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Behavioural macroeconomics and Keynesian wage and price setting

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Abstract

This paper argues that the theory of wage and price setting in macroeconomics should be broadened to include insights from behavioural economics, in particular prospect theory and loss aversion. The paper shows how broader microeconomic foundations can explain the main features of a realistic Phillips curve, which are the concurrence of a steep SRPC at low unemployment, a flat SRPC at high unemployment and speed-limit effects. The resulting macroeconomic model has the benefits of consistency with important properties of natural rate models, especially a crucial role for inflation expectations and, in determining the economy's macroeconomic potential, for supply factors, plus the benefit of consistency with the IS/LM model.

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1 Introduction

Recently, prominent mainstream economists have argued that macroeconomic practice and macroeconomic research are at present disconnected, see Krugman (2000) and Mankiw (2006). Macroeconomic practice, especially in policy formulation, is guided by models based on the IS-LM approach. However, the bulk of macroeconomic research eschews the IS-LM approach and instead uses variants of the natural rate of unemployment approach, in either New Keynesian theory or real business cycle theory. [1] Reflecting on this disconnect, Mankiw (2006) entertains the possibility that macroeconomics since 1968 has taken the wrong turn.

One of the faults that Krugman (2000) finds in current macroeconomic research is a failure to model price stickiness satisfactorily. Krugman criticises the plausibility of real business cycle theory because of its excessive flexibility in prices relative to empirical evidence, so excessive as to be implausible. On the other hand, he argues that the price stickiness in New Keynesian theory, based on menu costs and time-dependent contract lengths, is too simplistic to capture important subtleties in the real world. In particular, Krugman argues that the price stickiness in New Keynesian theory lacks useful predictions about when prices are sticky and when they are not. Krugman (2000, p.39) concludes that "models that build from menu costs to a realistic Phillips curve, just don't seem to be forthcoming". Mankiw (2006) agrees with these criticisms of Krugman. Gosolov and Lucas (2007) make a related criticism of the New Keynesian pricing model, emphasising the weakness of pricing decisions being modelled as time dependent rather than state dependent.

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[1] Mankiw quotes Laurence Meyer's memoir which shows that these new developments "have had close to zero impact on practical policymaking", Mankiw (2006, p.40). Central banks, whilst having moved in the direction of independence, are not rule-bound, but exercise discretion. Furthermore, the economic record while Alan Greenspan headed the Federal Reserve shows that discretion is consistent with low and stable inflation, counter to the Kydland and Prescott (1977) conclusion. The policy of tax cuts in 2003 was explained by President Bush using "quintessentially Keynesian", that is IS-LM, analysis and its economic impact was analysed using an IS-LM based econometric model.

The model of McDonald and Sibly (2005), called here the prospect-bargaining model, offers a way forward from the criticism of macroeconomic practice and macroeconomic research being disconnected. This model has microeconomic foundations, the sin qua non of macroeconomic research, and yet can support the fundamental Keynesian proposition which IS-LM analysis is designed to represent, that changes in nominal aggregate demand can have real effects through a direct effect on sales rather than through a divergence between expected and actual prices. In the prospect-bargaining model the short-run Phillips curve (SRPC) is steep at low rates of unemployment and flat at high rates of unemployment. It is the latter flatness that gives the model its Keynesian/IS-LM potential.

A feature of the prospect-bargaining model that is important for its ability to explain a pattern of wage and price behaviour that supports Keynesian properties is the use of ideas from behavioural economics, especially prospect theory and loss aversion, in its microeconomic foundations. It also makes use of bargaining theory and customer market theory.[2]

However, the prospect-bargaining model as set out in McDonald and Sibly (2005) has excessive stickiness in wages and prices at high unemployment and so does not explain when prices are sticky and when they are not. In particular, the model misses an important aspect of a realistic Phillips curve; that is the common observation of a speed-limit effect, which is an inverse relation between the change in the unemployment rate and the rate of inflation. Lacking this subtly of wage and price stickiness in the real world, the model is perhaps open to Krugman's critique noted above. The main aim of this paper is to show how that the prospect-bargaining model can be extended to yield the more subtle and realistic pattern of wage and price adjustment captured by the combination of a speed-limit effect with a flat SRPC. Thus the extended model explains a pattern where wages and prices are sticky but that stickiness can be overridden, temporarily, by changes in activity. This combination of

[2] Using ideas from behavioural economics, Akerlof, Dickens and Perry (1996), (2000) have put forward two models of nominal wage stickiness based on two different conceptions of money illusion, see Akerlof and Dickens (2007, p.32). Although the prospect-bargaining model as presented in this paper can generate Keynesian behaviour without the assumption of money illusion, it may be that there is something special about resistance to cuts in money wage. Fehr and Tyran (2001) present experimental evidence that supports the idea that people exhibit money illusion when there is coordination failure. However, note that even money wages are cut on occasion, as in the 1930s. As will be seen, the prospect-bargaining model as extended in this paper, whilst determining real wages, offers an explanation of when nominal wages are rigid and when they are cut that is consistent with the experience in the 1930s.

a speed-limit effect with a flat SRPC will also be described in this paper by the short-hand term, 'flex-fix price pattern', which captures the time-sequence of initially changes in wages and prices relative to expected wages and prices when there is a change in unemployment followed by fixity in wages and prices when the change in unemployment stops. An essential feature of the flex-fix price pattern studied here is that, for increases in unemployment, wages and prices stabilize, ie 'fix', at a higher rate of unemployment than the initial rate (with stabilisation at a lower rate of unemployment if the initial shock is an decrease in unemployment).[3]

The usual explanation of a speed-limit effect is the idea of bottlenecks in production forcing up prices. However, the bottleneck explanation would not explain why wages and prices stabilise at new levels of activity, because bottlenecks would only temporarily counter the fundamental forces of demand and supply. Thus bottlenecks alone do not seem to be capable of answering the challenge addressed by this paper; to provide an explanation of the combination of a flat SRPC and a speed-limit effect. This is, of course, not to say that bottlenecks are not part of the story of wage and price setting and may be worth incorporating into the prospect-bargaining model.

To provide a direct explanation of a speed-limit effect in money wages, in this paper a fixed cost of production is incorporated into the prospect-bargaining model. With a fixed cost, contractions will put pressure on factor incomes. If wages remain fixed, then profits would be severely squeezed, perhaps forced into losses. To relieve this pressure, in the model the fixity of wages from being tied through loss aversion to the reference wage, is overridden and wages are reduced.

Introducing into the prospect-bargaining model the possibility of squeezes on factor incomes as a cause of wage reductions is motivated by empirical evidence that downward wage flexibility is caused by the desire to prevent a firm or plant being driven out of business. Henle (1973) showed this. More recently, Bewley's interviews with managers of firms and labour leaders has revealed that workers will accept wage cuts if that relieves pressure to close down the firm or plant and so saves their jobs, see Bewley (1999, pp. 173, 181, 376, 380 and 395).[4] Akerlof, Dickens and Perry

[3] Note that the explanation of wage and price behaviour in the prospect-bargaining model is state dependent rather than time dependent and thus does not have the weakness of the new Keynesian model emphasised by Gosolov and Lucas (2007).

[4] Bewley's interviews reveal additional empirical support for the prospect-bargaining model in supporting a Keynesian view, see especially Bewley (1999, pp. 17, 153, 220, 221, 329 and 344), and

(1996) reinforce Bewley's findings with additional evidence from Bureau of Labor Statistics data, and conclude that "downward rigidity is broken when firms are under extreme duress", Akerlof, Dickens and Perry (1996, p.9).[5]

The prospect-bargaining model embodies two important characteristics of natural rate analysis. First, in the prospect-bargaining model the expected rate of inflation influences the actual rate of inflation. An implication of having this characteristic is that the prospect bargaining model can match the explanation offered by the natural rate model of the stagflation of the 1970s, a valuable characteristic of the natural rate model, as emphasised by Krugman (2000), but without incurring the cost of sacrificing a Keynesian theory of aggregate demand. Second, the boundary point between low and high unemployment, which is the point that separates the region of classical flex price behaviour from the region of a flex-fix price pattern, is determined by the same supply factors posited by Friedman (1968) and Phelps (1972) to influence the natural rate. This boundary point is called u^{min} in the prospect-bargaining model because it is the lowest rate of unemployment consistent with non-increasing inflation. In the prospect-bargaining model, u^{min} is the conceptual equivalent to the natural rate of unemployment in the classical model. [6]

In relation to the criticisms of Krugman and Mankiw noted above, this paper proposes that the right road for modelling the setting of wages and prices in macroeconomics is one with broader microfoundations that include insights from behavioural economics and prospect theory, in particular the importance of reference dependence and loss aversion. These broader microfoundations are shown in this

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the importance of loss aversion, see especially Bewley (1999, pp. 111, 134, 175, 176, 196, 431, and 432). However, the prospect-bargaining model of this paper would require further development to include explicitly Bewley's emphasis on the importance of morale for labour productivity.

[5] In their simulation model, Akerlof, Dickens and Perry (1996) allow low profitability to reduce nominal wages but do not use a model of individual decision-making to support this relation. Akerlof and Shiller, in their recent book on behavioural macroeconomics, Akerlof and Shiller (2009, pp.59-61), give a description of the pattern of wages and prices in the US depression of the 1890s that follows the flex-fix pattern, with initially a "sharp drop in wholesale prices" and "a great many" wage cuts, after which "prices remained more or less stable for the rest of the depression". Money wages also remained roughly constant from 1895 to 1898, during which unemployment remained at roughly 14%, see Lebergott (1964, Table A-19). The analysis of this paper suggests how their "favourite theory" Akerlof and Shiller (2009, p.105) could be modified by introducing loss aversion and economies of scale so that it explains the flex-fix mix.

