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Comment

Gita Gopinath, *Harvard University and NBER*

Introduction

Over the last decade, a large number of papers have been written on measuring the flexibility of prices using a wealth of new micro price data. The prices studied are at an extremely high level of disaggregation, including at the UPC level, and therefore lend themselves to direct measurement of price flexibility as opposed to having to infer it from aggregate data using structural assumptions. While the first step is to document a set of facts regarding the micro level features of pricing, the next step is to use these facts to zero in on an empirically relevant model of price adjustment that can be used to study positive and normative questions on topics such as monetary policy.

One often measured statistic is that of price durations; that is, the time duration between price adjustments. As is well known, price durations at the micro level alone tell us little about "aggregate" price flexibility, the latter defined as the sluggishness in adjustment of aggregate prices to a common shock such as a monetary shock. In the simplest Calvo model, where price adjustments are random, there is a one-to-one mapping between price durations at the micro level and aggregate price flexibility. At the other extreme, when price adjustment is a choice subject to a menu cost, aggregrate prices can be fully flexible regardless of the underlying degree of micro price flexibility as argued for early on in Caplin and Spulber (1987). This arises owing to a selection effect in menu cost pricing models, namely firms that adjust prices are the ones whose prices have the biggest (absolute) deviation from their desired price, and therefore their adjustment has a large impact on the price index, making any residual adjustment by other firms minor.

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There is clearly a need for other facts on price behavior to determine the impact of price durations on aggregate price flexibility. While there is no simple sufficient statistic that can be used to summarize the micro-data, the idea is to look at several moments of the data and hopefully find that the preponderance of evidence points toward a particular model. The literature has pushed in this direction and this paper makes several valuable contributions to this enterprise.

This paper looks for evidence of selection effects by viewing the data through the lens of Caballero and Engel (2007). It brings to bear new and interesting data that helps shed light on the question. It examines large observable shocks arising in international data and therefore can speak more directly to the question of selection effects, unlike a lot of the US-centric data that has few observable large shocks. The authors use the data and their analysis to conclude that there is strong support for selection effects and argue in favor of state contingent models of pricing as opposed to time dependent models of pricing. They also document that price behavior is sensitive to the environment (high versus low inflation) and the type of shocks. This paper, like others in the literature, concludes that there is a need for a large contract multiplier to bridge the gap between micro pricing behavior and macro price rigidity that has been documented. Impulse responses of output to monetary shocks reveal effects lasting over two years. The presence of strong selection effects using microdata makes it harder to reconcile the micro and macro facts.

In my discussion I will first go over the methodology that is used in the paper, highlighting some of its limitations. I will then discuss the empirical results and main conclusions. I will then briefly describe other kinds of selection effects evident in international data and conclude with some comments on ways to reconcile the micro and macro evidence.

Methodology

Caballero and Engel (2007) propose a methodology to decompose aggregate price flexibility into an "intensive" and "extensive" component. Under the assumption that when prices adjust they fully respond to all shocks, pass-through into inflation ($\Delta\pi$) of monetary shocks (Δm) can be expressed as

$$\text{Lim}_{\Delta m \to 0} \frac{\Delta\pi}{\Delta m} = \underbrace{\int_x \Lambda(x) f(x) dx}_{Intensive} + \underbrace{\int_x x \Lambda'(x) f(x) dx}_{Extensive},$$

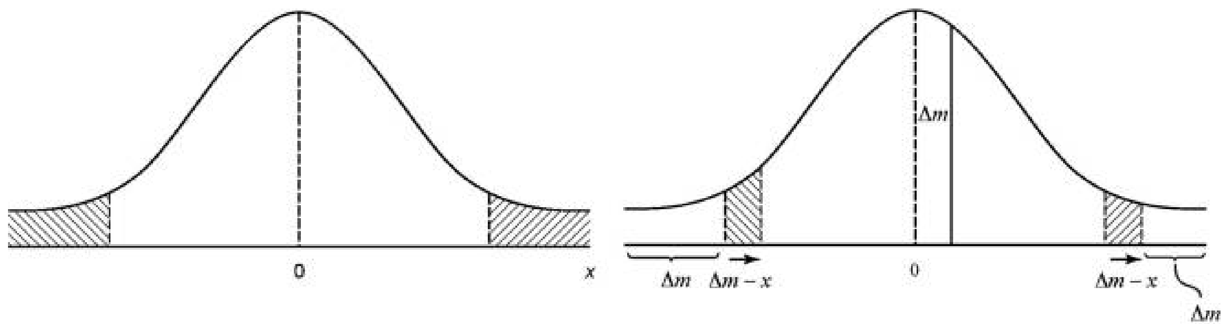
where x measures the deviation of the actual price from the reset price. The latter is the price the firm would set if it could adjust its prices, taking into account all of the nominal rigidities in the system. Variable $f(x)$ captures the distribution of x and $\Lambda(x)$ is the adjustment hazard as a function of the deviation of the actual price from the reset price. In the limit as the shock goes to zero, the first term on the right-hand side of the equality that measures the average frequency of price adjustment is the intensive margin and the second term that depends on the slope of the adjustment hazard function is the extensive margin. In the Calvo model where the adjustment hazard is a constant and independent of x, $\Lambda'(x) = 0$ and all of the adjustment is via the intensive margin. This is a useful benchmark.

