

# IS INTEGRATION, ENVIRONMENTAL DYNAMISM AND ECONOMIC PERFORMANCE

*Research-in-Progress*

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## Abstract

*Does Enterprise Systems (ES) integration pay off? Research on IS integration has been an enduring quest for the IS discipline. Is it really worth it? Research has often responded to the question positively. It is useful to explore which conditions ES is likely to yield value. Research has also shown that less imitable factors such as the quality of IT management and the nature of the environment which the firm operates likely play a key role in potential value derived from ES. Furthermore, more research has suggested that IT investment has differential impacts in terms of cost versus revenue. In this paper we differentiate both integration and dynamism into external and internal types looking at the interactions. Specifically, this research-in-progress paper provides evidence that: 1) firms with high internal and high external integration have lower sales and 2) high internal dynamism positively moderates the impact of external integration upon earnings.*

**Keywords:** Environmental dynamism; Firm performance; Enterprise applications

## **Introduction**

Does Enterprise Systems (ES) integration pay off? As Tanniverdi et al. (2011) pointed out, research on IS integration has been an enduring quest for the IS discipline. But is it really worth it? Research has often responded to the question rather positively (Hendricks et al., 2007; Poston and Grabski, 2001). Yet, very limited samples of prior research limit external validity. It is useful to explore in which conditions ES is likely to yield value. Research has also shown that less imitable factors such as the quality of IT management and the nature of the environment in which the firm operates likely play a key role in potential value derived from ES (Nevo and Wade, 2011). Furthermore, more recent research (Mithas, et. al., 2012) has suggested that IT investment has differential impacts in terms of cost versus revenue. As a result, this leads to the following research questions:

*Does enterprise system integration generate economic performance?*

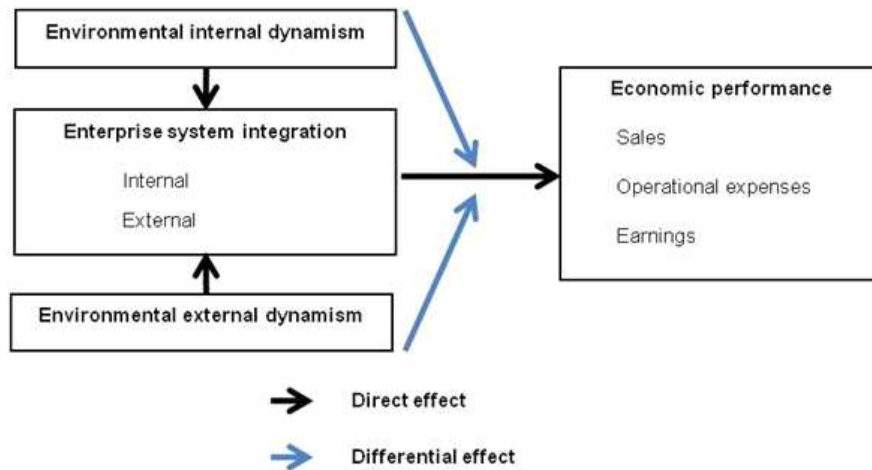
*If so, under what environmental dynamism conditions and by what mechanism?*

## **Theoretical background and propositions**

Our model builds upon the proposals of Nevo and Wade (2011) who develop a conceptual framework to trace the path that goes from I.T. assets all the way to firm profitability through the construction of I.T. enabled resources, which are a result of the following: I.T. assets, organizational resources, management efforts to integrate the latter two. Profitability is a result of the value of IT enabled resources which are generated. External environmental turbulence impacts one specific component of IT enabled resources which is the amount of external integration. The more turbulent an environment is, the more developed are connections with parties outside the firm, as if to sense what is happening. Nevo and Wade (2011) propose three avenues for future research which we also develop in our work:

- We develop our research on the topic based on direct measures of economic performance, similar to Mithas et al. (2012) and not perceptual ones as Nevo and Wade (2011) have done,
- We develop more robust and extended measures of environmental turbulence, through the notion of environmental dynamism, both internal and external
- We apply our approach to a wide array of I.T. enabled resources and not just to one type of IT enabled resource in one department (a CRM in a customer service department).

In our model (figure 1), Enterprise Systems are qualified based on how strongly integrated they are internally and externally, as explained below in the definition of our variables. Internal and external dynamism interact with IS integration and impacts some of its components, which in turn, impacts economic performance. This leads us to express two propositions as detailed below.



