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# Estimating the frequency of price re-optimization in Calvo-style models ☆

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**Abstract**

This paper assesses the empirical performance Calvo style models of price re-optimization. We first show that versions of these models in which firms update non-re-optimized prices to lagged inflation account well for the statistical behavior of post-war U.S. inflation rates. We then investigate whether these models imply plausible degrees of inertia in price setting behavior by firms. They do, but only if we depart from two standard auxiliary assumptions: monopolistically competitive firms face a constant elasticity of demand, and capital is homogeneous and can be instantaneously reallocated after a shock. We develop a version of the model in which these assumptions are relaxed and show that it is consistent with the view that firms re-optimize prices, on average, once every two quarters.


*Keywords:* Monetary transmission mechanism; Nominal rigidities

## 1. Introduction

This paper addresses two questions. First, can Calvo (1983) style models of infrequent price re-optimization account for the statistical behavior of post-war U.S. inflation? Second, can these models succeed statistically under plausible assumptions about how frequently firms re-optimize prices? We investigate these questions using a variant of Christiano et al. (2005) model in which firms update non-re-optimized prices to lagged

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inflation. For this model the answer to the first question is yes. The model passes the same type of tests that Galí and Gertler (1999) implement for a version of the Calvo model with some rule-of-thumb firms. Our answer to the second question is also yes, but only if we depart from two standard auxiliary assumptions: monopolistically competitive firms face a constant elasticity of demand, and capital is homogeneous and can be instantly reallocated after a shock. Under these assumptions, our estimated model implies that firms re-optimize prices roughly once every two *years*.

We develop a variant of the benchmark model in which the elasticity of demand facing firms is variable and capital is firm-specific and costly to adjust. The modified model is observationally equivalent to the original model in terms of its implications for the aggregate time series used in our analysis. In particular, we cannot separately identify the frequency with which a firm re-optimizes its price, the nature of demand elasticities, and the degree of capital mobility. However, we can identify the frequency of re-optimization if we have information about demand elasticities and the degree of capital mobility. If we assume that capital is firm-specific, and there are empirically plausible costs of adjusting capital, then the model implies a degree of inertia in price re-optimization that is much more plausible than the inertia implied by the benchmark model. Depending on our assumptions about demand elasticities, our measure of inflation, and the sample period under consideration, we infer that firms re-optimize prices once every 2.3–3 quarters. In no case can we reject, at conventional significance intervals, the hypothesis that firms re-optimize prices once every two *quarters*.

Despite ongoing controversies, models embodying nominal price rigidities continue to play a central role in analyses of the monetary transmission mechanism. In time-dependent models, the number of firms that re-optimize prices in any given period is specified exogenously.[1] In state-dependent models, the number of firms that re-optimize prices in any given period is determined endogenously.[2] While state-dependent models seem promising, at least to us, they are substantially more difficult to work with than time-dependent models. Here we take as given the widespread interest in time-dependent models. Rather than focus on price stickiness per se, we focus on the empirical properties of a Calvo-style model of infrequent price re-optimization.

We interpret the Calvo price re-optimization mechanism as capturing firms' responses to various costs of changing prices. The basic idea is that in the presence of these costs, firms fully optimize prices only periodically, and follow simple rules for changing their prices at other times. The type of costs we have in mind are those associated with optimization (e.g., costs associated with information gathering, decision making, negotiation and communication). These costs are different from menu costs which apply to all price changes.[3] We consider a Calvo-style model in which firms who do not re-optimize their prices index their prices to lagged inflation. This dynamic indexing scheme implies that inflation depends on

[1]Classic models of this sort were developed by Taylor (1980) and Calvo (1983). Modern variants are now central elements of a large class of models. See, for example, Christiano et al. (2005), Erceg et al. (2000), Galí and Gertler (1999), Rotemberg and Woodford (1997) and Yun (1996).

[2]Important recent examples of state-dependent pricing models include Dotsey et al. (1999), Burstein (2002) and Golosov and Lucas (2003).

[3]Zbaracki et al. (2000) provide some microeconomic evidence that costs associated with re-optimization are much more important than menu costs.