In the case of models with state contingent price adjustment there is both an intensive and extensive margin. Consider figure C1.

Panel A of figure C1 depicts the preshock distribution of prices as a function of x. For a given menu cost of price adjustment the dashed regions at the left and right tail of the distribution capture the region where prices adjust. The size of the adjustment zone is negatively related to the size of the menu cost of price adjustment. Starting from this distribution, consider a common shock to all firms (say, a monetary shock) $\Delta m > 0$. Now more firms will find their prices too low, as depicted in the figure by an increase in the adjustment zone on the left. On the other hand, there will be fewer firms who find their prices too high so there is a shrinkage of this region again depicted by a rightward shift of the bands of adjustment. Consider the firms that would have adjusted prices even in the absence of the shock. Their *additional* contribution to inflation is Δm and is referred to as the intensive margin of adjustment. Now consider the set of firms that switch from not-adjusting (left tail) to adjusting and from adjusting to not adjusting (right tail). For the former, their additional contribution to inflation is $0 - x + \Delta m > \Delta m$ since $x < 0$, and for the latter it is $0 - (-x) > 0$. Overall, there are fewer price cuts and bigger price increases. The adjustments associated with firms entering and exiting the adjustment zone is referred to as the extensive margin.

The goal of the paper is then to use the previous decomposition to empirically measure the size of the intensive and extensive margin of adjustment to shocks. If a large fraction of adjustment is attributed to the extensive margin it would be important evidence of state contingent pricing and selection effects.

While theoretically attractive, the empirical implementation of this



(a) Pre-shock distribution of Prices

(b) Post-shock distribution of Prices

Fig. C1. Intensive and extensive responses to a monetary shock decomposition is problematic. Even ignoring the restrictive assumptions behind this decomposition, one would need to be able to measure x, its distribution $f(x)$, and the adjustment hazard $\Lambda(x)$. This is far from simple since x is a shadow variable that is observed only when prices adjust. Secondly, the formula is derived under the assumption that when prices adjust they respond fully to the shock. That is, there are no real rigidities in price adjustment that would generate dynamics in the response of prices to shocks. The authors try to modify the decomposition to allow for real rigidities, but they necessarily rely on simplifications.

What the authors can deal with proficiently is having a well-identified shock to study. Here is where the authors have an advantage because they examine international data and study episodes of large exchange-rate devaluation, for which it is easier to make the case that macro shocks dominate idiosyncratic shocks. The authors employ a so-called "revelation principle" (not to be confused with the revelation principle of mechanism design) to measure x. The basic idea is that x is revealed when a price change is observed. This is the same argument used by Bils, Klenow, and Malin (2009) to calculate reset price inflation.

Overall, it is clearly not the case that there is a simple empirical measure for the relative size of the extensive margin the authors pursue. Nevertheless, the authors bring to bear interesting data that helps shed light on the question, something I turn to discuss in the next section.

Empirical Evidence

Intensive versus Extensive Margin

The authors examine the Mexican peso devaluation of 1994 and 1995, and the Mexico VAT tax increases of 2010 and 1995. They measure the extensive margin using the following relation:

$$\text{Extensive Margin} = 1 - \frac{\text{frequency}_{pre} \cdot \Delta m}{\Delta \pi}. \tag{1}$$

For each episode they estimate the average frequency of price change before the shock, frequency_{pre}, the observed change in inflation following the shock, $\Delta\pi$, and the observed shock (Δm). The extensive margin, as measured by equation (1), can be attributed to inflation that arises from changes in the frequency of price adjustment post-shock and to selection effects.

