of open market operations are likely to be non neutral : open market transactions will usually involve some but not all holders of money and have distribution effects (see Rotemberg [1984], Grossman and Weiss [1983]). But, except for the effects of steady inflation which may be substantial (especially when the non neutrality of the tax system is taken into account), these effects are mere intellectual curiosities ; they can account neither for the size nor for the shape of the effect of money on output which we shall review below. For that reason, most of the research has taken as a given that prices do not adjust fully and instantaneously to nominal money and focused on the reasons for and implications of imperfect price adjustment. This will also be the approach of this survey.

From Keynes to the mid 1970's, most researchers had shared a common framework, the so-called neoclassical synthesis. Changes in money led to changes in aggregate demand. Because nominal wages and prices adjusted slowly to changes in employment and output, changes in nominal money led to sustained changes in real money and in output. Within that framework, research had proceeded on each of the components, the "transmission mechanism" of money to aggregate demand on the one hand and the "wage price mechanism" on the other. By the early 70's, research on the wage price mechanism had a strongly empirical and atheoretical bent, which was to lead to a serious crisis. While the counter revolution of the 1970's was partly triggered by events, its success was due to the weakness of the theoretical foundations of the dominant approach. A brief description of the evolution of thought from Keynes to the early 1970's is given in Section I, which then goes on to review the facts, both on the relation of money and output, and on the joint behavior of prices, wages and employment. It concludes that the research on the wage price mechanism had its facts mostly right, and that the crisis was one of theory, rather than one of empirical adequacy. The rest of the survey is devoted to the reconstruction effort.

The initial strategy was to go back to a model with perfect competition, thus avoiding the theoretical muddle in which previous research had fallen, but to relax the assumption of perfect information. The initial model built by Lucas showed how, with imperfect information, nominal money could affect output. Subsequent research has examined, focusing on intertemporal decisions by firms and households, how money shocks could have both large and persistent effects on output. This direction of research is analyzed in Section II. Partly because of its own dynamics, partly because of mixed empirical success, this research program has moved away from studying the effects of nominal money and is now focused on the effects of real, productivity, taste or fiscal shocks.

By contrast, much of the recent research on the real effects of nominal money has been based on imperfect competition. While it has been labeled Keynesian, it often bears only a distant resemblance to the earlier models, and certainly does not yet constitute a unified whole. Recent developments are presented in Sections III and IV.

Section III starts by presenting the models built in the late 70's by Fischer and Taylor, which showed that one could introduce rational expectations in models with nominal wage and price setting and still get long lasting effects of nominal money on output. These models made an important point and have become workhorses in the field ; nevertheless they begged important questions, indeed the same questions which had not been answered by earlier research on the "wage price mechanism". Long lasting effects of money on output in the Taylor model for example require that two conditions be satisfied. The first is that the elasticity of the desired real wage with respect to movements in employment be small ; we can think of this as "real wage rigidity". The second is that, in addition, nominal wages be preset for some period of time ; we can think of that as "nominal wage rigidity". Why both types of rigidity are present is not answered in the model. Research has examined the two issues in parallel. The rest of Section III reviews the research on real rigidities, on why fluctuations in the demand for goods lead to movements in output with little movement in markups of prices over wages, and why fluctuations in the demand for labor lead to movements in employment with little movement in real wages.

Section IV describes research on nominal rigidities. It starts with the "menu cost" argument, which holds that, under imperfect competition, and in response to a change in aggregate demand, the private return to each price setter from adjusting his price is smaller than the social return. The argument is important for two reasons ; first, it implies that small menu costs may lead to nominal rigidities and

large output effects ; second it implies that the welfare effects of nominal rigidities arising from small menu costs may be large. The argument is however a static one, looking at the effect of a one time change in aggregate demand, starting with identical prices. Subsequent research has shown that the argument does not extend straightforwardly to a dynamic context. Individual price rigidity may or may not lead to aggregate price rigidity, depending on the specific nature of price rules and the interaction between price setters. The relation between welfare effects and menu costs is also much less clear cut than in the static context. The second half of Section IV reviews the current state of play.

Section V questions three implicit assumptions of the previous analysis. The first is that prices are set in nominal terms. The first part of Section V looks at the scope for indexation or other monetary reforms to automatically decrease or eliminate the effects of money on output. The second is that more price flexibility reduces the effect of money on output and the size of undesired output fluctuations. But, ever since Fisher and Keynes, we have known that more price flexibility may in fact be destabilizing, through its effect on real interest rates and through the redistribution of claims in the economy. This is discussed in the second part of the section. The third is that the economy, left to itself, eventually returns to its natural level of unemployment. Recent analysis suggests that this may not always be the case. If that analysis is correct, even short lived nominal rigidities may lead to permanent effects of nominal money, or of aggregate demand shocks in general, on output and employment.

Section VI concludes.

## Section I. From Keynes to the early 1970's

### 1. From Keynes to the neoclassical synthesis

Keynes' explanation in the "General theory" of the effects of nominal money on output was based on two main assumptions. He accepted the classical principle that employment could only increase if real wages decreased. But he added the assumption that, because workers focused mostly about nominal wages, nominal wages were more rigid, "sticky" (the word appears to be Keynes') than prices. An increase in money would then lead to an increase in prices, a reduction in real wages and an increase in output.

It will be convenient to use throughout a simple log linear structure to point out the major differences between models. As the focus is on aggregate supply, I shall for the most part use a simple -indeed simplistic- representation of aggregate demand, expressing output demand only as a function of real money balances, without any dynamics. I shall also ignore unimportant constants so as not to clutter the notation. The aggregate demand-aggregate supply framework corresponding to the General Theory can then be expressed as :

$$(1.1) \quad y = a(m-p) \quad a > 0$$

$$(1.2) \quad y = b(w-p) \quad b < 0$$

$$(1.3) \quad w = w^*$$

where  $y$  is the log of real output,  $m$ ,  $p$  and  $w$  the (logarithms of) nominal money, nominal prices and nominal wages respectively. If nominal wages are fixed at level  $w^*$ , increases in  $m$  increase both output and the price level. Aggregate demand increases with real money balances, and aggregate supply increases with the decrease

in the real wage<sup>1</sup>.

This model is a familiar one and has made it to the textbooks up to this day. It was however discarded by macroeconomists soon after the "General Theory" as it became quickly clear that it was in contradiction with the facts. Dunlop [1938] showed that, for the UK, real wages were if anything procyclical, an assumption difficult to reconcile with decreasing returns to labor and marginal cost pricing<sup>2</sup>. He also showed, using informal evidence, that unions often cared explicitly about the cost of living and suggested that the assumption that workers cared more about nominal than real wages may not be appropriate. These findings led most economists, including Keynes himself [1939], to conclude that a more drastic departure from classical theory was needed and that price setting in particular could only be understood by appealing to imperfect competition.

This task was however not taken up by macroeconomists working within the "neoclassical synthesis", the consensus view of macroeconomics which emerged in the 1950's and 1960's and within which most of the major developments of post war macroeconomics took place. The main achievement of the synthesis was to give solid theoretical foundations to many of the decisions taken by individuals and firms such as consumption or investment. But price and wage decisions were left out and few formal attempts were made to link them explicitly to, for example, bargaining models in the labor market or imperfect competition in the goods market. The prevailing mode

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<sup>1</sup> There is obviously more to Keynes [as always...] than this simplistic characterization. We shall return to some other aspects later in the chapter.

<sup>2</sup> Tarshis [1939] who is often credited with the same observation, showed instead that for the US there was a negative correlation between changes in manhours and changes in real wages.



of thinking about prices and wages was in terms of tatonnement, with prices and wages adjusting to excess demand or supply in their respective markets, along the lines of the dynamic process of adjustment studied by Samuelson in his "Foundations" [1948].

In retrospect there are probably two main reasons why the neoclassical synthesis did not take up the task. The first is that it was hard, and the marginal return to other explorations was higher. The second was the providential role played by the discovery of the "Phillips curve" relation between the rate of changes of nominal wages and unemployment (Phillips [1958]): the existence of a reliable empirical relation made less urgent the need for better microeconomic underpinnings of price adjustments. Because the facts seemed to be clear and progress on the theoretical front difficult, most of the research on wage and price behavior was, until the early 70's characterized by its strong empirical bent and a rather eclectic use of microeconomic justifications.

## 2. The wage-price mechanism as of the early 1970's

By the early 70's, there was a wide consensus as to the main empirical characteristics of the "wage-price mechanism". This consensus, summarized in a survey paper by Tobin [1972] (see also the survey by Santomero and Seater [1978]) was roughly the following :

Prices were markups over unit costs at standard rates of output and capacity utilization : they did not seem to respond to demand movements. The response to changes in input prices was quick, so that prices played a passive role in the adjustment of the price level to changes in nominal money : they reflected wage increases quickly and fully.

Wages were explained by the "augmented" Phillips curve. After its transplantation in the US by Samuelson and Solow [1960], the Phillips curve specification, augmented to allow for an effect of price inflation, had had an excellent track record in the 1960's. The rate of change of nominal wages was a function of the level of unemployment and of current and past price inflation. The question of whether the sum of coefficients on past inflation was equal to one was treated as an empirical issue, to be settled by the data. By the early 70's the consensus was that, while it had increased over time, the coefficient was still less than one, although not significantly so (Gordon [1972]). This implied the existence of a long term trade-off between inflation and unemployment.

In terms of our log linear model, the wage-price mechanism summarized by Tobin, can be written as :

$$(1.1) \quad y = a(m-p)$$

$$(1.4) \quad p = w$$

$$(1.5) \quad w-w(-1) = b(p(-1)-p(-2)) + c y ; 0 < b < 1, c > 0$$

Equation (1.1) is aggregate demand. Equation (1.4) is the price equation and embodies the assumption of quick passthrough of wage costs and no effect of demand. Equation (1.5) is the wage equation, giving wage inflation as a function of lagged price inflation and output, used as a proxy for unemployment<sup>3</sup>. This system reduces to a second order difference equation in  $p$ . If  $a$  is positive, the equation is stable, possibly with complex roots. An increase in the level of money leads to an increase

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<sup>3</sup> For simplicity, I shall assume throughout the models presented in this chapter, the existence of a linear relation between the logarithm of output, the logarithm of employment and the level of unemployment. I shall therefore use them interchangeably, as I do in equation (1.5).

in output ; output returns to normal over time, with or without oscillations. The model shares with the earlier Keynes' model the fact that aggregate demand determines output in the short run ; in contrast to the earlier model however, the real wage remains the same throughout ; this is the result of markup pricing by firms, as characterized in equation (1.4).

The wage-price blocks of the large macroeconometric models built in the early 70's were similar in structure to equations (1.4) and (1.5), with the implication that movements in money led to a slow adjustment of prices and wages, a long lasting effect on output and little or no movement in the real wage along the way.

### 3. The counterrevolution : the theoretical attack

It was clear even then that while the wage-price mechanism appeared to fit the facts successfully, its components were at sharp variance with standard neoclassical theory. In the price equation, whether the lack of effects of demand on the markup of prices over labor costs was due to flat marginal cost, or to a squeeze in profit margins as output increased, was not resolved (see Nordhaus [1972] for a critical analysis of those price equations). In the wage equation, letting the data decide whether the coefficient on inflation was equal to one was in contrast with, for example, the sophisticated derivation of the appropriate user cost under inflation in the investment literature. It was also not clear why unemployment affected the rate of change of wages independently of their level. While consistent with a tatonnement assumption that wages moved as a function of excess supply, measured by unemployment, it was in contradiction with the idea that, at least in the long run, there should be a relation between the level of the real wage and the level of labor supply.

These problems were clearer to some than to others. Two important contributions had questioned the possibility of a long run trade off on a priori grounds. Both Phelps [1967] and Friedman [1968] had argued that there could only be one equilibrium rate of unemployment, the "natural" rate and that there was no permanent trade off between unemployment and inflation ; unemployment could only remain below its natural rate if inflation accelerated. This "accelerationist hypothesis" was further refined in an influential book by Phelps et al [1970], which explored how models of search in the labor and goods markets could or could not explain wage and price behavior as embodied in the wage-price mechanism.

The proximate cause of the crisis however was the introduction of rational expectations. Together with the natural rate hypothesis, it implied that unemployment could only be associated with unexpected inflation, thus with unexpected demand movements. Furthermore, it was shown by Lucas in his celebrated critique [1976] that the natural rate-rational expectations hypothesis could be true while the sum of coefficients on inflation in the Phillips curve, which had been the subject of so much attention, was less than one. His argument was the following. Suppose that the true Phillips curve had the following form :

$$w-w(-1) = (E p-p(-1)) + c y$$

where E denotes the expectation of the price level based on past information, so that wage inflation depended on expected price inflation with a coefficient of one. Assume also that price inflation followed a first order autoregressive process :

$$p-p(-1) = \rho (p(-1)-p(-2)) + e$$

Then, if workers had rational expectations and formed expectations of inflation based on past inflation, the observed Phillips curve would be :

$$w-w(-1) = \rho (p(-1)-p(-2)) + c y$$

As long as  $\rho$  was less than one, the Phillips curve would appear to imply a long run trade off when in fact there was none. A change in the inflation process, coming for example from an attempt by the government to lower unemployment would lead to a change in  $\rho$  and a change in the coefficient on lagged inflation in the Phillips curve. The trade off would vanish as the government tried to exploit it.

The critique implied that the theoretical issue of whether there was a long run trade off could not be settled simply by looking at the sum of coefficients on lagged inflation. But the influence of the critique went far beyond that. It had in particular the effect of focusing attention on the underlying microeconomic underpinnings of the wage-price mechanism, and many found them lacking. What has happened since the mid 70's is best described as a return to basics (sometimes very basics), a search for theoretically consistent explanations of the movement of nominal wages and prices.

