Can "Price-Stickiness" Explain the Persistent Increase in Services Prices at the Euro Changeover?

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Abstract

The central assumption of this paper is that the transitory and the persistent price increases we observed at the Euro changeover have the same underlying cause: firms trying to take advantage of the confusion among consumers that comes with the introduction of a new and unfamiliar currency and the changing of all nominal prices. The hypothesis is that services prices only appear to have increased persistently because firms in these sectors tend to keep their prices unchanged for several months. The trade off these firms face is between the short run gains from taking advantage of the confusion and the losses in future months when the confusion disappeared but prices are still above the "optimum". Simulations of the model show that price stickiness may have contributed to the increase but is not enough to explain the magnitude we observe in the data.

key words: euro changeover, price stickiness

1 Introduction

In this note I present a model that tries to explain the persistent increase of services prices at the Euro changeover. The central assumption is that services prices are "sticky" in the sense that firms keep prices constant for several months.

In Germany nearly a third of the 686 series in the CPI basket increased with the introduction of Euro coins and banknotes. Almost all of these returned to their pre-changeover level after a few weeks but some, especially services prices, appear to have increased persistently. Several explanations for this phenomenon, such as menu costs or a multiplicity of equilibria, have been suggested. This note takes a different approach and argues that price stickiness can explain the persistent increase or at least that price stickiness contributed to this phenomenon.

For restaurant menus, price stickiness is well documented; see for example the paper by Gaiotti and Lippi (2005). Lünnemann and Mathä (2005) report that services prices in general are less flexible than prices of non-services. One of the reasons for this is that services are fairly labour intensive and wages do not fluctuate. In this note I will simply assume that services prices are set for several months without specifying why this might be.

The introduction of a new and unfamiliar currency and the changing of all prices may lead to some confusion on the side of consumers and firms might try to take advantage of this by raising prices. The "initial confusion" argument is reasonable and is the standard explanation for the transitory price increases. Here it is important to note that this explanation does not imply that firms actually succeeded in fooling their customers, only that they tried to do so.

Aim of this paper is to see how sticky-price firms optimally set prices given the initial confusion and given that they have to keep their prices constant for several months. For these sticky-price firms the short run gains arising from increasing prices at the changeover come with losses in future months when the initial confusion disappeared but prices are still above the "optimum". The important point is that the future losses are discounted so that a small increase is likely to be profitable. The question is only whether the 2 percent increase we observe in the data can be explained by reasonable assumptions on the preference parameters and on technology.

To answer this question the model presented in the next section is simulated in section 2. Comments on the assumptions and their plausibility conclude this note.

2 The Model

The model is based on a version of Dixit and Stiglitz's (1979) model of monopolistic competition. In this paper I am interested in how a single firm optimally sets its price given the prices set by other firms in the same sector and given economy-wide variables such as overall output, the overall price level and the wage rate. To model this situation the usual Dixit-Stiglitz model is amended so that in this paper the economy consists of a continuum of sectors and each sector consists of a continuum of firms.

2.1 The Household's Problem

The representative household maximizes utility

$$U = U\left(C_0, C\right),$$

where C_0 is an unproduced good and C is a basket of sectors and is given by

$$C = \left(\int_0^1 C\left(s\right)^{\frac{\sigma-1}{\sigma}} ds\right)^{\frac{\sigma}{\sigma-1}}.$$

The basket, thus, takes the form of a symmetric CES with $C\left(s\right)$ being the amount of consumption coming from sector s. The elasticity of substitution between the different sectors is given by $\sigma > 1$. The sectors are indexed by $s \in [0,1]$. Each sector is a basket of goods and takes the form of a symmetric CES as well.

$$C(s) = \left(\int_0^1 C(s,g)^{\frac{\gamma-1}{\gamma}} dg \right)^{\frac{\gamma}{\gamma-1}}$$

The goods within a sector are indexed by $g \in [0,1]$ and the elasticity of substitution between goods is given by γ. Each good, or each firm producing it, is thus identified by the two indices s and g. The variable $C(s,g)$ is the amount the household consumes of good g in sector s. The variable $C(s)$ is the demand for goods from sector s. I will assume that goods within a sector are better substitutes than sectors, so that $\gamma > \sigma$. See Matsuyama (1995) for a discussion of this point.

