AGGREGATE PRICE RIGIDITY AS A RESULT OF FIRM EXIT

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Abstract

Nominal price rigidity is considered a prerequisite for the efficacy of monetary policy. Nevertheless, satisfactory explanations for such a phenomenon have been scarce. This paper advances the argument that in a monopolistically competitive economy with heterogeneous firms it is possible to observe a "rigid" price level even if individual firms follow flexible pricing policies. Heterogeneity implies that adverse aggregate demand (or supply) shocks will accelerate the exit of the weakest firms. The surviving firms will face demand changes smaller than the aggregate since the demand orders of the exiting firms will be reallocated to them. This means that their prices and quantities will change less than expected when all firms survive. Hence the price level, which consists of the prices of the surviving firms only, will change less than predicted by a model with perfectly competitive homogeneous firms.

As the resources freed up by the exiting firms do not instantaneously reallocate to other firms, they remain inefficiently unemployed for a period of time. It follows that if monetary policy can counterbalance the aggregate shocks, it will be effective in preventing the acceleration of firm exit and avoid the inefficiency in the allocation of resources.

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I. **Introduction**

Macroeconomic fluctuations may be interpreted as failures of the economic system to efficiently allocate its scarce resources.[1] Economic modeling of these inefficiencies demonstrates that they most commonly result from the failure of prices to adjust quickly enough to clear markets. Non market clearing results in states of excess demand or supply or, alternatively, in larger than expected quantity adjustments. The phenomenon of slow price adjustment is dubbed 'price rigidity' and is a major ingredient of Keynesian economics. Phenomena such as wide procyclical fluctuations in employment, accompanied by acyclical movements in wages can be considered as prima facie evidence of price rigidity in labor markets. Furthermore, the fact that the aggregate price level of the economy has not experienced a negative rate of growth, at yearly frequencies, since 1956, can be seen as further direct evidence of price rigidity.

Extensive macroeconomic theorizing has demonstrated that if economic downturns are results of inefficient allocation of resources, government policies can be used to move the economy towards full employment. In other words, monetary policy will affect the real economy if inefficiencies are present. Consequently, price rigidity is a prerequisite for the efficacy of monetary policy.

The adverse effects of price rigidity on resource allocation and the role of monetary policy in alleviating them have been demonstrated in macroeconomic models by Fisher [1977], Taylor [1979] and Calvo [1983] among others. In these models, known as time-dependent models, firms set prices for a certain time interval and do not automatically adjust them as new information arrives. This firm-level price rigidity translates into aggregate price rigidity, which in turn is responsible for the inefficient allocation of resources.

These models have two drawbacks: they make an ad hoc assumption about the way firms set their prices, and they automatically assume that individual price rigidity implies aggregate price rigidity. Caplin and Spulber [1987] took issue with the second drawback and demonstrated that under some, admittedly restrictive, conditions individual price rigidity may not result in aggregate price rigidity and, hence, no inefficient resource allocation. Caplin and Spulber's conditions were that pricing is state-contingent, i.e. firms follow an (s,S) pricing strategy, and that the initial firm distribution over the (s,S) interval is uniform.[2]

The ad hoc pricing drawback cannot be dealt within the time-dependent and state-contingent models and, thus, remains valid. An alternative class of models has been introduced to deal with this drawback. The well-known menu-cost models are developed

on the assumption that firms face a "small" price adjustment cost. Consequently, they do not adjust their prices if the gain from the price adjustment is smaller than its cost and, thus, small deviations between actual and optimal (i.e. market clearing) prices will be observed. Models by Mankiw [1985], Akerlof and Yellen [1985] and others have shown that these small individual price deviations result in 'large' aggregate output deviations. The existence of menu costs significant enough to produce the observed aggregate output deviations is still debated.[3] In addition, introduction of menu costs in macroeconomic models is been shown to have counterfactual implications (Mankiw [2001], Lucas and Colosov [2003]).

The goal of this analysis is to turn the Caplin and Spulber result on its head, i.e. to demonstrate that it is possible to observe aggregate price rigidity in an economy where individual prices are fully flexible.[4] The argument is the following: Consider a monopolistically competitive economy, i.e. an economy of many small price setting firms producing close substitutes. Assume that these firms are characterized by heterogeneous cost structures, i.e. there are some low-cost and some high-cost producers. Firms operate without perfect foresight of their demand flows. At the beginning of each period they set their prices and a stream of demand orders flows to each firm sequentially. The substitutability of the products implies that the set prices will be relatively close to each other resulting in low profits for the high-cost producers and high profits for the low-cost producers. Consider next a reduction in the aggregate demand. All the firms now are expected to face smaller demand flows, which will reduce their profits. If the reduction in demand is sufficiently high, then some of the high-cost firms will be forced to exit the market.[5] As some firms exit the market, the order flow they were expected to satisfy will now be reallocated to the surviving firms. Therefore, the order flow of the surviving firms will not fall as much as the overall demand (since the lower aggregate demand will now be allocated among fewer firms), and they may actually experience an increase in demand. In such an economy, surviving firm will reduce their prices less that what will be expected in an economy where all the firms survive, and may actually find it optimal to increase their price (if exit results in individual demand increases).

The aggregate price level is actually measured as a weighted average of individual prices observed in the market. Since only the surviving firms' products reach the market, the price level will be the aggregate of prices that have changed little. This explains why the aggregate price level changes little (i.e., is rigid) especially downwards. On the other side, the aggregate output will reflect the change in the output of the surviving firms plus the loss in output from the exiting firms. It is thus reasonable to expect large output reductions during severe recessions.

The above sketched economy has some obvious advantages:

First, it can easily accommodate the fact that while the aggregate price level, at yearly frequency has not fallen since 1956, at monthly frequencies decreases are not uncommon.[6]

Second, it provides a natural explanation of the observed predominance of quantity adjustments. Firm exit and entry result in large overall quantity changes with small effects on prices.