[6] The estimates of the Phillips curve implied by the prospect-bargaining model for Australia and the US in Lye, McDonald and Sibly (2001) and Lye and McDonald (2006), (2008) show that u^{min} is significantly influenced by supply factors, especially unemployment benefits and, for Australia, trade union power. According to the pattern of u^{min} implied by these estimates, both the US and Australia experienced significant excess demand in the 1960s and early 1970s. Thus the accelerationist hypothesis, a central element of the natural rate view, is supported by these estimates.

paper to offer an explanation of the flex-fix mix and to support the fundamental Keynesian proposition, that changes in nominal aggregate demand can have real effects through a direct effect on sales rather than through a divergence between expected and actual prices aggregate demand, for which the IS-LM model is the basic analytical tool. [7]

In Section 2 of the paper, some evidence showing a flex-fix pattern of wage and price adjustment including the experience in the 1930s is briefly reviewed to establish the importance of the particular pattern of wages and prices that macro models have to explain. The 1930s experience is included partly because the deepness and persistence of the depression in the 1930s offers a substantive challenge to theory to explain the wage and price behaviour that ensued. The same flex-fix pattern is shown for the recessions in the 1930s, 1980s and 1990s. Section 3 develops the prospect-bargaining model of unemployment and inflation and shows how it can explain the concurrence of a steep SRPC at low unemployment, a flat SRPC at high unemployment and speed-limit effects. Section 4 shows how the prospect-bargaining model supplies a microeconomic foundation for the fundamental Keynesian proposition, which is that changes in nominal aggregate demand can have real effects through a direct effect on sales rather than through a divergence between expected and actual prices. Section 5 concludes the paper.

2 Some empirical evidence on the flex-fix pattern of wage and price adjustment

In the deep recession of the 1930s, inflation stopped falling when unemployment rates peaked. This flex-fix pattern is shown in Figure 1 for wage inflation for the US, the UK and Australia. To help appreciate the pattern the contraction phase is shown by thin lines connecting the end-points of the contraction with the thicker lines showing the annual inflation-unemployment outcomes that followed the contraction. The same pattern was followed by consumer price inflation for all countries for which Maddison (1991) reports inflation, see McDonald (1995). Thus the pattern was for inflation to fall as unemployment rose, the speed limit effect. This fall ended when unemployment ceased to increase. Fix followed flex at high rates of unemployment.

[7] Notwithstanding the extension to the IS-LM model proposed by Akerlof and Shiller (2009, ch.1) of including a confidence multiplier.

Figures 2 and 3 show a similar pattern for all G7 countries in the recessions of the 1980s and 1990s. Inflation fell as unemployment increased but when unemployment stabilized, inflation stabilized. As in the 1930s, fix followed flex at high rates of unemployment.

Thus the flex-fix pattern is a robust description of inflation-unemployment behaviour during these three recessions. Note that the cessation of the fall in inflation at high rates of unemployment is counter to the natural rate hypothesis.[8]

According to the Phillips loops, Phillips (1958), a somewhat similar pattern occurs during upswings. Of course, it is debateable whether the end of any particular upswing occurs before of after the economy has reached u^{min} and so more difficult to establish evidence in favour of the flex-fix pattern that is as conclusive as the evidence from recessions.

The paper now turns to showing how the prospect-bargaining model can explain this pattern.

3. Wage and price adjustment in the prospect-bargaining model

The prospect-bargaining model is based on reference dependence and loss aversion in buyer-seller relationships in selling goods and in wage bargaining. Asymmetric information also plays a role. The common analytic feature of these ideas is that they imply kinks in the firm's revenue function and the worker's utility function. These kinks make wages and prices fixed, immune from demand and supply shocks of sizes within limits. These limits are partly determined by the degree of sharpness of the kinks, ie the degree of loss aversion and the degree of asymmetry in information. Embodied into a macroeconomic model, these limits determine the extent of a range of equilibrium rates of unemployment. As will be seen, within the range the SRPC is flat. Furthermore the theories imply that the position of the kinks is determined, through their influence on reference wages and prices, by expected prices

[8] Eggertsson (2008, p.1476) argues that the "successful management of expectations about future policy" by Franklin Delano Roosevelt in 1933 changed the public's expectation of inflation to positive rates. This change in expectations, Eggertsson argues, can reconcile the US unemployment-inflation pattern of the 1930s with the natural rate model. Note that the change in expectations provides a reason for inflation to stop falling even although unemployment was high and thus is a possible explanation for the flex-fix price pattern. However, this explanation is specific to one country at one particular time. Figures 1 to 3 show there are several times and many countries which would require the detailing of similar regime changes for the Eggertsson explanation to be satisfactory.

and expected wages. Thus within the range it is expected prices and expected wages, not demand and supply, that determine actual wages and prices.

In Section 3.1, behavioural and microeconomic foundations for these kinks are discussed. In Section 3.2, the formal model of these foundations based on bargaining between worker and firm from McDonald and Sibly (2005), that is the prospect-bargaining model, is briefly described. It is shown how this formal model can explain a flat SRPC. This is by way of background for Section 3.3, in which the prospect bargaining model is extended to show how speed-limit effects can coexist with the flat SRPC, thereby producing the flex-fix pattern of price adjustment.

3.1 Behavioural and microeconomic foundations

The strong dislike of having one's wage reduced is obvious to most people from introspection. Another source of personal evidence is apparent to those who have, as heads of departments or deans of schools, dealt with the wages of academics. The extreme displeasure, indeed the feeling of insult experienced by academics when offered a wage below the wage they feel they deserve is palpable.[9] The dislike of wage cuts is strongly supported by the evidence collected by Truman Bewley in his interviews of business executives and labour leaders, Bewley (1999). And, of course, in the General Theory the dislike of a reduction in one's wage relative to the wage of others, see Keynes (1936, p.14), played a central role.

Bhaskar (1990) showed how the integration of prospect theory, and especially the concept of loss aversion, into a bargaining model of wage determination would explain resistance to wage cuts. Because of the discontinuity in the worker's utility function created by loss aversion, the bargained wage is immune to changes within limits in labour demand and in the worker's reservation wage. This range of immunity implies a range of equilibrium rates of unemployment.

Turning to the setting of prices, customer market analysis can yield a kinked demand curve and thus a range of immunity of price from demand and supply pressures. In customer market analysis, two mechanisms that determine such a kink have been developed in the literature. First, there is the Scitovsky effect, introduced by Scitovsky (1952, pp.272-81). According to the Skitovsky effect, price increases

[9] There may be a component of strategic bargaining in the expression of extreme displeasure.

will induce a rapid decrease in sales while price decreases will induce a slow increase in customers. This asymmetry in the response of sales is caused by an information asymmetry, which is that changes in the firm's price are learnt relatively quickly by existing customers and relatively slowly by potential customers. This is because potential customers, unlike existing customers, do not patronise this firm but buy from other firms. The price around which the asymmetrical sales response is centred is the expected price, that is the price existing customers believe is offered by the competing firms, the firms they do not patronise.

A second mechanism explaining a kink in the demand curve has been derived from prospect theory by Sibly (2002). See also Heidhues and Koszegi (2008). Sibly argues that a customer has a disposition towards a firm and that this disposition will influence the quantity of the customer's purchases from the firm. (Heidhues and Koszegi are similar in arguing that an unexpectedly high price is painful and will reduce the utility of buying a good from the high-price firm.) The customer's disposition toward a firm will depend on how the firm's price compares with the customer's reference price. Furthermore, the response of the customers's disposition to the firm to variations in actual price relative to the reference price is argued to be characterised by loss aversion. In particular if the customer discovers that price is above the reference price then the customer's disposition towards the firm will be radically reduced. On the other hand a price below the reference price will increase the customer's disposition to the firm by a relatively small amount. In consequence the effect on sales of price variations around the reference price will be asymmetric, yielding a kinked revenue function similar to that in the case of asymmetric information above.[10]

Joeseph Stiglitz (1979) and Arthur Okun (1981) emphasised the Keynesian macroeconomic implications of customer market analysis. [11] Subsequently models of

[10] Scitovsky's customer market theory and the reference dependence theory mutually reinforce each other in establishing the kink in the revenue function. The proclivity of people for the buyer-seller relationships that are central to the reference dependence theory provide a reason for repeat purchasing, that is for customers to exist. The repeat purchasing provides a scenario in which the Scitovsky effect will operate, thereby reinforcing the kink that is produced by the reference dependency theory. In the exposition of the prospect-bargaining model in this paper, the term 'reference price' will be used to cover the benchmark price for both theories of customer markets.

[11] Okun's description of customer markets, Okun (1981, pp.138-55) is mainly based on the Scitovsky information asymmetry. However, he also brings in fairness considerations, for example when arguing that firms are more likely to increase prices following increases in costs than following increases in demand. Kahneman, Knetsch, and Thaler (1986) use Okun's analysis of customer markets to introduce their analysis of fairness.

a range of equilibrium rates of unemployment were derived from customer market analysis by Woglom (1982), Kling (1982) and McDonald (1987). [12]

In price setting it is reasonable to argue that the reference price will move with the aggregate price level such that in an inflationary situation the reference price will increase with the expected rate of inflation and thus the reference price can be identified with the expected price. To see this, note that Kahneman, Knetsch, and Thaler (1991) point out that the experimental literature distinguishes two bases for the formation of reference levels: the 'status quo' and fairness. The reference price can be either the 'existing' price or the 'fair' price.[13] In either case the reference price can be argued to increase with the rate of inflation. This follows directly if the reference price represents the status quo. In the alternative case, observe that, if the reference price increases with the rate of inflation, its real price remains the same and the firm's real profit remains the same. In this respect, increasing the reference price at the inflation rate would be perceived by customers as fair. From this, the reference price increases in line with the expected rate of inflation.

In wage bargaining the bargained real wage is influenced by the reference real wage. Thus, for a given value of the reference real wage, the bargained nominal wage will adjust with the price level.

Bringing these mechanisms together, the prospect-bargaining model, described below, determines wages as the outcome of a Nash bargain. By taking into account jointly the interests of the two parties, the bargain is a cooperative solution, rather than one of class warfare. This cooperation is consistent with the evidence on workplace arrangements collected by Bewley (1999). Bewley (1999, p. 436, 437) emphasises the firm as a community in which workers and managers identify with a common interest, the health of the firm. Their common interest is particularly relevant for this paper in that Bewley finds that workers will accept "justified" pay cuts and that it is not impossible for management, in the appropriate circumstances where profitability and thus survival of the firm is threatened, to justify pay cuts to the workers.

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[12] More recently, Akerlof (2007, pp.26-7) has discussed how customer markets can generate behaviour inconsistent with the natural rate model. Akerlof emphasises the possibility of a long-run trade-off between inflation and unemployment rather than a horizontal SRPC.

[13] Kahneman, Knetsch, and Thaler (1986 pp. 730-1) note that people eventually 'adapt their views of fairness to the norms of actual behavior'. Thus, with time, the status quo becomes to be perceived as fair 'because it is normal, not necessarily because it is just'.