#### 4. The counterrevolution ; the facts

The above account emphasizes the crisis in theory. Some have emphasized the empirical failure of the wage-price mechanism. In a polemical article, Lucas and Sargent [1978] conclude to "an empirical failure on a grand scale". This is a considerable overstatement. It is true that estimated coefficient on lagged inflation kept rising with inflation, and that the estimated equations initially failed to predict the inflationary effects of the oil shocks of 1974-5. But once the coefficient on lagged inflation was increased, and the price equation was respecified so as to allow for materials costs, the equations were once again on track and have performed decently since then (see Englander and Los [1983] for example). This decent empirical performance should come as no surprise and may be seen as the result of the rather a-theoretical approach to the data which we described earlier.

Table 1. Effects of a 1% permanent increase in M1 in the DRI model

Quarters	4	8	12	16	20	24
Effects on :						
Real GNP	0.7	1.4	0.8	-0.5	-1.1	-0.8
WPI	0.7	1.4	1.7	1.6	1.6	1.6
PGNP	0.0	0.4	1.0	1.3	1.4	1.3
CPI	0.1	0.4	0.7	1.0	1.2	1.3
AHE	0.1	0.5	1.0	1.3	1.4	1.3
M1/PGNP	1.0	0.6	0.0	-0.3	-0.4	-0.3
AHE/WPI	-0.6	-0.9	-0.6	-0.3	-0.3	-0.3
AHE/PGNP	0.1	0.1	0.0	0.0	0.0	0.0
AHE/CPI	0.0	0.1	0.3	0.3	0.2	0.0

Source : DRI Model, 1985

All variables measured as % deviations from initial path.

GNP : real gross national product ; WPI : wholesale price index ; PGNP : price deflator for GNP ; CPI Consumer Price index ; AHE : average hourly earnings in manufacturing.

Indeed, while macroeconomists have been working on rebuilding theoretical foundations, the wage-price component of empirical macroeconometric models has not changed much since the early 70's. Major modifications have been the elimination of the long run trade off, the introduction of exchange rates, affecting both price behavior in sectors exposed to foreign competition, and introducing a wedge between producers' prices and consumer prices. Table 1 gives the results of a dynamic simulation of the 1985 version of the DRI model. An increase in money of 1% increases GNP for about 3 to 4 years ; it takes many more years for output to return to normal, and only after long and slightly damped oscillations. The behavior of the real wage depends very much on which price deflator is used. The real wage in terms of the GNP deflator varies with output. The real wage in terms of the CPI moves very little, increasing slightly before it returns to normal.

That empirical macroeconometric models have not changed suggests that, whether or not their structural interpretation of the data is appropriate, they capture accurately the important cross correlations present in those data. In what follows, I review the empirical evidence on the effects of money on output. That evidence can be divided into direct reduced form evidence on the relation between money and output, and evidence on each of the components of the wage-price mechanism.

#### Reduced form evidence on money and output

That money had a strong impact on output was the major theme of Friedman and Schwartz [1963]. Relying on evidence from the period 1867-1960, and in particular on a study of turning points in money and output, they concluded that there was a strong and stable relation between money, nominal and real income, with the causality often running from money to economic activity. Much of the research on reduced form

evidence since then has taken the same approach, but relied on formal econometric methods instead. To see what can be learned from such an approach, suppose that output is affected by money and other variables according to the reduced form relation :

$$(1.6) \quad y = \sum a_1 y_{-1} + \sum b_1 m_{-1} + \sum x_{-1} c_1 + e$$

where  $y$  is some measure of output, such as the logarithm of GNP,  $m$  a measure of nominal money, such as the logarithm of M1,  $x$  a vector of other variables, such as fiscal policy or exports, and  $e$  is serially uncorrelated. Sums run from 1 to  $n$  for  $y$ , from 0 or 1 to  $k$  for  $m$  and  $x$ .

When will estimation of this equation by ordinary least squares give unbiased estimates of the effects of nominal money on output ? Two conditions are required. The first is that all right hand side variables be uncorrelated with the current innovation in output,  $e$ . The second is that, if current money or  $x$  are not included, their true coefficients be equal to zero<sup>4</sup>.

Causality tests were first introduced by Sims [1972] to characterize the dynamic interactions between money and output. Bivariate causality tests are based on equations such as (1.6), but allowing for no other variables than  $y$  and  $m$ , and excluding current  $m$ . When applied to the relation between money and output, they typically have found that the estimated  $a_1$ 's and  $b_1$ 's imply a strong dynamic response of  $y$  to  $m$  (The dynamic response of  $y$  to  $m$  is given by the coefficients of  $(1-a(L))^{-1}b(L)$ , where  $a(L)$  and  $b(L)$  are the lag polynomials in (1.6)). A typical response

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<sup>4</sup> These conditions are regularly rediscovered. They were emphasized in the discussion of the Saint Louis model, and more recently when economists tried to understand what could or could not be learned from causality tests (see [Cooley and LeRoy 1985])



Table 2 Reduced form dynamic effects of money on output

Effects of a 1% permanent increase in nominal money :

Quarters	from Sargent		from Mishkin	
	on :	unemployment	output	
			anticipated	unanticipated
0		0.0	1.3	2.0
2		-0.3	1.9	2.3
4		-0.4	1.8	2.2
6		-0.3	1.3	2.0
8		-0.2	0.7	1.6
12		0.0	-0.4	0.5
16		0.1	-0.6	-0.4
20		0.1	-0.1	-0.3

Sources : Sargent [1976a] table 1, line 1.  
Mishkin [1983] table 6.5

pattern, from Sargent [1976a] is given in Table 2, column 1. It shows a response of unemployment to M1 peaking after 5 quarters and becoming negative after 11 quarters . Many bivariate causality tests have been run, using different empirical counterparts for the quantity variable and for money, different periods and sampling intervals, and different treatments of non stationarity in m and y. The effect of money has been found to be usually significant, although the level of significance depends on the method of detrending (stochastic, or deterministic) (Stock and Watson [1987]). Eichenbaum and Singleton [1986], for example, using first differences of log GNP and second differences of log M1, and monthly data from 1949 to 1983, find the effect of money on output to be barely significant.

Given our discussion above, it is clear that the conditions under which this estimated dynamic response is the true dynamic response are unlikely to be met. First, there are surely other variables than money which affect output and are correlated with money. Second, it is quite likely that current money is affected by e, innovations in output. It may even be that lagged money is correlated with the current innovation in output. This will be the case if the central bank has information about future output beyond what can be learned from the history of money and output ; in this case lagged money will help predict output even if it does not affect it (this is the stochastic extension of the "Post hoc, ergo propter hoc" argument made by Tobin [1970])<sup>5</sup>. The simultaneity problem may be less serious for some components of money than for others. King and Plosser [1984], using annual data from 1953 to 1978 find a weaker and shorter effect of high powered money than of M1. A possible interpretation is that the strong effect of M1 on output found by others comes in fact partly from the reaction of inside money to output.

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<sup>5</sup> These problems of economic interpretation of causality tests were pointed out by Sims ; users of causality tests have not always resisted the temptation to make unwarranted inferences.

Multivariate causality tests, that is tests in which other variables than  $y$  and  $m$  are allowed on the right hand side of (1.6) have also been implemented. Sims [1980] in particular has found that when short nominal interest rates are added to nominal money in (1.6), money no longer has a significant effect on output. What it means is however unclear and open to many interpretations ; McCallum (1983a) has shown that these results would arise if for example the Federal Reserve used money to peg interest rates.

Another line of research has looked at the effects of money while more explicitly controlling for the presence of other variables, the  $x$  variables in (1.5). The first attempt was made by Andersen and Jordan in the Saint Louis model [1970]. More recently, work by Barro [1977] has spurred a new set of estimates. Barro ran an equation similar to (1.6), allowing for the presence of a time trend and a proxy for exogenous government spending in  $x$ . He also decomposed money growth into two components, one "unanticipated", obtained as the residual from a forecasting equation including lagged money and other variables, and one "anticipated" and equal to the forecast value. Using annual data for the period 1946 to 1976, he concluded that the hypothesis that only the unanticipated component affected output could not be rejected, and that this unanticipated component affected output for up to three years. In Barro [1978], this approach was extended to look at the joint response of output and prices, and in Barro and Rush [1980] the same approach was used on quarterly data. The data have been reexamined by Mishkin [1983] who, using quarterly data for 1954-1976 and longer lag structures, concludes that both the unanticipated and the anticipated components have a long lasting effect on output. The dynamic response of output to an "anticipated" and an "unanticipated" permanent change in money, from Mishkin, is given in table 2, column 2. Both components of money have

large and long lasting effects on output. It is clear however that, while this approach is more careful about the inclusion of other variables than money in (1.6), the interpretation of the dynamic response as structural still depends on the maintained assumption of zero correlation between the innovation in output and current and lagged money, anticipated or unanticipated<sup>6</sup>.

The decomposition of money between anticipated and unanticipated components has also been questioned. Sargent [1976b] has pointed out that, if expectations of money were based only on past money, there would be infinitely many ways of decomposing a distributed lag of money as the sum of two distributed lags in anticipated and unanticipated money. Identification depends on the presence of explanatory variables other than money in the equation for money, and may therefore be weak. Fischer [1980] has also noted that the data are unlikely to be able to distinguish between Barro's specification and a specification in which output depends on anticipated money and unanticipated money  $n$  periods -rather than one period- ahead. The two specifications have however drastically different policy implications.

Poterba, Rotemberg and Summers [1986] have adopted an indirect approach to testing nominal rigidities that avoids this simultaneity problem, by looking not at the effects of money but at the effects of shifts between direct and indirect taxation. In the absence of nominal rigidities, it should not matter which side of the market a tax is collected on. In the presence of nominal rigidities, it may

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<sup>6</sup> It is interesting to note the qualitative similarity of the dynamic responses in table 2 to those in table 1, obtained from the DRI model. Reduced form estimates are however larger than those obtained from simulations of structural models. This was already noted and discussed in the context of the Saint Louis model. Potential explanations involve the bias in reduced form estimation discussed above, or the neglect of some transmission channels in structural models.

however affect the price level and output : if for example, nominal wages are fixed, the shift from direct taxation to a value added tax will increase the price level and decrease output. To the extent that changes in taxation are more exogenous than money, this avoids some of the problems mentioned above. Their analysis of the empirical evidence leads them to conclude that there are substantial nominal rigidities, both in the US and the UK.

Reduced form evidence thus suggests a strong relation between money on output. Part of it may be due to the effect of output on money. Part of it surely is not. The event studies provided by the UK and US disinflations of the early 80's, in addition to those described by Friedman and Schwartz, strongly support the view that monetary policy affects output.

#### Evidence on the components of the wage-price mechanism

It would take us too far afield to review the empirical work on wage and price behavior in any detail (we shall discuss some of it in relation to specific theoretical developments later on). But, in the spirit of the general skepticism that has permeated macroeconometrics since the mid 70's, research has proceeded to see whether the stylized facts on which the wage-price mechanism was based were actually present in the data.

The first stylized fact was the lack of response of the markup of prices on wages to movements in output or, put another way, the lack of a negative correlation between real product wages and employment, as would be expected if the economy moved along a stable demand for labor. Sargent [1978] suggested that the presence of costs

of adjustment for employment implied a more complex dynamic relation between real wages and employment and could be consistent with little contemporaneous negative correlation between the two. His attempt to explain the data in this way was however not very successful. Later research along the same lines has confirmed that there is no clear correlation at any lag between product wages and employment in the US, but has shown the existence of a negative correlation between lagged real wages and employment in some other industrialized countries (see Bruno and Sachs [1984], Geary and Kennan [1982]). Bils [1985], using US panel data on individual workers, concludes that the real consumption wage is procyclical.

The other main stylized fact was the Phillips curve, a relation between wage changes, past price changes and unemployment. Causality tests have consistently shown that lagged employment does not Granger cause real wages (Sargent [1978], Neftci [1978]). While this has been taken as evidence against the Phillips curve, it does not look at the same set of correlations ; the Phillips curve is a relation between nominal wage inflation, lagged inflation and current as well lagged employment, not necessarily between actual real wages and lagged employment. If the economy had both a Phillips curve and mark up pricing for example, there would be no relation between real wages -which are constant- and employment.

Looking at reduced form evidence on wages, prices and employment, I have asked whether an econometrician who ignored the existence of the wage-price mechanism described by Tobin could find it in US data (Blanchard [1986b]). To do so, I wrote down a structural model, with a wage, a price and an aggregate demand equation, and then derived and estimated the unconstrained reduced form. I then asked what structural price, wage and aggregate demand equations were consistent with the reduced form evidence and concluded that the reduced form evidence was roughly consistent with the existence of the structural wage price mechanism described by Tobin.

## 5. The reconstruction effort

To summarize, the crisis of the 70's arose not because the wage-price mechanism was in contradiction with the facts, but because its explanation of the facts was at variance with theory. Thus, the reconstruction effort has been largely theoretical. It is part of a much larger enterprise affecting all of macroeconomics, and it interacts with it. For example, if we think of contracts under asymmetric information as being an important factor in labor markets, then the price level is a potential signal and the study of why nominal wages are not fully indexed should start from there. Or if we think of imperfect competition as being important in goods markets, this may explain why, as price may exceed marginal cost most of the time, firms may be willing to accommodate increases in demand at a given price. We shall touch on those other developments only to the extent that they are relevant to the issue at hand.

Research has taken two radically different directions.

