Frictional capital reallocation I: Ex ante heterogeneity☆

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ABSTRACT

We study dynamic general equilibrium models where capital is traded in frictional markets featuring liquidity considerations. Gains from trade arise from ex ante heterogeneity: some firms are better at investment, so they build capital in the primary market, while others acquire it in the secondary market. We consider specifications with random search and bargaining, as well as those with directed search and posting, and provide strong results for both on existence, uniqueness, efficiency and comparative statics. Monetary and fiscal policy are discussed in detail. Among other advantages, the framework is tractable enough to analyze using simple diagrams.

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1. Introduction

Components necessary for efficient output and growth include: (i) getting the right amount of aggregate investment; and (ii) getting the capital available at a point in time into the hands of those best able to use it. In traditional macroeconomics, the former received more emphasis, but reducing *capital mismatch* via reallocation has recently received a lot of attention (the literature is reviewed below). Components (i) and (ii) are obviously related, since the ease with which used capital can be reallocated should affect incentives for investment in new capital, just like attributes of secondary markets for houses, cars and other assets influence demand and supply in primary markets. This paper develops a dynamic general equilibrium theory of investment featuring frictional markets for existing capital with two alternative micro-market structures: first we consider random search and bargaining; then we consider directed search and price posting.[1]

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[1] We emphasize our interest here is reallocation across firms, but one can also consider reallocating capital within firms (e.g., Giroud and Mueller, 2015), across sectors (e.g., Eberly and Wang, 2009; Ramey and Shapiro, 2001), across countries (e.g., Caselli and Feyrer, 2007), etc. Also, we focus mainly on trading unbundled physical capital. As Jovanovic and Rousseau (2002) say, "There are two distinct used-capital markets. Used equipment and structures sometimes trade unbundled in that firm 1 buys a machine or building from firm 2, but firm 2 continues to exist. At other times, firm 1 buys firm 2 and

Eisfeldt and Rampini (2006), and more recently Cao and Shi (2016), find the reallocation of existing capital is around 25% of total investment. However, these data exclude mergers, and ignore firms that are relatively small or not publicly traded, all of which can make 25% an underestimate. Cui (2013, 2017) and Dong et al. (2016) suggest the right number may be more like 30%. Also, these data are only for purchases, not rentals of capital, which may be at least as important. In any case, evidence suggests secondary capital markets may be qualitatively and quantitatively relevant. Moreover, again, the functioning of secondary markets influences investment in primary markets. Hence it seems interesting to develop models where the impact of fiscal and monetary policy on these variables can be tractably analyzed.[2]

We pursue the idea that secondary capital markets are neither perfectly competitive nor frictionless, although of course one could always model them that way (e.g., Holmes and Schimtz, 1990; Jovanovic and Rousseau, 2002). That capital reallocation is not frictionless is argued by, e.g., Kurmann and Petrosky-Nadeau (2007), Gavazza (2010, 2011a, 2011b), Cao and Shi (2016), Kurman (2014), Ottonello (2015) and Kurman and Rabinovich (2016). Imperfections include information issues related to adverse selection, financial constraints due to limited commitment, and holdup problems due to bargaining. We downplay adverse selection and other information issues (on these see, e.g., Li and Whited, 2014, and references therein). This allows us to concentrate on issues related to search, bargaining and liquidity. Thus, our secondary capital markets feature bilateral trade, as in equilibrium search theory, and the use of assets in exchange, as in modern monetary theory.