For bargaining to be relevant, it is not necessary to posit the existence of a union. If an individual worker cannot be costlessly replaced by a perfect substitute, as put forward by Lindbeck and Snower (1988), then there is a rent over which the individual worker can bargain. Thus the bargaining framework is relevant for a wider group of workers than just those who are unionised.

3.2 Fix-price: A flat SRPC from the prospect-bargaining model

In this section the behavioural and microeconomic foundations discussed in Section 3.1 are shown to generate a flat SRPC, that is fix-price behaviour. The prospect-bargaining model used is from McDonald and Sibly (2005).

In McDonald and Sibly (2005), the bargaining problem between worker and firm is written:

$$\underset{V,L}{\text{Maximise}} \qquad N = \left[U\left(V, \frac{V}{V^{REF}} \right) - U\left(V^{RES} \right) \right]^{\phi} \left[\frac{R\left(L, L^{E} \right)}{\overline{P}} - VL \right]^{(1-\phi)} \qquad (1)$$

where V=real wage, V^{REF}=worker's reference real wage, V^{RES}=worker's reservation real wage, L=employment, $\overline{P}$ =aggregate price level, ϕ=the relative power in bargaining of the worker(s) ($0<\phi<1$), and L^{E}=the level of employment at which the firm's price is equal to its reference price, P^{REF}. $[U(V, V/V^{REF})-U(V^{RES})]$ and $[R(L, L^{E})/\overline{P} -VL]$ are the net gains from the bargain to the workers and the firm respectively, with U(..) and R(..) being a worker's utility function and the firm's revenue function respectively, where R(..)=the nominal value of the firm's revenue. (1) could refer to wage bargaining at a particular plant of a firm.

To clarify the discussion of the model, it helps to use specific functional forms for these functions. To capture loss aversion of workers, specify the worker's utility function, $U(V, V/V^{REF})$ as

$$U(V, V/V^{REF}) = BV^{\beta_1}(V/V^{REF})^{\beta_2^-} \quad \text{for } V<V^{REF} \qquad (2)$$

$$U(V, V/V^{REF}) = BV^{\beta_1}(V/V^{REF})^{\beta_2^+} \quad \text{for } V \geq V^{REF} \qquad (3)$$

and

$$U(V^{RES}) = B\left(V^{RES}\right)^{\beta_1}, \quad (4)$$

with $0<\beta_1<1$ and $0<\beta_2^+ \leq \beta_2^- <1$.

The firm's revenue function is determined as follows. Revenue $\equiv PY$ with P=price of firm's output and Y=firm's output. To capture the kink implied by customer market analysis, specify the firm's demand function as

$$P= P^{REF}C^{-}Y^{\chi^{-}} \text{ for } Y \leq Y^E \quad (5)$$

$$P= P^{REF}C^{+}Y^{\chi^{+}} \text{ for } Y>Y^E \quad (6)$$

with $-1 < \chi^+ \leq \chi^- < 0$. The values of C^- and C^+ are assumed to be related, in order to ensure that the kink in the demand curve occurs at $P=P^{REF}$ and $Y=Y^E$, by setting $C^-\left[Y^E\right]^{\chi^-} = C^+\left[Y^E\right]^{\chi^+} = 1$. Note that this condition ensures that the demand curve is continuous at $\{Y^E, P^{REF}\}$.

The shift parameters Y^E, C^- and C^+ can capture the influence of the level of aggregate demand on the position of the firm's demand curve. This is discussed below in Section 4.

The firm's production function is written

$$Y=AL^{\alpha} -F, \quad (7)$$

where A>0 is the efficiency parameter, α is the measure of the marginal productivity of labour and F is an avoidable fixed cost component in the firm's production function. The motivation for including a fixed cost is, as explained in the introduction, to capture the empirical finding that a pressure on profits can induce wage concessions.

By 'avoidable fixed cost' is meant a fixed cost that can be avoided by closing down the firm or plant. This captures for example a production process where a minimum positive number of workers, denoted $\hat{L}=(F/A)^{1/\alpha}$, is required to operate the process.

With these specific functional forms, there is a set of macroeconomic equilibria described by proposition 1, based on McDonald and Sibly (2005).

Proposition 1. With the objective function given by (1) and the specific functional forms given by (2) to (7), the values of V and L that maximise (1) subject to the condition that $V=V^{REF}$ and $P=P^{REF}$ satisfy the following inequalities:

$$V^{LOW} \le V \le V^{HIGH}$$

where

V^{LOW} is determined by $\dfrac{\beta_1+\beta_2^+}{1-\left(\dfrac{V^{RES}}{V^{LOW}}\right)^{\beta_1}}=\dfrac{(1-\phi)}{\phi\left[\dfrac{Y}{V^{LOW}L}-1\right]}$

and

V^{HIGH} is determined by $\dfrac{\beta_1+\beta_2^-}{1-\left(\dfrac{V^{RES}}{V^{HIGH}}\right)^{\beta_1}}=\dfrac{(1-\phi)}{\phi\left[\dfrac{Y}{V^{HIGH}L}-1\right]}$

and

$$L^{LOW} \le L \le L^{HIGH}$$

where

$L^{LOW}=\left(\dfrac{V}{(\chi^+ +1)\alpha A}\right)^{\frac{1}{\alpha-1}}$ and $L^{HIGH}=\left(\dfrac{V}{(\chi^- +1)\alpha A}\right)^{\frac{1}{\alpha-1}}$.

Proposition 1 is proved as follows. First, holding V, V^{REF}, P^{REF} and L^E constant, where $L^E=\left(\dfrac{Y^E+F}{A}\right)^{\frac{1}{\alpha}}$, partially differentiate the objective function of the cooperative bargain (1) with respect to L. Because the derivative of the objective function with respect to L is discontinuous at $L=L^E$, the left-hand and right-hand derivatives of the revenue function with respect to L at $L=L^E$ differ by a discrete amount. From this discontinuity, the first order condition with respect to L implies that the real wage should lie between the left-hand and right-hand derivatives of the revenue function with respect to L deflated by the aggregate price level and can be written

$$\frac{P^{REF}C^-(\chi^- +1)\left(AL^\alpha - F\right)^{\chi^-}\alpha AL^{\alpha-1}}{\overline{P}} \ge V \ge \frac{P^{REF}C^+(\chi^+ +1)\left(AL^\alpha - F\right)^{\chi^+}\alpha AL^{\alpha-1}}{\overline{P}} \quad (8)$$

There is a range of values of P^{REF}, and thus L^E, at which the objective function is maximised at $P=P^{REF}$, and thus at $L=L^E$. At these values of V, rational expectations of

prices are satisfied in that $P=P^{REF}$. The lowest of these maximising values of V occurs where the right-hand derivative of the objective function with respect to L, with $L=L^{E}$, is equal to zero. The right-hand derivative is relevant because when that derivative is equal to zero the firm is on the verge of cutting output price below P^{REF} and increasing sales above the level produced by $L=L^{E}$.

For macroeconomic equilibrium, assume all firms in the economy are the same, that there is only one firm and that $P=\overline{P}$. With these assumptions, and because $L=L^{E}$ implies $C^{+}\left[Y^{E}\right]^{\chi^{+}}=1$, the lowest level of aggregate employment consistent with macroeconomic equilibrium, labelled L^{LOW}, is determined from (8) by

$$V=(\chi^{+}+1)\alpha A\left[L^{LOW}\right]^{\alpha-1} \qquad (9)$$

Similarly, the highest level of aggregate employment consistent with firms maximising the bargaining objective with respect to L, $P=P^{REF}$ and macroeconomic equilibrium, which is labelled L^{HIGH}, is determined from setting the left-hand inequality sign in (8) to equality and using $P=\overline{P}=P^{REF}$ and $C^{-}\left[Y^{E}\right]^{\chi^{-}}=1$ to get

$$V=(\chi^{-}+1)\alpha A\left[L^{HIGH}\right]^{\alpha-1} \qquad (10)$$

Second, holding L, V^{REF}, P^{REF} and L^{E} constant, partially differentiate the objective function (1) with respect to V. The discontinuity in the objective function at $V=V^{REF}$ implies that the first order condition can be written.

$$\left(\frac{\beta_1+\beta_2^{+}}{1-\left(\frac{V^{RES}}{V}\right)^{\beta_1}\left(\frac{V^{REF}}{V}\right)^{\beta_2^{+}}}\right)\leq\frac{(1-\phi)}{\phi\left[\frac{PY}{VL\overline{P}}-1\right]}\leq\left(\frac{\beta_1+\beta_2^{-}}{1-\left(\frac{V^{RES}}{V}\right)^{\beta_1}\left(\frac{V^{REF}}{V}\right)^{\beta_2^{-}}}\right) \qquad (11)$$

There are a range of values of $V=V^{REF}$ which satisfy this condition. From (11), the extreme values of the real wage consistent with maximising the bargaining objective with respect to V, $V=V^{REF}$ and $P=\overline{P}$, labelled V^{LOW} and V^{HIGH}, are determined by

$$\left(\frac{\beta_1+\beta_2^{+}}{1-\left(\frac{V^{RES}}{V^{LOW}}\right)^{\beta_1}}\right)=\frac{(1-\phi)}{\phi\left[\frac{AL^{\alpha}-F}{V^{LOW}L}-1\right]} \tag{12}$$

$$\left(\frac{\beta_1+\beta_2^{-}}{1-\left(\frac{V^{RES}}{V^{HIGH}}\right)^{\beta_1}}\right)=\frac{(1-\phi)}{\phi\left[\frac{AL^{\alpha}-F}{V^{HIGH}L}-1\right]} \tag{13}$$

This analysis implies that the levels of the real wage and employment consistent with macroeconomic equilibrium in the prospect-bargaining model lie within a set of {V, L} bounded by equations (9), (10), (12) and (13). This proves Proposition 1.

Differentiation of (9) and (10), called the L^{LOW} and L^{HIGH} curves, shows that L^{LOW} and L^{HIGH} are negatively related to the real wage. Differentiation of (12), called the V^{LOW} curve, reveals that the slope of the V^{LOW} curve can be written as

$$\frac{dV^{LOW}}{dL}=\frac{A(\alpha-1)L^{\alpha-2}+FL^{-2}}{\left[1+\frac{(1-\phi)}{\phi\left(\beta_1+\beta_2^{+}\right)}\left(1-(1-\beta_1)\left(\frac{V^{RES}}{V^{LOW}}\right)^{\beta_1}\right)\right]} \tag{14}$$

$V^{RES}\le V^{LOW}$ implies that the sign of $\frac{dV^{LOW}}{dL}$ is equal to the sign of the numerator.

