A Management Model of ICT Adoption in Latvia

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Abstract

This paper describes and analyzes the validity of a managerial model for ICT adoption. The proposed model of ICT adoption decision has two components: an objective component (largely from an economic understanding) and a managerial component (from firm level factors). The factors in both components were considered at firm level. The analysis and confirmation come from a survey of 500 businesses in Latvia in 2008. Confirmation of the theoretical model was accomplished using Ordered Logistical Regression analysis. Analyses results revealed that the dimensions of perceived benefits (top line growth and efficiency gains), technology absorption capacity (employees openness to change, commitment to learning and overcoming obstacles), and cultural factors (general shift towards more collaboration, and cluster effects) mediate the adoption of ICTs and were incorporated into the confirmed model. The primary work is supplemented by a survey in 2011 that confirms that ICT use has not changed significantly in Latvia since the beginning of the financial crisis in 2008. This second, 41 item Likert scale survey was of middle and senior managers of firms from a cross-section of industry sectors and sizes operating in Latvia, between the years of 2008-2010. The results were analysed primarily by an Item Response Theory model and confirmed that ICT use in Latvia has not changed since 2008. The model developed has value for policy makers in determining policies that are likely to encourage ICT adoption and for managers trying to understand what tools could best lead to positive adoption decisions.

Keywords: ICT adoption, Collaboration, Learning Orientation, Firm Performance, Economic Crisis

1. Introduction

Over the last two decades, much of the developed world has been transformed by Information and Communication Technologies (ICTs). These technologies made possible significant productivity gains in business [1],[2] through enabling great changes in how processes are carried out, for example reducing...
labour costs, increasing proximity to customers and standardizing products and brands [3]. This phenomenon however, was based on the needs present in large organizations typical of developed countries [4],[5]. The benefits that companies in emerging economies can attain, where the opportunities based on economies of scale are less apparent, offered less evidence of productivity gains [6], [7],[8],[9].

In order for individual firms, industries and whole economies to benefit from ICT, they (technologies) must diffuse and be adopted by individual firms. Diffusion is distinguished from adoption as diffusion is the take-up of technologies or ideas through defined communities, while adoption is the individual, firm level decision to start using or intensify the use of a given technology or idea. The traditional economic cost-benefit tradeoffs look at the net benefit of the innovation being offered. If the benefits are greater than the costs, the innovation has a good chance of being adopted. If the costs are greater than the benefits, the innovation is highly likely to fail. This concept is described as ‘relative advantage’ by Everett Rogers and is a key factor in product adoption.

However, there is also research that shows that adopters (managers or others) to do not always behave in an objective manner. Sometimes, while the objective net benefit may favour the innovation over the existing product, the psychological net benefit may do just the opposite and lead to a paradox where objective economic decision making would lead one direction, and real decision making is quite different. Hence, this paper considers adoption from both an objective and managerial (organizational cultural) perspective.

The original study called the Latvian Business Survey (LBS) reported here was conducted in 2007-8. As this period coincided with the beginning of the international economic crisis, it was decided to follow-up in 2011 to ascertain whether ICT use in Latvia had changed. This was done to confirm whether or not the results regarding use of ICT would continue to be valid in the post crisis environment.

Whereas the factors that explain adoption of ICTs by firms in developed countries have primarily to do with the impact of factor productivity as the principal basis of the financial and business case, the factors in Latvia reveal the importance of innovation and adaptation as more relevant for firms, especially in response to significant step changes (i.e. the financial crisis.)

This study used as the main framework the Agent Theory of Rogers, where Rogers defines diffusion as “the process by which an innovation is communicated through certain channels over time among the members of a social system.” [10]. Adoption is the individual-level decision to use a new technology. It is the aggregation of a number of adoption decisions. Diffusion research is then concerned with finding patterns across a large number of adoption decisions within a company or group of companies or sectors of business.

Within the framework of adoption agents, our study focuses on the importance of adaption and innovation, as the cultural based elements that effect firm adoption of ICTs to improve performance. In this context, the study begins by a literature review of adoption and diffusion theories and the formulation of the hypothesis. The first part of the research summarizes the results of ICT adoption factors in Latvia from a sample of 500 firms. The second part of the research corroborates the results and newest trends through a follow-up survey of 99 firms. The results of the analyses are discussed and a recommendation is offered for managers and policy makers.

2. Literature Review and Development of Hypotheses

2.1. Diffusion research
The perceived potential of ICT to transform economies and individual firms has led to large numbers of studies intent understanding how and why ICT and ICT use diffused in countries. This has been of particular interest in/to less developed economies. intent closing the productivity gap with more developed countries. It has been studied from points of view as varied as firm level decisions driving adoption, country development policies, capital expenditure and infrastructure build-up, technological leapfrogging, manufacturing impacts, utilization impacts, enablement of process transformation, and others reviewed below.

Some have posited that ICT has become a general purpose technology (GPT) and have compared ICT to electricity as a fundamental enabling technology, based on its pervasiveness (spread to most sectors), improvement (propensity to get better while lowering the costs of its users) and innovation spawning (make it easier to invent and produce new products or processes) [11],[12]. If this is the case, it is of particular interest for developing economies to catalyze the spread of ICT, as not having ICT could be likened to not having electricity. The elements of ICT fall into three principal categories: computers, telecommunications and multimedia data that form the technological basis for conducting all kinds of processes between humans and machines [13].

From the point of view of economic impact, empirical investigations using “rank models” have, by and large, used firm-level and sector-level data on the diffusion of a single technology in a single country and comparative studies between countries [14],[15]. These investigations provide solid evidence on the explicative power for firm level adoption of ICTs based on the variables selected for the research of firm level adoption of ICTs in Latvian companies.

