



The complementarity and substitutability relationships between information technology and benefits and duration of unemployment



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ABSTRACT

This paper aims to analyze the complementarity and substitutability relationships between information technology (IT) and unemployment benefits (B) and duration of unemployment (D), two important policy and macroeconomic variables, by using the partial adjustment (PA) valuation (PAV) approaches where the speeds of PA are fixed and time-varying. The proposed eight research models derived from the PAV approaches based on the theory of PA are fitted into a country-level panel data set covering the period from 1993 to 2008 for a sample of 12 countries and are estimated by the seemingly unrelated regressions (SUR) and nonlinear SUR (NLSUR) methods. The findings include: (i) the speeds of PA are dynamic and variable rather than constant, causing the fluctuations of the performance index over time; (ii) among the three production factors used, the traditional (non-IT) capital (K_{it}) is found to exert the greatest impact upon the desired (true) output and, consequently, upon the performance index; (iii) B or D or joint B and D has the power to shift the speeds of PA in the countries considered; (iv) the impacts of B, D, and the combination of B and D upon the actual (observed) output and, hence, upon the business value of IT vary from country to country; and (v) all in all, the empirical evidence strongly suggests that the government policy of B, D, or B and D combined is good for some advanced developed countries (e.g., US and CN) but may be ineffective for some newly developed nations (e.g., Greece and Norway) in the presence of IT, and that the policy of joint B and D is good for all four advanced developed countries and five (Australia, Denmark, Norway, Portugal, and Switzerland) of the eight newly developed economies in the absence of IT.

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1. Introduction

In the past decades, information technology (IT) has become one of the most prominent factors that impacts the firm's or country's productivity and performance. The term IT in its modern sense first appeared in an article published in the *Harvard Business Review* in 1958, in which the authors commented that, “the new technology does not yet have a single established name. We shall call it information technology.” Abundant research on the business value of IT has emerged since then, both at the firm and country levels. Numerous firm level studies [4,6,11,17,18,27, and others] claim that IT impacts the firm's performance positively and the IT productivity paradox has disappeared, where the productivity paradox is defined as the apparent lack of productivity improvements that are expected to occur as a result of IT investment; in other words, it means the lack of a substantial and statistically significant contribution of IT investment to firm output at the

firm level or to aggregate output at the country level [cf. 6,28]. Especially, [28] provides a conflicting opinion suggesting that the productivity paradox remains as an unpleasant phenomenon.

At the country level, the debates over the productivity paradox are even more severe. Some researches [e.g., 12] argue that the productivity paradox exists only in developing countries, while some others [7,23,25,26] demonstrate that the productivity paradox exists in both developing and developed countries. These conclusions provide important managerial implications for investors, governments and decision-makers as IT investment is expected to increase over time [6,18,23,25, 27–30].

During an economic recovery and an expansion, there is a misconception that benefits and duration of unemployment are harmful to the country's economic recovery and growth, thereby are not effective national policies; and they are actually the hurdles of economic recovery and growth. During an economic downturn and a recession (e.g. the most recent one taking place in 2008–2009), the misconception gets even more popular. Decision makers, managers, and ordinary people as well are concerned with the increasing unemployment rate, declining housing prices, scary stock prices, and paltry yields on bank accounts, etc. The media constantly reports how many Americans are looking for work and that payrolls, stock prices, and GDP growth

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point to another contraction, etc. The Congress has passed the bills of extending jobless benefits. No other U.S. post-war recession than the most recent one has been so prolonged and severe. Indeed, every recession causes a lot of pains, job losses, and the financial crisis. Mired in the stress of recession, people get desperate and overly sensitive to lengthened benefits and duration of unemployment.

Nevertheless, no one seems to question whether unemployment benefits (denoted by B hereafter) and/or the duration of unemployment (denoted by D hereafter) may have the potential positive or adverse impacts upon the country's GDP and, hence, the value of IT. Such an important economic issue should be taken seriously as a topic of research inquiry. The present study aims to bridge the gap by pursuing this important research topic.

In substance, this study concentrates on the complementarity and substitutability relationships between two well-familiar country characteristics (B and D) and IT within the framework of the partial adjustment methodologies. Here, a complementarity (a substitutability) relationship between any two variables (say, $X1$ and $X2$) is defined as a phenomenon in which the presence of $X2$ strengthens (weakens) the country's performance or the value of $X1$, measured by a performance metric (e.g., APR_t in Eq. (9) below) and, consequently, $X1$ and $X2$ are complementary (substitutable), and vice versa.

More specifically, the objective of this study is to analyze the relationships among IT, B , and D , and the effects of B , D , or B and D on the country's performance as measured by the performance index (ratio) when IT is present. In other words, the objective of this research is to answer three research questions, namely, (i) Does IT investment improve or worsen the country's performance as measured by the average performance ratio called APR in the presence or absence of B or D or B and D together? (ii) Does B , D or joint B and D have a positive or adverse (a negative) impact upon the country's performance as measured by APR in the presence of IT? (iii) Does B , D , or B and D combined strengthen or weaken the country's performance as measured by APR in the absence of IT? These research questions are critically important to an economy regardless of whether the economy is in a depression or an expansion era, amid the fact that IT value and impact research at the firm level is abundant but, in contrast, knowledge accumulation of IT value and impact at the country level is poor [7,23,29]. To achieve the objective, we apply the partial adjustment valuation (PAV) approaches with constant and time-varying speeds of partial adjustment.