The first has explored whether the stylized facts could be reconciled with a more standard neoclassical model. Thus, it has worked under the maintained "as if" assumption of perfect competition in all markets but relaxed the assumption of full information. It has focused both on the impact effects of disturbances such as money and on the channels for persistence. I shall refer to this approach as the "imperfect information" approach and review it in the next section.

The second has explored instead whether the many leads and insights of the earlier literature could be made more rigorous and could form the basis for a theoretically consistent explanation of the effects of money on output and of the wage-price mechanism. I shall refer to that approach as the "imperfect competition" approach and study it in sections III and IV.

While the two approaches differ in their philosophy, they share two common methodological precepts. The first is that any explanation for the effects of money on output should hold even under rational expectations. Nearly all of the research has indeed assumed rational expectations as a working hypothesis. The second, which we shall not focus on, is that fluctuations should be analyzed using the Frisch-Slutzky impulse-propagation framework in which fluctuations are thought of as the result of stochastic impulses affecting variables through a propagation mechanism<sup>7</sup>; this approach, which is consistent with time series methods, has allowed a better integration of macroeconomic theory and econometric methods ; this integration is perhaps as important a development as the substantive results described below.

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<sup>7</sup> Because linear stochastic processes are easier to deal with, work on non linear dynamic systems, which had been popular earlier, has dwindled. There has however been recently renewed interest in non linear deterministic systems which can generate rich dynamics or even dynamics similar to those of stochastic processes (see for example Grandmont [1985]). There are few results to date using this approach on the issues studied in this chapter.



Section II Imperfect information<sup>8</sup>

Models of search, developed initially by macroeconomists to explain the various aspects of the wage price mechanism had shown the importance and the potential of relaxing the assumption that markets were cleared by a fully informed auctioneer (see the introduction by Phelps to his volume [1970]). This had two main implications. First, because of imperfect information on the part of buyers and sellers, whoever set a price was likely to have at least transient monopoly or monopsony power. Markets could no longer be viewed as competitive. Second, if individuals had limited information, there was the potential for aggregate nominal shocks to affect output. The reason was sketched by Phelps. Individuals and firms faced both individual and aggregate shocks. Because they had limited information, they could not distinguish accurately between the two. Even if they had wanted to react only to individual shocks, they ended up reacting also to aggregate shocks such as changes in nominal money. Nominal money therefore could affect output.

Developing general equilibrium models with optimal price setting under imperfect information proved however difficult and, early on, the choice was made to examine the implications of imperfect information while maintaining the assumption of perfect competition in all markets. This was an important choice, making for more tractable models at the cost of eliminating important issues. The first macroeconomic models along those lines were developed by Lucas :

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<sup>8</sup> The material in this section is covered more extensively in chapter 21, from a different angle.

### 1. The Lucas Model

Lucas [1972] constructed a macroeconomic model with optimizing agents, decentralized markets and imperfect information. A streamlined version was given in [1973] and has the following structure :

$$(2.1) \quad y = a(m-p)$$

$$(2.2) \quad p_i = p + e_i \quad i=1, \dots, n$$

$$(2.3) \quad y_i = b(p_i - E_i p)$$

No distinction is made between workers and firms. Output is produced by  $n$  firms, indexed by  $i$ , each operating as a price taker in its own market. Equation (2.1) is aggregate demand. Equation (2.2) gives the price facing each firm,  $p_i$  ;  $p_i$  differs from the price level  $p$  by a random variable  $e_i$ , which reflects movements in relative demands across markets. The  $e_i$  are uncorrelated across firms and are white noise. The supply of each firm is given by equation (2.3) :  $E_i p$  is the expectation of the price level by firm  $i$ , based on its observation of  $p_i$ . Firms react only to perceived relative price changes.

When firms observe a high value of  $p_i$ , this may reflect either a high value of  $m$ , or a high value of  $e_i$ , or both. This leads them to revise upwards their expectation of  $p$ , according to  $E_i p = E_m + k(p_i - E_m)$ , where  $E_m$  is the expectation of  $m$  (and  $p$ ) they held before observing  $p_i$ . The parameter  $k$  depends on the relative variances of unanticipated money and of the shock  $e_i$ , and is between zero and one. Replacing in (2.3) gives  $y_i = b(1-k)(p_i - E_m)$ . The higher the nominal price it observes, the higher its conditional expectation of a relative price shock  $e_i$ , the higher the supply of firm  $i$ . Aggregating over firms gives an aggregate supply curve :

$$(2.4) \quad y = b(1-k)(p - E_m)$$

Solving (2.3) and (2.4) gives :

$$p = d E_m + (1-d) m \quad \text{where } d = b(1-k)/(a+b(1-k)) \text{ and}$$

$$(2.5) \quad y = ad (m - E_m)$$

Imperfect information leads therefore to an effect of unanticipated money on output. This is because firms partly misperceive money shocks for relative price shocks. The counterpart is that firms partly misperceive relative price shocks for money shocks and thus underreact to those ; this however has no macroeconomic implications.

The [1972] and [1973] models showed how, under market clearing and imperfect information, unanticipated money could affect output. Neither however showed why money could have lasting effects on output<sup>9</sup>, nor did they try to explain the specific behavior of firms versus workers, wages versus prices. Those issues were taken up by subsequent research.

## 2. Impulse and Propagation mechanisms

### Intertemporal substitution

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<sup>9</sup> While the 1973 model includes lagged output in the supply equation, leading to lasting effects of unanticipated money on output, it is, as Lucas indicated, an assumption without justification within the model.

The mechanism through which money had a positive effect on output in the Lucas model raised two questions. The first was asked by Lucas himself : how could misperceptions about money have such large effects on supply ? The second was raised most explicitly by Friedman [1978] : why was it that suppliers rather than buyers were the ones who misperceived prices ? If the information structure was such that suppliers observed prices accurately, but that buyers were misled in thinking that a high price meant in part a high relative price, wouldn't this lead to a decrease in demand and an output contraction instead ?

The answer to the first question had already been suggested by Lucas and Rapping [1969] who had focused on workers and labor supply. Perceived permanent changes in the real wage were unlikely to lead to large supply responses, because of conflicting income and substitution effects. Perceived temporary changes however had mainly substitution effects and could lead to large responses. More generally and more formally, the relevant intertemporal relative price to a supplier  $i$  was  $(P_i/P)/(1+r^e)(P_i^e/P^e)$ , the ratio of his perceived relative price (the real wage for workers) to his expected relative price discounted by the expected real interest rate. If when suppliers observed an increase in their price, they inferred that it was partly due to a favorable shift in demand, and if they did not expect these shifts in demand to be permanent, they would then respond to nominal shocks by increasing supply.

The issues raised by the second question were analyzed by Barro who, in a series of papers, constructed models allowing for intertemporal substitution and misperceptions on both the supply and the demand side. A general equilibrium model where money is the only asset so that the real interest rate is the negative of the rate of inflation and the relevant relative price is simply  $P_i/P_i^e$  was developed in Barro [1976] ; It was extended in Barro [1981] to allow for other assets than money

and to deal with the endogeneity of the real interest rate. These models show how intertemporal substitution and specific information structures can deliver positive effects of money on output ; they do not however make a convincing case for the specific information structure and set of structural coefficients which deliver such positive effects.

### Persistence

The second issue was how the initial misperception could have long lasting effects on output and employment. Two types of channels were later identified :

First, if the initial misperception led firms or workers to change a state variable, a variable which affected their decisions in subsequent periods, the initial impulse would have lasting effects. Lucas [1979] emphasized the role of capital in creating persistence. If misperceptions led firms to both sell and invest more, the higher capital stock would later on lead to a higher profit maximizing level of output. Output would be higher until firms decreased their capital back to equilibrium. While capital accumulation appears to be an unlikely channel for cyclical persistence, similar effects, but working through inventories or through employment in the presence of costs of adjustment were characterized by Blinder and Fischer [1981] and Sargent [1979] respectively. Howitt [1986] has recently shown that persistence also emerges from an explicit search model of the labor market, where persistence arises from costs of changing employment.

Another channel for persistence was identified by Taylor [1975] and Lucas [1975] : if direct information about nominal shocks was not available even ex post, large permanent changes in money could be misperceived for relative price changes for a long time, during which they would have an effect on output.

Those extensions still imply that only unanticipated changes in nominal money matter, but their effects on output can now be long lasting. There is however an obvious tension between the factors needed to get large impulses and those needed to get persistence. Strong intertemporal substitution, for example, leads to a strong response of labor supply to misperceptions, but through the accumulation of wealth, also leads to lower labor supply later, to negative serial correlation of output in response to shocks. Costs of adjustment on the other hand lead to more persistence, but to smaller initial effects of shocks.

### Policy Implications

Most of the models above share the same policy implications. These were first pointed out by Lucas [1973], Sargent [1973] and Sargent and Wallace [1975] : Anticipated money had no effect. Unanticipated money could in general affect output but, if the monetary authority had no more information than the public, this effect was unlikely to improve welfare : if the policy maker had no more information than the public, unanticipated monetary movements would be uncorrelated with other shocks, increasing noise and making signal extraction more difficult for individuals and firms, decreasing the allocative efficiency of the price system. If the policy maker had more information, money could then obviously be used to offset other shocks and improve welfare but an equally efficient way of achieving the same outcome would then be simply to make information available to the public. These conclusions have been slightly qualified later. Weiss [1980] and King [1982] have shown that policy rules based on public information can sometimes affect the outcome by changing the information content of observable prices. Other examples have been constructed of economies with other distortions in which additional noise can be welfare improving. These qualifications notwithstanding, the role for monetary policy is drastically reduced from the role it can play under the standard wage price mechanism.

### 3. Empirical Evidence

#### Reduced form evidence : money, output and the price level

The most striking implication of imperfect information models, and the most at variance with previous beliefs is that anticipated money does not matter. The evidence on the relation between money and output has been reexamined by Barro in a series of articles [1977, 1978, 1980] which we have already briefly described. Dividing money into two components, unanticipated and anticipated money, Barro concluded that he could not reject the hypothesis that anticipated money did not affect output. Further work by Mishkin [1983] has shown however that anticipated money also affects output, although by less than unanticipated money. These results were shown in table 2.

While money stock figures are published with little delay, they are subsequently revised. A literal interpretation of imperfect information models suggests that only the unperceived component of money, that is the difference between the final revision and the initial announcement, should affect economic activity. This was tested by Barro and Hercowitz [1980] and Boschen and Grossman [1982] and decisively rejected ; this is however a rejection only of an extreme and absurd version of imperfect information models.

An other implication of most -although not all- imperfect information models is that money affects output through price level surprises. An equation relating output movements to unanticipated price level movements was first run by Sargent [1976a] who found only weak evidence in favor of such an effect. Fair [1979] found instead, by extending the sample period to include the 1970's, a positive correlation between

unemployment and price level innovations ! These results have been challenged by Gray and Spencer [1984] who argue that whether the correlation between price level and output innovations are positive or negative depends on whether supply or demand shocks dominate the sample. Specifying unemployment as a function of price level surprises, energy price surprises and proxies for frictional unemployment, they find that price level surprises have a significant effect on unemployment. Using annual data, they find the following relation between unemployment and unanticipated price level movements :

$$u = -.4 (p-E(p|-1))-1.4(p-E(p|-2))-0.8(p-E(p|-3)) + (\text{supply factors})$$

where  $u$  is the unemployment rate, and  $E(p|-i)$  is the expectation of the (logarithm of the) price level at time  $t$  based on information available at time  $t-i$ <sup>10</sup>. Note that this relation can be rewritten as a price-price Phillips curve, namely as :

$$p = -.4 u + (.1 E(p|-1)+.6 E(p|-2) + .3 E(p|-3)) + (\text{supply factors})$$

What Gray and Spencer have thus shown is that the set of correlations traditionally summarized by the Phillips curve can also be given an alternative interpretation, an interpretation more consistent with the imperfect information approach<sup>11</sup>. More generally, one may conclude from a reading of the research on reduced form evidence that the comovements of output, prices and money are consistent with the view that unanticipated money has weaker effects on the price level and stronger effects on output than anticipated money<sup>12</sup>.

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<sup>10</sup> The presence of lagged expectations is easier to justify in a contract model, such as those studied in the next section than in an imperfect information model. Gray and Spencer derive their specification from such a contract model.

<sup>11</sup> The presence of lagged expectations is however easier to justify in the context of models with nominal rigidities reviewed in the next section.

<sup>12</sup> See however the discussion of identification of unanticipated versus anticipated money in the previous section.



Intertemporal substitution, the real wage, labor supply and consumption

While most imperfect information models share the same reduced form implications for output and prices, they differ in their implications as to the relation between real wages and employment, which depends crucially on the source of disturbances and the information structure. If firms perceive prices and wages accurately, money shocks must lead to movements along the labor demand of firms and are likely to imply a negative correlation of real wages and employment. But if instead workers perceive wages and prices accurately, movements take place along labor supply, with a likely positive correlation between real wages and employment. In all cases however, intertemporal substitution by workers in response to correctly or incorrectly perceived opportunities must be an essential part of the model. Thus, intertemporal substitution has been subject to exhaustive econometric examination :

If variations in individual wages largely exceed aggregate variations, misperception of current real wages because of incorrect perceptions of the price level, while essential to explain aggregate fluctuations, may be a minor issue for individual workers<sup>13</sup>. Thus, even if aggregate fluctuations are due to imperfect information, panel data on real wages and employment can still be used to estimate the elasticity of substitution. If individuals are formalized as intertemporal utility maximizers with additively separable utility in consumption and leisure, there are two ways in which the elasticity of substitution can be estimated. The first is to look at the effects of changes in wages on hours worked, controlling for

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<sup>13</sup> The fact that business cycle fluctuations are small compared to fluctuations in individual fortunes was stressed by Lucas [1977]

total wealth. The other is to estimate the static first order condition, which gives a relation between consumption, leisure and the real wage. Empirical evidence using both approaches is reviewed by Ashenfelter [1984] (see also Altonji [1986]). Most of the evidence points to a small positive elasticity, surely insufficient to explain the fluctuations in aggregate employment.