The representative household holds ownership shares of all profit-making firms, the budget constraint of the household is then given by

$$E \equiv C_0 P_0 + \int_0^1 \int_0^1 P(s,g) C(s,g) \, dg ds = WN + \Pi.$$

Where W is wage income, N is labour supply and Π are profits. $P(s,g)$ denotes the price of good $C(s,g)$. Expenditures, E, are given by the expenditures for the unproduced good $(C_0 P_0)$ and by the double integral over all differentiated sectors and goods. The optimization problem of the household yields the following demand for good $C(s,g)$

$$C(s,g) = \left(\frac{P(s,g)}{P(s)} \right)^{-\gamma} \left(\frac{P(s)}{P} \right)^{-\sigma} C, \tag{1}$$

which differs from the standard demand arising from Dixit-Stiglitz preferences only in the additional price ratio $\left(\frac{P(s,g)}{P(s)} \right)^{-\gamma}$. The overall price level P and the sector price level $P(s)$ are

$$\begin{aligned} P &= \left(\int_0^1 \left(P(s)^{1-\sigma} \right) ds \right)^{\frac{1}{1-\sigma}} \\ P(s) &= \left(\int_0^1 \left(P(s,g)^{1-\gamma} \right) dg \right)^{\frac{1}{1-\gamma}}. \end{aligned}$$

2.2 The Problem of the Firm

2.2.1 Flexible Prices, No Confusion

To illustrate how this model differs from the usual Dixit Stiglitz model of monopolistic competition, I will first look at the firm's problem assuming that firms can adjust their prices every period and that households are perfectly aware of the true price. Firms maximize profits (π) taking into account the demand for their goods $C(s,g)$ given by equation (1).

$$\pi = P(s,g)\,C(s,g) - WN(s,g)$$

The production function is given by

$$Y(s,g) = N(s,g)^{\frac{1}{\alpha}}$$

where $\alpha > 0$ is a scale parameter. With $\alpha > 1$ the production function exhibits decreasing returns to scale. Solving this optimization problem we get the firm's reaction function.

$$\left.\frac{P(s,g)}{P}\right|_{\substack{\text{flex. prices}\\ \text{no confusion}}} = \left(\frac{\alpha\gamma}{\gamma-1}\frac{W}{P}\left(\frac{P(s)}{P}\right)^{(\sigma-\gamma)(1-\alpha)} Y^{\alpha-1}\right)^{\frac{1}{1-\gamma(1-\alpha)}} \tag{2}$$

Equation (2) gives the firm's optimal price in terms of real marginal costs (W/P), the sector price level $(P(s)/P)$ and the overall output (Y). Note that with constant returns to scale $(\alpha = 1)$ this equation reduces to the familiar $P(s,g) = \frac{\gamma}{\gamma-1}W$. With constant returns to scale the individual firm's price is simply a mark-up over marginal costs and is independent of the prices set by other firms in the same sector.

2.2.2 Sticky Prices, Confusion

In this section two additional assumptions are made. First, firms expect households to be confused and therefore to underestimate the true price by a factor $\phi \in]0,1]$, so that

$$P_\phi(s,g) = \phi P(s,g)$$

where $P_\phi(s,g)$ is the price households believe to pay and $P(s,g)$ is the true price. The demand of the confused consumers is given by

$$Y_\phi(s,g) = \left(\frac{P_\phi(s,g)}{P(s)}\right)^{-\gamma}\left(\frac{P(s)}{P}\right)^{-\sigma} Y. \tag{3}$$

I assume that the confusion lasts for $m \geq 1$ periods and that it exists in only a few sectors of the economy, so that the effect on the household's budget constraint can be ignored. The second assumption is that firms keep their prices constant for $n \geq 1$ periods. The maximization problem of the firm is then given by

$$\begin{aligned}\max_{P(s,g)} \pi &= \sum_{i=1}^{m} D(i,m)\left[P(s,g)\,Y_\phi(s,g) - WN(Y_\phi(s,g))\right] \\ &+ \sum_{i=m+1}^{n} D(i,n)\left[P(s,g)\,Y(s,g) - WN(s,g)\right].\end{aligned}$$

Where the first summation denotes profits over the m periods in which households are confused and the second summation denotes profits over the $n-m$ periods in which households are aware of the actual price. $D(i,m)$ and $D(i,n)$ are discount factors that I will discuss below. Solving the firm's problem we find that the optimal price $\frac{P(s,g)}{P}$ is a mark-up over the price set when there is no confusion and prices are flexible.

$$\frac{P(s,g)}{P} = \underbrace{\left(\frac{B_m \phi^{-\alpha\gamma} + B_n}{B_m \phi^{-\gamma} + B_n}\right)^{\frac{1}{1-\gamma(1-\alpha)}}}_{\substack{\text{confusion mark-up} \\ \mu}} \times \left.\frac{P(s,g)}{P}\right|_{\substack{\text{flex. prices} \\ \text{no confusion}}} \tag{4}$$

Equation (4) is the central equation of this paper. It shows how consumers' confusion allows firms to temporarily increase their prices above the no-confusion price which is given in equation (2).

Consider the mark-up in equation (4). Assuming strictly decreasing returns to scale ($\alpha > 1$), the mark-up is equal or greater than one ($\mu \geq 1$). Without confusion ($\phi = 1$), the mark-up equals one and as the confusion rises (decreasing ϕ) the mark-up increases.

