Rational inattention, multi-product firms and the neutrality of money ☆

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A B S T R A C T

In a model where firms set prices under rational inattention we allow them to produce multiple goods. In addition to monetary shocks and firm-specific shocks, good-specific shocks affect firms, consistent with micro price data. When per-good expected losses in profits from inattention are held constant, monetary non-neutrality quickly vanishes as the number of goods per firm rises. This result is due to (1) economies of scope that arise naturally in the multi-product setting, where processing information is costly but using already internalized information is free, and (2) good-specific shocks.

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1. Introduction

Rational Inattention Theory (Sims, 1998, 2003) is an increasingly popular formalization of the idea that limited ability to process information (or "attention") may be behind the simplicity of human actions relative to those of agents in economic models. A prime example – as pointed out in Sims' seminal work – is that prices only respond slowly to monetary shocks because firms allocate most of their attention to highly volatile idiosyncratic shocks. Little attention in turn to less volatile, monetary shocks means high observational noise and a slow response to monetary shocks. This result is confirmed quantitatively by Mackowiak and Wiederholt (2009) who calibrate a rational inattention model of price setting to US data to find large and long-lasting monetary non-neutrality even when the friction is "small."

This paper revisits this result of rational inattention after relaxing the usual assumption in macroeconomics that firms price a single good. In doing so, we also make two additional assumptions: First, that shocks can be both good-specific and firm-specific, in addition to monetary.[1] Second, that profit losses per good due to inattention remain constant as the number of goods varies. Then, under these assumptions, our main result emerges: a calibrated model of rationally inattentive, monopolistically competitive firms predicts much milder monetary non-neutrality when firms price multiple goods rather than a single good. This result is particularly strong when firms are interpreted as retailers since empirically, retailers price a large number of goods; but multi-product pricing has a strong effect even for producers who price a much smaller number of goods.

  [1] Adding regional or sectoral shocks would make no difference in the analysis.

Three factors drive the main result: First, multi-product firms have stronger incentives to pay attention to monetary and firm-specific shocks. The reason lies in economies of scope in information processing: The attention to reduce observation noise is the same for all kinds of shocks, but information about monetary and firm-specific shocks can be used to price all goods. By contrast, the benefit of paying attention to good-specific shocks does not scale up with the number of goods. We call this force "economies of scope in information processing."

Second, a force going in opposite direction is that firms must allocate their limited attention to more shocks as they price more goods, spreading "thin" their attention. As as result, if total attention is held constant, monetary non-neutrality may increase if the number of goods is small but always decreases as this number goes to infinity (so economies of scope dominate). However, expected profit losses per good due to the friction also increase with more goods. In other words, stronger monetary non-neutrality can only happen as the friction becomes more binding. This is where the assumption on profit losses becomes important: Once economies are compared for which the friction is equally binding, attention to monetary shocks and monetary neutrality unambiguously increase as firms price more goods.

Third, strategic complementarities amplify the effects of these forces. Starting from a situation in which firms pay little attention to monetary shocks, more attention to these shocks has a large effect on reducing monetary non-neutrality. The reason is that under stronger complementarities among competing firms, aggregate prices respond faster to monetary shocks if competitor prices respond faster to these shocks. A corollary of the same effect is that firms pricing a single good respond fast to monetary shocks when they coexist with multi-product firms that respond fast to these shocks.

Our key assumptions are based on empirical evidence. First, there is strong evidence that firms indeed price multiple goods. Just to fix ideas, retailers price on average about 40,000 goods (FMI, 2010) and producers about 4 goods (Bhattarai and Schoenle, 2014). There is also suggestive evidence that firms price their goods in centralized units.[2] To support our assumption of firm- and good-specific shocks, our analysis documents a new empirical fact: Within-firm dispersion of log price changes accounts for 51.6% and 59.1% of total cross-sectional dispersion in U.S. Consumer Price Index (CPI) and Producer Price Index (PPI) micro data. Although there are many plausible explanations for this fact, our quantitative results hold as long as good-specific shocks explain a non-zero fraction of this dispersion.

Since our assumption on profit losses that disciplines information capacity plays an important role, our analysis explores alternative assumptions in Section 3.3. The first alternative is that the shadow price of information capacity is constant regardless of the number of goods. The second is that the shadow price of information capacity per good is constant. The first alternative implies a decrease in monetary non-neutrality as the number of goods increases, and the second unchanged monetary non-neutrality. Our baseline assumption of constant profit losses dominates both alternative assumptions. Why? If profit losses were allowed to increase with the number of goods which is what both alternatives imply, our model would not be internally consistent: Firms would like to split up their pricing decisions into single-good units to minimize total losses.[3] The second assumption is a priori also implausible since it means that the marginal cost of expanding information capacity is higher for firms that price more goods.[4]

Next, our analysis confirms the theoretical results by calibrating the model. The benchmark for the calibration is the setup of Mackowiak and Wiederholt (2009), which features firms pricing a single good and is calibrated to micro moments from the CPI. Our main twist is to allow for the number of goods to vary and to calibrate our firm- and good- specific shocks to account for the ratio of within-firm to total dispersion of price changes in the data. When firms price two goods, our model yields only one third of the monetary non-neutrality of the benchmark, holding expected per-good losses constant. When firms price eight goods or more, money is almost neutral. Thus, our main result emerges: In a quantitative rational inattention model, monetary non-neutrality quickly vanishes as firms price more goods under the same conditions that lead to strong monetary non-neutrality in a single-good setting. Remarkably, this quantitative result holds although firms' attention to monetary shocks always remains a small portion of their total attention.

Our main result also holds in a calibrated, more realistic heterogeneous-firm model where firms in the economy differ in the number of goods. The model is calibrated using PPI data since this dataset allows for the computation of micro moments after sorting firms into four bins that depend on the number of goods they price.[5] Again, our model yields approximately a third of the monetary non-neutrality of our benchmark, holding expected per-good losses constant. As before, firms spend little attention on monetary shocks, but now additionally prices of all firms (including single-product firms) exhibit very similar impulse responses, another effect of strategic complementarity among firms. We also flip our exercise around to show a general tradeoff between monetary neutrality and the friction: To yield the same monetary non-neutrality as in our benchmark, the cost of the friction has to go up. In our quantitative exercises, the cost of the friction must exceed the range typically found/assumed in the literature to yield the same monetary non-neutrality as our single-product benchmark.

Our calibration exercises suggest two conclusions: First, since retailers typically price a large number of goods, multi-product pricing can be very important quantitatively for a rational inattention model where firms are interpreted as retailers. Second, multi-product pricing is also quite important when firms in the model are interpreted as producers

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[2] The Bureau of Labor Statistic's (BLS) defines a firm as a "price-forming unit" in the PPI micro data. In this dataset, only 1.5% of firms price a single good. Further, Zbaracki et al. (2004) present a case study of the pricing process of a firm. They report that all regular prices are decided at headquarters while all sale prices are decided by local managers. At both levels there is a *single* price setting unit for all goods.

[3] This does not mean that firms would also decentralize their production or commercialization processes.

[4] For example, buying software to support the pricing process would more expensive if firms decided more prices (or if their total sales were larger).

[5] The main paper discusses the patterns of these moments across bins which for brevity are omitted here.