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Investment-cash flow sensitivities and capital misallocation

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ABSTRACT

This paper directly estimates the effect of financing constraint on capital misallocation. We provide a simple theoretical framework that links the heterogeneity in investment-cash flow sensitivity, a common indicator of financing constraint, to the dispersion of marginal revenue product of capital, a direct measure of allocative inefficiency. Our model shows that the existence of both constrained and unconstrained firms is a sufficient though not necessary condition for capital misallocation. Empirically, we run an error-correction investment model for U.S. Compustat and Chinese manufacturing firms, and for various sub-samples of the Chinese firms. Our estimates on investment-cash flow sensitivities imply a 5% and 15% total factor productivity loss respectively for the balanced and unbalanced panels of Chinese firms. Our identification strategy does not require any monotonic relationship between investment-cash flow sensitivities and severity of financial frictions, thus is not subject to the Kaplan and Zingales critique.

1. Introduction

Inputs misallocation across heterogeneous production units lowers aggregate total factor productivity (TFP). A new and growing literature, as surveyed in Restuccia and Rogerson (2013), finds that difference in allocative efficiency may be an important explanation to the large and persistent cross-country income differences. Among various sources of misallocation, perhaps the single most studied mechanism is through financial frictions.

Quantifying how much the observed capital misallocation can be accounted for by financial frictions is the central theme of a recent literature.[1] While modelling details and estimated magnitudes differ, these studies share a common methodology: they develop theoretical models and gauge the size of TFP loss, by calibrating model parameters to match the distribution and dynamics of output across production units. In this paper, we propose an alternative accounting framework to estimate TFP loss due to financial frictions, using investment-cash flow sensitivity.

Investment-cash flow sensitivity arises from a large body of empirical literature, which aims to test the presence of financial frictions. Following Fazzari et al. (1988), this literature adds a cash flow variable to a standard Q model of investment, and investigates the sensitivity of investment to cash flow across different sub-samples of firms. A common finding is that there is a stronger correlation between investment and cash flow for sub-samples that are considered more likely to face financing constraint. This finding has often been cited as evidence of significant capital market imperfections.

Though investment-cash flow sensitivity is frequently used as an indicator of financing constraint, and financing constraint is one of the major sources of capital misallocation, there has not been any research, to our knowledge, that connects capital misallocation directly to investment-cash flow sensitivity. This paper attempts to fill in this gap by providing a simple yet consequential theoretical model, which links the heterogeneity in investment-cash flow sensitivity, a common indicator of financing constraint, to the dispersion of marginal revenue product of capital (MRPK), a direct measure of allocative inefficiency. We then apply this accounting framework to a panel of Chinese manufacturing firms and calculate the aggregate TFP loss implied by the investment-cash flow sensitivities estimated from various sub-samples.

The validity of this new approach, of course, depends crucially on the answers to two methodological questions. First, whether investment-cash flow sensitivity is a reliable indicator of financing con-

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[1] For example, Jeong and Townsend (2007), Banerjee and Moll (2010), Amaral and Quintin (2010), Greenwood et al. (2010), Buera et al. (2011), Cole et al. (2016), in addition to those papers we discuss below in detail.

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straint. Even under perfect capital markets, cash flow sensitivity may result from measurement errors in Tobin's Q (Ericson and Whited, 2000), or from imperfect competition and/or decreasing return to scale (Cooper and Ejarque, 2003), or from the presence of capital adjustment costs (Pratap, 2003), or a combination of measurement error in Q and identification problems (Gomes, 2001). Furthermore, a firm's cash flow position is endogenous to its productivity shocks and may contain information about its investment opportunities (Hennessy and Whited, 2007).

To address these concerns, we present a structural model of costly external finance. Firms in this model are allowed to face imperfect competition and/or use decreasing returns to scale technology. In the absence of any friction, our model generates the same optimal condition as those models in the recent literature: optimal capital stock is only a function of current output, Jorgensonian user cost of capital and production technology. This allows us to develop an empirical specification for investment that does not rely on Tobin's Q. We then consider an autoregressive-distributed lag structure to accommodate the possibility of capital adjustment costs, which yields an error-correction specification as in Bond et al. (2003). Under the null hypothesis of no financial frictions, cash flow should not affect investment under this specification. We allow for the potential endogeneity of cash flow in our estimation using GMM techniques. And we test whether the cash flow terms show significantly different predicting powers across those samples that produce significantly different investment-cash flow sensitivities.