Table C1
Mexican Peso Crisis

	Shock (Δm)	$\Delta\pi$	Frequency-pre	Intensive Margin
Peso crisis	0.5	0.046	0.25	$\frac{0.25 * 0.5}{0.046} = 2.72$
Peso crisis	0.5 * 0.11	0.046	0.25	$\frac{0.25 * 0.5 * 0.1}{0.046} = 0.29$

Table C1 lists the calculations made for the peso crisis. The shock is the 50 percent devaluation ($\Delta m = 0.5$). The observed change in inflation is 4.6 percent. The prefrequency price adjustment is 25 percent. Based on these numbers alone, equation (1) implies that the intensive margin explains 272 percent of the observed change in inflation (row 1 of table C1). That is, the observed change in inflation is "too low." This is the kind of calculation that was made in Burstein, Eichenbaum, and Rebelo (2005), when they pointed out that the observed inflation following a large devaluation was too low to be consistent with flexible prices and complete exchange rate pass-through.

To reconcile the numbers, Burstein, Eichenbaum, and Rebelo (2005) argue that only a small fraction of goods in the Consumer Price Index (CPI) were directly impacted by the exchange rate shock, and that most goods consumed are not traded. In the case of Mexico, only 11 percent of the CPI is impacted by imported goods and the price of nontraded goods changed little. The authors use this 11 percent number to adjust the size of the shock affecting the economy and arrive at the numbers in row 2 of table C1. Based on this calculation, the intensive margin accounts for only 29 percent of the change in inflation, and the extensive margin plays the dominant role.

This exercise is not as clean as one would wish because in effect what the authors do is alter the size of the shock. For the case of most developing countries their import prices are set in dollars and these dollar prices are not very sensitive to developments in the developing economy. The import price in local currency of the goods at the dock consequently adjusts one-for-one with the exchange rate. This has nothing to do with local currency prices being flexible. It is just a matter of local prices being indexed to the exchange rate, so when the exchange rate changes, all prices change one-for-one. Based on such a calculation, one could conclude that all of the shock is passed through via the intensive margin.

The evidence that speaks more directly to the presence of an extensive margin are the facts on the change in frequency of price adjustment. The near doubling in the frequency of price adjustment clearly suggests evidence of state contingency in price setting. This evidence is related to earlier work in Gagnon (2009), who showed persuasively that in response to large shocks one does observe state contingency in pricing, unlike studies that use developed country data and find it hard to discern much of a role for state contingency.

The other empirical studies on the VAT tax hike in 1995 and 2005 are very clean. They compare price change behavior before and after for the set of goods that were affected. They have a nice control group for goods that were not subject to the VAT change. They find that the extensive margin played a big role in 2005 and less so in 1995. This is because in the case of the latter, the economy was already in a high inflation regime, in which case the small VAT tax increases had little impact on the already high frequency of price change. Interestingly, the response to the VAT increase is relatively quick and complete. This could reflect the salient effect of shocks such as VAT tax increases.

Local Competition and the Adjustment Hazard

The authors use an impressive amount of data contained in Symphony-IRI Marketing data set to investigate pricing decisions and their relation to the prices of local competitors. This data set contains UPC-level information on weekly sales and prices of US grocery stores and drugstores. They estimate the difference between a store's price and the average of its competitor's price at the UPC level, and for a high level of geographical concentration. They then plot the frequency of price change as a function of this deviation, which can be viewed as a proxy for x. They find that the hazard function slopes upwards away from zero, as one would expect in the case of state contingent pricing. This evidence is extremely nice and very well done.

It would be interesting if one could relate these findings to evidence of strategic complementarity in pricing. Deviations of x might have nothing to do with strategic pricing effects. The shape of the hazard function could arise because one's competitors' prices capture common shocks that the firm has yet to respond to and therefore adjust to, or it could capture strategic complementarities in pricing, owing to which firms like to keep their prices close to their competitors' prices and do not tolerate large deviations in these prices. It might be useful to relate the findings in this paper to those in Klenow and Willis (2006), who find less evidence of comovement in prices across competitors.