Third, it provides a rationale for active government policies. In a dynamic economy, continuous streams of entry and exit will occur and resources redeploy from the exiting to the entering firms. Reductions in aggregate demand will accelerate exit and decelerate entry. If exit accelerates, resources will be freed and will remain unemployed for a time since entry will have decelerated. In other words, the inefficiency in the allocation of resources results from upsetting the orderly process of reallocation. Policies that prevent the reduction in aggregate demand will prevent these changes in the streams of exit and entry and keep the process of redeploying resources orderly and the allocation of resources efficient.

Fourth, it is admitted that the above inefficiency will not be observed if resources could be redeployed instantaneously. If laid-off workers can retrain instantaneously, and capital adapted to new uses momentarily, and the prices of these resources reduced appropriately, then entry will actually accelerate (due to lower costs) and counterbalance the exit. Obviously these three conditions are unrealistic. Reductions in aggregate demand will be accompanied by marginal resources being inefficiently idle in the short run.

Fifth, the above identified inefficiency could also be produced by an adverse productivity shock that will lead to accelerated exit of high-cost firms.

Additional implications of the model are discussed throughout the text. The paper is organized as follows: The next section discusses critically the literature on price rigidity. Section 3 presents a rudimentary partial equilibrium model that demonstrates the effects of exit on the price level. A simple yeoman-farmer monopolistic competition macromodel is presented in Section 4 that essentially repeats the point of Section 3 in a more general setting. Section 5 discusses, informally, the components of a more realistic macroeconomic model and speculates as to the results that can be obtained from such a model. Conclusions are given in Section 6.

II. Literature Review

A. Price Rigidity

There is an extensive literature exploring the reasons why prices are rigid or sticky. While many reasons have been proposed to explain real rigidity, nominal rigidity explanations are scant and fall into basically two categories: Costs of price adjustment (aka menu costs), and costs of consumer reactions.[7]

Wolman [2000, 2003] extensively surveys the empirical literature with a favorable predisposition, while Wynne [1995] also surveys the earlier literature but with a critical eye.

The costs of price adjustment justification is theoretically treated by Barro [1972], Sheshinski and Weiss [1977, 1979, 1983], Danzinger [1983, 1984] and Benabou [1988]

among others. These administrative costs, are considered by many economists as too small to be of significance. Therefore, the next step is to try to establish empirically their existence and size.

The existence of menu costs can be indirectly established by their implication, i.e., the slow adjustment of prices. Work by Cecchetti [1986], Kashyap [1995], Lach and Tsiddon [1992] among many others[8] establishes that individual prices change infrequently, but price change frequency increases with inflation.

Another strategy is to attempt to estimate menu costs directly. Levy and his collaborators have a series of papers where they attempt to actually measure menu costs. For example, Levy et al [1997] looks at supermarket prices and establishes that menu costs are about 0.70% of revenue and 35.2% of their net margins. The majority of their supermarkets changes about 15% of their prices each week. Zbaracki et. al. [2000] examine the pricing costs of a large industrial manufacturer. They show that the firm changes prices annually, and the bulk of price changing costs are managerial and customer costs, while the costs of physically changing price (i.e. the menu costs) are very small (about 3.3% of the overall costs associated with the price changes).

A number of criticisms have been advanced against the menu costs literature (some of them pointed out by Wynne [1995]):

First, most of the times empirical work involves list prices which are most probably not the transaction prices. Stigler and Kindall [1970] look at transactions prices and argue that they are not rigid.

Second, even if prices do not change often this is not evidence that markets do not clear. Carlton [1986] argues that firms can make changes along other dimensions, such as quality, advertising, marketing efforts etc., that can help reestablish the set price as the market clearing price. For example, if the demand the firm faces decreases then at the set price the firm faces an excess supply. One alternative the firm has is to lower the price to eliminate the excess supply and reestablish market clearing. Another alternative is to increase marketing effort to try to sell the unsold excess supply. But increased marketing effort increases the firm's costs and, consequently, shifts its marginal cost curve upwards enough to reestablish the "marginal cost equals marginal revenue" condition at the original price, eliminating the excess supply and, thus, restoring efficiency.

Third, most of the empirical work fails to discuss the alternative hypothesis of flexible prices. While in some markets, like the stock market, prices do change every few minutes and there is no argument about their flexibility, it is not clear how often supermarket prices or magazine prices should change in order to be considered flexible. Should the supermarket change prices daily, and charge higher prices on Fridays when demand is higher? Or should the supermarket charge a price that it expects to keep constant for, say, eight weeks; accept small temporary excess demand or excess supply amounts that result from temporary demand fluctuations and cancel each other out over the few weeks; and only consider changing the price only if persistent excess demand or supply are observed? If the second case sounds more reasonable, price flexibility will be fully compatible with only relatively few prices changing every week. Along the same

vein, Bils and Klenow [2002] use BLS data to demonstrate that economy-wide prices change every 4.3 months on average, which is a lower estimate than the previous literature was claiming and can be consistent with price flexibility.

Fourth, it is not clear whether a larger component of what Levy and his collaborators measure as menu costs are not actually already taken into consideration as normal business costs. If a firm has a pricing manager on its regular payroll, then his cost cannot be claimed to be a hindrance to a price change since, when it comes to an additional price change, the manager's cost is a sunk cost. A similar argument may apply to supermarket employees that have changing price tags among their regular job tasks.

Fifth, a much more direct and relevant test of price rigidity will be to demonstrate that firms fail to change prices in the presence of persistent excess demand or supply. Up to now I am not aware of any empirical work that takes this approach.

These criticisms lead to the belief that price rigidity, especially downward, is not a major problem at the firm level. Actually, in many instances, especially in the high tech sector, price decreases are observed quite often, as are price decreases throughout the economy. Hence, an alternative explanation must be sought to explain the aggregate price rigidity, which ultimately is the kind of rigidity that matters in the macroeconomic models.

B. Firm Entry and Exit

Schumpeter [1942] forcefully elaborated the idea that functioning (as opposed to ideal) capitalistic systems are characterized by continuous entry and exit of firms, a process he called "creative destruction". Most economists recognize creative destruction as a realistic concept, but the vast majority of economic models fail to incorporate it and study its effects. Actually, most economic modeling utilizes the "representative firm" approach which by definition excludes entry and exit of firms.