**Figure 1. Research Model**

Under the label of technology readiness technologies that form the basic infrastructure of e-business such as EDI and extranet, front-end websites functionalities and back-end integration with internal databases have been shown to have a positive impact on sales and ecommerce value in the financial industry (Zhu et al., 2004). Zhu (2004) has also demonstrated the complementarity of back end integration and external Information systems integration and its impact on sales, albeit on a limited sample of 114 firms in the retail industry. This is an important result for the Resource-Based-View literature in IS. However, if not so many firms achieve a high level of such complementarity and have to make a choice in their resource allocation, it is worth investigating which of the two sides of IS integration pays-off best: internal or external?

However, as envisioned by Nevo and Wade (2011) the turbulence of the environment plays an important role in enabling the firms to increase their economic performance. In this paper we use environmental dynamism, a concept close to environmental turbulence. Oh, Teo and Sambamurthy (2012) show that environmental dynamism positively moderates the relationship between explorative competence and firm performance, and that IT-enabled channel integration capability is an important antecedent to this explorative competence. In the literature, the dynamism of the environment is often considered to be a dimension of uncertainty (Xue et al., 2011). However, they measure performance using perceptual measures of how the firm fares with respect to the competition and mix items such as net profits, revenue growth and returns to measure their performance construct. Our aim in this paper is to distinguish how economic earning is formed using accounting and economic measurements that are available in a large sample of firms.

Prior literature has exposed the enabling benefits of integration, both internal and external. However, integration both enables and constrains firms (Benner and Tushman, 2003). Integration is likely to improve customer satisfaction for existing customers through improved coordination, resulting in improved sales to existing customers. New customers, however, can often have different requirements from existing customers and in such circumstances too much integration can lead to rigidity and inability to explore new potential customer bases. This leads to the following proposition:

*P1: Greater internal integration negatively moderates the impact of external integration on sales.*

The role of dynamism has primarily been explored in the literature through the lens of external dynamism and primarily through the role of IT to increase firms' ability to respond to external events. The general argument is that integration increases the speed at which a firm can respond to external shocks. However, the role of integration in internal changes has remained relatively unexplored. During times of internal change greater integration could act as a source of rigidity constraining firms and directing more resources internally to overcome this rigidity. When the integration is primarily internal this might very well be the case. However, when firms have strong external integration these external linkages increase the possibilities for the firm. External integration allows firms to more quickly substitute external

resources for internal resources and become a source of much needed flexibility. As a result we propose the following proposition:

*P2: Increased internal dynamism positively moderates the impact of external integration upon earnings.*

## Methodology

### Data Collection and Sampling

To study the relationship between internal/external integration and business value, we rely on a large survey conducted by the French National Institute of Statistics and Economic Studies (INSEE) in 2006. This may complement the knowledge we have of the diffusion of ERP and integrated systems in France (Bidan et al., 2012). The primary aim of the so-called COI-TIC survey ("Organizational Changes and Technologies of Information and Communication) is to focus on IS integration, the extended enterprise and functional related aspects.

Questionnaires including 44 questions were sent by regular mail to a nationally representative sample of about 17,000 firms (randomly drawn) with at least 10 employees. The survey was mandatory, i.e. it was an administrative obligation for firms to answer it. This explains why so many firms answered the questionnaire even with sensitive questions such as those on security. Most of the time, the survey was filled in by the CIO, or in small firms by the member of the Top Management Team in charge of IT issues. At the same time, this process also explains why the survey was unable to go too far in asking behavioral questions related to the use of systems and to security. The response rate is equal to 85% and 13,790 firms filled in the questionnaire correctly. With such a response rate this defines a weighted sample of 163,099 firms of 10 employees and more, representative of the French economy since the population source is drawn with the constraint of being representative in terms of firm size and industry.

As our primary concern is on integration, we choose to select the subsample of firms having the six following functions either internally managed or managed by a subcontractor or a service provider : i) marketing, ii) production, iii) finance, iv) R&D, v) human resources, and vi) logistics. This leaves us with an unweighted sample of 9,721 firms (the weighted size is 102,615). In so doing, we restrict our attention to multi-functional firms that are by definition larger on average. For instance, the proportion of firms with 500 employees and more is 16.5% in our sample instead of 13.9% in the original sample. This selection will have to be kept in mind when interpreting our results.