Mankiw, Rotemberg and Summers [1985] have examined the joint behavior of aggregate consumption, employment and real wages, to see whether consumption and employment could be explained as the result of optimal intertemporal choice by a "representative" individual. This approach implicitly assumes that workers can observe actual real wages and have common expectations about the future. They show that the joint behavior of aggregate employment, consumption and real wages is inconsistent with such assumptions. The reason why is a simple and important one : business cycles are characterized by comovements in consumption and employment, or equivalently by opposite movements in consumption and leisure. If utility is additively separable in time, this can only be explained by large procyclical movements in the aggregate real wage (this point is further developed by Barro and King [1984]), which however are not present in the data. Attempts to reconcile the behavior of the real wage, consumption and leisure by allowing for non time separability in utility have not been successful (Eichenbaum, Hansen and Singleton [1987]). There appears to be only two ways to reconcile the data with large intertemporal substitution effects : the first is that business cycle fluctuations are largely the result of taste shocks, taste shifts between consumption and leisure. The other is that the real wage is not equal to the marginal rate of substitution between leisure and consumption : this would be the case if labor contracts provided insurance through real wages<sup>14</sup>. In this latter case, the marginal rate of

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<sup>14</sup> We describe briefly the implications of such contracts in the next section.

substitution should still be equal to the marginal product of labor ; thus, intertemporal substitution may still be testable.

### Current developments

Research on macroeconomic models with imperfect information has dwindled in the 1980's. Many of its proponents have moved on to develop real business cycles models, models in which money and misperceptions play little or no role and where shocks come instead from either government spending (Barro [1986]), or tastes and technology (see for example Prescott [1986]). In those models, the correlation between money and output is explained by reverse causality ; money may precede movements in output if, for example, it is an input in production and production takes time (King and Plosser [1984], Eichenbaum and Singleton [1986]). There are probably two reasons for this shift in focus :

The first is that, as the emphasis has shifted more and more to intertemporal choice, it has proven convenient to work with explicit representative agent models, in which cycles are formalized as the result of equilibrium with intertemporally maximizing identical firms and identical individuals. These models have complex dynamics even in the absence of money and imperfect information. The focus on real business cycles may then be justified as a tractable and necessary first step.

The other reason arises from the mixed empirical success of the imperfect information-money shocks approach. Focusing on other types of shocks may help reconcile the behavior of quantities and prices. Allowing for taste shocks for example may help explain the opposite movements in consumption and leisure in the face of little movement in real wages. It is too early to tell whether this approach will be more successful (see Summers [1987] for a negative forecast). But it surely falls outside the scope of this chapter and is covered at length in Chapter 21.

### Section III Imperfect Competition

For those who believed that the wage-price mechanism was generally sound despite its weak theoretical foundations, the immediate task was to explore how it could accommodate rational expectations. Two important papers, by Fischer [1977a] and by Taylor [1980], developed models which embodied nominal rigidities and rational expectations, and which implied a role for policy in general and for monetary policy in particular. The section starts with them. While these models answered the immediate challenge, they did not however dispose of most of the earlier theoretical objections to the wage-price mechanism. Much of the research since has attempted to put price and wage determination on more solid foundations. This is reviewed in this and the next section.

#### 1. Price and wage setting, and the effects of money on output

##### The Fischer model

Fischer [1977a] introduced the following model <sup>15</sup> :

$$(3.1) \quad y = (m-p) + u$$

$$(3.2) \quad y = -(w-p)$$

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<sup>15</sup> A closely related model was presented at the same time by Phelps and Taylor [1977]. It is interesting to note that Phelps, in presenting his model, thought of it as a natural extension of the work presented in the Phelps volume, in particular of the work on the implications of imperfect information on price setting. In that sense, both the imperfect information and imperfect competition approaches trace back to the same origin.

$$(3.3) \quad w = E(p|-1)$$

Equation (3.1) is aggregate demand, with, for convenience, unit elasticity of output with respect to money balances.  $u$  is a non policy demand disturbance. Equation (3.2) is output supply, obtained from profit maximization, with again for convenience, the assumption of unit elasticity of output supply with respect to the wage<sup>16</sup>. The important equation is (3.3), which says that nominal wages are preset at the beginning of the period, on the basis of available information so as to achieve, in expectation, a constant real wage and constant employment. The information available when the nominal wage is set includes lagged but not current values of  $m$  and  $u$ .

Solving for  $w$  under rational expectations and replacing gives<sup>17</sup> :

$$y = (1/2)[(m-E(m|-1)) + (u-E(u|-1))]$$

Thus, demand and money shocks affect output only to the extent that they are unanticipated ; the reduced form relation is very similar to that of the Lucas model. But the channel is the same as in Keynes : as prices are flexible but nominal wages fixed within the period, demand shocks increase prices, decrease real wages and increase output.

In this first model, if policy makers cannot act more often and do not have more information than wage setters, there is no role for policy to stabilize output. But this is no longer true when nominal wages are set for periods of time longer than the time between policy decisions. This is shown in the second model presented by

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<sup>16</sup> Fischer introduces also a supply disturbance  $v$  ; in the presence of such a disturbance, workers cannot in general choose nominal wages so as to achieve both constant expected real wages and constant expected employment. I do not want to deal with those issues here and put  $v$  equal to 0. I return to those issues when I study indexation below.

<sup>17</sup> For the mechanics of solving linear models with rational expectations, see Taylor [1986b]

Fischer. In that model, at the beginning of each period, half of the labor force now presets its nominal wages for two periods, the current and the next. Each nominal wage is again set so as to achieve a constant expected real wage in each of the two periods. The model becomes :

$$(3.1) \quad y = (m-p)+u$$

$$(3.2') \quad y = -(1/2)[(w-p)+(w(-1)-p)]$$

$$(3.3) \quad w = E(p|-1) \quad w(-1) = E(p|-2)$$

Equation (3.2') gives the wage relevant to firms. It is a weighted average of the nominal wages currently in existence. The first, which applies to half of the labor force, is the wage chosen for this period at the beginning of this period ; the second is that chosen for this period at the beginning of the previous period. They are denoted  $w$  and  $w(-1)$  respectively. Equation (3.3) states that each of these two nominal wages is in turn equal to the expectation of the current price level based on information available as of the time the wage was set : wages are set so as to achieve, in expected value, a constant real wage. Solving for output under rational expectations gives :

$$y = (1/2)[(1/3)(m-E(m|-1))+(2/3)(m-E(m|-2))] + \\ (1/2)[(1/3)(u-E(u|-1))+(2/3)(u-E(u|-2))]$$

Output movements still depend only on unanticipated money and demand shocks. But unanticipated money is now equal to money minus a weighted average of money anticipated as of this and the previous period. This has two implications. The first is that the effects of money on output last for two periods. The second is that monetary policy based only on information available at the beginning of the period can decrease output fluctuations. To see this, assume for example that  $u$  follows a random walk, say  $u = u(-1) + v$ , where  $v$  is white. Then, if money was constant, output would follow :

$$y = (1/2)[v + (2/3)v(-1)]$$

If instead, monetary policy follows the rule  $m = -(2/3)v(-1)$ , output follows  $y = (1/2)v$  and has smaller variance. The reason for why money works is simple : in response to unexpected demand disturbances this period, nominal wage setters would like to readjust their nominal wages for next period. Half of them cannot but the monetary authority can, by adjusting money for next period, cancel the effect of the unexpected demand disturbance on next period's price level.

An implication of this result is that if an optimal feedback rule is used for money, the variance of output does not increase with the number of periods during which nominal wages is fixed. Thus, activist monetary policy can offset the effects of multiperiod predetermination of wages. The model makes a strong case for activist policy.

### The Taylor model

Following an earlier paper by Akerlof [1969], John Taylor [1980] introduced a model similar in most respects to the two period staggered wage setting model of Fischer but with one important difference : wages were not only predetermined but fixed for two periods, that is set at the same nominal level for those two periods<sup>18</sup>. A simpler version was presented by Taylor [1979] and has the following structure :

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<sup>18</sup> The two other differences are unimportant. In Fischer, firms operate under decreasing returns and workers desire a constant real wage. In Taylor, firms operate under constant returns to scale and workers desired real wage is an increasing function of employment. Thus, in Fischer, output appears in the price equation, but not in the wage equation. In Taylor, output appears in the wage equation, but not in the price equation. As long as labor supply and labor demand are not both infinitely elastic with respect to the wage, whether output appears in one or in the other or in both equations does not affect the qualitative effects of money on output. It does affect however the qualitative effects of money on real wages. In Taylor, real wages are constant ; in Fischer, they are countercyclical.

$$(3.4) \quad y = (m-p)$$

$$(3.5) \quad p = (1/2)(w + w(-1))$$

$$(3.6) \quad w = (1/2)[p+E(p(+1)|-1)] + (1/2)a[E(y|-1)+E(y(+1)|-1)]$$

Equation (3.4) gives aggregate demand. We do not allow here for shocks other than nominal money.

Each period, half of the labor force chooses a nominal wage for the current and the next period ; this wage is denoted  $w$ . Thus in the current period, half of the labor force is paid  $w$ , and half is paid  $w(-1)$ . Equation (3.5) gives the price level as a weighted average of these two wages. The markup of prices over wages is assumed not to depend on the level of output.

Equation (3.6) gives  $w$ , the wage chosen this period for the current and the next period. If workers could choose their nominal wage each period, it would be an increasing function of the price level, with unit elasticity, and of output (employment), with elasticity  $a$ . As they preset their nominal wage for two periods, the nominal wage  $w$  depends on the price level and on output this period and expected for the next. Money is assumed to be known only after wages have been set and is therefore not in the information set when  $w$  is chosen.

Replacing  $p$  and  $E(p(+1)|-1)$  from (3.5) in (3.6) and reorganizing :

$$(3.7) \quad w = (1/2)[w(-1)+E(w(+1)|-1)] + a [E(y|-1)+E(y(+1)|-1)]$$

This suggests an alternative interpretation of wage behavior. Workers care about relative wages, thus about  $w(-1)$  and  $E(w(+1)|-1)$ , the wages paid to the other half of the labor force this period and next. This is the interpretation given by Taylor<sup>19</sup>.

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<sup>19</sup> It is sometimes argued that the Taylor model depends on the assumption that workers care directly about their wages in comparison to other wages, an assumption which is thought by some to be unattractive. As the first presentation of the model in the text should make clear, this is not the case.



To solve this model under rational expectations, it is easier to specify a process for  $m$ . If  $m$  follows for example a random walk, the solution is given by :

$$w = k w(-1) + (1-k)m(-1)$$

$$p = (1/2) (w+w(-1))$$

$$y = (m-p)$$

$$\text{where } k = (1-\nu a)/(1+\nu a) < 1$$

Consider the dynamic effects of an unanticipated increase in money. Because wages are set before money is observed, money has no effect on wages or prices in the current period and thus has a full effect on output. Over time however, nominal wages adjust and so does the price level. Output returns to equilibrium over time at an exponential rate. The smaller the parameter  $a$ , which measures the effect of labor market conditions on wages, the closer is  $k$  to one and the longer lasting the real effects of money.

These results differ from those of Fischer in one important way : the effects of money last for much longer than the time during which each nominal wage is fixed. The intuition behind this result is that, as shown in (3.7), staggering implies that workers care indirectly about relative wages. If the effect of labor market conditions is weak, workers choose a new nominal wage  $w$  close to the existing wage  $w(-1)$  ; nominal wages and thus the price level adjust slowly to equilibrium<sup>20</sup>

### The issues

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<sup>20</sup> Although we do not show it here, this wage setting structure also implies that anticipated money affects output.

While the models of Fischer and Taylor showed that rational expectations could be introduced in the "wage-price mechanism", could generate long lasting effects of nominal money and leave a role for policy, they left many issues unanswered. Taking the Taylor model as an example, that model raises for example two sets of issues :

Long lasting real effects of money require  $k$  to be close to unity. This in turn requires  $a$ , the elasticity of the (target) real wage with respect to employment to be small. Taylor assumes that the markup is insensitive to movements in output but, if we were to relax this assumption and allow the markup to be a function of demand, say with elasticity equal to  $b$ , a parallel condition would emerge : long lasting real effects of nominal money would require  $b$  to be small as well.

More generally, a necessary condition for persistent real effects of money is the presence of real rigidities. Put another way, which is more intuitive but slightly misleading, long lasting effects of money require flat supply curves for goods and labor<sup>21</sup>. The issue is then to reconcile such required small values of  $a$  and  $b$  with the presumption that, ruling out strong intertemporal substitution effects, the elasticity of labor supply with respect to wages is likely to be small and with the presumption that, if capital is fixed in the short run, marginal cost is upward sloping. I discuss this first set of issues in the next subsection.

Real rigidities are a necessary but not a sufficient condition for persistence : if wages and prices adjusted continuously, money would still be neutral,

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<sup>21</sup> The way in which this is misleading is that if, for example, when a price is set by monopolist, or a wage determined as a result of bargaining between a firm and a union, there is no such thing as a supply curve. There is however a relation between prices and output, or wages and employment, which is traced out by shifting demand, which can be thought of an implicit supply curve.

independently of the values of  $a$  and  $b$ . In the Taylor model, the two elements, the nominal rigidities, which imply non neutrality of money are presetting of nominal wages, and staggering of wage decisions. But this raises a second set of issues. If the reason why wages are set only at discrete intervals of time is the presence of costs of changing wages, can such costs, which are likely to be small, explain the fluctuations in output we actually observe? If wage setters are free to choose the timing of their decisions, is staggering an equilibrium? If nominal wage setting and staggering are the result of optimal wage setting by individuals or firms, doesn't this imply that fluctuations in output are optimal, when account is taken of the costs of adjusting wages? I discuss those issues in the following section.

