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The role of inventories and capacity utilization as shock absorbers

Leonardo Auernheimer [a,1], Danilo R. Trupkin [b,*]

[a] Texas A&M University, United States
[b] Department of Economics, Universidad de Montevideo, Prudencio de Pena 2440, 11600 Montevideo, Uruguay

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ABSTRACT

We examine the role of inventories and capacity utilization (of both capital and labor) for the propagation of business cycle fluctuations. We document a new set of facts regarding the U.S. cyclical regularities of inventories and capacity utilization. First, we find that capital utilization and the flows of services from both capital and labor are procyclical, and comove with the holdings of inventories. Second, we find that labor utilization is procyclical as well, but is weakly negatively correlated with inventories. We build a model that accounts for these facts, and also accounts for the stylized inventory facts, i.e., inventory holdings are procyclical, while the inventory-to-sales ratio is countercyclical. The analysis is centered on the effects of two possible shocks: preference (demand) shocks and technology shocks. Our model shows that inventories and the rate of capital utilization are mostly complements, while inventories and the rate of labor utilization are mostly substitutes. It further shows that temporary demand shocks emphasize the role of inventories as being a "shock absorber," whereas high-persistence demand shocks, as well as technology shocks of any persistence, emphasize the role of inventories as being a complement to consumption.

1. Introduction

The primary goal of this paper is to analyze the role of inventories and capacity utilization – the intensity of use of both capital and labor – in the transmission of business cycle fluctuations. We study the relationship between these variables and whether they respond symmetrically to supply and demand shocks of different rates of persistence.

Stylized facts on inventory cycles show that, at the aggregate level, output is more variable than sales, and thus inventory investment is procyclical, while the inventory-to-sales ratio turns out to be countercyclical. We show that capital utilization and the flows of services from both capital and labor are procyclical and comove with the holdings of inventories. Further, we find that labor utilization is procyclical as well, but is weakly negatively associated with inventory holdings. We finally observe that the cyclical components of both the stock of inventories and inventory investment are positively correlated with consumption expenditures. Our model is able to replicate these facts and further provide novel explanations, as it examines both roles of inventories in the business cycle: as shock absorbers and as complements to consumption.

We find that temporary demand shocks result in a negative correlation between inventories and both rates of capacity utilization, so that they behave as substitutes. Temporary shocks to technology, in contrast, make inventories complement the utilization of both factors of production. Finally, high-persistence shocks either to preferences or technology make inventories complement capital utilization but substitute labor utilization.

* Corresponding author.
E-mail address: dtrupkin@um.edu.uy (D.R. Trupkin).
[1] Author deceased.

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Our contributions are important for the following reasons. Empirically, it has long been recognized that inventory fluctuations play an important role in the business cycle. Although inventory investment has averaged roughly one-half of 1 percent of U.S.' GDP over the post-World War II period, changes in inventory investment have averaged more than one-third the changes in quarterly GDP, while the drop in inventory investment accounted for more than 80% of the drop in total output during the average postwar recession period in the U.S.[2] Blinder suggests that "business cycles are, to a surprisingly large degree, inventory cycles." (Blinder, 1990, p. 8). Moreover, the literature is still debating the role of inventories for the propagation of business cycle fluctuations.[3] Hence, understanding the dynamics of inventories is key to understanding business cycles.

Capacity utilization, being a central component of the economy's supply side, is also recognized as having an important role in the business cycle. For instance, variable factor utilization is thought to account for much of the variation in the Solow residual (40–60 percent according to Basu and Kimball, 1997), and thus provides an important insight in characterizing the state of real activity.

At a theoretical level, an analysis of the association between inventories and capacity utilization seems natural, since physical capital can be seen as a stock ultimately destined to be transformed into an inventory of finished goods. Likewise, inventories could be seen as a stock of physical capital already transformed into finished goods. Moreover, once we introduce the possibility of variable rates of utilization of both capital and labor, then such rates of utilization and inventories can be seen as providing a short-run adjustment "buffer stock" mechanism.