About half a century after Schumpeter's work, work using the Longitudinal Research Database (LRD) of the Census of Manufacturing and studying labor flows at the plant level, established that the economy is characterized by continuous streams of job creation and destruction (Davis and Haltiwanger [1990, 1992], Davis, Haltiwanger and Schuh [1996] among others). Job flows can be thought of as proxies for firm entry and exit. Actually, Davis, Haltiwanger and Schuh [1996] report that while a large percentage of job turnover happens within large firms, a non-trivial percentage (20%) is due to new entrants and exiting firms.

Further study of the job flows reveals that over the business cycle job creation experiences relatively small decreases and sometimes actually increases, while job destruction accelerates during recessions and decelerates during expansions (Schuh and Triest [1998]). The implication is that understanding the behavior of the economy during recessions requires, among others, consideration of the effects of accelerated firm exit.

Geroski [1998] argues that not all firms suffer during recessions. Actually, the effects of recessions are concentrated on a few firms (some of which exit the market), while the majority of firms is either not affected or actually prosper.

Following the empirical results on job creation and destruction flows, a number of theoretical models were developed to demonstrate how such flows can be derived. Pissarides and Mortensen [1994] present such a model. They assume that the economy consists of firms employing one worker each. There is a continuum of firms distributed according to their productivity. New firms/jobs are created at the top of the productivity distribution and firms at the bottom of the distribution are forced to exit. The implied job creation and destruction rates from the model are consistent with the Davis, Haltiwanger and Schuh [1996] data. Cabbalero and Hammour [1994] present another model consistent with the same data. They introduce exogenous distributions that characterize firm entry and exit rates. Exogenous demand shocks cause shifts in these distributions that produce the observed acceleration and deceleration flows in the data. Horvath [1999] is a unique attempt to provide a model characterized by entry and exit that endogenously derives business cycles. His argument is that new entrants are uncertain about their productivity. Only after they start operation they learn their actual productivity, and if it is very low they exit the market. While the learning idea is interesting, it is not very persuasive. Usually, new entrants will invest in new capital that embodies the latest technology. The Pissarrides-Mortensen claim that firms enter at the top of the productivity distribution seems much more reasonable, although research on firm exit shows that smaller, younger firms fail more often that larger, older firms (Dunne, Roberts and Samuelson [1989]).

Neither Cabbalero and Hammour [1994] nor Horvath [1999] examine the question asked in this paper, i.e., what are the effects of firm entry and, especially, exit upon the aggregate price level.

III. A Partial Equilibrium Model

In this section, the goal is to use the simplest possible framework to examine the implications of firm exit on the price level. As was pointed out above, in this section the aggregate price level is defined as a weighted average, using quantities as weights, which is conceptually close to actual price index calculations.[9]

Let a monopolistically competitive economy with heterogeneous producers as described in the introduction. In order to keep the model as simple as possible, the simplest form of heterogeneity is assumed. Firms are classified in two categories: high-cost producers (H-firms) and low-cost producers (L-firms). The goal is to introduce an aggregate demand reduction that forces high-cost firms to exit the market.

All firms operate under a linear total cost function:

$$TC_i = c_0 + c_1 q_i$$

where i indexes the firms, c_0 is the fixed cost and c_1 is the marginal and average variable cost. The economy consists of N firms, of which N_H is the number of high-cost firms and N_L is the number of low-cost firms. All high-cost firms are similar and have fixed cost c_0^H and marginal cost c_1^H. Correspondingly the L-firms have fixed cost c_0^L ($c_0^L < c_0^H$) and marginal cost c_1^L ($c_1^L < c_1^H$). In other words, L-firms have lower fixed and marginal costs.

The demand side of each firm is captured by the following function:

$$q_i = \frac{Y}{N} - bN\left(\frac{p_i}{P} - 1\right)$$

where q_i is the quantity demanded, Y is the aggregate demand, N is the number of firms, b is the slope parameter, p_i is the nominal price of firm i, P is the economy's price level, and p_i/P is the firm's real price. This demand function implies that if all firms charge exactly the same price, then their relative price will equal one, eliminating the second term and giving each firm a share Y/N of the aggregate demand. If, on the other side, a firm charges a price above that of its competitors, i.e., $p_i/P > 1$, then its quantity demanded will be below its equal share Y/N. Furthermore, as the number of firms in the economy increases, the individual demand will experience a smaller intercept Y/N, and a flatter slope –bN.

Solving the above demand function with respect to the relative price yields the inverse demand function:

$$\frac{p_i}{P} = \left(\frac{aY}{N^2} + 1\right) - \frac{a}{N} q_i \qquad \text{where } \alpha = 1/b > 0$$

A way to guarantee that the firm continues operating and its optimal solution is interior, is to impose a so-called profitability condition. That condition simply requires that the firm's average variable cost (AVC), which here is also the marginal cost (MC), is not above the maximum price the firm is able to charge, i.e. the price that corresponds to the vertical intercept of the inverse demand function. Specifically, since the maximum possible price is:

$$\frac{p_i^0}{P} = \left(\frac{aY}{N^2} + 1\right),$$

the profitability condition is:

$$\left(\frac{aY}{N^2} + 1\right) \geq c_1.$$

When the profitability condition is satisfied, the firm's optimal policy is:

$$q_i^* = \left(\frac{N}{2a}\right)\left(\frac{aY}{N^2} + 1 - c_1^i\right)$$

$$\frac{p_i^*}{P} = \frac{1}{2}\left(\frac{aY}{N^2} + 1 + c_1^i\right)$$

Note that the profitability condition guarantees that the term in the second parenthesis in the optimal quantity formula is non-negative.