Two weights appear in the confusion mark-up, B_m and B_n. B_m is the weight of the periods in which households are confused. Assuming exponential discounting B_m is given by

$$B_m = \sum_{i=0}^{m} D(i,m) = \sum_{i=0}^{m} \beta^i.$$

The longer households are confused the larger the weight B_m and the larger the mark-up. Assuming that households are confused only in the first period (month) after the changeover, B_m equals 1. The other weight, B_n, arises from price stickiness. Assuming exponential discounting B_n is given by

$$B_n = \sum_{i=m}^{n} D(i,n) = \sum_{i=m}^{n} \beta^i.$$

The longer firms need to keep their prices constant the larger B_n and the smaller the mark-up. This is intuitive. Firms weigh the gains of increasing prices against the losses. The gains arise only in the beginning when households are confused. As soon the initial confusion is over, firms having set the price higher to take advantage of the initial confusion will incur losses. The longer prices are fixed, the higher these losses.

3 Simulation Exercise

Given that the losses are discounted it is likely that even sticky-price firms will increase prices slightly to take advantage of the initial confusion. The question is whether the model can generate the sizable increases we observe in the data with reasonable assumptions on the preference and technology parameters. This section tries to answer this question. The parameters to be specified and the values assumed are:

- $\alpha = 1.1$, scale parameter in production function; $\alpha > 1 \rightarrow$ decreasing returns to scale
- $\gamma = 5$, elasticity of substitution between different goods
- $\phi = 0.8$, "confusion parameter"
- $B_m = 1$, weight of periods in which consumers are confused
- B_n, weight, assuming a price stickiness of n periods
  - $B_0 = 0$, assuming flexible prices
  - $B_{12}^{hyp} = 5$, assuming 12-month-stickiness and hyperbolic discounting
  - $B_{12}^{\exp} = 8$, assuming 12-month-stickiness and exponential discounting

For values of α and γ I follow Blanchard and Kiyotaki (1988). An elasticity of substitution (γ) of 5 seems reasonable for items within the same sector, but the elasticity of substitution between different sectors should be smaller, somewhere around 2. An estimate for ϕ can be calculated from the transitory increases. Recall that prices in many sectors increased significantly at the changeover, prices of vegetables even by more than 20% (seasonally adjusted). To generate increases of this size I need to set $\phi = 0.8$, that is, firms expect households to underestimate the true price by 20 percent.

Setting $B_m = 1$ means that consumers are confused only in the first period after the changeover, that is, $m = 1$. This is a fairly conservative assumption; a higher B_m would help me to increase the effect I want to generate. From the data it is not clear whether firms expected the confusion to last one month or longer. What we observe is that most prices returned after one month, but the return after one month might simply be driven by the fact that firms realized that they had underestimated consumers' ability to observe the correct price.

I distinguish between three different B_ns. The longer firms have to keep prices constant, the higher will be B_n. With $B_n = 0$, prices are flexible. $B_{12}^{\exp} = 8$ presumes 12-month-stickiness and exponential discounting and a $B_{12}^{hyp} = 5$ presumes 12-month-stickiness and hyperbolic discounting. Hyperbolic discounting is modelled as $\beta\delta-$discounting, following Phelps and Pollock (1968). See also the papers by Laibson (1984, 1997). The formula used is

$$B_{12}^{hyp} = \beta \sum_{i=m}^{12} \delta^i$$

with $\beta = 0.7$ and $\delta = 0.923$. Hyperbolic discounting puts a particularly large weight on current period utility or profit, ignoring somewhat future losses and

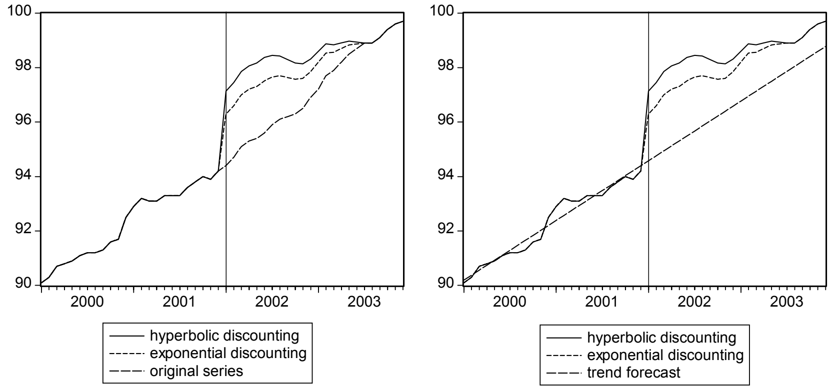

Figure 1: The effect of confusion assuming that prices are sticky. Prices rise sharply at the changeover (denoted by a vertical line) and then return gradually to their pre-changeover path. The figure on the right hand side shows the two simulated series with a linear forecast. Here the increase seems to be permanent even though it is not.

thus making the consumption plans time inconsistent. Hyperbolic discounting, however, describes actual behaviour better than exponential discounting (see for example Frederick, Loewenstein and O'Donoghue 2002). More comments about hyperbolic discounting below.