From this $\frac{dV^{LOW}}{dL}\begin{matrix}>\\=\\<\end{matrix}0$ as $L\begin{matrix}<\\=\\>\end{matrix}\tilde{L}$ where $\tilde{L}=\left(\frac{F}{A(1-\alpha)}\right)^{\frac{1}{\alpha}}$. Note that $\tilde{L}>\hat{L}$. The slope of the V^{HIGH} curve is described by a similar equation with the same condition for its sign. Thus V^{LOW} and V^{HIGH} are positively related to L for $L\in\left\{\hat{L},\tilde{L}\right\}$. Furthermore, as inspection of (12) and (13) shows, at $V=V^{RES}$ the V^{LOW} and V^{HIGH} curves converge at $[V=V^{RES}, L=L^{min}]$ where L^{min} is determined by $V^{RES}=Y/L$.

The four curves describing the equilibrium outcomes are depicted in Figure 4, where only positively sloped portions of the V^{LOW} and V^{HIGH} curves are shown. The

diamond-shaped area lying between the four curves, labelled diamond of equilibria, is the set of macroeconomic equilibrium outcomes. The areas outside the diamond are areas of disequilibrium.[14]

The relation between inflation and unemployment when the economy is within the diamond of equilibria will embody a flat SRPC. This is because, within the diamond of equilibria, given values of P^{REF} and V^{REF} are consistent with the range of equilibrium outcomes of unemployment. Within the diamond the expected price level is equal to P^{REF}. Comparing the given value of P^{REF} with last period's price level implies a given expected rate of inflation at the time of wage and price setting. Because $V=V^{REF}$ within the diamond, the rate of money wage inflation will also equal the rate of expected inflation. Thus within the diamond of equilibria, the rate of inflation is determined by the expected rate of inflation and is independent of the level of activity, ie the SRPC is flat.

Within the range of equilibria, the determination of the actual equilibrium outcome by aggregate demand is discussed below in Section 4.

3.3 Flex-price: The speed-limit effect from the prospect-bargaining model

The evidence presented in Section 2 shows that increasing unemployment is associated with decreasing inflation and that inflation stops decreasing when unemployment stops increasing, even although unemployment has reached greater rates than those previously associated with stable inflation. The previous section showed the fix part of this pattern. In this section the flex part is shown, thereby completing the explanation of how the prospect-bargaining model is capable of explaining the flex-fix pattern of wage and price behaviour. Initially, in section 3.3.1, homogenous firms are assumed. Then, in section 3.3.2, heterogeneity across firms with respect to profitability is shown to strengthen the ability of the prospect-bargaining model to explain the flex-fix pattern of wage and price adjustment.

[14] One could assume that V^{RES} is influenced by market pressure and so model V^{RES} as negatively related to the rate of unemployment. (Assuming for convenience that the labour force is fixed, the rate of unemployment=1-(L/labour force).) That would increase the upward slope of the V^{LOW} and V^{HIGH} curves. While this modification would not reinforce quantitatively the results presented below, it would divert attention from the empirically more important determinant of wages cuts, that is the desire by workers to avoid firm or plant closure as shown by the empirical evidence discussed above, especially from the Bewley (1999) surveys. Section 3.3 shows that the model of the paper explains the flex-fix mix of wage and price adjustment that is consistent with the Bewley evidence.

3.3.1 Homogeneous firms

In this section the assumption of homogenous firms made in Section 3.2 is maintained.

To derive a flex-fix pattern of wage and price adjustment, the status quo effect is assumed. The status quo effect is that reference wages and prices will adjust towards actual wages and prices and that this adjustment is not foreseen at the time of wage and price setting. As noted above, Kahneman, Knetsch and Thaler (1991) argue that there is empirical support for the idea that reference wages and prices will adjust towards actual wages and prices. Empirical evidence also suggests that people underestimate how a change in actual outcomes will cause their reference point to change. Loewenstein, O'Donoghue and Rabin (2003) call this projection bias.[15] The specification of the bargaining problem in (1) is consistent with this bias.[16]

To derive a downward flex-fix pattern of wage and price adjustment, consider the behaviour of wages in the region above the V^{HIGH} curve labelled 'downward money wage pressure' in Figure 4. For {V, L} outcomes in this region to be consistent with the maximisation of (1) with respect to L, V has to be less than V^{REF}, unlike outcomes within the diamond of equilibria where $V=V^{REF}$. This property, that $V<V^{REF}$ for $V>V^{HIGH}$, can be inferred from equating the centre and left-hand expressions in (11) and partially differentiating the resulting equation with respect to V^{REF}, holding L constant. This differentiation yields

$$0 < \left.\frac{dV}{dV^{REF}}\right|_{dL=0} = \frac{\frac{V}{V^{REF}}}{1+\frac{\beta_1+\phi\beta_2^-+(1-\phi)(1-X)}{(1-\phi)\beta_2^- X}} < 1 \qquad (14)$$

[15] For example, experiments reported in Loewenstein and Adler (1995) show that people when told they will be given a mug in the future are unaware of the loss aversion they will attach to the mug.

[16] Albeit an extreme version of this bias, where no allowance is made for the possibility that even some of the future adjustment in the reference points is foreseen at the time of wage and price setting. Because the focus in the paper is on the return to equilibrium, this is not a limitation of its purpose. In as far as movements in reference points is anticipated at the time of wage and price setting, the adjustment discussed in this section, that is the flex part of the flex-fix price pattern, would be speeded up.

where $X = \left(\frac{V^{RES}}{V}\right)^{\beta_1}\left(\frac{V^{REF}}{V}\right)^{\beta_2^-}$. (Noting that, from the equation of the centre and left-hand expressions in (11), $1-X = \frac{\phi\left[\beta_1+\beta_2^-\right]}{(1-\phi)}\left[\frac{PY}{VL\bar{P}}-1\right] > 0$, the left-hand inequality in (14) can be inferred from both the numerator and the denominator in the expression for $\left.\frac{dV}{dV^{REF}}\right|_{dL=0}$ being positive. The right-hand inequality in (14) can be inferred from the following. $V=V^{REF}$ implies the right-hand inequality. Thus, higher values of V^{REF} will cause $V/V^{REF}<1$ thereby reinforcing the right-hand inequality.) So comparing with a point on the V^{HIGH} curve, a higher value of V^{REF} will cause V to be higher but by a smaller amount, implying $V<V^{REF}$ at $V>V^{HIGH}$. Thus bargained real wage outcomes above the V^{HIGH} curve will be less than the reference real wage.

At outcomes above the V^{HIGH} curve, $V<V^{REF}$ will, through application of the status quo effect, cause V^{REF} to be decreasing. This will cause V to be decreasing. Thus V^{REF} and V will be decreasing in the area above the V^{HIGH} curve. This dynamic process for outcomes above the V^{HIGH} curve can be captured by the following differential equation,

$$\frac{dV_t}{dt}\frac{1}{V_t} = \psi\left(\frac{V_t^{HIGH}}{V_t}-1\right) \le 0 \text{ for } V_t \ge V_t^{HIGH}, \text{ with } \psi>0 \qquad (15)$$

The dynamic response of the money wage for the region labelled 'downward money wage pressure' can be inferred from (15) as follows. In this area $P=P^{REF}$ because this area lies between the L^{LOW} and L^{HIGH} curves. Thus the real wage can be written $V=W/P^{REF}$. Differentiation of $V=W/P^{REF}$ and substitution of (15) gives

$$\frac{dW_t}{dt}\frac{1}{W_t} = \psi\left(\frac{V_t^{HIGH}}{V_t}-1\right)+\frac{dP_t^{REF}}{dt}\frac{1}{P_t^{REF}} \text{ for } V_t \ge V_t^{HIGH} \text{ and } L_t^{LOW} \le L_t \le L_t^{HIGH} \qquad (16)$$

where $\frac{dP_t^{REF}}{dt}\frac{1}{P_t^{REF}}$ =the expected rate of inflation at time t. Clearly $\frac{dW_t}{dt}\frac{1}{W_t}$ is less than the expected rate of inflation for $V_t \ge V_t^{HIGH}$, which implies downward money wage pressure for $V_t \ge V_t^{HIGH}$ and $L_t^{LOW} \le L_t \le L_t^{HIGH}$. This downward adjustment

of money wages relative to the expected rate of inflation restores profits from their low levels at the high real wages above the V^{HIGH} curve, in the interest of sharing factor incomes. In this way the behaviour of the prospect-bargaining model captures the empirical evidence on the causes of wage concessions documented above.

By a similar argument, (16) with V_t^{LOW} substituted for V_t^{HIGH}, captures the adjustment for money wages for $V_t < V_t^{LOW}$ and $L_t^{LOW} \leq L_t \leq L_t^{HIGH}$. In this case, cooperative bargaining requires wages to be increased from their low levels in the interest of sharing factor incomes, such that wages gain and profits suffer.

Using (16), a flex-fix pattern of money wage adjustment can now be established. Assume the economy is initially at point A in figure 4, that is on the V^{HIGH} curve, between the L^{LOW} and L^{HIGH} curves. Then a decrease in L, which as will be shown in section 4 can be caused by a decrease in the nominal level of aggregate demand, will push the economy to say point B. At point B, $V > V^{HIGH}$, which, by (16), will cause money wage inflation to be less than the expected rate of inflation and the actual rate of price inflation. The implied reduction in the real wage will continue until the economy hits the V^{HIGH} curve, at point C for example, where wage inflation will return to be equal to the expected rate of inflation.[17] A flex-fix pattern of wage adjustment has occurred, with the final equilibrium being at a lower level of activity from the initial equilibrium. Wage inflation will have stabilised at a higher rate of unemployment. Thus we have a theoretical explanation of the flex-fix pattern described in Section 2.

As noted above, for $L > \tilde{L}$ the V^{LOW} and V^{HIGH} curves slope downwards. This introduces the possibility of perverse speed limit effects, that is the possibility that a reduction in L in the range $L > \tilde{L}$ could cause an increase in money wages relative to the expected rate of inflation if it pushed V below the V^{LOW} curve, and the possibility that an increase in L in the range $L > \tilde{L}$ could cause an increase in money wages relative to the expected rate of inflation if it pushed V above the V^{HIGH} curve. These 'perversities' are due to the weakening of the influence of the fixed cost parameter for $L > \tilde{L}$.