Based on the fact that ($c_0^L < c_0^H$)and ($c_1^L < c_1^H$), it follows that the low cost firm will produce a larger quantity and charge a lower price than the high costs firm, i.e.,

$$q_L^* > q_H^* \quad , \quad \frac{p_L^*}{P} < \frac{p_H^*}{P}$$

Define next a critical level of aggregate demand Y^C such that the profitability condition of the high cost firms is satisfied with equality, i.e.,

$$\left(\frac{aY^C}{N^2} + 1\right) = c_1^H$$

At that critical level, high cost firms are indifferent between operating and closing down. If aggregate demand falls to Y' which is marginally below that critical level then every high cost firm independently makes the decision to cease operation. As the N_H high cost firms close, only the N_L low cost firms survive. Since now the number of firms is smaller, the individual inverse demand intercept will increase and the slope becomes steeper, i.e. the surviving firms face:

$$\frac{p_i}{P} = \left(\frac{aY'}{N_L^2} + 1\right) - \frac{a}{N_L} q_i$$

The change in demand will, obviously, necessitate that the surviving firms adjust their optimal policy. The following proposition derives the condition under which the surviving firms will actually increase their nominal prices despite the fact that the aggregate demand has fallen.

Proposition 1.

If the exit of the high cost firms results in an increase of the vertical intercept of the inverse demand function of the surviving firms, i.e., if:

$$\left(\frac{aY'}{N_L^2} + 1\right) > \left(\frac{aY}{N^2} + 1\right)$$

then the surviving firms will increase their relative (and, consequently, their nominal) prices.

Proof:

Under the new demand the optimal pricing policy becomes:[10]

$$\frac{p_L^{*'}}{P} = \frac{1}{2}\left(\frac{aY'}{N_L^2} + 1 + c_1^L\right)$$

Comparison of this optimal price with the previous one reveals that when the above condition holds,

$$\frac{p_L^{*'}}{P} > \frac{p_L^{*}}{P}$$

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If the condition in Proposition 1 holds with equality, i.e., if the reduction in aggregate demand reduces the individual inverse demand intercept, but the exit of the high cost firms increases the intercept back to its original level, then the surviving firms will leave their prices unchanged.

Even if the condition does not hold, it is apparent that the surviving firms will reduce their prices much less than a "representative firm" model would predict since such a model ignores the "exit" effect.

It should be noted that the effect of the aggregate demand reduction and the high cost firm exit upon the optimal quantity of each of the surviving firms is ambiguous, even if the condition of Proposition 1 holds. Nevertheless, the exit effect implies that the changes in individual prices and quantities are relatively small, while the aggregate change in output is large due to the large output reduction by the exiting firms. It is now obvious that even in this simple model one observes large quantity adjustments, accompanied by much smaller price adjustment.

A. The price level

This section uses a simple approach to understand the possible behavior of the measured price level in the model presented above.

Assume that during a base year, a government agency constructs a representative basket of the good produced in this economy. Further assume that they include M of the N products available in the market, M<N. The value of the basket during the base year will then be:

$$V_0 = \sum_{i=1}^{M} p_{i0} q_{i0} \quad , \quad \text{M} < \text{N}$$

During period t the basket is re-priced and its value becomes:

$$V_t = \sum_{i=1}^{M} p_{it} q_{i0}$$

The price index for period t is then defined as:

$$P_t = \frac{V_t}{V_0} = \frac{\sum_{i=1}^{M} p_{it} q_{i0}}{\sum_{i=1}^{M} p_{i0} q_{i0}}$$

The presence of both low and high cost firms can be introduced in the index by assuming that the sample contains M_H high cost firms ($M_H < N_H$) , and M_L low cost firms ($M_L < N_L$). Thus

$$P_t = \frac{\sum_{i=1}^{M_H} p_{it}^H q_{i0} + \sum_{j=1}^{M_L} p_{jt}^L q_{j0}}{\sum_{i=1}^{M_H} p_{i0}^H q_{i0} + \sum_{j=1}^{M_L} p_{j0}^L q_{j0}}$$

Consider next that in period t+1 the aggregate demand falls along the lines discussed in the previous section. As a result the high cost firms cease production and their products no longer exist in the market.[11] This creates a problem for the price collectors. This problem in reality is dealt with in two ways: either replace the "lost" good's price with the price of a substitute (actually price collectors are provided with a list of acceptable substitutes for each good), or ignore the product (and recalculate the price index by increasing the weight of the remaining prices). Given the assumption that in the economy there are many close substitutes, only the first way will be analyzed.

All prices collected in period t+1 will be those of low cost surviving firms, and the index becomes:

$$P_{t+1} = \frac{\sum_{j=1}^{M} p_{jt+1}^L q_{j0}}{\sum_{i=1}^{M_H} p_{i0}^H q_{i0} + \sum_{j=1}^{M_L} p_{j0}^L q_{j0}}$$

Proposition 2.

A reduction of aggregate demand will be accompanied with an increase in the price index if, in addition to the condition of Proposition 1, the following condition holds:

$$\left| \sum_{i=1}^{M_H} \left(p_{it+1}^{L} - p_{it}^{H} \right) q_{i0} \right| < \left| \sum_{j=1}^{M_L} \left(p_{jt+1}^{L} - p_{jt}^{L} \right) q_{j0} \right|$$

Proof:

Subtraction of P_t from next period's price level P_{t+1} yields the difference:
$\sum_{i=1}^{M_H} \left(p_{it+1}^{L} - p_{it}^{H} \right) q_{i0} + \sum_{j=1}^{M_L} \left(p_{jt+1}^{L} - p_{jt}^{L} \right) q_{j0}$ in the numerator.
This expression is positive if the condition of Proposition 2 holds.

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Note that the second term of this expression may be positive if the condition in Proposition 1 holds. The sign of the first term is ambiguous, since it compares the price of the surviving firms after the aggregate demand fell and high cost firms exited, with the price of the high cost firms before. The proposition's condition requires that the first term whether negative or positive be smaller than the second to ensure the positive sign.[12]

The analysis up to now has studied a reduction in aggregate demand that has led to firm exit which essentially freed up resources, but has assumed that the cost functions of the surviving firms have not been affected, hence the partial equilibrium nature of the analysis. It could be argued that owners of resources when they observe the adverse aggregate demand shock immediately reduce their prices down to the level consistent with market clearing, which in turn reduces the costs of all existing firms, which in turn leads to lower product prices by all firms, a reduction in the aggregate price level and restoration of the aggregate demand to its previous real level. Under this scenario there will be neither exit nor job destruction. While this scenario is theoretically possible, it is not plausible and empirical evidence provides strong arguments against it.[13]

The following section argues that the firm exit implication on the price level derived here can also be derived in a simple macromodel under certain conditions.