## 2. Real rigidities

I review here research on the behavior of the goods and labor markets from a narrow angle, namely by asking : Can models of the goods market explain why, in response to shifts in demand, the adjustment falls mostly on quantities and not on prices, given wages? Can models of the labor market similarly explain why shifts in the demand for labor fall mostly on employment and not on wages, given prices ?<sup>22</sup>

### The goods market

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<sup>22</sup> I have made no attempt to give a complete bibliography of the work presented in this subsection. Many of the references are themselves surveys and serve that function.

Research on the goods market has focused on the implications of imperfect competition. Imperfect competition per se does not imply price rigidity : it is well known that the price rule followed by a monopolist in response to multiplicative shifts in isoelastic demand is the same, up to a constant reflecting monopoly power, as the supply curve which would follow from competitive behavior with the same technology. But if technologies differ under perfect and imperfect competition, or if the degree of monopoly power varies with the level of demand, imperfect competition may then lead to more price rigidity :

If imperfect competition leads firms to have more capital at a given level of demand than would be the case under perfect competition, marginal cost may be flat over a larger range of output : this may arise if entry leads firms with monopoly power to dissipate profit (Hall [1986]) through excess capacity, or if excess capacity serves as a barrier to entry (Fudenberg and Tirole [1983]). Is marginal cost flat at normal levels of production ? This is doubtful. While labor productivity is procyclical, the proportion of overtime labor, of labor paid time and a half, is strongly procyclical. If firms had cheaper means of increasing production, they would not use overtime. Bils [1985], pursuing this line of reasoning, concludes that marginal cost is upward sloping in most industries, so that this does not appear to be the explanation for real price rigidity.

The monopolist example above assumes that the degree of monopoly power, which in that example is only a function of the elasticity of demand, is constant. But, if monopoly power is countercyclical, an increase in demand will lead to lower markups of prices over marginal costs, thus to less movement in the markup than in marginal cost. This may be the case if the elasticity of demand increases with the level of demand, so that monopoly power is lower in booms (see Stiglitz [1984] for a review of such cases). It can also be the case if the sustainable degree of collusion is lower when demand is high (Rotemberg and Saloner [1986a]).

Many stories do not however make a theory of price rigidity. They also suggest that price rigidity should vary across markets, in particular as a function of market structure. The evidence is however mixed, with some evidence that markups are more cyclical in concentrated industries (Domowitz, Hubbard and Petersen [1986]). A more radical departure from standard price setting has been developed by Okun [1981] who suggests that, in all customer markets, customers develop a notion of fairness. If price changes are perceived as unfair, a firm may actually lose profit by increasing prices in response to increases in demand. While there is evidence that fairness plays an important role in goods markets (Kahneman et al [1986]), the issue becomes that of what in turn determines fairness.

#### The labor market

If we believe that intertemporal substitution in labor supply is not of major relevance for macroeconomic fluctuations, and that the elasticity of labor supply with respect to permanent changes in the real wage is small, the fact that shifts in demand for labor appear to fall mostly on employment rather than on wages is puzzling. It also suggests that a radical departure from perfect competition is needed. Research on real wage rigidity has explored three different directions :

The first has been the implication of the presence of unions. Again, the presence of a union does not necessarily imply more real wage rigidity than in a competitive labor market (see the surveys by Oswald [1985] and Farber [1986]). But it may : McDonald and Solow, [1981] concentrating on the case of bilateral monopoly between a firm and a union, have shown that, if in response to shifts in demand, both sides decide to share gains from trade "fairly", the outcome will usually be one of large employment fluctuations and small real wage fluctuations.

Large parts of the labor market are neither unionized, nor under threat of unionization. Another direction of research has explored the scope and the implications of implicit contracts between workers and firms. Initially, the implications of insurance by risk neutral firms to risk averse workers were seen as providing a potential explanation for real wage rigidities and large employment fluctuations. It was soon realized however that while this could explain real wage rigidity, it implied, absent income effects from insurance, exactly the same employment pattern than under perfect competition and thus could not, if individual labor supply was inelastic, explain large employment fluctuations (see Azariadis [1979]). The theory of implicit contracts was then extended to allow for asymmetric information between workers and firms. The employment characteristics of optimal contracts under asymmetric information depend very much on the relative degrees of risk aversion of firms and workers and on the information structure. There does not, at this stage, appear to be good reasons to think that they will, in general, lead to larger employment fluctuations than full information contracts (see the survey by Stiglitz [1986]). Hart and Holmstrom [1986] discuss also the potential role of such contracts in explaining macroeconomic fluctuations.

The last direction of research has focused on "efficiency wage" models, models in which the wage may directly affect the marginal product of labor. One possible reason, emphasized by Akerlof [1982], and closely related to the customer market argument of Okun discussed above, is simply that workers form wage norms and sharply decrease their effort if wages go below the norm. As in the case of fairness, the issue is again here that of what determines those norms, given that they clearly evolve over time, increasing for example as productivity increases. Other models which do not rely on interpersonal comparisons of utility have also been developed (see the surveys by Yellen [1984] and Katz [1986] of the theoretical and empirical

evidence). If, for example, effort can only be imperfectly monitored, it may be optimal for a firm to pay a wage above the market : it is then costly for a worker to be caught shirking and fired, and workers may then choose the optimal amount of effort.

To see what efficiency wage theories may imply for the issue at hand, consider the following example from Solow [1979]. Suppose that profit for a firm is given by  $aF(e(W)L) - WL$ , where  $L$  is the number of workers and  $e$  is the effort per worker. Effort is assumed to be an increasing function of the real wage  $W$ . The firm chooses  $L$  and  $W$  so that the first order conditions are :

$$(3.8) \quad e'(W)W/e(W) = 1$$

$$(3.9) \quad e(W)aF'(e(W)L) = W$$

The real wage chosen by the firm is given by (3.8) and is such the elasticity of effort with respect to the wage is equal to one. Equation (3.9) in turn determines employment.

In this example, there is complete real wage rigidity. A shift in  $a$ , which can be interpreted as a shift in the relative price facing the firm, has no effect on the real wage paid by the firm and falls fully on employment. The model however assumes that effort depends only on the absolute level of the real wage. Suppose that effort depends instead positively on the wage paid by the firm relative to the aggregate wage, and positively on unemployment, as is the case in the shirking model. In that case, the condition corresponding to (3.7) then gives the relative wage as a function of unemployment. In equilibrium, all wages must be the same ; this in turn determines a relation between the real wage and unemployment. In the model of Shapiro and Stiglitz [1984], workers have a reservation wage below which they do not work and above which they supply one unit of labor, so that, absent efficiency wage considerations, aggregate labor supply has an inverted L shape. With efficiency

wages, this labor supply locus is replaced by a smooth increasing equilibrium relation between wages and employment. Thus, an economy which, absent efficiency wages, operated at full employment with shifts in demand translating only into changes in wages, will, with efficiency wages, experience movements in both wages and employment. Employment fluctuations will be larger, and wage fluctuations smaller, under efficiency wages than under perfect competition.



Section IV . Imperfect competition (continued)1. Nominal rigidities : the static case

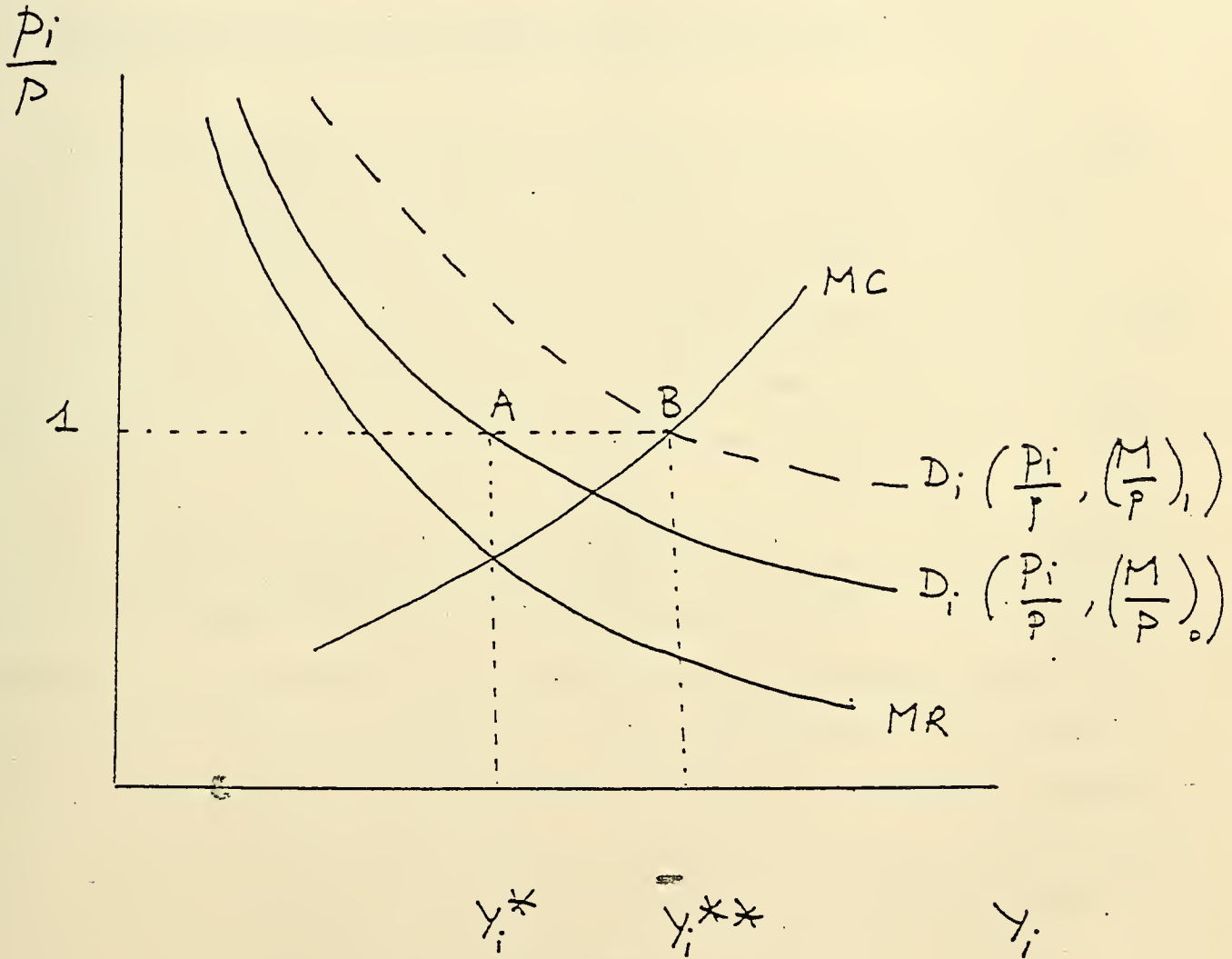
An old but vague Keynesian theme, starting with Keynes' own explanation of nominal wage rigidity, is that of coordination problems. The argument is the following : to be neutral, a decrease in money requires a proportional decrease in all nominal prices, leaving all relative prices the same. But if price setters do not want to change relative prices, none of them will want to decrease his price first. The outcome will be nominal rigidity, or at best slow adjustment of nominal prices.

The argument is clearly right in the extreme case in which price setters want to keep relative prices constant, in the case of complete real price rigidities. A change in nominal money, at given prices, changes real balances, output and employment but does not lead any price setter to change his price given others. The analogy with Daylight Saving Time in the US, introduced by Friedman [1953] to make the case for flexible exchange rates, is revealing. While it may be socially desirable to change the hours during which stores are open in winter, this will not happen without explicit coordination of decisions, as each store wants to keep the same hours as other stores. A change in the clock achieves the result without need for coordination. Woglom [1982] develops an economic model with the same structure. The economy is composed of monopolists who face kinked demand curves. This leads them not to want to change their relative price in response to changes in demand ; this in turn leads to nominal rigidities and non neutrality of money.

But the argument, at least in this simple form, does not hold when the relative price chosen by each price setter is an increasing function of the output he



Figure 1. The monopolistically competitive equilibrium.



$y_i^*$ : monopolistically competitive equilibrium output  
 $y_i^{**}$ : competitive equilibrium output.



produces. In this case, an increase in nominal money, which increases demand and output, leads all price setters to attempt to increase their relative price ; as this is impossible, all nominal prices increase until real money balances are back to equilibrium. The initial argument holds however in slightly modified form ; its structure has recently been clarified and I now present it.

#### Nominal rigidities, pecuniary externalities and menu costs

The argument requires some deviation from perfect competition and its specific form depends on the specific deviation. I present it here in a simple general equilibrium model with monopolistic competition, which follows Mankiw [1985], Kiyotaki [1985], Ng [1986] and is extended in Blanchard and Kiyotaki [1986]. Akerlof and Yellen [1985] have developed a closely related argument, but in a model with efficiency wages in the labor market and imperfect competition in the goods market.

The economy is composed of  $n$  workers-producers,  $i=1, \dots, n$ , selling differentiated products, but otherwise identical. The demand facing producer  $i$  is a decreasing function of his relative price ( $P_i/P$ ) and an increasing function of aggregate real money balances ( $M/P$ ). Each producer also faces an upward sloping marginal cost function, which reflects increasing marginal disutility of work and/or decreasing returns to scale in production. Marginal cost, demand and marginal revenue functions facing producer  $i$  are drawn in figure 1. Demand and marginal revenue are drawn for an arbitrary level of aggregate real money balances.

