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On the interaction of financial frictions and fixed capital adjustment costs: Evidence from a panel of German firms

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ABSTRACT

This paper analyzes the interaction of financial frictions and non-convex adjustment costs. Non-convex adjustment costs imply that firm-level investment is lumpy. Firms invest infrequently but each investment is large. This allows financial variables to influence investment along two margins. They can alter the size of the stock of capital a company wishes to hold in the long run or they can influence the frequency at which investment projects are undertaken. The empirical analysis of this paper reveals that finance has nearly no long-run influence on the stock of capital in a sample of German companies. By contrast, the influence of finance on investment decisions is substantial. Consequently, finance primarily affects investment frequencies and financial factors and fundamental capital productivity strongly interact in the determination of investment.

1. Introduction

Empirical research on investment still lacks a conclusive summary of the determinants of investment both at the micro-level as well as for the aggregate. Seemingly well-established is only the fact that the neoclassical, *q*-theoretic model investment with quadratic adjustment costs has difficulties in explaining empirical patterns of investment (see Caballero, 2000). Still, this finding leaves open the qualitative question of which of the assumptions of the neoclassical model lead to its

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empirical failure. Moreover, it calls to quantify the extent to which each deviation from the neoclassical model actually helps to explain investment data.

Beginning with Fazzari et al. (1988), the empirical literature has emphasized the role of financial factors in company-level investment. More recently, attention has been drawn to the role of non-convexities in investment technology.[1]

This paper looks at the interaction of these deviations from the neoclassical model and employs an error correction, in other words cointegration, approach to investment in the empirical analysis.

In particular, we focus on the exact way in which finance affects investment, if it does so at all. Bayer (2006a) finds that financial frictions may alter target levels of capital as well as the probability of infrequent investment in a setting with fixed adjustment costs. We apply the error-correction model and two-step econometric technique outlined in that paper to a sample of German companies. In difference, the employed estimation strategy takes into account at all steps of the estimation that both the financial situation of a company as well as the intensity of its fundamental investment incentives are endogenous. Thus, we are modifying and improving upon the technique proposed in Bayer (2006a).

In the first step of the estimation we determine the difference ('gap') between the actual stock of capital and the stock of capital a company would like to hold if there were no adjustment costs in the current period. This capital gap (technically: the error term) can be understood as the 'mandated investment'. The second step of the analysis then focusses on the investment process itself, which is understood as the adjustment process of capital that subsequently closes the capital gap.

A distinct feature of our error-correction approach is that it can be derived from a structural model of investment both under the neoclassical null hypothesis of quadratic adjustment costs as well as under the alternative hypothesis of fixed adjustment costs and capital market frictions.[2] Because of this feature, it allows us to simultaneously analyze both fixed costs and capital market frictions.

In particular, the approach enables us to differentiate between short- and long-term influences of financial variables, because we sequentially estimate target levels of capital and adjustment dynamics. The estimation hence reveals whether abundant financial resources alter investment rates mainly by directly shifting average investment rates, or by changing the investment process in a more complex manner in interaction with fundamental investment incentives.

For adjustment costs themselves, inference mainly draws from the estimate of the adjustment paths of capital, i.e. investment. Within the error-correction approach to investment, the difference in model alternatives manifests in a different form of the error-correction process. Under quadratic adjustment costs and a unit root in productivity, the error correction is linear. If adjustment costs are non-convex instead, e.g. fixed, then higher-order terms of the cointegration error become significant and the adjustment speed varies with the size of the error term, i.e. gap between the desired and actual stock of capital.

While our approach is borrowed from Bayer (2006a), we modify and extend it to cope with a broader class of endogeneity issues. The non-parametric analysis in Bayer (2006a) is replaced by a parametric non-linear error-correction model. This allows us to address endogeneity of the regressors in the investment regression. This endogeneity stems from the presence of residual

[1] For evidence on non-convex adjustment costs, see Caballero et al. (1995), Doms and Dunne (1998), Cooper et al. (1999), Caballero and Engel (1999), Goolsbee and Gross (1997), Abel and Eberly (2002), Nielsen and Schiantarelli (2003), Carlsson and Laséen (2005), or Cooper and Haltiwanger (2006).

The literature on financial frictions and their impact on investment has been surveyed by Hubbard (1998). Mairesse et al. (2001) also give a broad overview. More recent contributions are e.g. Kaplan and Zingales (1997), Gilchrist and Himmelberg (1998), Guarglia (1999), Cummins et al. (2006), Erickson and Whited (2000), or Bond et al. (2003). Particularly, Gomes (2001) is an interesting contribution in this nexus, as it looks at the effect of non-convexities in finance on investment. This paper's results call for an integrative approach.

[2] See Sargent (1978) and Rotemberg (1987) for the quadratic adjustment costs setup, Caballero and Engel (1999) for a setup with fixed adjustment costs, and Bayer (2006a) for a fixed adjustment costs and financial frictions model. Because of this wide applicability, the gap approach is preferable to a q-theoretic model of investment. Measures of Tobin's q are known to be problematic whenever stock markets are not (perfectly) efficient (Cummins et al., 2006), whenever there are rents not related to the stock of capital (Merz and Yashiv, 2007), or when adjustment cost is not convex (Barnett and Sakellaris, 1999, p. 259).