The price increases the model predicts for the parameters above are:

- 7.72% increase if prices are flexible ($\mu = 1.0772$)
- 2.96% increase with prices sticky for 12 months and hyperbolic discounting ($\mu = 1.0296$)
- 2.16% increase with prices sticky for 12 months and exponential discounting ($\mu = 1.0216$)

The model predicts that a firm that can adjust prices every period should increase its price by 7.7%. A firm that keeps its price constant for 12 months should increase its price by 2.16%. This is below the three percent we observe in the data, but assuming hyperbolic discounting the model predicts an increase of just about 2.96% which is close to the 3% we observe in the data.

The figure illustrates the simulation exercise. To generate the figure I took a series (cinema tickets in the early 90s) from the German CPI basket to feed the model above. The model predicts a price increase of 2.16% (exponential discounting) and 2.96% (hyperbolic discounting) at the changeover. After 12 months the price index returns to its pre-changeover path. The reason why in the figure the series does not drop down after 12 months is that only the *average* stickiness is assumed to be 12 months. I assume that $\frac{1}{12}$ of the prices return after six months, another $\frac{1}{12}$ after seven and so on. The longest stickiness is 18 months. With this assumption the series does not drop after twelve months but returns gradually to their pre-changeover trend. After 18 months the series fully returned to its pre-changeover level, as can be seen in the left hand panel of the figure. The assumption that prices return successively and not all bunched in the same period seems reasonable.

The right hand panel shows the two simulated series and a linear forecast based on the first 24 observations. The original series (cinema tickets) was deliberately chosen so that the increase in the right hand panel looks permanent even though it is not. I did this to illustrate the difficulty to distinguish between permanent increases (caused by a change in equilibria for example) and increases that last several months. Only if we knew how the index had developed without the changeover a definite answer to the question can be given.

4 Conclusion

The idea of this paper was to see how sticky-price firms optimally set their prices at the changeover given the initial confusion and given that they have to keep their prices constant for several months. The paper claims that both the transitory and the persistent increases might eventually be caused by the same cause: firms trying to take advantage of the initial confusion that comes with the introduction of a new currency. From a policy perspective the argument that both the transitory and the persistent increases have the same underlying reason is interesting because it implies that a policy that prevents the transitory increases would also prevent the persistent increases.

The simulation exercise showed that the model is capable to generate persistent price increases of around three percent, similar to the ones we observe in the data. However, the simulation is based on several assumptions that I now want to review.

The assumption that prices in the services sector are "stickier" than in other sectors is probably the least problematic assumption of the paper. Hyperbolic discounting does not seem too far-fetched for services firms that are often small family-owned businesses. The simulation presumed a confusion parameter ϕ equal to 0.8 which implied that consumers underestimate the actual price by 20%. This seems quite high, especially because consumers generally have a fairly good idea about services prices. However, even with $\phi = 0.8$ the model was able to generate transitory increases of only 7.7%. This illustrates how difficult it is to explain prices hikes of more than 20% (seasonally adjusted) in the fruit and vegetable sector.

The strongest and most problematic assumption is that firms are ignoring the incentives of their competitors to increase prices as well. In section 1 I assume that the individual firm that tries to take advantage of the initial confusion by slightly increasing its prices does not expect other firms in the same sector to do so as well. If instead the firm expects the whole sector to take advantage of the initial confusion, the demand function (equation 3) reads

$$Y_\phi(s,g) = \left(\frac{P_\phi(s,g)}{P_\phi(s)}\right)^{-\gamma} \left(\frac{P_\phi(s)}{P}\right)^{-\sigma} Y, \tag{5}$$

where $P_\phi(s) = \phi P(s)$. With this change, the reaction function (equation 4) is unchanged except that then all the $\gamma's$ are replaced by $\sigma's$. Assuming that goods within a sector are better substitutes than sectors ($\gamma > \sigma$), the increase caused by the initial confusion is *lower* than what I reported in section 2. Setting $\gamma = 2$ (before we had $\sigma = 5$), the model predicts an increase of 0.9% (before we had 2.96%) assuming 12-month-stickiness and hyperbolic discounting. It is difficult to believe that firms did not expect other firms to take advantage of the initial confusion as well.

The mechanism described in this note might have contributed to the increase in services prices at the changeover, but does not seems large enough to be the sole explanation for this phenomenon.

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