The profit maximizing level of output for producer  $i$  is given by the intersection of marginal cost and marginal revenue, with the associated price being given by the demand curve, point A. In symmetric equilibrium, all prices must be the

same, so that  $P_1/P = 1$ . This in turn determines the equilibrium level of real money balances and the price level.

If each producer acted competitively instead, the equilibrium would be at the intersection of marginal cost and demand. In symmetric equilibrium,  $P_1/P$  would still be equal to one, so that the equilibrium would be at point B instead. This in turn implies that, as the demand curve must go through B, the equilibrium real money balances would be higher under perfect competition, the price level lower. Note that, as all producers have the same degree of monopoly power, monopoly power has no effect on the relative price of produced goods. Monopolistic competition affects instead the relative price of goods in terms of money, the price level, which is higher than under competition. Welfare, measured by consumer and producer surplus<sup>23</sup>, is higher under perfect competition.

The informal argument can now be formalized and proceeds in two steps.

(1) Associated with the monopolistically competitive equilibrium is a pecuniary externality :

A decrease in an individual producer's nominal price has two effects. First it increases the demand for that producer's good ; second, by decreasing (slightly) the price level, it increases real money balances, increasing demand and output of all other producers. In equilibrium, prices are such that the first effect on profit is equal to zero to a first order : each producer has no incentive to change his price. But, because output is initially below its socially optimal level under monopolistic competition, the second effect leads to an increase on welfare.

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<sup>23</sup> In Blanchard and Kiyotaki, marginal utility of income is constant and the sum of consumer and producer surplus for a representative market is indeed the appropriate measure of welfare.

Put another way -which will be convenient below- a small proportional decrease in all nominal prices, a decrease in the price level, would increase output and have a first order positive effect on welfare. But, no individual producer has an incentive to decrease his own price given other prices, as he would experience a second order loss in profit.

(2) In the presence of small costs of changing prices, "menu costs", the pecuniary externality implies nominal price rigidity.

Instead of a small decrease in the price level given nominal money, consider a small increase in nominal money given the price level. Output and welfare increase to a first order ; but each producer has a second order incentive to increase his price. Absent menu costs, the economy would return to the initial level of output with higher prices. Small menu costs, that is second order costs but larger than the loss in profit associated with not changing the price, will however prevent this adjustment. If they do, nominal prices will not adjust and the change in nominal money will affect output and have first order effects on welfare.

To summarize, imperfect competition implies that, in response to an increase in nominal money, the incentive to adjust relative prices may be weak. Small costs of changing prices will prevent adjustment of relative prices, thus of nominal prices, leading to an increase in aggregate demand. Because price initially exceeds marginal cost, firms will willingly increase output even if they do not adjust prices. Output will go up and so will welfare.

Extensions : the role of structural parameters ; multiple equilibria

Two more sets of results can be derived from this simple framework.

(1) The first relates the size of menu costs needed to prevent adjustment of prices to the parameters of demand and cost. Second order menu costs are sufficient to imply real effects of small changes in nominal money. But, with respect to larger changes in nominal money, the size of the menu costs required to prevent adjustment depends on the the characteristics of technology and market structure.

If marginal cost was constant, a condition which implicitly requires both constant marginal disutility of work and constant returns in production, no price setter would want to change his relative price and nominal prices would remain unchanged even in the absence of menu costs. By continuity, as long as marginal cost is fairly flat, small menu costs can prevent adjustment of prices. But, if the disutility of work is a strongly increasing function of the level of work -an assumption which would imply an inelastic labor supply in a competitive labor market- the menu costs required to prevent price adjustment become implausibly large. This shows the limits of the menu cost argument and the need to construct models which combine menu costs with real rigidities. This has been for example the approach followed by Akerlof and Yellen [1985] who develop a model with efficiency wages in the labor market, and monopolistic competition and menu costs in the goods markets. Their version of efficiency wages, which is the same as that in equations (3.8) and (3.9) delivers movements in employment with no change in the real wage. As long as there is unemployment, this implies that the labor market behaves as if labor supply was infinitely elastic at the prevailing wage. Thus, as long as firms operate under close to constant returns to scale, monopolistic competition and menu costs in price setting easily deliver nominal rigidity of both prices and wages, and real effects of nominal money.



The other main parameter in the model above is the elasticity of substitution between goods, which determines the elasticity of demand with respect to relative prices. The higher this elasticity, the higher the opportunity cost of not adjusting relative prices and thus the higher the menu costs required to prevent adjustment of prices. Rotemberg and Saloner [1986b] use this argument to explain why prices appear to be more rigid under monopoly than under duopoly in which each firm perceives a more elastic demand curve.

(2) What has been shown above was that if menu costs were large enough, there was an equilibrium with unchanged nominal prices. What has not been shown is that this was the only equilibrium. Whether or not it is depends on the interactions between prices. The argument has been formalized by Ball and Romer [1987b] and Rotemberg [1987] and has the following structure :

A change in the price level has two effects on the nominal price that an individual price setter wants to set. Other things equal, an increase in the price level leads to a proportional increase in the desired nominal individual price. But, at the same time, an increase in the price level decreases real money balances, shifting inwards the demand curve faced by the price setter, and leading him to decrease his desired relative price. The net effect is in general ambiguous, depending on the strength of the effect of real money on aggregate demand and on the degree of substitution between goods. In the -more likely- case where the substitution effect dominates, an increase in the price level increases the desired individual nominal price ; following Cooper and John, this case can be called the case of "strategic complementarity"<sup>24</sup>.

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<sup>24</sup> Cooper and John (1985) have looked at the characteristics of equilibria in games such as this one where the action of one player depends positively on the actions of other players, a condition they call "strategic complementarity". They show that many "Keynesian" models exhibit such a characteristic and that those games exhibit "multiplier effects" and may have multiple equilibria.

Assuming strategic complementarity and the presence of menu costs, consider the effects of an increase in nominal money. The incentive for a given price setter to adjust his price is clearly stronger the larger the proportion of other price setters who adjust theirs. This suggests that for some values of the menu costs, there may be two equilibria, one in which all price setters adjust, making it optimal for each price setter to adjust, and one in which no one adjusts, making it optimal for each price setter not to adjust. The papers by Ball and Romer and by Rotemberg show that this is indeed the case. This potential multiplicity of equilibria is more than a curiosum. It appears in some guise in many of the dynamic extensions of the static model which we describe below.

#### From statics to dynamics : the issues

The menu cost argument points to an important externality in price setting. Before it can be used to conclude that macroeconomic fluctuations are in part the result of such an externality, two sets of questions must however be answered :

(1) The menu cost argument as we have presented it assumes that all prices are initially equal and set optimally. In a dynamic economy and in the presence of menu costs, such a degenerate price distribution is unlikely to prevail. But if prices are initially not all equal or optimal to start with, it is no longer obvious that even a small change in nominal money will leave all prices unaffected. It is no longer obvious that money will have large effects on output.

(2) Even if nominal money has large effects on output, it must be the case that money is sometimes unanticipatedly high, sometimes unanticipatedly low. When money is high, output increases and so does welfare to a first order. When money is low, output decreases and so does welfare, again to a first order. These welfare effects

would appear to cancel out to a first order. It is therefore no longer obvious that, even if menu costs lead to large output fluctuations, the welfare loss of those fluctuations largely exceeds the menu costs which generate them. This point is developed by Ball and Romer [1987a] in the context of the static model above, but assuming money to be a random variable.

I now review what we know about the answers to those two questions in dynamic models. It turns out that the answers depend very much on the specific form of nominal rigidities, on the specific price rules used by price setters. I start by reviewing what we know about the effects of money if price setters use either time dependent or state dependent rules. I end the section by discussing what rules are likely to be chosen, and the nature of actual price and wage rules.

## 2. Time dependent rules and the effects of money on output

The simplest time dependent rules are rules in which the time between price decisions is fixed<sup>25</sup>. As the Fischer and Taylor models show, time dependent rules do generate non neutrality. As the difference between the two models also shows, an important issue, if prices are fixed -rather than predetermined- between price decisions, is whether those decisions are synchronized or staggered. Staggering leads to longer lasting effects of nominal money on output. Research has thus proceeded in two directions. The first has studied the determination of the time structure of price decisions. The second has studied the implications of alternative staggering

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<sup>25</sup> This however is not necessary. An example of a time rule with random time between price decisions is given below.

structures, taking staggering as given. While the first logically precedes the second, it is only recently that research has focused on the first.

### Implications of alternative staggering structures

Research on the implications of wage staggering has focused on the implications of staggering for monetary policy, in particular for disinflationary policies. Phelps [1979] had shown that if wage setting was characterized by staggering and rational expectations, there was in principle, and in sharp contrast to the implications of the standard Phillips curve, a path of disinflation consistent with no output loss. Taylor [1983] has extended this analysis by computing the actual path of disinflation consistent with no recession given the actual staggering structure of wage setting in the US. The path needed to decrease inflation from 10% to 3% at no output loss has interesting characteristics : inflation goes from 10% to 9.9% in the first year, from 9.9% to 8.7% in the second, and from 8.7% to 3.6% in the third. The very slow initial decrease is needed because past wage decisions which were taken before the change in money growth have to be accommodated. But this slow initial decrease raises obvious issues of credibility, as little happens in the first two years after the change in policy. These issues have been studied by Fischer [1985] and are analyzed at more length in chapter 23. Fischer [1984] has extended the analysis to the open economy to study the implications of the change in real exchange rates implied by monetary contraction. While the analyses of Taylor and Fischer are based on the assumption that staggering is unaffected by changes in monetary policy, and are thus subject to the Lucas critique, empirical studies of the 1979-1982 US disinflation suggest that there was indeed little change in aggregate wage behavior during the period (Englander and Los [1983]).

I have studied the implications of staggering of price decisions. While most prices change more often than wages, I have shown (Blanchard [1983]) that if output is produced through a chain of production, with price decisions being taken at different times at different production steps, there can be substantial price level inertia even if each price setter takes price decisions very often. US empirical evidence (Blanchard [1987]) shows this effect to be important : I find that, while prices adjust fast to input prices and wages at the disaggregated level, interaction between price decisions implies substantial aggregate price inertia. I conclude that price level inertia in the US comes as much from staggering of price decisions than from staggering of wage decisions. I have also studied (Blanchard [1986a]) the implications of wage and price staggering, showing that, even under rational expectations, such staggering generates a wage price spiral, as well as cost push and demand pull inflation, ideas which had been emphasized in earlier work on inflation.

All staggering structures have in common that, after an increase in nominal money which increases demand, price and wage setters attempt to increase or at least to maintain relative prices and wages. Along the path of adjustment, there are oscillations but no systematic movement in relative prices and real wages. Implications of staggering for the variability of relative prices have been drawn and examined by Taylor [1981] in particular.

All the above papers assume that price decisions are taken for fixed periods of time and that the cost of changing prices is independent of the size of the change. Two alternative formalizations have also been explored. Calvo [1982] has built a model with a continuum of price setters, and in which the probability for a given price setter to change his price at any point in time is constant. Together, these

two assumptions imply that a constant proportion of prices changes at any point in time, and give a very convenient continuous time specification of aggregate price dynamics. Rotemberg [1982] has developed and estimated a model of monopolistic competition with quadratic costs of adjustment of nominal prices, so that the cost varies with the size of the change<sup>26</sup>. Most of the above papers focus on the effects of price setting rather than on the relation between money and aggregate demand. Svensson [1986] attempts to integrate the two strands of recent research on money demand on the one hand and on price setting by monopolistic competitors on the other.

#### Determination of the time structure of decisions

The research reviewed above takes the structure of staggering as given. The other direction of research has been to see whether such a structure can indeed arise as an equilibrium if each price setter is free to choose both the length of time between price changes and the timing of his decisions in relation to others.

The question has been studied by Parkin [1986], Ball [1986a] and Ball and Romer [1986] in models similar to the model of monopolistic competition sketched above. Their argument has the following structure<sup>27</sup> :

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<sup>26</sup> Julio Rotemberg has pointed out to me that, despite their different motivations, his and Calvo's model have the same dynamics. This can be seen as a justification for using the quadratic cost formalization as a convenient "as if" approach.

<sup>27</sup> The three models differ in various ways. The first two assume that prices are predetermined between price decisions (a la Fischer). The third assumes that prices are fixed between price decisions (a la Taylor). Parkin assumes that money follows a feedback rule while the other two papers take money as exogenous.

Suppose that nominal money follows a given stochastic process and that each price setter takes price decisions at fixed intervals of time, say -by defining the period appropriately- every two periods. Each producer still has the choice between taking decisions at the same time as the others, say at even times, or at a different time, at odd times. It is clear that symmetric staggering is an equilibrium : if exactly half of the price setters take decisions at odd times and half at even times, the stochastic environment faced by a price setter is the same whether he takes decisions at even or odd times and he is therefore indifferent to timing<sup>28</sup>. But one can ask whether this staggered equilibrium is stable, whether for example, if the economy is characterized initially by asymmetric staggering and if individual price setters are allowed to change their timing, the economy will converge to the staggered equilibrium.