The rest of the paper is organized as follows. Section 2 conducts a literature review; Section 3 describes the theory of partial adjustment (PA), the PAV approaches, the performance measure, the research models, and the estimation methods. Section 4 discusses the variables and the set of country-level panel data used, while Section 5 presents the various specification and validity tests, the empirical results needed to answer the three research questions, a detailed discussion of the results to answer the research questions, implications for policy makers and for academic researchers, and the links of the study to DSS. Section 6 concludes the paper with some remarks and managerial decision-making benefits of this study.

2. Literature review

As mentioned above, numerous researches have investigated the value of IT and held conflicting opinions on the so-called productivity paradox phenomenon. The studies can be classified into two major groups: one group focuses on IT and productivity [6,12,13,30]; and the other on IT and productive (technical) efficiency [7,20,23–25,27]. These researchers undertake either a firm- or a country-level analysis; and conflicting conclusions have been reached towards the existence of the productivity paradox, as we discussed in the preceding Section.

Meanwhile, previous studies apply different methodologies. Some [6,12,18] of them have applied the traditional regression-analysis approach; many others have used the data envelopment analysis (DEA)

approach; and still other studies [7,17,23,27,28] are based on the time-varying stochastic production frontier (SPF) approach. Moreover, Lin et al. [25] and Lin and Kao [26] proposed the one-equation and the two-equation PAV approach with constant and time-varying speeds of partial adjustment, respectively, to evaluating and measuring the value of IT. Though different approaches have been employed, there are only a few studies [e.g., 7] that concern the factors that influence the business value of IT.

In a narrow sense, IT value can be measured by technical efficiency (TE) associated with the SPF approaches or by the performance index (PI) associated with the PAV approaches. In a broad sense, IT value can be expanded to include the TE (or PI) change index that is the ratio of the productivity growth index (or total factor productivity index) to the technological progress index [24]. Moreover, according to Steil et al. [39] and Miozzo and Walsh [32], IT induces technological change and innovation which in turn stimulate economic growth, globalization, and international competitiveness. Having reviewed some selected firm-level studies of IT value published in the 1990–2002 period and selected industry- and country- level studies of IT returns during the 1987–2001 period, Dedrick et al. [14] have found the relationship between IT and productivity and, hence, economic performance, and concluded that the productivity paradox has been effectively refuted.

In contrast, however, the firm- and country- level studies of [28] (which used the same set of data as used in [e.g., 6,18,27]), [7,23,28, etc.] have concluded that the productivity paradox remains in large U.S. firms and in a country regardless of whether it is a developed or developing country.

The aim of this study is to investigate the impacts of the country's two essential macroeconomic unemployment factors, namely, unemployment benefits (B) and the duration of unemployment (D), upon the business value of IT, and vice versa.

To fulfil the goal, we apply the two-equation PAV approach with time-varying speeds of adjustment [26] and, simultaneously, compare to the one-equation PAV approach with constant speeds of adjustment [25]. The two-equation PAV approach is featured by several merits. First, like the one-equation PAV approach, the two-equation PAV approach has a solid theoretical foundation since it is based on the theory of partial adjustment.

Second, the two-equation PAV approach is appropriate for the present study investigating the influence of B and D upon the business value of IT. We base this point on the scientific literature and on convincing explanations. (i) On the basis of the scientific literature, the two-equation PAV approach is featured by several merits as compared with other methods such as DEA and SPF: (a) DEA is mathematical programming-oriented, lacks theoretical foundation, and is deterministic and nonparametric; thus, unlike DEA, the PAV approach is stochastic and parametric as SPF. (b) The two-equation PAV approach with dynamic and variable speeds of adjustment is particularly suitable for research topics engaged in PA towards a desired (maximum) target (e.g., PA towards maximum output in this research, PA towards target capital structure, etc.), but both DEA and SPF are not. (ii) On the basis of convincing explanations, the PAV approach with dynamic and variable speeds of adjustment is constituted by two equations (see Eqs. (3) and (4) below) to evaluate and measure the performance of the country and, hence, the value of IT; and the performance is influenced by the desired (maximum) output through the first equation where IT capital appears, and is also impacted by the changes in the observed (actual) output via the second equation where B , or D , or both B and D appear.

Third, the PAV approaches (one-equation and two-equation) and their accompanied (built-in) performance measures are easy to apply since, unlike the SPF approach, the PAV approach with either constant or time-varying speeds of partial adjustment does not involve a half-normally distributed random inefficiency variable. Simply because the SPF involves a half-normally distributed random inefficiency variable, its two-stage estimation procedure is complicated and may fail if

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