Selection Effects: Other Evidence

The selection effect explored here is one where all firms have the same desired pass-through to the shock. There are several reasons to consider the case when desired pass-through varies across firms. In response to exchange rate shocks, the desired degree of pass-through even when all firms have adjusted prices can vary across industries because of variation in the sensitivity to the shock. Consider, for instance, a German firm exporting to the United States. Suppose this firm's production uses a combination of local inputs like labor and foreign imported inputs, whose prices are fixed in dollars (and are insensitive to the euro/dollar exchange rate). When the euro appreciates (dollar depreciates), this raises the cost of production in dollar terms for the German firm. However, to the extent it is only partly impacted by the shock because of its use of foreign inputs, its desired percent increase in prices is less than 100 percent. Another source for variation across industries is the sensitivity of the elasticity of demand to relative price movements across competitors. In industries where this elasticity is high, and since the exchange rate shock is not a common shock to all firms producing in an industry, the desired pass-through is low. That is, the higher the elasticity of demand, the lower the pass-through.

There are, therefore, several reasons why desired pass-through can vary across firms in response to certain shocks. Because the same variables such as the curvature of the demand function and the sensitivity to the exchange rate shock should be relevant to the decision of which currency to price in and for the decision of how frequently to adjust prices (given the same menu cost), one might expect to see a relation between these variables in the data. In Gopinath, Itskhoki, and Rigobon (2010) we use BLS data on US import and export prices at the dock that contains information on the currency in which goods are priced.[1] We find that for US imports, goods priced in a nondollar currency (the currency of the exporter) have a higher pass-through, even conditional on a price change as compared to dollar priced goods. The medium run pass-through is 90 percent for nondollar priced goods and 20 percent for dollar priced goods. Table C2 extends the results in Gopinath, Itskhoki, and Rigobon (2010) to data from more recent years. It covers the period January 2004 to October 2009. Consistent with the evidence

Table C2
Medium-Run Pass-Through and Currency of Pricing

	Dollar Estimate	Std. Error	Nondollar Estimate	Std. Error
All	0.16	0.01	0.80	0.04
Japan	0.17	0.02	0.84	0.06
Germany	0.22	0.04	0.84	0.08
Canada	0.25	0.07	0.60	0.45
France	0.18	0.06	0.81	0.10

in Gopinath, Itskhoki, and Rigobon (2010), there is a large difference in the medium-run pass-through between dollar and nondollar priced goods.

This evidence is consistent with the existence of a selection effect for which goods price in dollars versus nondollars when exporting to the United States. Because firms can index to a currency in the period when they do not change prices if they desire high pass-through, then they will keep their prices fixed in nondollars to mimic the 100 percent pass-through they desire. Similarly, firms that desire low pass-through even when they change prices will choose to price in dollars, in which case their pass-through is 0 percent. This evidence is inconsistent with the assumption that the pass-through during the period of price rigidity is very different from pass-through conditional on a price change. That is, it is not the case that one observes 0 percent pass-through in the short run and when prices adjust we observe 100 percent pass-through. On the contrary, the two pass-throughs are quite close.

In Gopinath and Itskhoki (2010a) we document a positive relation between the frequency of price adjustment and pass-through. We show that goods whose long-run pass-through is high also adjust prices frequently. This is again consistent with the argument that the frequency of price adjustment is chosen by firms depending on their industry characteristics and is evidence also of a selection effect.

Conclusion

As the current paper argues, and consistent with other evidence that has become available, the fact that there is evidence of a selection effect as to which prices adjust makes it more difficult to reconcile the micro-based evidence to the macro evidence of the long-lived nature of monetary nonneutrality. The presence of additional sources of real rigidities can perhaps reconcile the two pieces of evidence. In Gopinath and Itskhoki (2010b) we argue that based on international evidence, while there is evidence of strategic complementarities in pricing, it is still the case that quantitatively this channel alone (without exogenous sources of persistence) does not generate long enough monetary nonneutralities.

The response to different kinds of shocks can, of course, vary and it might be, as has been argued, that the response to monetary shocks are quite different even at the micro level. This could explain why at the aggregate level, where the effect of only aggregate shocks remain, the response of prices is different from that at the micro level. Information-based models that suggest slow updating to certain macro shocks can also help reconcile the facts. It will be interesting if the authors can use their data to shed light on information-based models of price adjustment, as opposed to focusing solely on state-contingent or time-dependent models. There is a lot more work to be done, and empirical work at the micro level along the lines of the current paper is crucial to pushing the literature forward.

Endnote

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1. For more details see Gopinath and Rigobon (2008).

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