The answer turns out to depend on whether the strategic complementarity condition described earlier is satisfied or not, whether an increase in the price level increases or decreases the nominal price that an individual price setter wants to set. In the more likely case where an increase in the price level increases desired individual prices, staggering cannot be stable. The intuition for this result is simple. Suppose that initially a larger proportion of price setters changes prices at even than at odd times, so that the price level moves more on average at even than at odd times. A price setter who was initially taking decisions at odd times has an incentive to move so as to take decisions with the majority of price setters. The stable equilibrium is one in which all price decisions are taken at even times. In

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<sup>28</sup> This assumes that the price setter is small compared to the economy, so that in considering whether to change his price at even or odd times, he takes the stochastic process followed by the price level as given. Fethke and Policano [1984] have studied the properties of the equilibrium when the number of price setters is small.

the less likely case where an increase in the price level decreases individual nominal prices, staggering can be stable but this hardly provides a convincing explanation for the general presence of staggering in the economy.

The introduction of stochastic idiosyncratic shocks does not make staggering more likely. With respect to idiosyncratic shocks, choosing odd or even timing is irrelevant, so that, if strategic complementarity holds, price setters still have an incentive to move with others and staggering is not a stable equilibrium. If idiosyncratic shocks have however a deterministic, "seasonal" component, if for example some firms experience shocks mostly at odd times, some mostly at even times, staggering can then be an equilibrium, with each firm choosing its natural timing habitat<sup>29</sup>. This will be the case if idiosyncratic shocks are large, or if the strategic complementarity effect is weak. This is explored by Ball and Romer [1986], who also analyze the welfare properties of the equilibrium. The empirical importance of such shocks seems however limited, and insufficient to provide a general explanation of staggering.

Two other ideas have been explored. The first, pursued by Ball and Cecchetti [1987] is that, in the presence of imperfect information, price decisions carry some information and it may be optimal for a price setter to wait for the information before deciding on his own price. The question is however of whether an equilibrium will exist in such a context. If each price setter prefers to take decisions just after the others, it is not clear that an equilibrium exists, at least not an equilibrium with fixed timing of price decisions. The second, explored by Maskin and Tirole [1986], is that staggering may change the nature of the game played by price

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<sup>29</sup> An example may be that of grocery stores which change prices with new deliveries. Prices will then change as the delivery truck goes from store to store, leading to staggering.



setters and allow price setters to achieve a more collusive sustainable outcome. Both of these approaches have implications which go far beyond staggering. Imperfect information reintroduces some of the channels studied in Section II. Maskin and Tirole show that games with staggered decisions may generate outcomes which resemble for example those obtained with kinked demand curves. This last example shows that further progress requires a better integration of the theories of real and nominal rigidities.

It may well be that trying to generate staggering given fixed timing of individual price changes is the wrong strategy. After all, it is plausible that if price setters experience different histories of shocks, they will naturally change prices at different times. This however points to state rather than time dependent rules, rules in which the decision to change prices is a function of the state. I now examine the aggregate implications of such rules.

### 3. State dependent rules and the effects of money on output

The simplest state dependent rules are Ss rules, which in our context, imply that the nominal price is readjusted whenever the difference between the actual price and a target price exceeds some fixed threshold value. Ss rules are optimal only under restrictive assumptions ; because they are analytically convenient, research has usually proceeded under those restrictive assumptions, or simply assumed the use of Ss rules as convenient if suboptimal rules.

The optimal Ss rule for a monopolist facing random walk fluctuations in demand was characterized by Barro [1972] under the assumption of no inflation. Sheshinski and Weiss [1977],[1983] derived instead optimal Ss rules in the presence of

deterministic or stochastic inflation and no demand uncertainty<sup>30</sup>. Benabou [1986a] has extended their analysis to the case where goods are storable, showing that, even in the absence of uncertainty, firms may resort to randomized strategies to avoid price speculation in anticipation of price changes.

The important question, for our purposes, is that of the aggregate implications of Ss rules. These rules, with their implication that the length of time between individual price changes is random, seem to have the potential to explain staggering and thus price level inertia. Rotemberg [1983] and Caplin and Spulber [1985] have shown however that this is not necessarily the case. In their paper, Caplin and Spulber derive the aggregate behavior of prices and output in response to changes in nominal money when individual price setters follow Ss rules. A simplified version of their argument is the following<sup>31</sup> :

Suppose that there are  $n$  price setters. The (log of the) nominal price  $p_1^*$  that each price setter would choose in the absence of costs of changing prices is only a function of nominal money and an idiosyncratic shock. Furthermore,  $p_1^*$  is assumed to be a non decreasing function of time (i.e there is enough average money growth that even if there is an adverse idiosyncratic shock,  $p_1^*$  does not decrease).

There are fixed costs of changing prices, which lead each price setter to adjust the actual nominal price  $p_1$  according to the following Ss rule : when the deviation  $p_1^* - p_1$  exceeds a threshold value  $S$ ,  $p_1$  is readjusted so that the deviation is equal to  $s$ .

Caplin and Spulber then show that :

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<sup>30</sup> A mistake in Sheshinski and Weiss [1983] is corrected in Caplin and Sheshinski [1987].

<sup>31</sup> The formal model they develop does not have idiosyncratic shocks.

Figure 2. The Caplin - Spulber neutrality result.

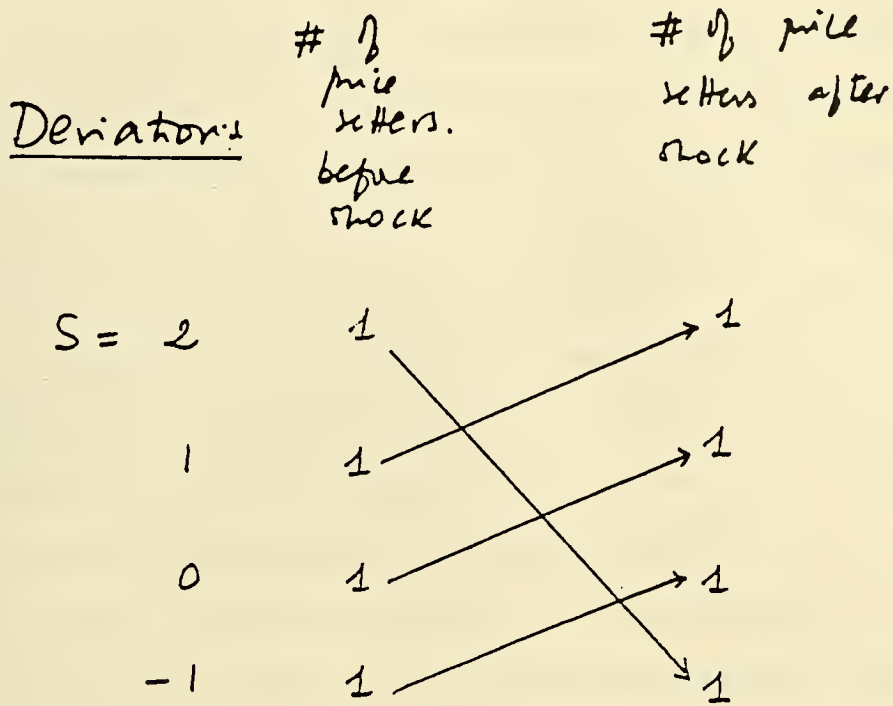
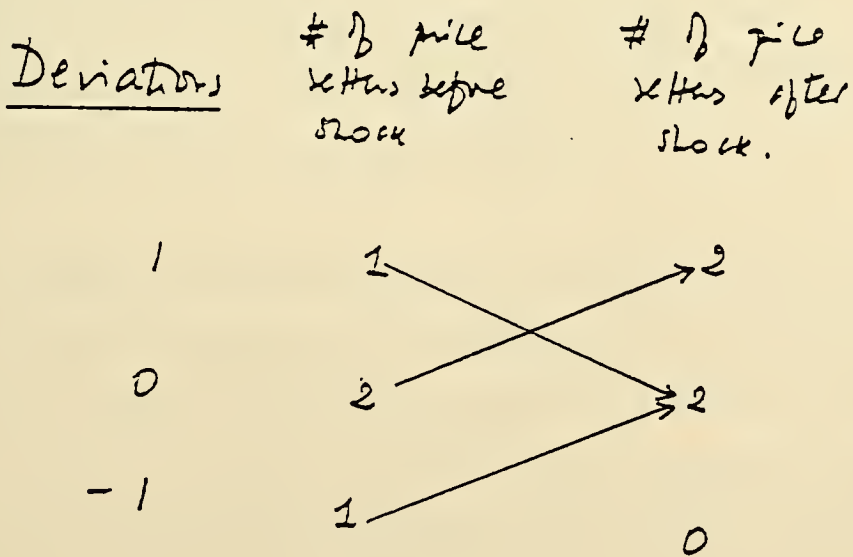


Figure 3. An example of non neutrality.





(1) For a given price setter, the deviation  $(p^*_i - p_i)$  is uniformly distributed between  $S$  and  $s$ . That is, if we observe  $(p^*_i - p_i)$  at a point in time, we are as likely to observe any value of the deviation between  $S$  and  $s$ . Furthermore, as long as the idiosyncratic shocks are not perfectly correlated, the distribution of deviations  $(p^*_i - p_i)$  across price setters is also joint uniform :  $(p^*_i - p_i)$  and  $(p^*_j - p_j)$  are uncorrelated for all  $i$  and  $j$  ; together, these propositions imply that price decisions will be, on average, uniformly staggered. While this would appear to provide foundations for slow adjustment of the price level to changes in nominal money, the next proposition shows just the opposite to be true.

(2) Changes in nominal money lead on average to proportional increases in the price level. Figure 2 provides the intuition for this result. Assuming that there are 4 prices in the economy and that the distribution of deviations is uniform between  $[s=-1, S=+2]$ , the initial distribution is characterized in the first column of Figure 2. An increase in nominal money of 1 increases all target prices by 1, one price is adjusted and the new distribution is given in the second column, which is obviously identical to the first. Although only one price has increased, it has increased by four times as much as it would have, absent costs of adjustment. Thus, the price level increases by as much as nominal money.

This result shows that menu costs do not necessarily imply non neutrality of money. All which is needed for it to obtain is that the distribution of deviations be uniformly staggered. It applies for example if desired prices depend for example on the price level, real money balances and relative demand shocks. Benabou [1986b] constructs a general equilibrium model where consumers search optimally given the dispersion of prices implied by  $Ss$  pricing by firms and in which  $Ss$  rules are optimal given the search behavior of consumers. In his model as well, money is neutral.

The neutrality result in the above example follows from the fact that while only one out of four prices is readjusted, it adjusts by four times the size of the change in nominal money. More formally, the size of the price adjustment is equal to the support of the distribution of deviations. This is not however a characteristic of all Ss rules and thus not all Ss rules imply neutrality.

An example will show why. In Caplin and Spulber, the desired nominal price increases through time. The firm just needs one threshold value, such that when the actual price is too low, it is readjusted upwards. Suppose instead that the average inflation rate is zero so that the desired nominal price increases or decreases through time, with equal probability. The firm then needs a rule with both an upper and a lower threshold (such as in Barro [1972]). Under such a rule, the price is readjusted whenever it becomes too low or too high. Aggregation of such rules is difficult and no general result is available ; changes in money do not however lead in general to contemporaneous proportional adjustment in the price level. An example is given in Figure 3. Assume that there are four prices, which are readjusted to equal the target price whenever the deviation between actual and target price exceeds 1 in absolute value. Under such a rule, price deviations are more likely to be at the return point, 0, than at -1 and +1 (see for example Barro [1972]), so that in Figure 3 two price deviations are assumed initially equal to zero, one to -1 and one to +1. An increase in nominal money of 1, assumed to increase all target prices by 1, leads to the readjustment of one price by 2, and to an increase in the price level of 1/2 only.

Whether aggregation of such Ss rules can explain long lasting effects of money remains to be seen. An interesting implication of this line of research is that, the higher the average rate of inflation, the closer Ss rules will be to the one sided

rules assumed by Caplin and Spulber, the more neutral money will be<sup>32</sup>.

#### 4. Time or state dependent rules ?

To summarize, the static menu cost argument is an important insight. It does not however extend straightforwardly to the dynamic case. With time dependent rules, menu costs generate real effects of nominal money ; a complete analysis of the relation of welfare effects to menu costs remains however to be done. With state dependent rules, money may still be neutral. This raises two further issues.

The first is that of the type of rule price setters are likely to adopt. Why would price and wage setters ever use time rather than state dependent rules ? One simple possibility is that the state is costly to observe or verify ; in that case, it may be optimal to collect information and revise the price at fixed intervals, with the interval determined by the characteristics of the process determining the underlying target price. This may explain why labor contracts, in which agreement on the state may be costly are negotiated at fixed intervals of time. In general, the optimal rule is likely to be both state and time dependent. What the implications of such rules will be remains to be seen. Non neutrality of money is likely but little else can be said.

The other issue is empirical. What type of rule do price and wage setters actually use ? The answer is far from clear. Labor contracts are signed for fixed

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<sup>32</sup> This is true however only under the maintained assumption of fixed values for  $S$  and  $s$ . For general stochastic processes for money, fixed  $Ss$  rules are dominated by rules in which  $S$  and  $s$  are also functions of the state. Tsiddon [1986] has shown that under such more general rules, a decrease in money growth, rather than being neutral, would instead be initially contractionary.

periods of time, and while nominal wages are not fixed for the duration of contracts, cost of living adjustments are usually both state and time dependent. Many more prices are changed in January in the US than would be expected from a uniform distribution<sup>33</sup>, which suggests some time dependence. Evidence on individual prices suggests that prices are adjusted faster in periods of higher inflation (Cechetti [1986] on newspapers) ; this is however consistent with time dependent rules, where the length of time between price decisions is a function of the underlying parameters of the economy and thus changes over time. Evidence on individual price setting within manufacturing is also provided by Carlton [1986] who reexamines the Kindahl and Stigler data base. This reexamination does not lead to a simple characterization of price changes or of price rules.