We now turn to price adjustment. A flex-fix pattern for price adjustment can be derived from the analysis of the region of "downward price pressure". In the area

[17] Section 4 discusses how the expected rate of inflation could change during this adjustment.

of disequilibria to the left of the L^{LOW} curve, profit-maximising price behaviour has to satisfy, from equating the centre and right-hand terms in (8)[18],

$$P^{REF}C^{+}(\chi^{+}+1)\left(AL^{\alpha}-F\right)^{\chi^{+}}\alpha AL^{\alpha-1}=\bar{P}V \qquad (17)$$

Analysis of (17) shows that to the left of the L^{LOW} curve, firms will choose to set P to be less than the reference price. This is because, for $L^{E}<L^{LOW}$ the marginal revenue product of labour at $L=L^{E}$ will exceed the money wage. To see this, consider the value of the left-hand side of (17) at $L=L^{E}$. Denote this value of the marginal revenue product of labour M^{+}. From (17), with $C^{+}\left[Y^{E}\right]^{\chi^{+}}=1$ to capture $L=L^{E}$, $M^{+}=P^{REF}C^{+}\chi^{+}\alpha A\left(L^{E}\right)^{\alpha-1}$. Differentiation of M^{+} with respect to L^{E} holding V constant yields $\frac{dM^{+}}{dL^{E}}=P^{REF}C^{+}\chi^{+}\alpha(\alpha-1)A\left(L^{E}\right)^{\alpha-2}<0$. Because from (9) $M^{+}=\bar{P}V$ for $L^{E}=L^{LOW}$, it follows from $\frac{dM^{+}}{dL^{E}}<0$ that $M^{+}>\bar{P}V$ for $L^{E}<L^{LOW}$. This implies that at {V, L} outcomes in the area to the left of the L^{LOW} curve which maximise the objective function (1), the firm will be setting its price below P^{REF}. This will, through the downward pressure on the price level, put, at a given money wage, upward pressure on the real wage. This dynamic process can be captured by the following differential equation

$$\frac{dV_t}{dt}\frac{1}{V_t}=\varphi\left(\frac{M^{+}}{\bar{P}_tV_t}-1\right)\geq 0 \text{ for } L_t\leq L_t^{LOW} \text{ with } \varphi>0 \qquad (18)$$

The dynamic process described by (18) will, through the status quo effect, cause the reference real wage to increase.

The dynamic response of the money wage for the region labelled 'downward price pressure' can be inferred from (18). Writing P=W/V and, because $V=V^{REF}$ for $V_t^{LOW}\leq V_t\leq V_t^{HIGH}$, that the rate of wage inflation is equal to the expected rate of inflation, (18) implies that the dynamic adjustment of price is determined as

[18] This expression is used rather than the expression for the L^{LOW} curve, (9), because to determine the firm's decision, the macroeconomic equilibrium constraint, $P=\bar{P}$, and the $P=P^{REF}$ constraint should not be imposed.

$$\frac{dP_t}{dt}\frac{1}{P_t} = \varphi\left(1 - \frac{M^+}{\bar{P}_t V_t}\right) + \frac{dP_t^{REF}}{dt}\frac{1}{P_t^{REF}} \text{ for } L_t \le L_t^{LOW} \text{ and } V_t^{LOW} \le V_t \le V_t^{HIGH} \quad (19)$$

Thus in the region labelled 'downward price pressure', price inflation will be less than the expected rate of inflation.

By a similar argument, (19) with $M^- = P^{REF} C^- \chi^- \alpha A\left(L^E\right)^{\alpha-1}$ substituted for M^+ captures the adjustment of price for $L_t \ge L_t^{HIGH}$ and $V_t^{LOW} \le V_t \le V_t^{HIGH}$.

A flex-fix pattern of price adjustment can now be established. Assume the economy is initially at point D in figure 4, that is on the L^{LOW} curve, between the V^{LOW} and V^{HIGH} curves. Then a negative aggregate demand shock will push the economy to say point E. At point E, $\bar{P}V_t < M^+$, which, by (19), will cause price inflation to be less than the expected rate of inflation and the rate of money wage inflation. The implied increase in the real wage and, through the status quo effect, the reference real wage, will continue until the economy hits the L^{LOW} curve, at point F for example, when price inflation will return to be equal to the expected rate of inflation. A flex-fix pattern of price adjustment has occurred, with the final equilibrium being at a lower level of activity than the initial equilibrium.

The adjustment required to return from the region of downward price pressure to equilibrium is more complicated than the adjustment from the region of downward wage pressure because both reference levels, price and real wage, have to adjust. If the reference real wage is slow to adjust upwards then the downward price movements may spillover to cause downward money wage movements. For example, if the reference real wage remains at the level V_3 when demand is restricting employment to the level given by E, the emerging excess of the real wage over the reference wage caused by the fall in price would be offset by a reduction in the money wage.

Increases in aggregate demand can lead, by similar chains of logic, to wage and price increases. That is, speed-limit effects causing upward wage and price movements will be caused by increases in employment when the economy is pushed into the regions of 'upward money wage pressure' or 'upward price pressure'. [19]

[19] The other 4 regions of disequilibria in Figure 4 are not central to this paper and so are not discussed in detail. The dynamic movements for these regions shown in Figure 4 are a combination of the effects for the four regions discussed in this section.

A generalised hypothesis that emerges from this disequilibrium analysis is that downward (upward) speed-limit effects on wages are likely to arise when the wage share is large (small). The converse holds for the speed-limit effects on prices.

To test the generalised hypothesis, the importance of heterogeneity across firms/plants suggests that tests using micro data would be appropriate to see how robustly the theory supports the macro evidence of flat SRPCs combined with speed-limit effects.

In adjusting to a substantial decrease in aggregate demand, it is likely that some firms or plants will close down. Davis, Haltiwanger and Schuh (1996) find that a substantial proportion of job destruction is associated with plant closure. Some firms will close down if the lower level of activity is simply too low to support the pre-existing number of firms, assuming no government bailouts to keep them afloat. The crucial condition is that there are some firms after the shock for whom profits are negative even if they were able to reduce real wages to the minimum level of V^{RES}.

It is possible that bargaining mistakes may be made at firms that could survive at a real wages greater than V^{RES} due, for example, to self-serving bias as in Linda Babcock and George Loewenstein (1997). In this case some workers are sticking out for a wage that is unprofitable, forcing a closure of the plant and large job losses. While, as noted above, Bewley's evidence suggests that credible wages cuts are made and the evidence from the data on wages shows a strong response to negative demand shocks, this does not rule out errors of self-serving bias in practice. Extending the model to allow for self-serving bias is beyond the scope of this paper.

Note that firm closures shift the relation between the individual firm employment level and the aggregate level of employment. Thus the aggregate level of employment associated with lowest equilibrium level of firm employment shown in Figure 4 would be reduced if the number of firms is reduced.

3.3.2 Heterogeneous firms

The analysis with homogenous firms found that the flex-fix pattern was exhibited by money wages alone in the regions labelled 'downward money wage pressure' and 'upward money wage pressure'. Only in the regions labelled 'downward price pressure' and 'upward price pressure' was the flex-fix pattern exhibited simultaneously in prices and money wages and then the simultaneous occurrence

depended on the reference real wage being slow to adjust. Given that in practice it appears that it is usual for the flex-fix pattern to occur simultaneously in both prices and money wages, this is a restrictive property of the model with homogeneous firms. However, if it is assumed that firms are heterogenous with regard to profitability then flex-fix patterns covering both wages and prices are a more general characteristic of the model.

Heterogeneity in profitability across firms is realistic and can be inferred from the well-documented distribution of productivity across firms, even after allowing for the less than complete correspondence between the two, see Foster, Haltiwanger and Syverson (2007, p.1). Including heterogeneity across firms (and plants of firms) in productivity/profitability, implies that a decrease in aggregate demand may push some firms, the low productivity/profitability firms, into the region of downward wage pressure and some other firms, the high productivity/profitability firms, into the region of downward price pressure. An example is given in the Appendix to illustrate these effects. The macroeconomic outcome will be a combination of these different components and will show a flex-fix pattern in prices and money wages.

An increase in demand can have the upward flex-fix pattern in prices and money wages by pushing the low productivity/profitability firms into the region of increasing price and the high productivity/profitability firms into the region of increasing money wages.

A heterogenous structure of firms has a further implication which further strengthens the prediction of a flex-fix wage and price pattern. Consider a heterogenous structure of firms with some firms having intermediate levels of productivity/profitability such that for these firms $V=V^{REF}$ and $P=P^{REF}$. Money wages and prices at these intermediate firms can be affected by wage and price movements of those firms with higher and lower levels of productivity/profitability, that is the outer firms for which $V \neq V^{REF}$ and $P \neq P^{REF}$. Wage and price falls at the outer firms can be transmitted via the effect on the aggregate wage level and price level to the money wage value of the reference real wage and the reference price of the intermediate firms for which $V=V^{REF}$ and $P=P^{REF}$. The intermediate firms would then reduce both money wages and prices. Thus, allowing for heterogeneity across firms in

profitability strengthens the ability of the prospect-bargaining model to explain the flex-fix pattern in both prices and money wages.[20]

4. The IS-LM model and the flex-fix pattern of wage and price adjustment

In this section it is shown how aggregate demand determines at which of the range of equilibrium outcomes the economy actually settles. This shows how the prospect-bargaining model provides microeconomic foundations for the Keynesian proposition that changes in the nominal level of aggregate demand can cause changes in the rate of unemployment.[21] As noted in the introduction, Krugman (2000) argues that the empirical validity of this proposition explains the continuing use of the IS-LM model in macroeconomic practice. For simplicity, the discussion assumes the case of homogenous firms.

The Keynesian product market equilibrium condition is that the planned level of aggregate demand in nominal terms is equal to the nominal value of output. For the firm in the prospect-bargaining model, the nominal value of output is equal to revenue. Denote by Λ the portion of nominal aggregate demand directed at the representative firm in the prospect-bargaining model. With the assumption of one firm, Λ=total nominal aggregate demand and so the Keynesian product market condition is

$$\Lambda \equiv PY^D = PY \qquad (20)$$

where Y^D=the planned level of aggregate demand. Y continues to be the output of the representative firm.