**Table 1. Descriptive Statistics**

Variables		Mean nb of security tools	Mean score of internal integration	Mean score of external integration	Mean score of internal dynamism	Mean score of external dynamism	Number of observations
Industry	Agro-business	3.422	0.442	0.459	1.371	7.823	661
	Consumption goods	3.515	0.457	0.388	1.627	7.593	651
	Equipment goods	3.582	0.535	0.393	1.660	7.939	912
	Intermediary goods	3.565	0.522	0.410	1.626	8.137	1,615
	Construction	3.013	0.323	0.138	0.927	7.346	901
	Commerce	3.425	0.385	0.370	1.478	7.470	2,014
	Transportation	3.496	0.347	0.285	1.123	8.252	667
estate	Finance and real	4.197	0.447	0.193	1.595	7.183	748
	Firm services	3.799	0.409	0.258	1.631	6.533	1,552
Firm Size	10-19 employees	2.813	0.259	0.178	1.086	7.198	1,298
	20-49 employees	3.114	0.323	0.241	1.183	7.391	2,594
	50-249 employees	3.641	0.455	0.341	1.488	7.528	3,118
	250-499 employees	4.017	0.558	0.438	1.796	7.779	1,110
	500+ employees	4.381	0.611	0.484	2.048	7.841	1,601
Group belonging		3.934	0.507	0.395	1.734	7.615	5,686

Network belonging		3.561	0.384	0.346	1.449	7.554	1,343
Market Scope	Local/regional	3.168	0.325	0.219	1.049	7.102	2,691
	National	3.580	0.404	0.289	1.355	7.332	2,198
	European	3.555	0.426	0.359	1.532	7.681	1,267
	International						
(outside EU)		3.831	0.529	0.421	1.864	7.914	3,565
All		3.554	0.431	0.327	1.480	7.528	9,721

### **Measurement of internal and external integration**

We now turn to the measurement of internal and external integration, each indicator being constructed from a large set of questions filled in the COI-TIC survey. Internal integration, which allows relevant information about business activities or transactions to be shared within the firm, is supposed to depend on the following items: use of ERP, use of software package, use of in-house software, lack of computing tools respectively for the R&D, purchase, sales, production, human resources and accounting departments; presence of central database respectively for R&D, sales, human resources, and accounting, and presence of database interface tools.

Concerning external integration (how companies and business partners integrate systems at different points in a supply chain), we rely on the following questions : use of an extranet, use of an EDI, use of tacking tools, use of supply chain management software, if the use of purchasing/sales delivery systems is coupled with supply/billing software, if the firm receives/places orders through internet or EDI, if its largest client has its system coupled for orders and billing with that of the firm, if the firm has its system coupled with its largest suppliers for orders and billing. It is important to recall here that external integration is an approximate concept for what we really measure which is the extent of external linkages or interconnectivity and the two should not be confused (Venkatraman, 1994).

A central issue consists in aggregating these various integration outcomes (respectively 29 internal outcomes and 13 external outcomes) into two synthetic indicators. Instead of relying on an ad hoc procedure like equal weights for the various components of the indicator, we consider a principal component analysis to determine endogenously these weights following Filmer and Pritchett (2001). This multivariate statistical technique is used to reduce the number of variables into a small number of dimensions that capture the common information most successfully. When there is a high degree of correlation among the selected variables, then only a few components are required to pick up common information. A detailed description of the procedure is provided in de Corbière et al. (2012). When turning to the data, our synthetic indicators stem only from the first component, which explains by definition the largest possible amount of variation in the data. The proportion of the covariance explained by the first component is respectively 18.7% for the internal index and 27.9% for the external index. The mean values of our synthetic indicators are by construction set to 0, their standard deviations being equal to 2.33 (external) and 1.90 (internal). Integration (either internal or external) is simply higher within firms characterized by larger values of the corresponding score.

The coherence of such aggregate indicators is investigated in de Corbière et al. (2012). These authors show for instance that the mean value of the external index increases strongly with the number of firm functions computerized within the firm. Also, they find that firms with large external linkages scores are much more likely to use ERPs than firms with low scores. The same pattern holds true for firms having database either for design, sales, human resources or accounting or having database interface tools. All these features (use of ERP or of database) are by definition evidence of a high degree of external integration, which proves the validity of such principal component analysis techniques. As shown in Table 1, the pattern of integration (either internal or external) strongly varies by type of industry or firm size. The mean score of internal integration is significantly higher in the sectors of equipment goods (0.535) and intermediary goods (0.522), while it is much lower in construction (0.323) and transportation (0.347). External integration is also much lower in the construction sector (0.138), but we also note that a score below the average is found for firms involved in finance and real estate activities (the situation is

different for internal integration). Such pattern is expected given the security needed for financial transactions. Agro-business (0.459), consumption goods (0.388), equipment goods (0.393) and intermediary goods (0.410) are sectors where firms have more integrated systems with business partners. Table 1 further shows that the score of both external and internal integration strongly increases with the size of the firm, with market scope and for firms belonging to a group.

