



# Drivers and outcomes of open-standard interorganizational information systems assimilation in high-technology supply chains

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## ABSTRACT

In recent years, firms in high-technology supply chains have established internet-based electronic linkages with their trading partners. As a result, they have improved their ability to coordinate and synchronize shared business processes by using more complete, accurate, and timely information. These electronic linkages are based on open-standard interorganizational information systems (OSIOS), which are fundamentally different from traditional electronic data interchanges. OSIOS capture not only the technical specifications for data interchange but also the sequential steps for the execution of shared business processes. Because OSIOS are still at an early diffusion stage, it remains unclear why firms would assimilate such an innovation and whether assimilation provides firms any benefits. In this research, we develop a framework grounded on the economics of standards, institutional theory, and strategic interorganizational information systems literatures to investigate the drivers and outcomes of OSIOS assimilation in a focused context. In order to test our hypotheses based on this framework, we used data from a high-technology supply chain and employed econometrics techniques. We found that both competition asymmetry across supply chain echelons and OSIOS assimilation within supply chain echelons predict individual firms' OSIOS assimilation. The results also suggest that firms' supply chain dominance is both a driver and an outcome of OSIOS assimilation, highlighting a mutually reinforcing process. In addition, our study reveals boundary conditions of the hypothesized relationships. The use of multiple theoretical perspectives, a unique dataset, and innovative statistical techniques to investigate OSIOS assimilation in high-technology supply chains contributes to the body of knowledge in both the supply chain management and management of information systems disciplines.

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## 1. Introduction

Innovation assimilation – the overall process of invention, adoption, and deployment of new technology and related process improvements (Schumpeter, 1934) – is a key source of competitive advantage (Abernathy and Utterback, 1978). In high-technology supply chains characterized by networks of firms (Stuart, 2000), the locus of innovation assimilation lies in a wide array of interorganizational relationships (Oke and Idiagbon-Oke, 2010) that are beyond the purview of individual firms (Choi et al., 2001). In light of assertions that pressures in institutional environments influence competitive strategy (Dacin et al., 2002) and supply chain management (SCM) (Liu et al., 2010; Rogers et al., 2007), understanding the determinants and implications of innovation assimilation involving

multiple trading partners in these supply chains is important for both theory and practice.

In this research, we investigate the emergent phenomenon of assimilation of open-standard interorganizational information systems (OSIOS) that integrate information technology (IT) with interorganizational business process standards (Bala and Venkatesh, 2007) in high-technology supply chains. Because the assimilation of OSIOS to support the integration of IT and interorganizational business standards in supply chains is a fairly recent phenomenon (Paulraj et al., 2012; Zhou and Benton, 2007), research has only identified a few initial drivers and benefits of OSIOS assimilation. According to prior studies, OSIOS contribute to an orderly sharing of information between firms (Zhou and Benton, 2007) by clearly defining the structure and format of electronic exchanges through a common language. Extant research has also underscored how OSIOS can support the choreography of these exchanges through a sequence of steps required to execute cross-boundary business processes between two or more firms (Zhu et al., 2006b). Thus, from an SCM perspective, research has depicted OSIOS as

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enablers of modularized interoperability between supply chain partners (Gosain et al., 2003; Nelson et al., 2005). OSIOS are typically developed by standard-setting consortia of firms (Zhao et al., 2007) and are also known as electronic procurement innovations (Rai et al., 2009), IT-enabled interorganizational business process standards (Bala and Venkatesh, 2007), Internet-based electronic business (e-business) (Zhu et al., 2006b), Internet-enabled SCM systems (Liu et al., 2010), standard electronic business interfaces (Malhotra et al., 2007), and vertical information systems standards (Nelson et al., 2005; Wigand and Steinfield, 2005).

Studies investigating the drivers (Boh et al., 2007; Nelson and Shaw, 2003; Zhu et al., 2006b) and outcomes (Gosain et al., 2004; Malhotra et al., 2005; Saeed et al., 2005) of the assimilation of IT innovations in general and OSIOS in particular have predominantly focused on the diffusion of innovations literature and used either the technology acceptance model (Davis, 1989; Davis et al., 1989) or the technology–organization–environment model (Tornatzky and Fleischer, 1990) to describe, rather than to explain or predict, this phenomenon. Although such frameworks describe the assimilation of these innovations in generalizable settings, they do not incorporate the salient characteristics of both drivers and outcomes of OSIOS assimilation by individual firms competing within and trading across supply chain echelons.

This research aims to address this deficiency in the literature by shedding light on three main characteristics in the context of high-technology supply chains: (1) firm supply chain dominance, a firm-level variable that captures a firm's market power in relation to other firms in the supply chain; (2) competition asymmetry across supply chain echelons, an industry-level variable that reflects the variability between competition levels within and across echelons of the supply chain; and finally (3) OSIOS assimilation within a firm's supply echelon, an industry-level variable that reflects the aggregate level of OSIOS assimilation by competitors positioned within the same echelon as the focal firm. Our approach of investigating these characteristics at multiple levels of analysis provides a more nuanced understanding of OSIOS assimilation, including cases in which firms make plans to adopt OSIOS but fail to actually deploy (i.e., accept, adapt, routinize, and institutionalize) them (Fichman and Kemerer, 1997).