In IS-LM analysis, Y^D is determined by the IS-LM intersection. Because the IS-LM model, by including saving, investment and borrowing, incorporates inter-temporal decisions, the prospect-bargaining model would, strictly speaking, have to

[20] Replacing the constancy of V^{RES} with respect to the level of activity by a positive relation, reflecting the influence of labour market conditions on V^{RES}, would provide an additional reason for the V^{LOW} and V^{HIGH} curves to be upward sloping and would therefore give further support to the derivation above of the speed-limit effect using the region of downward money wage pressure. As noted, this effect of market forces is not included in the main argument in order to highlight how the model can explain the influences on wages internal to the firm which are found to be empirically important in Akerlof, Dickens and Perry (1996), Bewley (1999) and Henle (1973).

[21] The prospect-bargaining model in its form in this paper implies that the real effects of changes in nominal aggregate demand are permanent. Even if extensions of the model reduce 'permanent' to long-lasting, the resulting behaviour is acceptable as Keynesian because the mechanism operates through changes in sales rather than divergences between expected and actual prices.

be extended to a multi-period setting to do the IS-LM model justice. That would take this paper too far. The focus here is on the Keynesian proposition of how the level of aggregate demand determines the level of output.

Fiscal and monetary policy can change planned aggregate demand through the usual IS-LM mechanisms. A helicopter drop of money, the simplest example, or government expenditure financed by government borrowing and/or printing money can increase planned aggregate demand.[22] This, through (20) would, if the price level does not change, increase actual real output and thus employment.

Using the prospect-bargaining model as a microeconomic basis for IS-LM analysis implies that the IS-LM diagram should incorporate a vertical line, the Y^{max} line, representing the level of output produced when unemployment equals u^{min}.[23] To the right of the Y^{max} line changes in nominal aggregate demand will ultimately fall on the price level along the lines of the standard expectations Phillips curve and in that region the accelerationist hypothesis can be told.[24]

Supply factors determine the position of the Y^{max} line, as in natural rate theory they determine the natural rate. In particular, estimation referred to in Section 2 shows that unemployment benefits and, for Australia, union power have a significant impact, in that increases in either of these supply factors tend to reduce Y^{max}.

To the left of the Y^{max} line, changes in the nominal level of aggregate demand can change the levels of output and employment. However, by how much depends in part on their effect on P. Even changes in the nominal level of aggregate demand that do not push the representative firm out of the diamond of equilibria and thus maintains $P=P^{REF}$, may change the price level through changing P^{REF}. Remembering that the expected price level is equal to P^{REF}, the stability of inflationary expectations in the face of changes in nominal aggregate demand is an important factor in this

[22] Government borrowing raises the possibility of Ricardian equivalence. Formal consideration of Ricardian equivalence would require a multi-period model. However, note that Akerlof (2007) argues that behavioural economics provides good reason to doubt Ricardian equivalence. Akerlof focuses on the "warm glow" from giving. In addition, present bias would break the Ricardian equivalence result because it implies that people undervalue the future and so will tend to increase expenditure from a tax cut even although there will be a higher tax burden in the future. Thaler and Bernatzi (2004) show that present bias is relevant for the determination of saving patterns, supporting the argument here that present bias is an effective factor in undermining Ricardian equivalence

[23] There is a case for another vertical line at Y^{min}, the output produced when the economy is at u^{max}. However, empirical experience reported in Section 2 suggests that this case is weak.

[24] Productivity shocks will also affect the aggregate level of employment through changes in the efficiency factor, A, in the firm's production function.

transmission process. To allow for this, decompose the effect of changes in Λ between output and/or price according to

$$\frac{d\Lambda}{\Lambda}=\frac{dP}{P}+\frac{dY^{D}}{Y^{D}}=\frac{dP^{REF}}{P^{REF}}+\frac{dY^{E}}{Y^{E}} \qquad (21)$$

Clearly from (21) the real effect of a change in nominal aggregate demand depends on the split of its effect between P^{REF} and Y^{E}. The determination of this split is not modelled here and so, for expositional purposes, specify $\frac{dP^{REF}}{P^{REF}}=\lambda\frac{d\Lambda}{\Lambda}$, where, to capture various cases of interest, λ is treated as a constant with $0\le\lambda\le1$. In the literature on range of equilibria models, two polar cases of λ=0, called the Keynesian case, and λ=1, called the monetarist/classical case, have been emphasised, see Bhaskar (1990), Woglom (1982) and McDonald and Sibly (2005). Factors which affect the stability of inflation expectations will determine the actual value of λ that is relevant for a particular economy at a particular time. For example, inflation targeting, by locking in inflation expectations, will tend to produce a low, perhaps even zero as in the Keynesian case, value of λ.

In terms of the IS-LM model, an increase in government spending financed by borrowing from the public will shift the IS curve to the right. Planned aggregate demand will increase by the amount determined by the new IS-LM intersection. Should this fiscal expansion increase P^{REF} and thus P then, with a fixed money supply the LM curve will shift left, and the net increase in planned aggregate demand will be smaller. In the Monetarist case as defined above, ie by λ=1 instead of by a vertical LM curve, the LM shift will completely offset the IS shift, implying the whole change in nominal aggregate demand falls on the price level.

In general, for $0\le\lambda\le1$, the effects of changes in nominal aggregate demand on price and output are

$$\frac{dP}{P}=\frac{dP^{REF}}{P^{REF}}=\lambda\frac{d\Lambda}{\Lambda} \quad \text{and} \quad \frac{dY}{Y}=\frac{dY^{E}}{Y^{E}}=(1-\lambda)\frac{d\Lambda}{\Lambda} \qquad (22)$$

For the Keynesian case, λ=0 and the entire change in nominal aggregate demand falls on real output and employment. For the monetarist/classical case, the entire adjustment falls on price.

Relating this analysis back to the prospect-bargaining model shows that the split between prices and output of a change in nominal aggregate demand captured by λ is paralleled by the nature of the shift in the firm's demand function, that is through how a change in Λ will affect the parameters C^- and C^+. From $P^{REF}C^-\left(Y^E\right)^{\chi^-} = P^{REF}C^+\left(Y^E\right)^{\chi^+} = 1$, the shift parameters C^- and C^+ will change with changes in nominal aggregate demand according to

$$\frac{dC^-}{C^-} = -(1-\lambda)\chi^- \frac{d\Lambda}{\Lambda} \text{ and } \frac{dC^+}{C^+} = -(1-\lambda)\chi^+ \frac{d\Lambda}{\Lambda} \qquad (23)$$

((23) is derived as follows. From $P^{REF}C^-\left(Y^E\right)^{\chi^-} = 1$ implies $\frac{dC^-}{C^-} = -\chi^- \frac{dY^E}{Y^E}$ and $\Lambda = P^{REF}Y^E$ implies $\frac{dY}{Y} = \frac{dY^E}{Y^E} = (1-\lambda)\frac{d\Lambda}{\Lambda}$ the first part of (23) follows. Using $P^{REF}C^-\left(Y^E\right)^{\chi^-} = P^{REF}C^+\left(Y^E\right)^{\chi^+}$ the second part of (23) follows.) The shift parameters, C^- and C^+, adjust if $\lambda<1$. If $\lambda=0$, the Keynesian case in which P^{REF} is unaffected by changes in the level of nominal aggregate demand, then the change in C^- and C^+, and thus the horizontal shift in the firm's demand curve, is at its largest for a given change in nominal aggregate demand. In the Monetarist case, $\lambda=1$ and so C^- and C^+ are unaffected by changes in aggregate demand, and instead P^{REF} bears the entire burden of adjustment, shifting the firm's demand curve vertically. In the intermediate cases of $0<\lambda<1$, the shift in the firm's demand curve is a combination of horizontal and vertical movements.

The analysis in Section 3.3.1, the case of homogenous firms, showed that changes in employment that pushed the economy outside the diamond of equilibria can lead to a flex-fix price pattern. In terms of the IS-LM model, the flex-fix price pattern analysed in Section 3.3.1 would occur for levels of Y less than the Y^{max} line. The interaction of the price level change with the LM curve can be addressed with IS-LM analysis. That is, at $Y<Y^{max}$ a decrease in planned aggregate demand may, through the speed-limit effect activated by the decrease in activity, cause some decrease in the price level. With a fixed money supply there would be a right-ward

shift of the LM curve that would counteract to some extent the decrease in planned aggregate demand and thus the negative impact on the level of activity.[25] This counter effect would be greater the greater is the speed-limit effect. For increases in planned aggregate demand, an increase in price will also mitigate the increase in planned aggregate demand and thus the impact on output.

5. Conclusion

This paper has presented a theory that, for an economy operating below potential, explains when wages and prices are flexible and when they are fixed. The particular mix of flex and fix predicted by the theory is that wages and prices will fall, relative to expected levels, when activity falls but will stabilise when activity stabilises. Thus the pattern of wage and price movement is flex followed by fix, that is a flex-fix price pattern. The theory is symmetric, in that wages and prices will increase when activity increases but will stabilise when activity stabilises. In the language of the Phillips curve, the pattern is a short-run Phillips curve (SRPC) that is flat at high levels of unemployment and is accompanied by speed-limit effects. (Speed limit effects are a negative relation between changes in unemployment and the rate of inflation.) At low levels of unemployment the theory generates, in conventional fashion, a downward–sloping SRPC.

The theory in the paper is also shown to offer a resolution of the criticism made by Krugman (2000) and Mankiw (2006), that macroeconomic research is disconnected from macroeconomic practice. The theory has explicit microeconomic foundations, the requirement of macroeconomic research, and yields macroeconomic behaviour that is consistent with the fundamental Keynesian proposition, that changes in nominal aggregate demand can have real effects through a direct effect on sales. These real effects do not depend on a divergence of expected and actual prices and so their persistence is not dependent on a persistent error in expected prices. The fundamental Keynesian proposition is the centre piece of macroeconomic practice.

While there is plenty of evidence supporting the flex-fix price pattern at high rates of unemployment, even for the extremely large and persistent increases in unemployment in the depression of the 1930s, this pattern has not registered amongst

[25] If a liquidity trap is binding then there would be no counteracting effect.

economists in general as an important phenomena requiring explanation. Given the empirical evidence, this is puzzling. Richard Lipsey describes this neglect as "the major scandal which was apparent from the outset of NR [=natural rate] theorising: the failure of inflation to decelerate continually during periods of persistent high unemployment", Lipsey (1997, p.209). Instead, to accommodate fixity in prices, natural rate thinking has suggested to scholars a fix-flex pattern, that is prices are sticky for at most a temporary period of time and will eventually respond to market forces. However, this view is inaccurate and misleading for recessions, where the usual pattern is flex-fix.