### ***Measurement of external and internal environmental dynamism***

The COI-TIC survey offers to consider two components, external and internal (Robles, 2011) of environmental dynamism to the extent that they have affected the firm being 2003 and the date of the survey.

First, each firm indicates to what extent its activity has been influenced by the following modifications since 2003 : i) change in sanitary/legal standards and rules, ii) change in technological processes, iii) market uncertainty, iv) variation in exchange rates and raw material costs and v) entry of new competitors. For each item, the respondent firm indicates whether the impact was either null or very weak, weak, strong or very strong. We assign values ranging from 0 to 3 for each answer and sum the various scores to obtain an aggregate indicator of external environmental dynamism. According to the COI-TIC survey, firms were on average more affected by market uncertainty (with a mean of 1.78) and to a lower extent by changes in standards and rules (1.58). About 19% of firms claimed that they were strongly affected by market uncertainty and 18% were strongly affected by variation in exchange rates and costs.

Secondly, we define an indicator of internal environmental dynamism using questions related to organization changes since 2003. Each firm surveyed indicates whether it has experienced i) a financial restructuring (merger, acquisition, sale, buy-out), ii) organizational restructuring, iii) relocation of part of the production (offshoring), iv) location of new sites abroad (without relocation). We also know the strategic importance of new products for the firm and consider that there is a strategic need for novelty when answers given mentioned either a strong or very strong importance. This concerns 59.4% of firms in our sample. On average, 29% have experienced a financial restructuring, 42.2% an organizational restructuring, 6.6% some offshoring and 10.8% an extension of business activities abroad. Finally, we sum up the five dummies to obtain our indicator of internal uncertainty.

As shown in Table 1, the intensity of dynamism depends on the type of industry. Internal dynamism is much higher for equipment goods (1.660), firm services (1.631) and consumption goods (1.627). Conversely, internal dynamism was much lower between 2003 and 2006 for the construction (0.927) and transportation (1.123) sectors. The pattern is clearly different when considering external dynamism. The highest score is for instance found for transportation and the lowest for firm services. The correlation between both types of dynamism is nonetheless positive, equal to 0.155. A final comment is that largest firms are more concerned with internal dynamism than small and medium-size firms. As expected, firms that operate internationally suffer more often from both types of dynamism.

### ***Baseline Model and Control Factors***

We selected three dependent variables for economic performance: sales, operational expenses and earnings. As a baseline model for each of the three dependent variables we regressed them with the costs of the major inputs (raw material, labor and average long term financial assets) and a number of classical controls. In addition to classical controls such as sector (note that financial assets or labor expenditures already measure firm size), in our empirical model we use I.T. assets which are made up of the tools such as networks and security tools which enable Enterprise Systems to function, as control variables. We also use Performance measurement abilities, which should positively impact economic performance in certain economic sectors (Fernandez et al., 1996).

Thus, the survey allowed us to construct a measure of number of security tools based on whether the firm had implemented 1) antivirus software, 2) firewalls, 3) secured servers, 4) remote access back-up, 5) authentication mechanisms (Baskerville et al., 2012). The survey also took into account network assets such as the type of internet connection (ISDN, DSL, cable and others) and bandwidth. For Performance measurement abilities, we measured how reporting was done and distinguish when Financial ROI reporting or activity monitoring, or both are used (Fernandez et al., 1996).

Baseline model variables and dependant variables were calculated based on data provided in annual financial surveys conducted by the French National Statistical Institute (INSEE). For year 2006, we managed to pair this financial survey with the above mentioned I.T. survey. We also had access to financial annual surveys from years 2002 to 2007. After pairing, we ended up with a database of 9 721 companies for year 2006.

In order to select relevant accounting indicators we had to overcome two challenges.

First, three different types of questionnaires are used for the annual financial survey, each adapted to a specific group of sectors (the construction and the transport industry each have a specific questionnaire; other sectors have an almost identical questionnaire with minor variations across sectors). A core number of variables are identical across all questionnaires, although they are not always given the same name. Specific variables are collected for some sectors (such as leasing contracts for the transport sector and for industry). The first step was to select variables which would be identical across all sectors in order to use identical economic performance indicators. This was done by looking at the definition of the variables for each questionnaire and selecting those variables which had the same definition and were useful to understand economic performance.