IV. A Simple Macroeconomic Model

In this section I use a version of the simple "yeoman farmer" model used by Ball and Romer [1990] (among others), to demonstrate how firm exit may result in a "rigid" aggregate price level in a general equilibrium framework.

The economy consists of n yeoman farmers. Each farmer produces a product using his own labor. He then sells his product to the other farmers and with the proceeds buys portions of the products of the other farmers. The farmer decides on the amount of labor he will supply, which in turn determines his income; and upon the proportions of the products of the other farmers he will demand. Farmer j's utility function is:

(4.1) $$U_j = C_j - \frac{\varepsilon - 1}{\gamma \varepsilon} L_j^{\gamma}, \quad \text{where} \quad C_j = \left[\sum_{\iota=1}^{n} c_{i,j,}^{\frac{\varepsilon-1}{\varepsilon}} \right]^{\frac{\varepsilon}{\varepsilon-1}}$$

Parameter ε represents the elasticity of substitution between any two goods (ε > 1). Parameter γ is the extend of increasing marginal disutility of labor (γ > 1). C_j is an index of farmer j's consumption, $c_{i,j}$ is the quantity of good i consumed by farmer j, and L_j is the labor supply of farmer j.

It is assumed that farmer j produces under a linear production function:

(4.2) $$Y_j = a_j L_j ,$$

where Y_j is the farmer's output and a_j is a productivity parameter. The productivity parameter is used to introduce heterogeneity in the model. The parameter is supposed to take values from a distribution supported on the interval (a_L, a_U), $a_L < a_U$. Low productivity farmers are characterized by an a_j near a_L , while high productivity farmers have an a_j near a_U.

Farmer j's nominal income is obtained by selling his output at price p_j and is used to pay for the farmer's purchases, i.e.

(4.3) $$I_j \equiv p_j a_j L_j = \sum_{\iota=1}^{n} c_{i,j} p_i$$

Define aggregate output Y, aggregate consumption C and price index P as:

(4.4) $$Y = \sum_{j=1}^{n} Y_j ; \quad C = \sum_{j=1}^{n} C_j ; \quad P = \left[\frac{1}{n} \sum_{j=1}^{n} p_j^{1-\varepsilon} \right]^{\frac{1}{1-\varepsilon}} .$$

Utility maximization under the income constraint in (4.3) yields that the demand of product k by farmer j is:

$$c_{k,j} = C_j \left(\frac{1}{n} \right)^{\frac{-\varepsilon}{1-\varepsilon}} \left(\frac{p_k}{P} \right)^{-\varepsilon} .$$

Aggregating over all farmers yields the market demand for product k

(4.5) $$\sum_{j=1}^{n} c_{k,j} \equiv c_k = C \left(\frac{1}{n} \right)^{\frac{-\varepsilon}{1-\varepsilon}} \left(\frac{p_k}{P} \right)^{-\varepsilon} .$$

Note that the demand for every product in this economy depends positively upon the aggregate demand C, inversely upon the number of firms n, and also inversely upon the relative price of the product.

The market clearing relative price is obtained by equating demand (4.5) with supply (4.2):

$$\left(\frac{p_k}{P}\right)^* = \left(\frac{\mathrm{a}_k L_k}{C}\right)^{-\frac{1}{\varepsilon}} \left(\frac{1}{n}\right)^{-\frac{1}{1-\varepsilon}} . \tag{4.6}$$

That is the optimal relative price depends directly upon the aggregate demand C, and inversely upon the farmer's output and the number of firms in the economy. It is interesting to note that more productive firms find it optimal to charge a lower relative (and thus nominal) price than their less productive counterparts. This, of course, follows from the fact that they have a larger amount of output to sell, everything else equal.

The utility maximizing labor supply is:

$$L_j^{\gamma-1} = \frac{\varepsilon}{\varepsilon - 1}\left(\frac{1}{n}\right)^{\frac{1}{1-\varepsilon}} \mathrm{a}\, j\left(\frac{p\, j}{P}\right) \tag{4.7}$$

Apparently, labor supply is directly affected by the number of firms, productivity parameter and the relative price. The positive relation with the number of firms implies that as the number of farmers, and thus output variety, increases each farmer attempts to produce more by increasing his labor supply. Increases in productivity and/or relative price will lead to higher income and, thus, higher labor supply.

After substituting for the market clearing price:

$$L_j^{\frac{1+\varepsilon(\gamma-1)}{\varepsilon}} = \frac{\varepsilon}{\varepsilon - 1}\mathrm{a}\, j\left(\frac{C}{\mathrm{a}_j}\right)^{\frac{1}{\varepsilon}} . \tag{4.8}$$

As before, the labor supply of the yeoman farmer depends directly both upon the aggregate demand/consumption and the productivity parameter.

Assume, like Ball and Romer [1990], that a transactions technology determines the relation between aggregate spending and real money balances:

$$Y = \frac{M}{P} , \tag{4.9}$$

where M is the nominal quantity of money. Using (4.9), and recognizing that C=Y, the price level of the economy can now be determined as:

$$P = M\left[\sum_{i=1}^{n} (\mathrm{a}_i L_i)^{\frac{\varepsilon-1}{\varepsilon}}\right]^{\frac{\varepsilon}{1-\varepsilon}} . \tag{4.10}$$

The aggregate price level depends directly upon the level of the money supply and inversely upon an "index" of the aggregate output of the economy. Note that if the

elasticity of substitution approaches infinity, the output index approaches the inverse of the aggregate output.