Any analysis of reallocation builds on gains from trade, with capital flowing from lower- to higher-productivity firms in the model, as in the data (e.g., see Andrade et al., 2001; Maksimovic and Phillips, 2001; or Schoar, 2002). The formulation here is based on ex ante heterogeneity: firms in the secondary market have different capital stocks due to differences in their investment ability in the primary market. Hence, there are gains to reallocating capital from those with more to those with less, since the latter have a higher marginal product, even if they have the same technology conditional on their capital stock (see also Xiao, 2017). In a companion paper, Wright et al. (2017), we alternatively study a formulation with ex post heterogeneity, where firms in the secondary market have similar capital stocks but different productivities due to idiosyncratic shocks. We think both are interesting. In any case, we assume decreasing returns to scale in production, because otherwise, given any two firms, the efficient outcome is for the more productive one to get all the capital. With decreasing returns, the more productive firm may get some but not necessarily all of the other's capital.[3]

For random search and bargaining or directed search and posting, we prove existence and uniqueness of steady state equilibrium. Under certain conditions both specifications can be reduced to two equations, one for capital and one for money, that determine investment and reallocation, or, supply and demand in the secondary market. This allows us to easily show how investment, reallocation and other endogenous variables depend on monetary, fiscal and other exogenous variables. The analysis also provides insights into observations deemed interesting in the literature. One such observation is that reallocation is procyclical even though capital mismatch appears countercyclical (e.g., Cao and Shi, 2016; Cui, 2013; Eisfeldt and Rampini, 2006; Lanteri, 2016). Our model is consistent with this stylized fact because in good times there may well be less incentive to reallocate capital, due to lower dispersion in productivity, but there is also more capital, so actual reallocation can be greater.

Capital investment and reallocation are not generally efficient in equilibrium. In fact, conditional on investment, reallocation is efficient if and only if monetary policy runs the Friedman rule, which is the limit $\iota \to 0$, where ι is the nominal interest rate. But that is conditional on investment, which is not generally efficient. In the bargaining version of the model, there is no bargaining power that delivers efficiency due to a double holdup problem. If random search and bargaining are replaced by directed search and posting, however, efficiency obtains in equilibrium at $\iota = 0$. Alternatively, we discuss how taxes or subsidies on capital income can deliver efficiency. Generally, higher nominal interest (or inflation or money supply growth) rates reduce capital reallocation, and they reduce investment under reasonable conditions. This is consistent with conventional Keynesian wisdom, but the logic is unconventional, as discussed below. Perhaps less surprisingly, but no less relevant, higher capital income taxation also reduces investment and reallocation.

Further in terms of the literature, Cao and Shi (2016) also use a search-based model, but it is quite different; in particular, they focus on market tightness as determined by entry, while we abstract from that to highlight other margins. Ottonello (2015) also models capital reallocation through search to explain recovery from a financial crisis, but there are again many differences – e.g., he has households selling capital to entrepreneurs, while we have firms trading with each other. Kurman and Rabinovich (2016) and Dong et al. (2016) are also complementary with key differences – e.g., they have capital trade intermediated by dealers with access to a frictionless interdealer market, while again we have firms trading bilaterally. Moreover, none of the above papers consider monetary economies. Rocheteau et al. (2017b) study a monetary

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[2] On fiscal policy, taxation has been shown to have big effects on capital investment, output, and welfare by, e.g., Chari et al. (1994), Cooley and Hansen (1992), McGrattan et al. (1997) and McGrattan (2012). On monetary policy, there is much precedent for studying the impact of inflation on investment, going back to Tobin (1965), Sidrauski (1967), Stockman (1981) and Cooley and Hansen (1989). These papers take reduced-form approaches, using money-in-utility-function or cash-in-advance models. In contrast, we are solidly in the New Monetarist camp that avoids such short cuts. Work using microfoundations based on Lagos and Wright (2005), like our model, includes Aruoba and Wright (2003), Aruoba et al. (2011) and Andolfatto et al. (2016). Other related work includes Shi (1998, 1999a, 1999b), Shi and Wang (2006), Menner (2006) and Berentsen et al. (2011b), based on Shi (1997), and Molico and Zhang (2006), based on Molico (2006). Rocheteau and Nosal (2017) provide a textbook treatment

[3] When one firm gets *all* the capital of the other, it looks like a merger or acquisition. This can happen even with decreasing returns, in general, but not with standard Inada conditions.

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thereby gets to own all of firm2's capital. In both markets, the traded capital gets a new owner." We emphasize the first type, but make a few remarks on mergers and acquisitions (see, e.g., Harford, 2005 for more).