Second, French accounting standards differ in some ways from US or international ones. The major difference of interest to us here is in the way the matching principle is applied (matching as precisely as possible the expenses and the revenues of a given accounting period). In the French system, transfer of expenses from one accounting period to the next can be applied under certain conditions. For example, some major repairs to equipment can be spread over three years. Another example is depreciation, which, under given circumstances, can be written back. Although these rules have an economic justification and can lead to give a better “true and fair view” of a company’s financial situation, they can also, even within the limits of the law, lead to window dressing behavior and income smoothing. Furthermore, specific tax rules also lead companies to adopt depreciation and amortization methods which will provide tax breaks, although these methods are not necessarily justified from an economic point of view. Thus, based on what was available, we had to select economic indicators, which would be understandable for an international audience and would not integrate French rules.

This led to the following selection for the baseline model:

- Cost of purchases (HA). This includes the cost of goods and raw materials incorporated into the goods and services sold by the company or, for a commercial company, the cost of the goods purchased for resale.
- Cost of labor. This includes all labor related expenses, including salaries paid directly to the employees, bonuses, and the cost of mandatory health and retirement insurance plans.
- Average long term assets. Data on the net value of assets was not available. Data on equity was not available. Data that would have enabled us to calculate the net value of fixed assets or of equity, in a reliable manner, was also not available. The indicator available to us was the gross value of fixed tangible and intangible assets. This indicator measures the historical cost of the company’s assets such as patents (intangible), buildings, equipment (tangible), that is the value at which these assets were purchased.

For dependent variables, we made the following choices.

- Sales. In this case the choice was straightforward. Sales represent the commercial ability of a company. Evolution of sales over many years can indicate which way the company is going commercially. Benchmarking sales with the average value of the company’s sector can tell whether a given company is outperforming, or not, its sector.
- Operational expenses (OPEX): this includes the cost of running the company operations such as maintenance, utilities, advertising and other services from suppliers, labor expenses, miscellaneous operational tax expenses. Expenses which can lead to window dressing or income smoothing are not included in this calculation.
- Earnings. We chose to calculate a “gross operational surplus”. This indicator is obtained by subtracting cost of purchases and operational expenses from sales. It corresponds to what is internationally known as EBITDA (Earnings Before Interest, Tax, Amortization and

Depreciation). It only includes revenues and expenses which correspond to cash flows and thus cannot be impacted by differences in tax and accounting rules or income smoothing strategies.

## Results

Regression results are presented in tables 1 and 2 below. Overall model fit was good.

**Table 2. Base Model**

Variables	Base models			Base models plus IT proxy		
	Log sales	Log operational expenses	Log EBITDA	Log sales	Log operational expenses	Log EBITDA
Constant	1.286***	0.729***	11.165***	1.229***	0.678***	11.170***
<u>Inputs (measured in 2007)</u>						
Raw material expenditures	0.119***	0.017***	0.006***	0.119***	0.017***	0.006***
Labor expenditures	0.804***	0.910***	0.021***	0.791***	0.898***	0.022***
Average long term assets	0.107***	0.087***	0.018***	0.105***	0.085***	0.018***
<u>Firm's characteristics (measured in 2006)</u>						
Sector						
Consumption goods	-0.159***	0.007	-0.018	-0.146***	0.019	-0.019
Equipment goods	-0.188***	-0.100***	-0.033***	-0.173***	-0.086***	-0.034***
Intermediary goods	-0.167***	-0.081***	-0.030***	-0.152***	-0.068***	-0.031***
Construction	-0.088***	0.162***	0.051***	-0.063**	0.185***	0.049***
Commerce	0.215***	-0.083***	-0.010	0.221***	-0.077***	-0.011
Transportation	-0.144***	0.233***	-0.035***	-0.132***	0.244***	-0.036***
Finance and real estate	0.416***	0.379***	0.097***	0.417***	0.381***	0.097***
Firm services	Ref	Ref	Ref	Ref	Ref	Ref
Number of security tools				0.048***	0.043***	-0.004*
Number of observations	6244	6244	6244	6244	6244	6244
R <sup>2</sup>	0.901	0.929	0.140	0.902	0.930	0.140

Source : survey COI-TIC 2006.

Note: significance levels are respectively 1% (\*\*\*), 5% (\*\*) and 10% (\*), standard errors are not reported.

