



# Inventories, market structure, and price volatility

Henry Thille

*Department of Economics, University of Guelph, Guelph, Ont., Canada N1G 2W1*

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## Abstract

The effect of inventories on the level and volatility of price is analyzed under alternative market structures. In a fairly general setting, it is shown that inventories have no effect on the average level of prices in a Cournot duopoly in the absence of depreciation. The effect of storage on price volatility is analyzed in a more restrictive, linear-quadratic setting in which it is found that imperfectly competitive producers make less use of inventories for smoothing random fluctuations than is efficient. The effect of market structure on price volatility depends on whether demand shocks or cost shocks are more important.

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## 1. Introduction

The purpose of this paper is to examine the use of inventories by imperfectly competitive producers in order to understand the effects of storage on both the level and the variability of price in oligopolistic markets. Imperfectly competitive firms will recognize the effects of their storage decisions on future outcomes, and so may alter their behavior from that of perfectly competitive firms. A particular concern in the analysis of inventories is the extent to which they smooth price

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*E-mail address:* [hthille@uoguelph.ca](mailto:hthille@uoguelph.ca).

fluctuations,<sup>1</sup> so it is important to understand how imperfect competition affects the use of inventories for this purpose in addition to how it affects the price level.

The complications caused by imperfect competition are easy to see. If production costs are convex, by reducing the amount of production required to meet a given level of sales, firms can reduce the marginal cost of sales in a given period by drawing down inventories. This is the basic idea behind models that examine the production smoothing usage of inventories in competitive markets.<sup>2</sup> When producers are imperfectly competitive, these inventories will potentially have strategic value due to this ability to reduce the marginal cost of sales in future periods. In addition to any effect this strategic use of inventories may have on the price level, it is also possible that this consideration will also alter how firms respond to random disturbances, which will affect the use of inventories for price smoothing.

The effect of storage on the equilibrium of a duopoly market has been examined in the context of a two period game in which duopolists can carry inventories into the second period. Allaz (1991) shows that the possibility of storage results in lower prices than is the case if storage were not possible. Producers wish to have lower costs than their rival in the second period and in the attempt to gain such an advantage invest in inventories which result in higher second period sales and lower price. Another paper that examines this issue is by Arvan (1985) who demonstrates that the equilibrium may be asymmetric when storage costs are linear, although he does not show what the effect on price is. Mitraile (2004) takes the analysis of Arvan further. He allows demand to vary over the two periods and shows that, for constant marginal production cost, the use of inventories will result in a lower second period price when demand is falling and have no effect when demand is rising. As these papers illustrate, a crucial determinant of the equilibrium in the two period game is how excess inventories are treated in the second period. Allaz assumes that they must be sold, while Arvan and Mitraile allow unsold inventories with no penalty. I focus on an infinite horizon in this paper in order to remove the effects of any assumption that must be made regarding inventories in the terminal period.

Thille (2003) extends the analysis of strategic forward trading and storage to an infinite horizon. He shows that the strategic use forward trading is lessened by the possibility of storage. In the model of Thille (2003) there is no uncertainty, so it has no implications for price volatility. One result of that paper was to demonstrate that for a game with storage but without forward trading, the price level was the same as in a Cournot duopoly. The conditions under which this result is more generally true are examined in this paper.

There are a couple of other papers that have examined storage in a long horizon duopoly. Kirman and Sobel (1974) analyze an infinite horizon, stochastic dynamic game in which firms simultaneously choose production and price at the beginning of a period. After these decisions are made, the stochastic quantity demanded is realized and the difference between demand and production is subtracted from or added to

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<sup>1</sup>See Newbery and Stiglitz (1981).

<sup>2</sup>See Blinder and Maccini (1991) and Ramey and West (1997) for summaries of the production-smoothing model in macroeconomics.

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