Journal of Macroeconomics 53 (2017) 235–250

Contents lists available at ScienceDirect

Journal of Macroeconomics

journal homepage: www.elsevier.com/locate/jmacro

Panel cointegration estimates of the user cost elasticity☆

Huntley Schaller[1], Marcel Voia*

Department of Economics, Carleton University, 1125 Colonel By Drive, Ottawa, Ontario K1S 5B6, Canada

ARTICLE INFO

Article history:
Received 8 March 2017
Revised 6 August 2017
Accepted 8 August 2017
Available online 12 August 2017

JEL classification:
H25
C23
E22
E62

Keywords:
Investment
Capital stock
User cost elasticity
Interest rate
Taxes
Capital goods prices
Panel cointegration

ABSTRACT

The effect of user cost on the capital stock is an issue of central importance in economics, with implications for tax policy, economic development, growth, monetary policy, business cycle models, and other areas. Estimating the user cost elasticity raises serious simultaneity problems because of the large fluctuations in investment demand at business cycle frequencies. If shifts in the supply curve (due to technological change and tax reforms) are more persistent than shifts in demand, cointegration techniques, which emphasize long-run movements, can reduce the simultaneity problem. If shocks to capital demand are partially idiosyncratic, the use of firm-level panel data should also reduce the simultaneity problem. In this paper, we therefore use cointegration techniques to estimate the user cost elasticity on panel data. Specifically, we employ a newly constructed data set with a long time series of firm-level data on the capital stock and with detailed industry-specific data on the interest rate, the price of investment goods, risk, and taxes.

1. Introduction

According to neoclassical growth theory, the capital stock is one of the main determinants of the long-run standard of living. In some versions of endogenous growth theory, the capital stock plays an even more important role by influencing the rate of economic growth.

According to standard economic theory, the long-run capital stock is determined by user cost. The quantitative magnitude of these effects is of crucial importance for many areas of economics, including monetary policy, business cycle models, tax policy, trade, economic development, and growth. Unfortunately, there is little consensus on the magnitude of these effects. For example, Chirinko (1993) concludes that "the response of investment to price variables tends to be small and unimportant relative to quantity variables," while Hassett and Hubbard (2002) conclude that the user cost elasticity is probably between −0.5 and −1.

☆ We would like to thank Dale Jorgenson for providing data on tax parameters (not to mention his pioneering work on the theory of optimal capital choice and user cost!), seminar participants at MIT, the American Economic Association, and the CEA for useful comments and suggestions, and Mark Blanchette for excellent research assistance. Schaller thanks MIT for providing an excellent environment in which to begin this research.

* Corresponding author.
E-mail address: marcel.voia@carleton.ca (M. Voia).

[1] The preparation for submission of this paper has been overshadowed by Huntley Shaller's death in January 2015. This article is submitted in his memory.

http://dx.doi.org/10.1016/j.jmacro.2017.08.001
0164-0704/

Caballero (1994, 1999) and Schaller (2006) argue that there are serious problems in obtaining unbiased estimates of user cost elasticity from short-run movements in investment, as the great majority of the previous literature has tried to do. Empirical researchers are trying to estimate the elasticity of the demand for capital, but the equilibrium quantity and price depend on both supply and demand. At business cycle frequencies, there are substantial movements in demand. If the supply curve for capital is upward sloping in the short run, as we believe most supply curves are, econometric methods that emphasize high-frequency fluctuations in the data will tend to pick up movements along this supply curve, biasing the elasticity estimate toward more positive values.[2]

On the basis of these economic issues – and their implications for the appropriate econometric techniques – Caballero (1994, 1999) and Schaller (2006) argue that it will be possible to obtain better estimates of user cost elasticity by using low-frequency movements in the variables. To see this, note that shifts in the supply curve for capital are probably due primarily to technological change, which tends to have persistent effects on the price of investment goods and the real interest rate, and tax reforms, which also tend to be relatively persistent. This implies that techniques that emphasize low-frequency movements will tend to trace out points on the demand curve for capital while techniques that emphasize high-frequency movements are more likely to trace out points on the supply curve.[3]

There are at least two other ways to address the simultaneity problem that plagues estimates of the user cost elasticity. Schaller (2006) points out that the supply curve for capital in a small, open economy will be flat. Theoretically, this should help to reduce the bias towards positive estimates of the elasticity. Empirically, he finds that the estimated elasticity for equipment capital is substantially larger for a small, open economy (about −1.4) than the Caballero (1994) estimate for a large economy (about −0.9).