The second concern regarding investment-cash flow sensitivity and financing constraint is the well-known Kaplan and Zingales critiques.[2] Kaplan and Zingales (1997) argue that investment-cash flow sensitivities do not always monotonically increase as firms become more financially constrained. Thus one cannot in general use estimates of investment-cash flow sensitivities to proxy the severity of financial frictions. Our theoretical model shows that the relationship between investment-cash flow sensitivities and the severity of financial frictions indeed depends on the curvature of the profit function and the cost function of external finance. However, even though more-financially-constrained firms do not necessarily exhibit higher sensitivity, it remains the case that unconstrained firms should display no investment-cash flow sensitivity. Therefore, finding that one group of firms has positively significant sensitivity while the other group shows no sensitivity is a sufficient though not necessary condition of capital misallocation, which is indeed the general pattern of our empirical finding. Given that our identification strategy only relies on investment-cash flow sensitivities instead of excess investment-cash flow sensitivities, it is not subject to the Kaplan and Zingales critique.

By proposing an alternative approach and providing another set of estimates, this paper is closely related and contributes to the current literature, which addresses the ongoing debate regarding the importance of financial frictions on aggregate TFP. On the one hand, there is a large literature, such as Buera and Shin (2013) and Caselli and Gennaioli (2013), that simulates a substantial TFP loss from various models of financial frictions. On the other hand, Midrigan and Xu (2014) find that a collateral constraint model consistent with Korean plant-level data only implies a fairly small loss, where the key mechanism that undoes the capital misallocation is self-financing. Using firm-specific borrowing costs for U.S. manufacturing firms directly from the interest rate spreads on their outstanding publicly-traded debt, Gilchrist et al. (2013) also find a very modest loss. More recently, the literature has pointed out two important reasons that may drive the wide range of the effects: the persistence of the productivity shocks (Buera and Shin, 2011; Moll, 2014); and whether the effect is on transition dynamics or steady state (Jeong and Townsend, 2007; Buera and Shin, 2013; Moll, 2014).

[2] A recent discussion and evaluation on the Kaplan and Zingales critiques can be found in Bond and Söderbom (2013).

According to our accounting framework, the observed MRPK is a function of both investment-cash flow sensitivities and firm's optimal choice on capital stock and external finance. This implies that we do not have to directly calibrate the persistence of the productivity shocks, or any other model parameters. Neither do we have to take a pre-assumption on whether the firms are at the steady state. Instead, we take a snap shot of the firms in our sample and ask how large the efficiency loss is, according to their actual investment and financing behavior. On this regard, we share the same spirit as Gilchrist et al. (2013). That is we directly make use of the observed firm behavior, which is the outcome of both financial frictions and firm's optimal response.

The findings of the paper are as follows. When we apply the error-correction investment model to a 10-year balanced panel of U.S. Compustat firms, we do not detect any investment-cash flow sensitivity. In contrast, there are significant sensitivities for a 10-year balanced panel made of Chinese firms. Within Chinese firms, when splitting the sample using any criterion based on age, size, ownership or political connection, and both for the balanced and unbalanced panels, we obtain significant cash flow effects for those that are young, small, non-state-owned and without political connection. The resulting aggregate TFP loss implied by these investment-cash flow sensitivities are 4.0–5.2% for the balanced panel and 10.0–15.2% for the unbalanced panel.

The rest of this paper is organized as follows. Section 2 provides a theoretical framework mapping the investment-cash flow sensitivities to MRPK. Section 3 describes the empirical specification used to estimate investment-cash flow sensitivities. Section 4 presents our estimates on investment-cash flow sensitivities and calculates the implied aggregate TFP loss due to financing constraint. Section 5 concludes.

2. Model

2.1. The production environment

Firm i receives an investment opportunity represented by a stochastic productivity parameter Z_i. It makes an investment I_i to build up capital stock $K_i = (1-\delta)K_{i,-1} + I_i$, where δ is the depreciation rate and $K_{i,-1}$ is its lagged capital stock. The firm employs capital K_i and variable inputs L_i to produce output Y_i according to a production technology,

$$Y_i = Z_i^{1-\eta}\left(K_i^{\alpha} L_i^{1-\alpha}\right)^{\eta},$$

where $0 < \eta < 1$ is the degree of returns to scale.[3]

Denote w as the wage rate. For a given capital stock K_i, firm i chooses variable inputs L_i to maximize its instantaneous gross profit:

$$\pi_i = \max_{L_i} \{Y_i - wL_i\}.$$

The solved-out profit function is given by

$$\pi(Z_i, K_i) = Z_i^{\gamma} K_i^{1-\gamma}, \tag{1}$$

where

$$\gamma \equiv \frac{1-\eta}{1-\eta+\alpha\eta}. \tag{2}$$

The first-order condition for optimal choice of variable inputs yields

$$\frac{wL_i}{Y_i} = (1-\alpha)\eta,$$

which implies that the gross profit is always a constant share of output in this model,

$$\frac{\pi_i}{Y_i} = 1 - \eta + \alpha\eta. \tag{3}$$

[3] Decreasing returns to scale may be due to managerial technology (where η is the Lucas span-of-control parameter), or due to Dixit-Stiglitz type of monopolistic competition in an environment with heterogenous products (where $1-\eta$ is the inverse of the demand elasticity).