In this economy, a reduction in the nominal money supply M will reduce the price level proportionally, while there will be no effects on production, relative prices and labor supply. Thus if money supply falls to M^L, the price level will fall to:

$$P^L = M^L \left[\sum_{i=1}^{n} (a_i L_i)^{\frac{\varepsilon-1}{\varepsilon}} \right]^{\frac{\varepsilon}{1-\varepsilon}}. \tag{4.11}$$

In order to allow for firm exit, it will be assumed that an exogenously determined source of alternative income is available to yeoman farmers. This alternative income can be thought of as coming from accumulated wealth or from some other outside source. It works as follows: An outside source guarantees a certain nominal payment I^0 to farmers that decide to exit the market. Thus, given the level of aggregate demand and productivity, individual farmers compare their level of utility with and without production. If their utility level under production is below that obtained under the alternative income, the farmer stops production. The unemployed farmer then collects the alternative income and uses it to buy portions of the goods produced by the surviving farmers.

This scenario provides a path through which reductions in the nominal quantity of money have real effects. A reduction in M is expected to reduce the price level, increasing the real value of the alternative income and providing an incentive for low productivity farmers to exit the market. But, as argued before, exit reduces aggregate production since the increasing marginal disutility of labor makes it highly unlikely that the surviving farmers will increase their labor effort enough to compensate for the output lost from the exiting farmers. In addition, the exogenous alternative income payments will mitigate the reduction in aggregate demand. Further, the fact that now only the surviving farmers produce, while all farmers consume will put upward pressure on all relative prices (c.f. 4.6). As the surviving farmers try to increase their relative prices by increasing their nominal prices, the price level will also increase! Whether it will increase enough to overtake the price level before the aggregate demand reduction depends upon the specific values of the parameters and variables, but it can be shown that the possibility exists.

The existence of the alternative income I^0 implies that there exist a critical value a^0 of the productivity parameter defined as the level that makes the farmer's income equal to his alternative income:

$$I_j^0 = p_j a_j^0 L_j \quad \text{or} \quad a_j^0 = \frac{I_j^0}{p_j L_j}. \tag{4.12}$$

Apparently, when $a^0 < a_L$ all farmers operate. When a reduction in aggregate demand leads the farmer to decrease his nominal price, the critical value of the productivity parameter increases and eventually enters the interval (a_L, a_U). Then, farmers with

productivity in the interval (a_L , a^0) exit the market since they are better off with the alternative income.

Suppose next that money supply falls to a level M^R such that (n-m) farmers exit the market and m farmers continue operations. The economy now produces only m goods that are allocated among the n farmers. The nominal aggregate demand is now $M^R + (n-m)\, I^0 = M^0$, while aggregate output, consumption and the price index are:

$$(4.13) \qquad Y^R = \sum_{j=1}^{m} Y_j; \quad C^R = \sum_{j=1}^{m} C_j + \sum_{j=m+1}^{n} C_j{}^0; \quad P^R = \left[\frac{1}{m} \sum_{j=1}^{m} P_j^{1-\varepsilon} \right]^{\frac{1}{1-\varepsilon}}.$$

Note that in the recession state most of the summations are over the m surviving farmers. Repeating the above utility maximization and market clearing exercise yields the following price level:

$$(4.14) \qquad P^R = M^0 \left[\sum_{i=1}^{m} (a_i L_i{}^R)^{\frac{\varepsilon-1}{\varepsilon}} \right]^{\frac{\varepsilon}{1-\varepsilon}}.$$

Proposition 3:

For the same aggregate demand reduction, allowing firm exit results in a higher price level.

Proof:

Starting from full employment, introduce a reduction in the level of money supply. Without exit the price level fully adjusts and falls to P^L, while with exit it changes to P^R. Given that the new level of nominal aggregate demand is the same, i.e., $M^L = M^0$, and since exit results in a reduction[14] in overall output the following ratio:

$$(4.15) \qquad \frac{P^L}{P^R} = \frac{M^L}{M^0} \left[\frac{\sum_{i=1}^{n} (a_i L_i)^{\frac{\varepsilon-1}{\varepsilon}}}{\sum_{i=1}^{m} (a_i L_i{}^R)^{\frac{\varepsilon-1}{\varepsilon}}} \right]^{\frac{\varepsilon}{1-\varepsilon}}$$

is smaller than one, i.e. $P^L < P^R$. This proves that the price level is "rigid".

The next proposition establishes that it is possible to observe an increase in the price level as the economy slides into a recession.

Proposition 4

If the following condition holds, an aggregate demand reduction that leads to firm exit will be accompanied by a price level increase.

$$\frac{M}{M^0} < \left[\frac{\sum_{i=1}^{n} (a_i L_i^R)^{\frac{\varepsilon-1}{\varepsilon}}}{\sum_{i=1}^{m} (a_i L_i)^{\frac{\varepsilon-1}{\varepsilon}}} \right]^{\frac{\varepsilon}{1-\varepsilon}} \tag{4.16}$$

Proof:

The following is the ratio of the price level under full employment given in (4.10), divided by the price level under recession and exit given in (4.14):

$$\frac{P}{P^R} = \frac{M}{M^0} \left[\frac{\sum_{i=1}^{n} (a_i L_i)^{\frac{\varepsilon-1}{\varepsilon}}}{\sum_{i=1}^{m} (a_i L_i^R)^{\frac{\varepsilon-1}{\varepsilon}}} \right]^{\frac{\varepsilon}{1-\varepsilon}} \tag{4.17}$$

The size of the ratio is indeterminate. The first term is obviously larger than one, reflecting the fact that a reduction in aggregate demand led the economy to a recession. The second term in the right hand side is smaller than one, since the output under recession is smaller than under full employment, and the exponent is negative. If condition (4.16) holds, the product in the right hand side is smaller than one which proves the proposition.

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Propositions 3 and 4 establish that in a model that allows firm exit during periods of low aggregate demand, the price level will not fall as much as a model without exit will predict and may actually not fall at all. Note that this result is obtained without any assumptions about firm-level price rigidity.

V. Towards a More Realistic Macromodel

The yeoman farmer model in the previous section uses a "contrived" way to motivate market exit and demonstrate its effect on aggregate price rigidity. In a more general model, exit should result from a "natural", i.e. economically reasonable or endogenous, mechanism. This will require more complex modeling. In what follows I present some arguments as to the components of such as model, as well as speculate about some of the expected rewards from such an exercise.