Our paper, therefore, contributes to the existing literature by providing a theoretical intuition of how these components relate to each other and, as a result, affect the transmission of business cycles. Most of the previous related research has either examined partial-equilibrium settings; for example, Galeotti et al. (2005) integrate inventories and labor decisions, distinguishing between employment, hours and effort in a partial-equilibrium model; or have focused on the effects of inventory shocks as drivers of business cycles; for instance, Iacoviello et al. (2011) introduce inventories into a general-equilibrium model with variable capital utilization, to examine the propagation mechanisms of each one of input and output inventories.

The new set of business cycle facts that we document show, essentially, that inventories are highly (and positively) associated to the flows of services of both factors of production, but less related to their rates of utilization – indeed, inventories appear to be negatively related to the rate of labor utilization. What we learn from our theory is that the association between inventory holdings and factor services emphasizes their complementarity mechanism, while the association between inventory holdings and the rates of capacity utilization emphasizes their short-run adjustment buffer-stock mechanism. Our findings provide additional insights to the understanding of the business cycle transmission mechanism.

Finally, our paper also contributes to the discussion on how aggregate labor supply responds over the business cycle (see, e.g., Ljungqvist and Sargent, 2011). Aggregate shocks, in particular demand shocks, are not only 'buffered' by fluctuations in average hours (and changes in the intensity of use of capital) but also by fluctuations in inventory stocks. Introducing inventory investment and variable capacity utilization together into a standard macroeconomic model allows us to identify the short-run substitutability that exists between inventories and hours worked. This provides an additional explanation to reconcile the relative lack of variability of average hours worked seen in the data.

We develop a dynamic, stochastic general equilibrium (DSGE) model that distinguishes from earlier models in that it introduces (i) endogenous capital depreciation, (ii) variable use of the labor force, (iii) adjustment costs in physical capital, and (iv) inventory holdings. Endogenous capital depreciation captures the idea that the depreciation rate is a variable subject to choice by the user of the capital good. As such, this rate enters into the model as a function of the intensity of use of capital – see, e.g., the works of Greenwood et al. (1988), and of Rumbos and Auernheimer (2001). Variable labor utilization, which can also be interpreted as variable effort, is introduced into the model by allowing the agent to modify the working time during the production process. Investment adjustment costs are introduced as in Christiano et al. (2005).

The demand for inventories, which are zero-return assets, is motivated by the idea that a larger stock allows consumers either to match their tastes more effectively or to economize on shopping costs. As in Kahn et al. (2002) and Iacoviello et al. (2011), we assume that inventories enter the consumers' utility function. This specification is equivalent to one in which inventories enter instead in the budget constraint reducing shopping time costs.[4] Other approaches for generating a demand for inventory holdings introduce inventories as inputs in the production function (e.g., Kydland and Prescott, 1982) or emphasize the timing of deliveries rather than the timing of production, such as the (S, s) specifications of Caballero and Engel (1999), Fisher and Hornstein (2000) and Khan and Thomas (2007b).[5]

We are aware that the shortcut of introducing inventories in the utility function makes the model lack of a deeper, microfounded demand for inventories. However, by doing so we obtain, as a first step in the literature, a general-equilibrium

[2] See the surveys by Blinder and Maccini (1991), Fitzgerald (1997) and Ramey and West (1999).

[3] See, for example, McConnell and Perez-Quiros (2000), Khan and Thomas (2007b), and Iacoviello et al. (2011).

[4] This argument follows Feenstra (1986)'s rationalization of money-in-the-utility-function models. In an online appendix (available at http://dx.doi.org/10.1016/j.red.2013.04.003, we show this equivalence in the context of our model.

[5] Although the focus of this work is on the analysis of final good inventories, we can still apply it to the analysis of intermediate good inventories. For instance, we can think of producers with larger inventories of intermediate goods as ultimately increasing consumers' possibilities (and utility) by expanding their different alternatives.