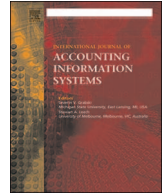




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Riding the waves of technology through the decades: The relation between industry-level information technology intensity and the cost of equity capital

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ABSTRACT

This paper examines the effect that information technology (IT) investments have on the industry cost of equity capital. We find that industry IT intensity, defined as the relative amount of IT investment to total fixed asset expenditures, is negatively related to the industry cost of equity capital. These results indicate that industries with higher levels of IT investment have lower cost of equity capital. We also find that the relation between IT intensity and cost of equity capital changes over time. Initially, investors viewed IT investments as risky ventures and demanded higher levels of cost of equity (or higher return on their investment) for those industries investing in IT. However, beginning in the 1980s, as IT became more reliable, more cost effective, and had the ability to transform businesses, investors viewed IT Intensity as a positive business strategy with less associated risks and reduced their required cost of equity capital (or lower return on their investment). Extrapolating from our industry results, IT investments allow firms to potentially raise capital at a lower price so they have more assets to employ, indicating that IT investments can be a key factor for business success.

1. Introduction

The past six decades have seen information technology (IT) continuing to evolve – from the original vacuum tube computer to the complex networking systems of today (Hirschheim and Klein, 2012). Each decade or “wave” of technology changed IT applications, system reliability, and managerial processes employed by the firm (Rockart, 1988). Given each wave's distinctive characteristics and associated risks, the relation between IT and firm performance measures is likely to be different for each wave. Accordingly, we examine the following research question: how is IT intensity, defined as the relative amount of IT investment to total fixed asset expenditures, associated with the cost of equity capital in each of the last six waves, or decades, of technology?

Various approaches and output measurements have been used to examine the impact of IT investments on firm performance (c.f. Kobelsky et al., 2014; Dedrick et al., 2003; Dehning and Richardson, 2002). Initially, little empirical evidence of the (positive) relation could be found leading to the term “productivity paradox” (Brynjolfsson and Hitt, 1996). However, more recently, research has found support for the relation. Firms strategically invest in technology to enhance their financial performance (Grabski et al., 2011; Dehning et al., 2003; Im et al., 2001; Dewan et al., 2007). For example, IT spending is an important aspect of a firm's value

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chain (Kobelsky et al., 2008) and this relation may be mediated through revenue enhancement and cost savings (Mithas et al., 2012). We extend this literature by examining IT's relation to the cost of equity capital, which is the rate of return that firms have to pay for the equity used (Easley and O'Hara, 2004).

The cost of equity capital varies between firms to reflect differences in risk (Barth et al., 2013). Higher risk firms are subject to a higher cost of capital, while lower risk firms enjoy a lower cost of capital (Easley and O'Hara, 2004). However, the relation among IT investment, risk and cost of equity capital is not obvious. On the one hand, due to the riskiness of new technologies and the potential obsolescence of existing technologies, IT can be viewed as increasing the overall risk of the firm (Ren and Dewan, 2015), suggesting a higher cost of equity capital.

On the other hand, investments in IT have been shown to reduce risks in firms (Otim et al., 2012). One potential reason for the reduction in risk is Bezos' Law, which states that the price of a single unit of computing power is reduced by 50% every three years (O'Connor, 2014), continually decreasing the total cost of ownership. This cost reduction means that firms can invest in IT in hopes of reducing coordination costs and eventually firm size (Dedrick et al., 2003) as well as increasing both productivity and revenue (Im et al., 2013). Another potential reason for the reduction in risk is that IT, if implemented effectively throughout the firm, allows managers to generate more accurate forecasts indicating that IT investments provide managers with higher quality information (Li 2012) (hopefully) leading to better strategic decisions. So, over time as the price drops, more computing power becomes available making investments in IT (potentially) have a greater strategic impact, which should decrease a firm's overall level of risk and its associated cost of capital.

To address our research question, we employ different measures than most extant IT productivity research. Instead of using IT spending or IT budgets, we use IT intensity, defined as the comparative investment of a firm on their IT resources, because the measure better captures the relative mix of IT used in strategic priorities (Stiroh, 2002). Our IT intensity measure is available at the industry level from the Bureau of Economic Analysis. Therefore, we examine the relation of industry-level IT intensity with the industry-level cost of equity capital, which captures the risk often associated uniquely with an industry (Fama and French, 1997). We also examine this relation over time to reflect the evolutionary changes in the IT waves since the 1950s.

Conducting our analysis at the industry level is appropriate because it eliminates any idiosyncratic issues that could be present at the firm level (Hu, 2005). Moreover, given that production environments tend to be highly correlated within industries because firms within an industry typically use similar *technologies* and face similar production functions, markets, *and risks* (Ely, 1991, emphasis added), the relative IT investment levels and cost of equity capital should be similar for firms throughout an industry.¹ This industry-level examination allows us to capture unique industry risks, attributes, and characteristics as well as provide a broader understanding of the effect (Brynjolfsson et al., 1994; Chou et al., 2012). Thus, by testing industry-level data, this study presents an overall understanding of a macro-level benefit of IT investment, potentially helping to evaluate the decades of studies on the "productivity paradox."

We find that the overall relation between IT intensity and cost of equity capital from 1950 to 2009 is significantly negative indicating that investors appear to have rewarded firms that invest in IT with a lower cost of equity capital. However, further inspection reveals that the relation between IT intensity and cost of equity capital changes over time. In the first decade marked by the first UNIVAC computer (1950s), industry-level IT intensity was positively related to the industry-level cost of equity capital, signifying a higher cost of equity for industries investing in IT. Thus, it appears that initially investors viewed IT investments as risky ventures with only limited applications and markets, therefore requiring a higher level of cost of equity for those industries investing in IT. During the 1960s and 1970s, there is no clear relation between IT intensity and the cost of equity capital. However, beginning in the 1980s, IT intensity is negatively related to cost of equity capital, signifying a lower cost of equity for industries investing in IT. The 1980s ushered in the PC, which increased IT's reliability, cost effectiveness, and transformational power (Brynjolfsson et al., 1994). At this point, investors likely began to view IT investments as a positive, less risky, business strategy thereby reducing their required cost of equity capital. Extrapolating from these industry results, effective IT investments appear to now lower cost of equity capital, allowing firms to raise capital at a lower price so they have more assets to employ. Finally, we find that the results are independent of industry.

The remainder of the paper is organized as follows. Section 2 develops the hypotheses concerning the impact of IT intensity on the cost of equity capital. Section 3 presents the methods employed in this research. Section 4 presents the empirical findings. Finally, Section 5 concludes.

2. Hypothesis development

2.1. Cost of equity capital

Investors use cost of equity capital to evaluate investment opportunities. The cost of equity capital can be thought of as the rate of return that must be paid for equity (Easley and O'Hara, 2004). Thus, the cost of equity capital represents the compensation that the market demands in exchange for owning the asset and bearing the risk of ownership. This measure is often referred to as a risk metric because it provides investors with a sense of the market's perception of risk. Higher levels of risk require higher returns (i.e., a higher cost of equity capital) than lower levels of risk (Ashbaugh-Skaife et al., 2009).

¹ Thus, based on this argument, a firm-level analysis should provide similar results. Unfortunately, our IT intensity measurements are not available at the firm-level to confirm this conclusion.

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