Comments on Implications of Micro Price Data for Macro Models by Mackowiak and Smets

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The paper provides a very careful survey of the recent work that uses micro-price data in order to study the role of sticky prices in shaping the monetary transmission mechanism. It has three themes. The first one is a survey of the facts uncovered in recent work using price data made available by the BLS and through the Inflation Persistence Network, as well as scanner price data. The picture that emerges is one of considerable complexitity and heterogeneity in the price-setting behavior of retail firms. Dealing with this complexity has been the goal of a recent surge of work inspired by this data, some of which I review in greater detail below. A second theme is that pretty much independently of how one deals with this complexity, the overriding conclusion is that prices change much too frequently, both in Europe and in US, for menu costs alone to be able to account for the sluggishness in prices at the aggregate level. The third part of the paper deals with the challenge of bridging the gap between the flexibility observed in the micro data and the inertia in the aggregates. In particular, the authors emphasize real rigidities and informational frictions as promising avenues for building models in which firms do not responde to nominal disturbances even though they adjust frequently. I would like to add inventory-theoretic models of money demand that emphasize frictions that segment asset markets to the list of potential solutions to this challenge.

I will start by describing some of the challenges the wealth of micro-data has posed to macroeconomists and some of the progress we have made to address these. The first challenge is the large heterogeneity in the frequency of price changes across different sectors. To see the extent of this heterogeneity, the frequency of price changes in the Bils and Klenow (2005) study ranges from coin-operated laundry machines that experience price changes every 80 months on average to regular unleaded gasoline that experiences price changes about every 2 weeks on average. There is also considerable skewness in this distribution: according to Nakamura and Steinsson (2007), the median frequency of price changes is 21.1% per month, while the mean frequency is 8.7% per month. A natural question is thus: what is the effect of this heterogeneity on the real effects of money in sticky price models? What frequency of price adjustment should one use in a homogeneous-firm economy that abstracts from this heterogeneity? Carvalho (2006) studies this question in the context of a time-dependent model. He finds that the heterogeneity in price adjustment amplifies the real effects of money because of the convexity of the relationship between the real effects of money and the frequency of price changes. In fact, a heterogeneous-sector economy calibrated to match the distribution of frequency of adjustment in the micro-data generates three times larger real effects than a homogeneous-sector economy calibrated to the mean of this distribution. Nakamura and Steinsson (2007) study a similar question in the context of a menu-cost setting. They find again that heterogeneity amplifies the real effects of money. Moreover, although a homogeneous-agent economy calibrated to the mean (21.1%) frequency of price adjustment in the data understates the real effects of money, a similar homogeneous-agent economy calibrated to the median (8.7%) frequency of price changes generates similar real effects as the heterogeneous-agent economy.

A second challenge discussed in the paper is the fact that an important number of price changes in the data are temporary discounts (sales). Sales are special types of price changes because they are short-lived and because they frequently revert to the price the firm was charging prior to the sale. If one includes sales in the definition of price changes, prices appear to change frequently, every 4.3 months in the study of Bils and Klenow (2005). If one excludes sales from the definition of price changes, prices are much stickier and change every 9-11 months, as in the study of Nakamura and Steinsson (2007). Kehoe and Midrigan (2008) take up the issue of how to deal with sales in the data. They emphasize that the special feature of sales is that they are temporary and formulate a model in which firms have two technologies for price adjustment available. The firm can pay a fixed cost to change its regular price change, as well as another fixed cost to undertake a temporary price change. If the firm changes its regular price, it buys the option to sell at this price forever into the future. In contrast, if the firm changes its price temporarily, it is able to charge this price for one period only, after which, absent another intervention, the firm charges its old regular price. The model they write is thus able to match the salient features of the micro-price data, including the predominance of temporary price changes. They find that the approach of leaving temporary price changes out of the data overstates the real effects of money by 40%. In contrast, the approach of leaving sales in the data and treating them like any other price change predicts real effects of money that are 1/5th those in the model where sales are temporary. Kehoe and Midrigan also discuss a number of shortcuts that can be used in economies without temporary price changes to replicate the real effects of money in an economy that has both regular and temporary price changes.

A third challenge is the complicated mapping from the frequency of price adjustment to the degree of monetary non-neutrality in economies that explicitly model price stickiness as arising from menu costs. The question is really: does the Caplin-Spulber (1987) well-known neutrality result in a menu cost economy survive in a more general setup that is consistent with the micro price data. In the Caplin-Spulber model money is neutral for any degree of price stickiness at the firm level because the firms that change prices at any given point are exactly those that need the largest price change. Thus, even though few adjust, those that do so change prices by an amount that is sufficiently large to ensure that the aggregate price level responds one-for-one to changes in the growth rate of money. Key to this result however is the self-replicating uniform distribution of desired price changes of individual firms, thus leaving open the question of how general this finding is. A recent paper by Golosov and Lucas (2007) argues that the result survives in a much more general setting, provided one allows for large idiosyncratic shocks that allow the economy to match the roughly 10% average size of price changes Klenow and Kryvtsov (2007) document in the BLS data. The intuition is similar to that of Caplin and Spulber: the firms that choose to adjust in times of, say, a monetary expansion, are exactly those firms that stand to gain most from increasing their prices. Thus money has a strong selection effect, in that it affects the identity of adjusting firms, thus rendering the aggregate price level much more flexible than individual prices. Midrigan (2006) shows, however, that the strength of this selection effect is much smaller if one calibrates the economy to match the large dispersion (in addition to the mean targeted by Golosov and Lucas) in the size of price changes. An economy capable to replicate the large number of small price changes as well as the fat tails of this distribution implies a much smaller selection effect (money has much less effect on who gets to adjust) than in the Golosov and Lucas model and predicts real effects of money that are 4/5th of those in the Calvo model in which the selection effect is, by assumption, absent.