First, the model should have a monopolistically competitive structure. Price setting ability is crucial in explaining macroeconomic phenomena. In addition, monopolistic competition is much more compatible with entry and exit. Schumpeter [1942] states : "The introduction of new methods and new commodities [i.e. entry] is

hardly conceivable with perfect – and perfectly prompt – competition from the start." (p. 105)

Second, the model should consist of heterogeneous firms. Heterogeneity is a fact of economic life and may result from a number of sources such as: different vintages of capital, different capital/labor intensities, different labor or management talent pools, different business models/plans/strategies and differences in their implementation, etc. Introducing heterogeneity may open the door to study effects of managerial decisions, advertising campaigns, quality control mechanisms etc., upon the firm's survival and, ultimately, upon the overall economy.

Third, the model should include a more sophisticated treatment of uncertainty. Much of macroeconomic modeling, including the last section, uses perfect foresight models in which an unanticipated shock is introduced. Such modeling is incompatible with an economy with continuous streams of entering and exiting firms. A more realistic environment should be envisioned where firms operate in an uncertain world, form probabilistic expectations about their demand and costs, and choose their price and quantity to maximize the present value of their profits over some horizon. Such models have been used in the "monopoly under uncertainty" literature (see Zabel [1986], Blinder [1982]). Under uncertainty, real world features such as exit or liquidation costs may induce firms to exit when they first detect signs of adverse shifts in their demand and/or cost distributions, even if they are profitable during the current period. On the other side, slow realization of these adverse shifts may delay exit. It is thus possible to explain patterns where exit rates lead or lag the business cycle.

Apparently, building and solving such a model is extremely difficult since, among others, it involves aggregation over heterogeneous firms. Nevertheless, I am arguing that such a model would have considerable payoffs in terms of understanding macroeconomic phenomena. In addition to the price rigidity phenomenon that naturally arises within such a model as argued above, acyclical real wages, productivity gains during recessions and other phenomena seem to have natural explanations within this model.

A. Acyclical real wages

One of the first criticisms of the Keynesian model was that it implied countercyclical real wages while the evidence indicates that real wages are either acyclical or mildly procyclical[15] (Dunlop [1938]). Since then, real wage implications have become a litmus test of macroeconomic models. For example, real business cycle models have to assume unreasonably high intertemporal labor supply elasticity in order to accommodate this fact. In a model with entry and exit, real wage acyclicality can easily be handled by assuming implicit contracts. If the firm hires its labor offering implicit contracts conditioned upon local variables such as the firm's price and quantity, as well as global variables such as the price level, then it easily follows that during a recession

nominal (and real) wages will not change much since, as shown before, individual firm prices and quantities as well as the overall price level do not change much. Again, most of the change will come from employment (i.e. quantity) reductions by the exiting firms. The freed up workers will be unemployed but the effect of this unemployment upon real wages will only be felt gradually and this explains the mild procyclicality observed. In other words, in the short run, the *firm level* demand for labor does not change much, and neither does the supply, due to the implicit contract.[16] In the intermediate run, as contracts are to be renegotiated, the supply of labor the firm faces may increase due to the workers laid off by the exiting firms. This may put downward pressure on wages especially as the economy is at the later stages of a recession.

B. Productivity during recessions

Recent empirical data indicate that output per worker, i.e. productivity, kept increasing through recessions. Long accepted concepts such as labor hoarding during recessions predict the opposite. In a model with entry and exit the phenomenon has a straightforward explanation. As low productivity firms exit the market, the higher productivity surviving firms are remaining in the measuring sample, hence productivity increases.

VI. Concluding Remarks

Keynes [1936] posited a fixed price level and proceeded to demonstrate how aggregate demand deficiencies may lead to systemic failures, like the great depression, in the short run. As memories of the depression waned, the search for a theoretically convincing explanation for price rigidity proved fruitless, and Keynesian demand management policies proved unable to deal with aggregate supply shocks during the 1970s, the Keynesian model lost its popularity, at least among prominent academic economists. "Real business cycle" models are now popular among these economists. These models are characterized by considerable theoretical elegance, but their empirical performance, apart of calibration exercises by their most ardent proponents, has been dubious. Critics have focused on the unreasonably large intertemporal labor elasticities required by these models.

New-Keynesian and Neo-Keynesian models, including the menu costs variants are also plagued by empirical failures, in addition to their, sometimes, ad-hoc theorizing.

The present work argues that economics researchers need to move beyond these representative agent models and the consequent homogeneity. By adopting, practically, the process of creative destruction of Schumpeter [1942], I have argued that a model of heterogeneous monopolistic competition under uncertainty shows a lot of promise in both, endogenously deriving phenomena that long have puzzled economists and deriving implications that conform with empirical facts.

Ultimately, the argument is that, as in the Keynesian model, it is possible for the economy to fail to fully employ its resources in the short run. This failure is the result of disturbances in the order of the process of creative destruction. In a vibrant and dynamic capitalistic economy, continuous flows of entering and exiting firms are observed. Exit frees up resources that are reallocated to the entering firms. During this reallocation resources are considered frictionally unemployed and the duration of their unemployment is a few weeks. Adverse shocks in aggregate demand (or productivity) disrupt the order of the process by accelerating the exit flow and decelerating the entry flow. The implication is that the freed up resources must wait longer now to be reallocated to the entering firms. The longer duration of unemployment is *inefficient* in the sense that is not necessary for the function of the system. If the adverse shock had not occurred, exit will still happen but at a slower rate and the marginal resources will still be producing. The exit acceleration results in lost output, i.e., inefficiency. Therefore, there is room for government policies that will counter the adverse shocks and restore the order of the creative destruction process.

The model suggests a richer menu of government policies than the Keynesian demand management policies. Policies here are judged on their effect upon the flows of entry and exit. Policies that help accelerate the entry flow during recessions, such as accelerated investment depreciation, and policies that help firms avoid failure, such as policies against corporate fraud, are now within the logic of the model and should be added to the mix.