Moreover, building on the work of Bala and Venkatesh (2007) and Zhu et al. (2006b), we focus on OSIOS assimilation during an early diffusion stage of OSIOS in high-technology supply chains. Focusing on an early diffusion stage of OSIOS within high-technology supply chains is important for two reasons. First, these supply chains operate in highly dynamic environments (Eisenhardt, 1989), and as a result, their management requires intense collaboration among firms positioned across different echelons to survive (Nelson et al., 2005; Stuart, 2000). Second, these supply chains are subject to strong network externalities (Schilling, 2002), in which investments in innovations entail uncertainty and risk (Katz and Shapiro, 1985). Therefore, it is unclear why certain firms would move from planning the adoption to actually deploying OSIOS, especially at an early diffusion stage in the assimilation of these standards. Although firms pursuing OSIOS assimilation at an early diffusion stage would incur high levels of risk and cost, they would also accrue significant benefits from such a move. Indeed, research has argued that OSIOS have the potential to shape supply chain structures (Dedrick et al., 2008) and fundamentally transform industries (Varian, 2001; Wigand and Steinfield, 2005). Therefore, OSIOS users stand to gain by being at the forefront of this innovation's assimilation in their supply chain. However, given the novelty of OSIOS, this issue remains largely untested empirically.

This study also uses a unique dataset that captures actual OSIOS assimilation by firms and objective measurements of the drivers as well as the outcomes of the assimilation over time. This approach is better suited for capturing OSIOS assimilation than

the predominant empirical approaches in the literature, which are based on perceptual measures from cross-sectional survey data and qualitative measures from case study analyses. Although these empirical approaches capture important managerial beliefs, intentions, and expectations behind assimilation, they are limited in predicting whether and why firms deploy OSIOS. Surveys and case studies are also limited in capturing inherently dynamic longitudinal relationships regarding actual OSIOS assimilation (Bala and Venkatesh, 2007; Rai et al., 2009), particularly at an early diffusion stage, because they gather restricted timeframe data. Moreover, these empirical approaches are based on path models that have neglected the possibility of a two-way direction of causality between the drivers and the outcomes of OSIOS assimilation.

To develop our model of drivers and outcomes of OSIOS assimilation, we first provide a description of OSIOS and their key differentiating attributes in SCM. We then introduce the economics of standards behind OSIOS assimilation and review the literature on institutional theory and strategic interorganizational information systems. This forms the theoretical foundation to develop our hypotheses that link competition asymmetry across supply chain echelons, OSIOS assimilation within a firm's supply chain echelon, firm supply chain dominance, and firm OSIOS assimilation. To test these hypotheses, we first compile a dataset comprising OSIOS assimilation at an early diffusion stage and both industry and firm data from a high-technology supply chain. We then analyze the data by estimating simultaneous equation models based on two-stage least squares and the generalized method of moments (GMM) approaches. We conclude with a discussion of our analysis' findings, theoretical and practical contributions, and opportunities for further research.

## 2. Background

### 2.1. OSIOS and their key differentiating attributes in SCM

OSIOS assimilation has critical implications for supply chain partnerships. Fuelled by the impact of the Internet's open standards in business operations, the growth of OSIOS assimilation has the potential to transform how trading partners do business (Johnson and Whang, 2002; Mukhopadhyay and Kekre, 2002). The proliferation of internet-based IT, especially Extensible Markup Language (XML), has laid the foundation for firms to electronically share richer information with partners in their supply chains (Johnson and Whang, 2002; Swaminathan and Tayur, 2003). Such information sharing can promote efficiency (Rai et al., 2009; Saeed et al., 2005) by facilitating interorganizational collaboration and coordination (Balakrishnan and Geunes, 2004; Fawcett et al., 2011), joint knowledge creation and assimilation (Malhotra et al., 2005; Salomon and Martin, 2008), and mutual adaptation (Malhotra et al., 2007). Moreover, OSIOS can provide firms strategic flexibility to interconnect with multiple partners (Gosain et al., 2004). In environments punctuated by rapid changes in demand, competition, and products (D'Aveni, 1994), these benefits can provide firms that assimilate OSIOS greater market power than other supply chain constituents (Riggins and Mukhopadhyay, 1994; Saeed et al., 2005). In contrast, the lack of common open standards for linkages using more traditional interorganizational information systems, such as electronic data interchange (EDI), has hindered interconnectivity and information sharing among firms (Frohlich, 2002; Gosain et al., 2003). Moreover, the closed nature of standards in these traditional systems has made it economically infeasible for groups of firms to promote a wider assimilation of these systems across industries. In order to support their efforts in assimilating OSIOS, firms have joined standard-setting consortia (Zhao et al., 2007), such as RosettaNet. OSIOS supported by these consortia are distinct

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