Journal of Macroeconomics 56 (2018) 15–34

Contents lists available at ScienceDirect

Journal of Macroeconomics

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

Business capital accumulation and the user cost: Is there a heterogeneity bias?☆

Serena Fatica[1]

European Commission – Joint Research Centre, Address: BLDG 36 01/114, Via Enrico Fermi 2749, I-21027 Ispra (VA), Italy

ARTICLE INFO

Keywords:
Capital accumulation
User cost of capital
Corporate taxation
Panel data

JEL classification:
E22
H25
C33

ABSTRACT

Using data from 23 sectors in 10 OECD countries over the period 1984–2007 we show that the homogeneity assumption underlying empirical models of capital accumulation may lead to misspecification. Thus, we adopt a fully disaggregated approach – by asset types and sectors – to estimate the responsiveness of investment to the tax-adjusted user cost of capital. Once all the sources of heterogeneity are accounted for, we find that capital accumulation is significantly affected by changes in the user cost, although the size of the impact is smaller than the unit benchmark. We do not find robust evidence that the long run substitution elasticities are statistically different across asset types.

1. Introduction

Capital accumulation is crucial for business cycles and economic growth. Understanding its drivers is therefore essential. Among the potential determinants, the literature has extensively investigated the role of the user cost (see Chirinko (1993a, 2008) for comprehensive surveys). Most studies treat capital as a homogeneous good. However, there is motivated concern that the single capital good model inadequately describes the effects of changes in the user cost on capital accumulation, primarily because it neglects compositional shifts in investment.

In fact, different capital goods command different prices, display different depreciation patterns, and receive a specific tax treatment. First, market prices vary widely across assets and over time. In some cases, price changes might reflect long-term trends, such as technological progress. For instance, quality improvements in high-tech components have led to a dramatic decline in market prices for computers and similar goods (Greenwood et al., 1997). Secondly, technological features directly affect adjustment costs, which presumably increase with the useful life of the assets. Likewise, the durability of capital goods determines the amount of replacement investment needed to sustain a given level of production, under unchanged technological constraints. Thirdly, the impact of tax policy differs across capital asset types. Tax allowances for depreciation of capital expenditure are typically asset–-specific, or defined for relatively narrow asset categories (Clark, 1993; House and Shapiro, 2008). Moreover, even non-targeted tax policy measures translate into different relative changes of the user cost of different assets, depending on its initial level (Cummins et al., 1996).

Importantly, both asset and sector specificities matter for the trajectories of capital accumulation. In so far as different sectors are technologically constrained to rely on specific capital assets, investment evolves unevenly across industries. The responsiveness to cost variables changes also if supply is rigid and if the capital assets are not easily redeployable, even within sectors (Goolsbee, 1998).

☆ The views expressed in this paper are solely those of the author and do not necessarily reflect those of the European Commission.

E-mail address: serena.fatica@ec.europa.eu.

[1] Comments from an anonymous referee, Bob Chirinko, Eduardo Rossi, participants to the IIPF Congress in Dublin and to a seminar at the European Commission are gratefully acknowledged.

https://doi.org/10.1016/j.jmacro.2017.12.004
Received 24 February 2017; Received in revised form 13 December 2017; Accepted 20 December 2017
Available online 21 December 2017

Moreover, increased asset specialization, by reducing the incentives for disinvestment, might alter the sensitivity of investment to its cost. As Desai and Goolsbee (2004) point out, these types of irreversibilities are likely to manifest at the microeconomic level – i.e. at the level of the individual asset and sector – "rather than apply to all assets in all sectors homogeneously" .

Abandoning the assumption of homogeneous capital creates challenges for investment modelling. In the context of structural models, the combination of different types of capital goods into a single aggregate imposes unappealing restrictions, on either the level and the shape of adjustment costs (Wildasin, 1984; Chirinko, 1993b), or the degree of substitutability among assets (Hayashi and Inoue, 1991). On the empirical side, aggregation creates issues for the construction and measurement of variables in the first place. Moreover, naturally, econometric models with aggregate variables force homogeneity on the estimated parameters. Likewise, the standard panel data pooled estimators constrain the slopes in the estimating equation to be the same across cross-section units. This might have severe consequences in reduced-form models of capital accumulation resting on the long run cointegrating relationship between the actual and the frictionless level of capital implied by economic theory (Caballero et al., 1995).