A second way to address the simultaneity problem is to use panel data. The simultaneity problem in a large economy arises because shocks to capital demand affect the equilibrium interest rate. To the extent that shocks to capital demand at the firm level are partially idiosyncratic, the use of firm-level panel data should reduce the simultaneity problem. The intuition is the same as that for a small, open economy. Just as shocks to the demand for capital in a small economy have little effect on the world interest rate, idiosyncratic shocks to capital demand in a particular firm have little effect on the country's interest rate. To the best of our knowledge, our paper is the first to use firm-level data to estimate the user cost elasticity with panel cointegration techniques.

Another natural way to address the simultaneity problem would be through the use of instrumental variables – variables that do not affect the demand curve for capital but that shift the supply curve. In general, the literature has not come up with many good instruments. One exception is Cummins et al. (1994), who use tax reforms as instruments. Their results are consistent with the importance of the simultaneity problem. They obtain substantially larger estimates of the effects of user cost for years immediately following tax reforms.[4] One interpretation of their results is that they are able to trace out points on the demand curve by focusing on shocks (tax reforms) that lead to persistent shifts in the supply curve. Under the assumption that shifts in the supply curve – due to both technological shocks and tax reforms – tend to be more persistent than shocks to the demand curve, cointegration techniques provide a complementary econometric solution to the simultaneity problem.

The simultaneity problem provides a strong reason for using cointegration techniques, but there is a second important reason. Economic theories make quite different predictions about investment dynamics.[5] However, a wide variety of theories predict the same long-run relationship between the capital stock and user cost. Again, this suggests that better estimates can be obtained by using techniques that focus on low-frequency movements in the data.

The simultaneity problem is one reason that we use panel data. A second motivation is the traditional one: more variation in the data is usually helpful in obtaining better estimates.[6] In panel data, there is considerably more variation – both in the capital/output ratio and user cost – than in aggregate data. For example, the weighted average cost of capital differs across firms because of differences in the relative importance of debt and equity and because of cross-sectional differences in risk. In fact, the additional cross-sectional variation seems to help: our standard errors are generally quite small. There is also Monte Carlo evidence that panel cointegration techniques can help in reducing small sample bias in the estimation

[2] Guiso et al. (2002) also make the point that the demand curve for capital fluctuates substantially at business cycle frequencies. Moreover, they provide an additional reason (beyond increasing marginal cost or market structure) why the supply curve for capital may slope upward, based on the interaction between investment demand and monetary policy.

[3] Hamilton, James has made a similar argument in his textbook: Time Series Analysis, 1994, Section 19.2, p. 589.

[4] Related work includes Cummins and Hassett (1992) and Cummins, Hassett, and Hubbard (1996).

[5] In the neoclassical model without adjustment costs, the capital stock will respond immediately to shocks. In a Q model with convex adjustment costs, the transition path to the new steady state will depend on whether shocks are anticipated (or realized) and transitory (or persistent). In a model with irreversibility at the micro level, the estimated short-run elasticity at a higher level of aggregation will depend on the sequence of previous shocks and the cross-sectional distribution at a lower level of aggregation (e.g., at the plant level) of the gap between the desired and actual capital stock.

[6] In the specific case of panel cointegration, Monte Carlo simulations in Kao and Chiang (2000) show a large reduction in the standard deviation of the estimator in going from time series to panel data. For example, in Table 2, they find that the standard deviation of the estimator is reduced by more than 80% in going from a sample with $N = 1$, $T = 20$ (i.e., time series data) to a sample with $N = 20$, $T = 20$ (i.e., panel data), where N is the cross-sectional dimension and T is the time series dimension.