Variables	Base model plus direct effects			Full model		
	Log sales	Log operational expenses	Log EBITDA	Log sales	Log operational expenses	Log EBITDA
Constant	1.350***	0.800***	11.150***	1.359***	0.784***	11.199***
<u>Inputs (measured in 2007)</u>						
Raw material expenditures	0.113***	0.014***	0.006***	0.113***	0.014***	0.006***
Labor expenditures	0.778***	0.884***	0.025***	0.778***	0.884***	0.024***
Average long term assets	0.101***	0.080***	0.019***	0.101***	0.080***	0.019***
<u>Firm's characteristics (measured in 2006)</u>						
Sector						
Consumption goods	-0.166***	0.012	-0.019	-0.162***	0.013	-0.021*
Equipment goods	-0.192***	-0.097***	-0.032***	-0.186***	-0.093***	-0.034***
Intermediary goods	-0.177***	-0.078***	-0.030***	-0.174***	-0.076***	-0.032***
Construction	-0.014	0.222***	0.046***	-0.006	0.224***	0.042***
Commerce	0.198***	-0.083***	-0.013	0.197***	-0.083***	-0.012
Transportation	-0.128***	0.265***	-0.043***	-0.126***	0.265***	-0.045***
Finance and real estate	0.446***	0.396***	0.096***	0.440***	0.393***	0.096***
Firm services	Ref	Ref	Ref	Ref	Ref	Ref
Number of security tools	0.029***	0.029***	-0.002	0.027***	0.028***	-0.001
Internal Integration	0.041	0.093***	-0.034**	0.292**	0.325***	-0.051
External Integration	0.351***	0.155***	0.004	0.313**	0.073	-0.118**
Internal Dynamism	0.002	0.009***	-0.002**	-0.005	0.005	-0.007**
External Dynamism	-0.001	-0.005**	0.001	-0.010*	-0.006	-0.000
Internal Integration x External Integration				-0.369***	-0.175	0.014
Internal Integration x Internal Dynamism				-0.002	-0.007	0.004
Internal Integration x External Dynamism				-0.014	-0.017	-0.001
External Integration x Internal Dynamism				-0.001	0.006	0.010***



External Integration x External Dynamism				0.029**	0.017	0.007
Internal Dynamism x External Dynamism				0.001	0.001	-0.000
Number of observations	6244	6244	6244	6244	6244	6244
R <sup>2</sup>	0.904	0.931	0.142	0.904	0.931	0.146

Source : survey COI-TIC 2006.

Note: significance levels are respectively 1% (\*\*\*), 5% (\*\*) and 10% (\*), standard errors are not reported.

### **Consistency with prior literature**

As a check upon the validity of our findings we examined the results to see if they were consistent with prior literature on both the direct effects of integration and the differential effects of dynamism. In terms of direct effects prior findings have show positive effects to both internal and external integration. Consistent with prior literature we find that: 1) Greater internal integration is positively associated with increased sales and 2) Greater external integration is positively associated with increased sales.

In terms of differential effects of dynamism, prior findings have shown positive effects to integration in environments of high external dynamism. Consistent with prior literature we find that increased external dynamism positively moderates the impact of external integration on sales. We feel that these results add face validity to our findings and support the notion that the novel findings of this study are consistent with existent literature.

### **New Findings**

Initial results support the propositions presented in this paper. We find that having both high internal and high external integration is associated with lower sales. We believe this to be the result of integration constraining the pursuit of new customers. We also find evidence that increased internal dynamism positively moderates the impact of external integration on earnings. We feel this is a result of firms being able to access external resources more rapidly in times of internal change.

**Table 3. Summary of results**

Proposition	Result
P1: Greater internal integration negatively moderates the impact of external integration on sales.	Supported
P2: Increased internal dynamism positively moderates the impact of external integration upon earnings.	Supported

### **Conclusion**

To conclude, IS integration has long been a topic of great interest for the IS discipline. However, is it really worth it? Research on this question has generally responded to the question positively. Research has also shown that less imitable factors such as the quality of IT management and the nature of the environment which the firm operates likely play a key role in potential value derived from ES. Research has suggested that IT investment has differential impacts in terms of cost versus revenue. In this paper we differentiate both integration and dynamism into external and internal types looking at the interactions. Specifically, this research-in-progress paper provides evidence that: 1) firms with high internal and high external integration have lower sales and 2) high internal dynamism positively moderates the impact of external integration upon earnings.

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