The theory presented in the paper is an extended version of the prospect-bargaining model of McDonald and Sibly (2005). In the prospect-bargaining model, loss aversion plays an important role in causing rigidities in wages and prices. Workers dislike wage cuts and customers dislike price increases because the consequent losses in utility are large. The asymmetric effect of loss aversion, that is losses are more keenly felt than gains, yields wage and price stickiness over a range of unemployment rates.[26] This range result yields the flat region in the SRPC.

The temporary overriding of fix-price behaviour in prices is caused by downward pressure from decreases in costs. This is a conventional story modified slightly for the customer market context. For wages, the mechanism put forward in the paper is novel. The temporary overriding of fix-price behaviour in wages results from postulating a theory in which contractions in demand will put pressure on factor incomes. The introduction into the prospect-bargaining model of a fixed cost of production is shown in the paper to cause pressure strong enough for the stickiness in wages implied by loss aversion to be overridden in the interests of the cooperative wage bargain. The converse holds for increases in aggregate demand, where the sharing of increased revenue can require an increase in real wages.

Thus forces internal to the firm, that is the need to protect income shares, can contribute through wage adjustment to speed limit effects. This is consistent with the empirical evidence gathered by Bewley (1999), who found that depressed labour market conditions external to the firm were of little importance in the determination of wage reductions. What was important, according to Bewley's findings, was the

[26] The information asymmetry in customer markets, pointed out by Scitovsky (1952) also plays a role in the micro foundations of the prospect-bargaining model.

sharing of reduced factor incomes. Akerlof, Dickens and Perry (1996) and Henle (1973) found similar evidence.

Appendix: An example of how heterogeneity across firms in profitability implies a speed limit in both wages and prices

In the model, heterogeneity across firms in the production process can be captured by firm-specific values of the parameters A and F. [27] To see how a macro speed limit that combines firm-specific speed limits from the regions of downward money wage pressure and downward price pressure, consider the simple case of two firms with different production technologies. Assume $A_1<A_2$, where the subscript 1 (2) refers to the less (more) productive firm. The parameters of their demand curves are assumed identical.

Figure A shows an example of this case of differing productivity across two firms.[28] The differing levels of productivity, $A_1<A_2$, is reflected in the $L^{LOW,firm1}$ curve lying to the left of the $L^{LOW,firm2}$ curve. Assume initially the same real wage of V_1 at both firms and the initial equilibrium outcomes of point A for firm 1 and point D for firm 2. These initial outcomes are a macro-equilibrium. Note that employment at the high productivity firm exceeds employment at the low productivity firm. Note also that profitability at the high productivity firm exceeds profitability at the low productivity firm.[29]

Now assume an aggregate demand contraction. For the low productivity firm, the contraction in employment pushes that firm into the region of downward money wage pressure, eg point B. For the high productivity firm, the contraction in employment pushes that firm into the region of downward price pressure, eg point E. As intuition suggests, the low productivity firm is experiencing pressure on factor rewards, because it is operating near to its minimum level of employment. This pressure on factor rewards induces, through cooperative bargaining, wage concessions. For the high productivity firm, as intuition suggests, the lower marginal cost at a lower level of output is the dominant force, inducing the firm to compete in its market for sales by cutting price.

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[27] Alternatively, one could also assume that the parameters of the demand function vary across firms and get a similar result.

[28] It is assumed in Figure A, for convenience, that F_1, A_1, F_2, and A_2 are related such that the $V^{HIGH,\ firm\ 1}$ curve intersects the $V^{LOW,\ firm\ 2}$ curve at $\{V^{RES}, L^{min}\}$, which is ensured if F_1, A_1, F_2, and A_2 are related according to $(A_1 - A_2)\left(L^{min}\right)^{\alpha} = F_1 - F_2$.

[29] Writing x=F/A, $\Pi = (1-\alpha)\left(\frac{V}{\alpha}\right)^{\frac{\alpha}{\alpha-1}} A^{\frac{1}{1-\alpha}} - xA$ and so $\frac{d\Pi}{dA} = \left(\frac{V}{\alpha}\right)^{\frac{\alpha}{\alpha-1}} A^{\frac{1}{1-\alpha}} - x = \alpha\left(\frac{V}{\alpha}\right)^{\frac{\alpha}{\alpha-1}} A^{\frac{\alpha}{1-\alpha}} > 0$.

The process of adjustment to macroeconomic equilibrium will require opposite movements in the real wage at the two firms. The low productivity firm will achieve equilibrium when its reference real wage has adjusted to a lower level such as given by point C. For the high productivity firm equilibrium is achieved when its reference real wage has adjusted to a higher level such as given by point F. This divergence of real wages reflects the divergent productivity levels of the two firms.

Thus, a decrease in aggregate demand has pushed one firm into the region of downward wage pressure and the other firm into the region of downward price pressure. The macroeconomic outcome will be a combination of these different components. This supports the discussion in the text of how allowing for heterogeneity across firms in profitability can lead to a macro speed limit effect that combines movements in both wages and prices.

Figures

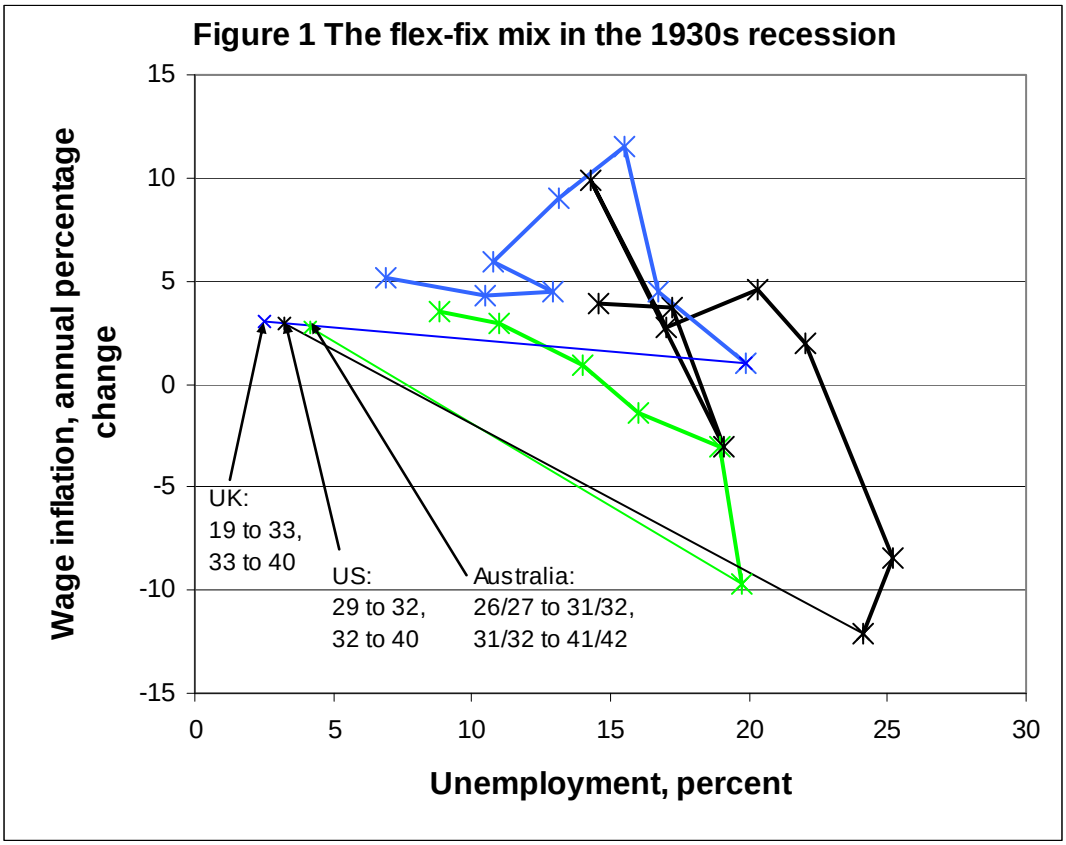


Figure 1 The flex-fix mix in the 1930s recession
Wage inflation, annual percentage change
Unemployment, percent
15
10
5
0
-5
-10
-15
0
5
10
15
20
25
30
UK:
19 to 33,
33 to 40
US:
29 to 32,
32 to 40
Australia:
26/27 to 31/32,
31/32 to 41/42

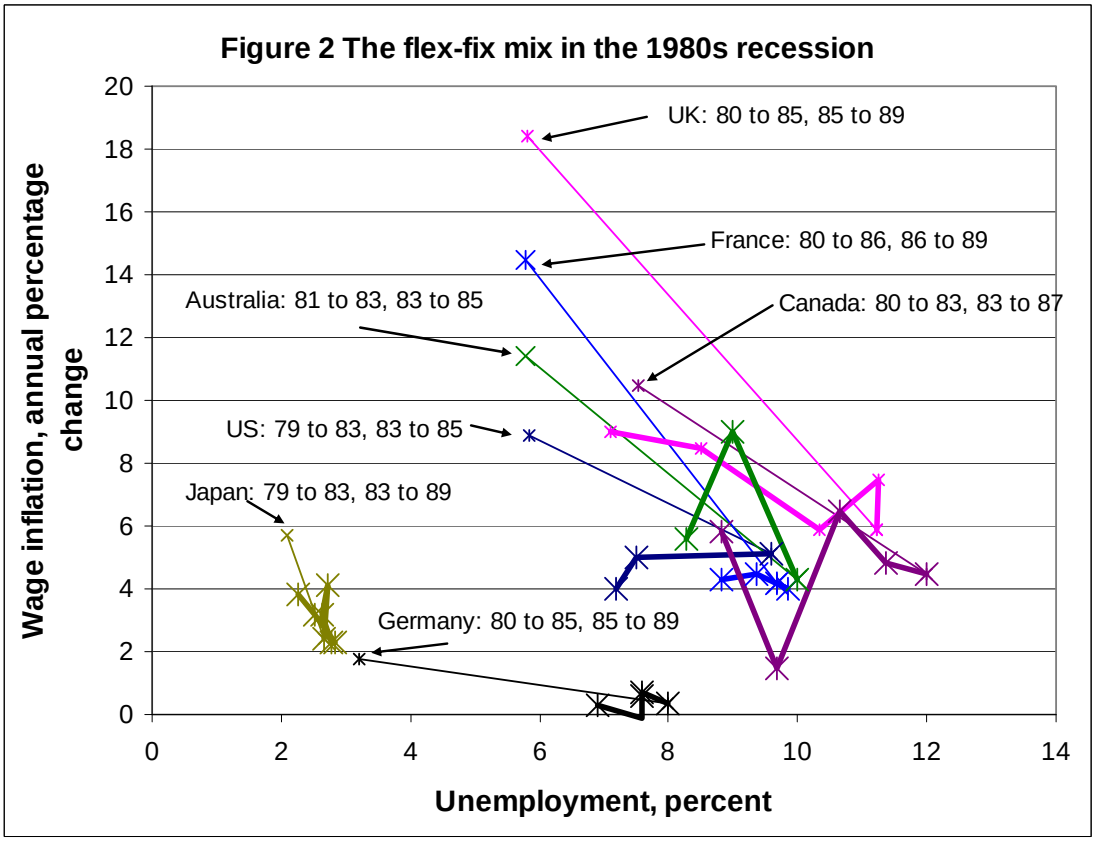


Figure 2 The flex-fix mix in the 1980s recession
Wage inflation, annual percentage change
Unemployment, percent
20
18
16
14
12
10
8
6
4
2
0
0
2
4
6
8
10
12
14
UK: 80 to 85, 85 to 89
France: 80 to 86, 86 to 89
Australia: 81 to 83, 83 to 85
Canada: 80 to 83, 83 to 87
US: 79 to 83, 83 to 85
Japan: 79 to 83, 83 to 89
Germany: 80 to 85, 85 to 89