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Appendix A

Yearly and Monthly Inflation Rate Distributions

Table 1
Frequency of Yearly Inflation Rates (Year Averages)

Magnitude	1956-2004	%	1921-2004	%
Less than 0%	0	0%	12	14%
0%	0	0%	2	2%
Larger than 0%	49	100%	70	84%
TOTAL	*49*	*100%*	*84*	*100%*

Source: U.S. Department of Labor: Bureau of Labor Statistics; Consumer Price Index for All Urban Consumers: All Items; Not Seasonally Adjusted

Table 2
Frequency of Monthly Inflation Rates

Magnitude	1956-2004	%	1921-2004	%
Less than 0%	33	5.6%	143	14.1%
0%	96	16.3%	261	25.9%
Larger than 0%	459	78.1%	604	60.0%
TOTAL	*588*	*100%*	*1008*	*100%*

Source: U.S. Department of Labor: Bureau of Labor Statistics; Consumer Price Index for All Urban Consumers: All Items; Not Seasonally Adjusted

Appendix B

Partial Equilibrium Model: A Numerical Example

Each firm faces the following inverse demand function:

$$\frac{p_i}{P} = \left(\frac{aY}{N^2} + 1 \right) - \frac{a}{N} q_i$$

Let a=0.12, N=200 and Y= 100,000 during the **base** period. The implication is that the intercept of the inverse demand function is:

$$\left(\frac{aY}{N^2} + 1 \right) = 1.03$$

Of the 200 firms, let 30 be high cost and 170 low cost[17]. Further let the following marginal costs for H and L firms respectively: $c_1^L = 0.965$ and $c_1^H = 1.02862$. Using the optimality formulas from the text:

$$q_H^* = 11.50 \quad , \frac{p_H^*}{P} = 1.02931 \qquad\qquad q_L^* = 541.667 \quad , \frac{p_L^*}{P} = 0.9975$$

Assume that the agency calculating the price index samples 100 products, 15 from high cost firms and 85 from low cost firms, to keep the proportions in the population similar. The value of the representative basket is : $V_0 = 46104.12$ By definition, the Price level equals 1 during the base period.

Next period, assume that the aggregate demand falls to: Y' = 95,000. Under this lower demand, the high cost firms violate their profitability condition since:

$$\left(\frac{aY'}{N^2} + 1 \right) = 1.0285 < c_1^H = 1.02862$$

Therefore the high cost firms will exit. With 170 low cost firms remaining, the optimal policy will be:

$$q_{L1}^* = 527.3284 \quad , \frac{p_{L1}^*}{P} = 1.002223$$

Note that after the exit of the high cost firms, the new intercept will be:

$$\left(\frac{aY'}{N_L^2} + 1 \right) = 1.039446 \ > 1.03$$

In other words, the condition in Proposition 1 is satisfied. Hence their desired relative price increases from 0.9975 to 1.002223.

The price collecting agency now collect 100 low cost firm prices. The value of the representative basket in period 1 (using period 0 quantities, i.e. 11.50 units for 15 of the firms and 541.667 for the remaining 85) is: $V_1 = 46316.91$.

The price level in period 1, calculated by the ratio of the representative basket values equals 1.004 (= 46316.91/ 46104.12).

Thus, a reduction of Aggregate Demand by 5%, resulted in an increase in the price level of 0.4%. This demonstrates that it is possible to observe an increase in the price level as a result of firm exit.

ENDNOTES

[1] An alternative interpretation is that fluctuations in the availability of resources are responsible for the business cycle. Specifically, resource owners change their desired supply in response to various shocks. Under such an interpretation, resource allocation is always efficient. Real business cycle models take such an approach.
[2] Subsequent work by Carlin and Leahy[1991, 1997] and others showed that removal of the uniform distribution assumption restores the aggregate price rigidity implication in the state-dependent models.
[3] Ball and Romer [1990] argue convincingly that menu costs need to be accompanied by considerable real rigidities to have the effects claimed.
[4] Note that aggregate price rigidity is defined as a change in the price level smaller that implied in a 'perfect' model where resources are continuously allocated efficiently. Consequently, output fluctuations will be larger in the price rigidity model.
[5] Note that with perfect foresight, these firms will never have entered the market in the first place.
[6] See the appendix for inflation distributions at yearly and monthly frequencies. Note that before 1956, and especially before 1940, deflation was more frequent both at the yearly and the monthly frequencies.
[7] Rotemberg [2002, 2003] and Roufagalas [1994] present models when the price rigidity stems from the expected reactions of the consumers. Consumer reactions have not yet been used extensively in macromodels.
[8] See Wolman [2003] for a more complete list of references
[9] Abraham [2003] contains a fairly detailed description of the actual process of calculating the Consumer Price Index.
[10] Actually, since only one type of firms survives, the optimal relative price will equal one. This need not be the case of a second type of low cost firms is added.
[11] This is a significant problem for the index. Bils and Klenow [2003] report that 3.4% of the monthly price quotes have to be substituted. Schultze [2003] also states that : "some 30 percent of the sample of items…disappear from store shelves each year due to natural attrition." Apparently a good number of these disappearances are due to firm exits.
[12] Refer to Appendix 2 for a numerical example.
[13] The fact that unemployment duration rarely falls below 8 weeks is part of this evidence. The above scenario requires that it is close to zero weeks.
[14] The output reduction follows from the fact that aggregate demand and the number of firms are directly related to optimal labor supply (4.7 and 4.8). Thus fewer firms and lower aggregate demand imply lower overall output.
[15] Abraham and Haltiwanger [1995] argue that more careful treatment of the data leads to stronger support for procyclical real wages.
[16] Note that if the **aggregate** labor supply is treated as near-horizontal at the "contractual wage", exit results in a leftward shift in the aggregate labor demand that produces large employment changes and small wage responses. Keynes was unable to obtain acyclical or countercyclical wages because in his model firms travel up their labor demand during recessions, ending up at points with lower employment but higher wages. The real business cycle story, postulates that productivity shocks during recessions shift the aggregate labor demand to the left. To produce the relatively large employment adjustments and the relatively small wage adjustments, this story requires a very flat aggregate labor supply , i.e. the high intertemporal labor supply elasticity.
[17] Note that for the purposes of demonstration the number of firms is taken as given. The implication of this simplification (and the partial equilibrium nature of the analysis) is that the market in the aggregate may not clear. The general equilibrium model guarantees market clearing.