Finally, I have reviewed in this section only the research dealing specifically with foundations of price setting ; in that research, the dynamics of output in response to shocks arise mainly or exclusively from price and wage setting. This is in sharp contrast to the research summarized in Section II and to the channels for persistence emphasized there, such as costs of adjustment in employment, inventory and capital accumulation. The contrast is much too sharp. Price and wage setting equations such as those in Taylor have been integrated in larger models with richer dynamics, and used to look at many macroeconomic issues. Taylor [1986a], for example, has constructed a medium size multi-country model with staggering of wage decisions. He uses the model to analyze the effects of monetary policy on the US and the rest of the world and contrasts his results with those of traditional models. Reviewing those applications would however take us too far afield.

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<sup>33</sup> I owe this fact to Julio Rotemberg



## Section V. Indexation and other issues

In this section, I study three issues. The first is that of indexation and monetary reforms designed to make prices more flexible. The second is the possibility, raised by Keynes in the context of the effects of deflation, that price flexibility far from being stabilizing, may in fact exacerbate output fluctuations. The third is the possibility that changes in nominal money may not be neutral even in the long run.

### 1. Indexation and Monetary Reforms

The analysis of the previous sections suggests that changes in the price setting process, which allowed prices to adjust more quickly to other prices would be desirable. One such change is indexation which, at least in principle, makes prices or wages adjust quickly to changes in the price level.

#### Wage indexation

The debate about the effects of wage indexation on fluctuations was formalized in papers by Fischer [1977b] and Gray [1976]. Gray's model has a structure similar to that of the early Keynesian model :

$$(5.1) \quad y = (m-p)$$

$$(5.2) \quad y = -(w-p) - u$$

$$(5.3) \quad w = k p + (1-k) E_p$$

Equation (5.1) gives aggregate demand. Equation (5.2) gives labor demand under perfect competition, and allows for a supply or productivity shock,  $u$ , with expected value  $E u = 0$ . Equation (5.3) gives the wage setting rule, with the degree of indexation being equal to  $k$ , which is between zero (no indexation) and one (full indexation). The solution to those equations is, under rational expectations :

$$(5.4) \quad y = ((1-a)/(2-k))(m - E m) - (1/(2-k)) u$$

With no indexation, both nominal and real shocks affect output. Real shocks however, as they increase the price level, lead to a lower real wage, partly attenuating the effect of the shock on output. Full indexation protects the economy from nominal shocks but exacerbates the effects of real shocks as the real wage is fixed. Thus, Fischer and Gray argued, full indexation is not optimal in an economy with both real and nominal shocks<sup>34</sup> ; Gray proceeded to derive the socially optimal degree of indexation as a function of the variances of both sources of shocks.

The Fischer-Gray analysis has been extended in two main directions. The first has allowed for more sources of shocks, such as external shocks for an open economy ; the second has looked at the properties of alternative indexation schemes, such as whether wages should be indexed to the CPI or to the GNP deflator, or to nominal income (see for example Aizenman and Frenkel [1985]).

The simple Fischer-Gray model implies that full indexation leads to complete nominal and price flexibility. But actual indexation clauses index the nominal wage not to the current price level but rather to the lagged price level. As a result,

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<sup>34</sup> The relevant distinction is between demand and supply shocks. Here, the only demand shocks are nominal shocks.

they do not remove all nominal rigidities. The implications of actual indexation formulas were sketched in Fischer [1977b] and have been studied by Simonsen [1983] ; his conclusion is that actual indexation may in fact make disinflation harder and more costly in terms of output loss. The model above also assumes that the only source of nominal rigidities is wage setting. If price rigidities are important, as I have argued earlier, eliminating wage rigidities may still leave large real effects of nominal money. For both of those reasons, economies with different degrees of indexation are likely to have, at least at a given average rate of inflation, more similar behavior than is implied by the simple Gray-Fischer model<sup>35</sup>.

Just as in the case of nominal price setting and staggering, we must ask : Is the form of indexation rules and the degree of indexation which arise from individual decisions socially optimal ? I examined the question in Blanchard [1979] under the assumption of competitive goods markets. I assumed that each contract faced a fixed cost to indexing on the price level, and a further fixed cost to indexing in addition to the real shock. I then asked whether if private contracts decided to index only on the price level, this decision and the degree of indexation they chose were socially optimal. The answer was that they were. This assumes however that the costs of collecting information and designing indexation rules are private costs. If part of those costs can however be shared by firms and is therefore a public good, it may then be that indexation to more than just the price level, although not an equilibrium, would be socially optimal. Ball [1986b] has extended the analysis to monopolistically competitive goods markets.

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<sup>35</sup> Note the use of "at an average given rate of inflation". It may well be that wage indexation, because it changes the tradeoffs faced by policy makers, leads to higher inflation. This is discussed in Chapter 23.

Generalized indexation and monetary reforms

If wage indexation decreases the real effects of nominal money, why not introduce general indexation ? Various such schemes, which we can equivalently think of as monetary reforms, have been suggested and I briefly review the issues involved.

General indexation presents a conceptual problem that wage indexation does not. One can think of general indexation as a change in the numeraire, with all prices being set in terms of the price level instead of in dollars ; but if all prices are freely set in terms of the price level, only by coincidence will the average of those prices be in turn equal to the price level. Thus, general indexation schemes have considered the use of either one good or a small basket of goods as numeraire.

To see what such indexation may achieve, the analogy with Daylight Saving Time is again useful. Suppose that all stores, instead of announcing opening hours with reference to the clock, use a Sears and Roebuck standard, announcing for example they will open at the same hours than Sears and Roebuck. It is clear that this solves the coordination problem discussed in Section III. If it is desirable to change opening hours in winter, all which is needed is for Sears and Roebuck to change its opening hours in winter and it will do so as it knows that other firms will change hours simultaneously. In the same way, general indexation allows for changes in the price level without changes in relative prices.

The argument raises however further questions : Why is it better for the economy to have one price setter setting the price level given money than for the monetary authority to set money given the price level ? Or, in the context of the Sears and Roebuck example, what is it that Sears and Roebuck can do that the state could not do before by changing the clock in winter ? Is it because the set of

incentives facing the price setter are different from those facing the monetary authority ? Those questions must be answered before we understand the gains of monetary reform over more active monetary policy in the present system.

## 2. Destabilizing price flexibility

Another line of work has questioned whether price flexibility is indeed stabilizing. It is true that under complete and instantaneous adjustment of prices, money has no effect on output<sup>36</sup>. It has been argued however that the relation between price flexibility and real effects of money is in fact not monotone and that, given the existing degree of flexibility, more flexibility may increase rather than decrease output fluctuations. This is because aggregate demand, instead of depending only on real money balances as we have assumed until now, depends also on the rate of inflation.

The argument dates back at least to Irving Fisher and is part of Keynes' argument for why, even if nominal wages were flexible, this would not be enough to maintain full employment. Keynes was mostly concerned with the effects of deflation in response to unemployment. While deflation led to a lower price level, increasing real money balances and lowering nominal interest rates, its direct -price change-effect was however contractionary. It increased the real interest rate given the nominal rate (an effect now known as the Mundell effect) and led to transfers of wealth from debtors to creditors, increasing bankruptcies and disrupting credit markets. Both Fisher and Keynes thought that those direct effects might well offset the indirect effect through the lower price level and Keynes saw this as a strong

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<sup>36</sup> Except for the channels mentioned in the introduction

argument in favor of relying on expansionary monetary policy rather than deflation to avoid recessions. This argument was formalized by Tobin [1975] who concluded that it could indeed be that deflation led to increases in the real rate and could lead to more rather than less unemployment.

The issue has been recently reexamined under rational expectations by Driskill and Sheffrin [1986], DeLong and Summers [1986] and Chadha [1986], using the Taylor model but expanding the specification of aggregate demand to allow for price change as well as price level effects (See also McCallum [1983b]). Their aggregate demand specification is the reduced form of an ISLM specification, with the real interest rate in the IS equation and the nominal rate in the LM equation and has the form :

$$(5.5) \quad y = b(E(p(+1)|0) - p) + c(m - p), \quad b, c > 0$$

DeLong and Summers then characterize the dynamic effects of money on output when money follows the first order process  $m = r m(-1) + e^{37}$ . They compute the steady state variance of output as a function of both the elasticity of desired real wages to output (the coefficient  $a$  in equation (3.5)) and the length of time during which each wage is set. They conclude that, in most cases and for most plausible parameters, increased price flexibility -defined as an increase in  $a$ , or a decrease in contract length- is likely to increase the steady state variance. Their result is however quite different from the earlier Tobin result. In all cases, they find the steady state variance to be finite ; equivalently, in no case do they find that increased price flexibility may actually lead to an explosive path for output. The increase in output variance comes from an increased short run reaction to nominal shocks : in response to an increase in money, increased price flexibility has more

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<sup>37</sup> They actually look at the effects of IS shocks, assuming that the nominal money supply responds to the nominal interest rate. Their equation can however be reinterpreted as in the text.

effect on expected inflation than on the current price level, leading to a sharper initial decline in the real interest rate.

DeLong and Summers also show that although increased flexibility ultimately leads to smaller real effects, this happens at degrees of flexibility far in excess of those we observe. The conclusion one should draw is probably that of Keynes, namely that price flexibility may not be a very good substitute for activist monetary policy.

### 3. Hysteresis and long run neutrality

All the models we have seen impose long run neutrality of money as a maintained assumption. This is very much a matter of faith, based on theoretical considerations rather than on empirical evidence.

Summers and I, [1986] examining the evidence from both the current prolonged European recession and the prewar US and UK depressions were led to question this maintained assumption. We found that, in all three cases, high unemployment had, after a while, little or no effect on disinflation. Put another way, it appeared that equilibrium unemployment had eventually adjusted to actual unemployment. This has led us to explore the possibility that equilibrium unemployment may be affected for long periods of time by the history of actual unemployment.

We have explored in particular the implications of membership considerations in the determination of wages. To see what they imply, we can again start with a Fischer-like model, assuming that a union sets the nominal wage before money is realized<sup>38</sup> and that employment is chosen by firms after the realization of money.

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<sup>38</sup> In Blanchard and Summers [1986] we use a model with monopolistic competition and many unions. This difference is unimportant for the issues discussed in the text.

Assuming that the union chooses the nominal wage so as to achieve, in expected value, employment of its members and solving the model gives a relation between employment  $n$ , membership  $n^*$ , and nominal money of the form:

$$(5.6) \quad n = n^* + a(m - E(m|-1))$$

where  $a$  is a coefficient which depends on the parameters in the aggregate demand and labor demand equations<sup>39</sup>. Employment deviates from membership to the extent that unanticipated money differs from zero. The crucial issue is that of what determines membership in the union. If  $n^*$  is fixed over time, then the dynamics of the model are similar to those of the one-period Fischer model. But, if  $n^*$  depends on the past history of employment, if for example unions tend to represent mostly the currently employed, the dynamics are very different. If, to take an extreme case, the union represents only the currently employed,  $n^*=n(-1)$  so that employment follows :

$$(5.7) \quad n = n(-1) + (1/2)(m - E(m|-1))$$

In that case, unanticipated changes in nominal money have permanent effects on employment. The reason is a simple one : after a negative surprise for example, the workers who are fired are no longer represented and there is no tendency for employment to go back to its previous value.

The model generates hysteresis : the steady state of the economy depends on its path, and unemployment does not return to any fixed equilibrium value. But its conclusions are too strong : unemployed workers must always exert some direct or indirect influence on wage setting, so that over time unemployment returns to an

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<sup>39</sup> The derivation is as in section 3, with two minor differences. The equation gives employment rather than output, and  $n^*$ , which was constant and thus put in the constant term in section 3, is now treated explicitly.



labor supply, the adjustment may be very slow. In that case, the real effects of money do not come from prolonged price and wage rigidity . In the above model nominal wage rigidity lasts only for one period but the effects of money last forever.

## Conclusion

Considerable progress has been made in the last ten years on why money affects output. Some of it has come from clarifying old and fuzzy ideas, such as that of coordination problems, in clarifying the respective roles of expectations, of nominal and real rigidities. A lot of it has come from running into dead ends, such as the failure to explain the joint price and output responses to money in "as if" competitive models, or the failure of individual nominal rigidities to generate aggregate price inertia under simple Ss rules.

Where should research go from here ? I believe that research on real rigidities is the most urgent. It is a general feature of goods markets that fluctuations in demand lead mostly to movements in output rather than in markups, and of labor markets that fluctuations in the demand for labor lead mostly to movements in employment rather than in real wages. Given these features, a very small amount of nominal rigidity will lead to long lasting effects of nominal money on output. Indeed, as was shown in section IV, if all suppliers were happy to supply more at the same relative price, there would be no need for nominal rigidities : as no price setter desired to change his relative price, nominal prices would not move in response to changes in nominal money. While many reasons have been given (and reviewed in Section III) for why we observe such real rigidities, the sheer number of unrelated explanations is distressing. One cannot help but think that there might be some general explanation. While "fairness" and "norms" pretend to give such a general explanation, they remain at this stage vague and untestable ideas.

Work on nominal rigidities is also important. But in counterpoint to the previous paragraph, the amount of nominal rigidities may well have been overemphasized. In recent empirical work (Blanchard [1987]), I have found that in the post war US, the adjustment of nominal wages, and of prices to wages is more than  $2/3$  over within a year. Such lags may not be very difficult to explain, as a result of short lengths of time between changes in individual wages and prices, together with staggering. Work on time and state dependent rules and on the equilibrium time structure of price decisions is just beginning and is important and exciting.

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