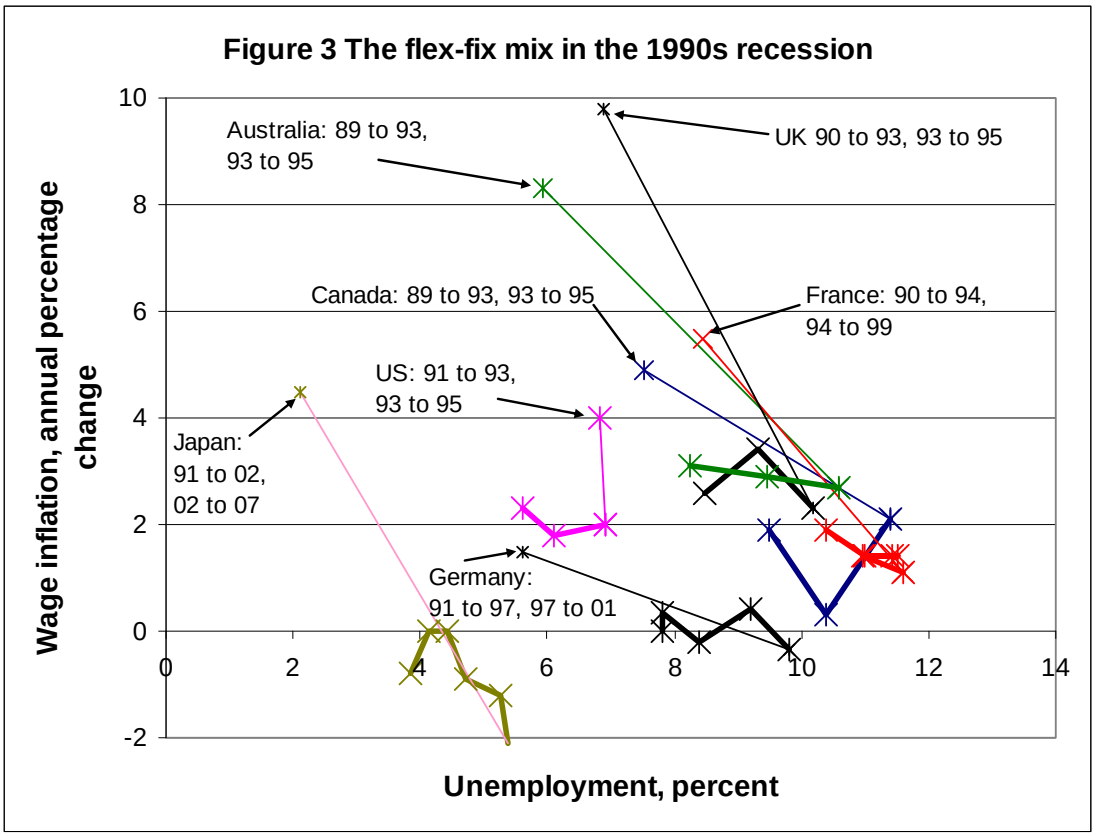


Figure 4 Equilibria and disequilibria in the prospect-bargaining model

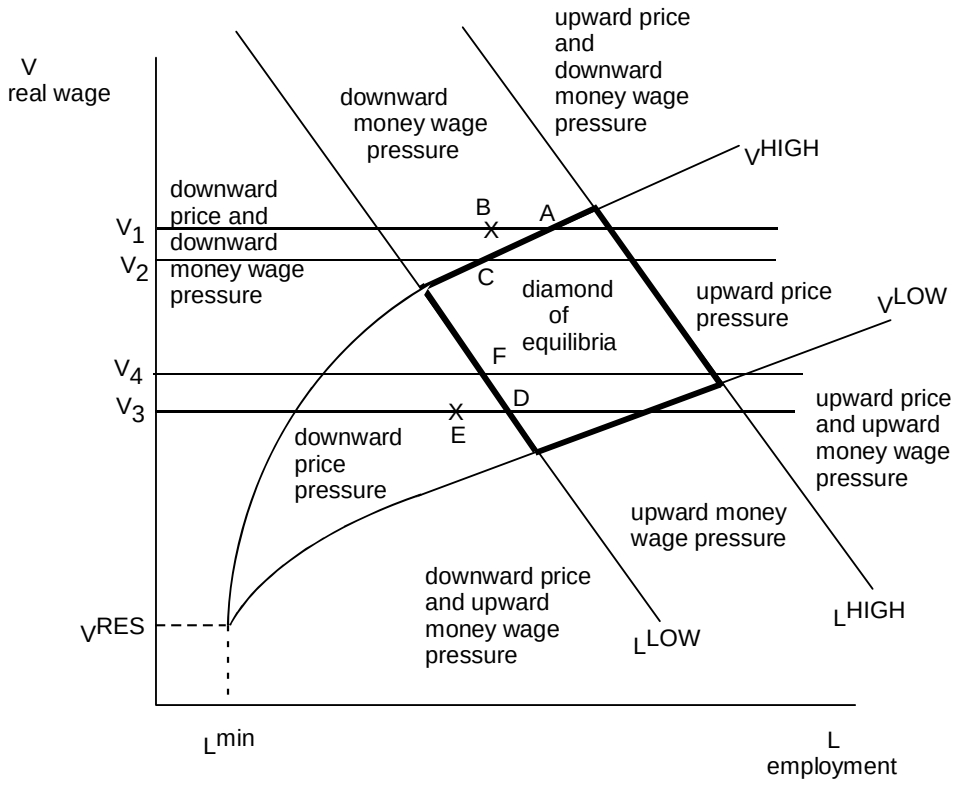
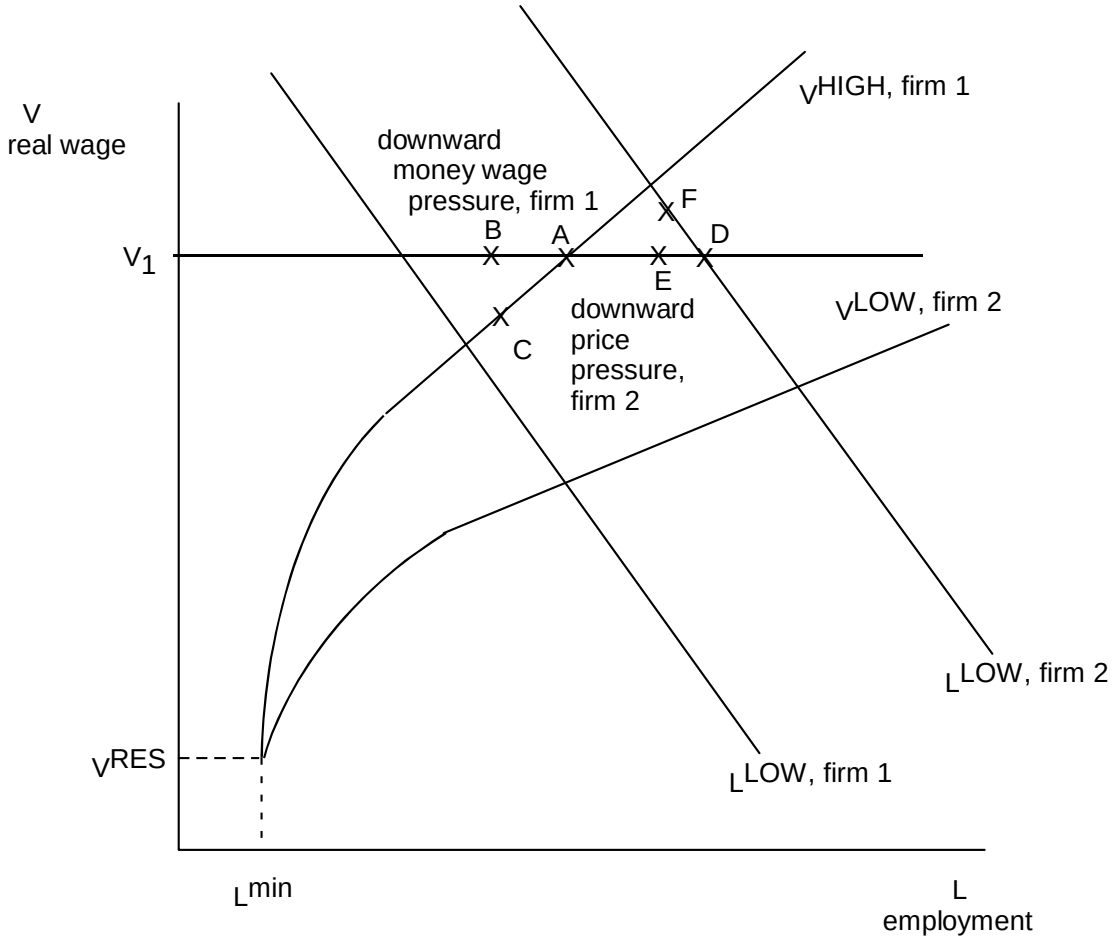


Figure A Two heterogeneous firms and the concurrence of downward money wage and price speed limit effects



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