In this paper, we investigate the consequences of imposing homogeneity when estimating the sensitivity of investment to the tax-adjusted user cost of capital. We use data – including detailed information on business tax incentives – for 23 sectors comprising the market economy in 10 OECD countries over the period 1984–2007. Our setup accommodates heterogeneity across capital asset types and economic sectors. As such, it departs from the bulk of the literature on the substitution elasticity, based on aggregate data (Schaller, 2006; Caballero, 1997; Bond and Xing, 2015). In focusing on asset heterogeneity we take inspiration from Tevlin and Whelan (2003), who reveal the shortcomings of aggregate models due to the rising importance of computers as of the 1990 s in the US. Smith (2008) and Bakhshi et al. (2003) provide similar analyses for the UK. We extend their contributions not only by considering a broader set of assets, countries and sectors, but also by systematically investigating the effects of neglected heterogeneity along these dimensions. Our paper also relates to the recent article by Bond and Xing (2015). They use the same investment data (although a slightly different sample definition) as we do, but still work with aggregate measures of capital. We show that their conclusions do not necessarily survive a finer definition of capital goods. Moreover, we formally examine how heterogeneity affects econometric estimates of the substitution elasticity, something that is inherently different from the focus of their analysis.

The remainder of the paper proceeds as follows. Section 2 discusses a way to deal with multiple capital assets in a standard empirical investment model. Section 3 introduces the data, and some stylized facts. Section 4 describes our empirical strategy. The results are in section 5. Finally, section 6 offers some concluding remarks.

2. Investment model: theoretical background and empirical specification

The traditional setup with aggregate capital series implicitly assumes a constant elasticity of substitution across assets. We stick to this assumption to derive the estimating equations, and then verify whether it holds in the data given the estimated elasticities.[2] The simplest way to accommodate different types of capital goods is a single-level constant elasticity of substitution (CES) production function. Under constant returns to scale, output in sector i is:

$$Y_{i,t} = \left[\sum_{j=1}^{J} A_{ijt} K_{ij,t}^{\frac{\sigma_i - 1}{\sigma_i}} + \left(1 - \sum_{j=1}^{J} A_{j,t} \right) L_t^{\frac{\sigma_i - 1}{\sigma_i}} \right]^{\frac{\sigma_i}{\sigma_i - 1}}, \tag{1}$$

where K_j denotes the j-th type of capital, L is labor, and the A_j's are distribution parameters capturing capital-biased technological progress. The parameter of interest is σ_i, the elasticity of substitution. While in Eq. (1) we allow for different sector-specific production functions, the CES implies that the elasticity of substitution is constant across asset types within each sector. As a special case, $\sigma_i = 1$ holds for the Cobb-Douglas production function.

In competitive markets without adjustment costs, the optimal level of capital type j is a log-linear combination of output and the user cost of capital:

$$k_{ij}^* = \widetilde{\alpha}_{ij} + y_i - \sigma_i c_{ij}, \tag{2}$$

where small caps indicate the natural logarithm of variables, and also $\widetilde{\alpha}_{ij} = \sigma_i \ln(A_{ij})$. If the marginal investment is financed by retained earnings, the tax-adjusted user cost derived by Hall and Jorgenson (1967) is:

$$C_{ij} = P_{ij}(r + \delta_j)\frac{(1 - \tau\Psi_{ij})}{1 - \tau}, \tag{3}$$

where P_{ij} is the price of the capital asset relative to the price of output, Ψ_{ij} is the net present value of depreciation allowances, r the real discount rate, and τ is the marginal corporate income tax rate. If instead the marginal source of finance is debt, one needs to account for the fact that in standard corporate income tax systems interest payments are deductible for tax purposes. The user cost of capital for a debt-financed investment is:

[2] A more flexible functional form allowing for different substitution elasticities, such as a translog function leading to interrelated factor demand equations, could be envisaged. We have estimated a static translog treating all capital assets as quasi-fixed. However, the cross-equation restrictions imposed by the translog were rejected by the data, leading us to prefer the approach followed in this paper. Given the limited time dimension of our sample, the CES framework, avoiding parameter proliferation, allows for a better modelling of the dynamics of capital accumulation.