My own reading of the literature that the authors survey is that we have made considerable progress towards understanding the role played by menu costs in light of the evidence from the micro data on prices. What has also become clear however is that menu costs alone are far from sufficient in generating a sizable monetary transmission mechanism. Here I use a narrow definition of what menu costs are: restrictions on the price-setting technology that prevent firms from changing prices. To see why menu costs are not enough, recall that the frequency of price changes in the micro-data is 2 to 3 quarters on average. In contrast, empirical evidence suggest that there is much more inertia in the response of the aggregate price level to nominal shocks. Models in which the only friction are technological restrictions on the firm's ability to reprice can replicate this aggregate inertia only if prices change as infrequently as every 10 quarters. Two other pieces of evidence point out that pure price adjustment frictions are not sufficient. First, the fact that after a sale prices return to the pre-sale level, cent for cent, makes it clear that it is not the physical menu cost in itself that renders prices sticky. The return from a sale involves changing the price and paying the menu cost; firms nevertheless choose to return to the level in effect prior to the sale. A second piece of evidence comes from work by Kehoe and Midrigan (2007) on cross-sectional international real exchange rates. They find that the persistence and volatility of real exchange rates for disaggregated sectors of the economy is pretty much independent of the stickiness of prices in that sector: flexible-price goods like unprocessed foods or fuels have international relative prices that track nominal exchange rates as closely as very sticky-price goods like services. This evidence makes it clear that the reason prices do not change with nominal exchange rates is not because firms *cannot* respond to these movements, but rather because firms *choose not to* respond.

Bartosz and Frank list two mechanisms that may be able to bridge the gap between the flexibility in the micro price data and the inertia in the aggregate: real rigidities and information frictions. To this list, I would like to add inventory-theoretic models of money demand as in Alvarez, Atkeson and Edmond (2008), in which changes in the velocity of money in the aftermath of nominal shocks impart sluggishness to the aggregate price level despite flexibility in micro prices. Considerable progress has been made in understanding the properties of economies that feature these mechanisms. I argue, however, that more empirical work, using both micro and macro data, is needed in order to distinguish among these competing models and to assess their quantitative properties. The distinction between these is crucial for formulating policy prescriptions. Even though these different mechanisms may have similar implications for the slope of the Phillips curve, they will, in general, have different implications about the behavior of other objects (e.g. relative price variability, other distortions caused by inflation) that may be of interest to policymakers.

Take the issue of real rigidities, for example. Two types of real rigidities have been emphasized by Ball and Romer (1990). The first type hinges on strategic interactions among competing firms that increase the firm's losses from having its price deviate from that of its competitors. With kinked demand curves or upward sloping marginal cost curves at the firm level, price setters have a strong incentive to keep prices close to that of their competitors. Adjusting firms thus *choose not to* respond to changes in the stance of monetary policy even when they do pay the menu costs and adjust their nominal prices. Recent work by Dotsey and King (2005), Klenow and Willis (2007), as well as Burstein and Hellwig (2007) has called into question the quantitative relevance of this mechanism. Intuitively, strategic complementarities of this type make it optimal for firms to change prices by small amounts to avoid relative price changes against their competitors. But price changes are large (10% on average): unplausibly large menu costs and idiosyncratic shocks are thus needed to reconcile this first type of real rigidities with the micro data. Although the conclusions of these recent studies may be challenged by explicitly modeling the source of the strategic complementarity (e.g. search frictions/customer switching costs) and allowing for multi-product price setters (which would render the relevant relative price the price of the bundle of goods the firm charges, rather than the price of individual items it sells), these studies are examples of well-executed and careful attempts to quantify the importance of this first type of real rigidities.

A second type of real rigidities hinges on slow responsiveness of aggregate real marginal cost to output fluctuations. Sticky wages, intermediate goods prices, assumptions on preferences or technology that keep the marginal cost of producing low during monetary expansions, dampen the response of prices to monetary shocks and lead to more inertia in the aggregate price level. Measuring the behavior of real marginal cost over the cycle is the subject of a large body of work (summarized by, e.g., Rotemberg and Woodford (1999)), but also a difficult task. Mapping observed factor prices into marginal cost requires making assumptions about technology, the nature of the relationship between buyers and suppliers, household preferences for intertemporal substitution of leisure etc. Bils and Khan (2000) argue that one can infer much about the behavior of marginal cost from the cyclical behavior of inventories. If marginal costs are strongly procyclical and rise sharply in the aftermath of a monetary expansion, firms should reduce their level of inventories. Similarly, if real marginal cost moves little over the cycle, inventories should increase. In recent work Kryvtsov and Midrigan (2008) show that the elasticity of real marginal cost with respect to output needed to account for the strongly countercyclical inventory-sales ratio observed in the data is only slightly lower than the inverse of the intertemporal elasticity of substitution for consumption. This finding, reminiscent of some recent results in the lumpy investment literature[1], suggests that one can use inventories in addition to other aggregate variables, to pin down the size of this second type of real rigidities in estimated

[1] Thomas (2002), Khan and Thomas (2007), Bachmann, Caballero, Engel (2007), House (2007).

dynamic stochastic general equilibrium models.

To conclude, the exciting recent work using micro-price data has proven very useful in sharpening our understanding of the role of menu costs in accounting for the slope of the inflation-output tradeoff. This work has also convincingly reinforced Ball and Romer's (1990) insights that menu costs alone are far from sufficient in accounting for the extent of monetary non-neutrality observed in the data. More empirical work aimed at distinguishing among several competing mechanisms that can amplify the effect of menu costs on aggregate price inertia should answer many open questions in future work.