The evidence on the impact of market structure on adoption and diffusion is, on the other hand, inconclusive [16]. Some recent studies in the European Union have concluded that in the majority of cases, ICTs’ application to process efficiency improvements in companies have shown a negative relationship to productivity improvement and employment. Applications aimed at creating new markets and growth on the contrary, show a positive effect.

The main summary of diffusion research in fields other than economics is Rogers [10] which compares the importance of information transmission in epidemic models of diffusion. Emphasizing communications and sociology, Rogers focuses on the role of communications networks in technology diffusion, from the perspective of the firm (independent adoption decision). This considers adoption from the perspective of the firm’s corporate culture and structure. In Latvia, where jobs had to often be created from scratch in the post-Soviet period, and because ICTs immediate effect is to reduce employment, we expect to find a negative correlation to attitudes towards change. These critical variables are considered through the incorporation of variables that capture cultural attitudes, management practices and disposition toward innovation [10].

2.2. Research into ICTs adoption in relation to innovation by firms in developing countries

The overall objective of strategies have been to contribute to the diffusion and adoption of ICTs but little is understood of how specific circumstances of companies in developing countries need to be considered in order to take advantage of the benefits offered by ICTs [4]. This phenomenon is present in Latvia perhaps not in an absolute way, as clearly an infrastructure and use of ICTs are present to a considerable degree as the study shows. Nevertheless, the digital divide does exist in more subtle ways that are revealed by how much these ICTs are used and for what purposes. At the same time, the controversy regarding the effect of ICTs on productivity and economic growth signalled that there was a significant gap between strategies and policy statements and empirical practice [17],[18].
According to Order-models, firms adopt the new technology in a progression that follows the net return that they obtain from it [19],[20]. The order effect arises from the existence of a fixed critical input into production such as skilled labour for software developers. The evaluation of the level of criticality is however, dependant on the perceived problem these resources solve. If as pointed out above, in developing countries the problems to solve do not require in an obvious way the use of ICTs that are more sophisticated or any ICTs at all, then the active intervention of policy makers seems a valuable element to formulate a direction that would or could trigger the start of ICT adoption between firms.

Order-models thus contradict some authors who argue that the Internet presents companies in developing economies with the opportunity to leapfrog several generations of technology development, to gain equal access to world markets [21]. Technology leapfrogging cannot be generalized to occur with the same effectiveness across countries, within countries, or across industrial sectors. This is because countries are known to be different in terms of the factors that facilitate or hinder the process of technology leapfrogging [22],[23],[24]. These widely espoused views are however popular with policy making bodies, including the Latvian National Development Plan, since they offer a rationale for attempting to overcome adoption obstacles.

During this phase, the role of policy and incentives could play a critical role in adoption to promote earlier adoption and more ambitious goals than would be granted by following a natural order process. Policy has the capability to ensure positive returns where net return on adoption is negative for firms that are slow to adopt relative to their rivals in more developed countries. Policy in this sense requires demonstrating a capability to speed-up innovations from ICTs. Policy in this respect has attempted for example to make opportunities to apply ICTs more economically attractive (for example in the drive most governments have followed to promote e-government in some way).

The use of policy incentives also receives attention due to the initial obstacles to first adopters in emerging economy countries. The Stock-model view sustains the idea that the net return on adoption for any firm depends on the total stock of firms that have adopted, with the net return on adoption declining as the stock increases [25],[26]. When the adoption of a new technology by a subset of firms in the industry lowers their average production costs to such an extent that output prices fall, Stock-effects may arise. Lower output prices in turn, reduce the net return on adoption. Also because of this order effect, initially it will only be profitable for a limited number of firms to adopt. However, over time, the net return on adoption increases (for the same reasons as in rank models) so that eventually more and more firms adopt.

The stock models imply that innovations diffuse at different speeds because for some technologies, the stock effect is stronger than for others (because, for example, the new technology has a larger impact on firm costs and therefore on output prices) or because for some technologies, the net return on adoption increases faster than for other innovations. In market conditions, where there is little volume to be gained, an effort towards planned innovations supported by public policy could be an inevitable need.

2.3. Development of Hypotheses

To investigate the determinants of ICTs’ adoption we look at two sets of variables: set one, considers a number of factors which gained attention in recent empirical work [10],[27], identifying profitability and costs to drive the adoption of ICTs; and, set two, which considers variables that have proved to be important for company growth and innovativeness [11],[28], including: the competitive environment, collaboration in the supply chain and innovation, and the presence of ICTs’ enabled processes supporting
these. The former, we call ICTs’ adoption and the latter, ICTs’ sophistication. To our knowledge the second set of variables has not been previously studied as drivers of ICTs adoption.

The analysis is primarily based on a “rank model” of technology diffusion. Rank models are premised on the idea that heterogeneity among firms explains observed diffusion patterns based on differences in the expected present discounted profitability of the new technology relative to the old one [29],[30].

The information collected for this purpose is on the relevance of specific objectives of and obstacles to the adoption of ICTs as assessed by the firms themselves. Thus, information and adjustment costs are taken into account [30], and the anticipated benefits and related uncertainties as perceived by the companies. Following Hollenstein we also add firm size as an independent explanatory factor and we take account of the interaction of firm size with other explanatory variables (size-dependence of the model) [10]. The latter is explored by estimating the adoption model separately for small and large firms to see whether the driving forces behind adoption differ between the two size classes. Management capabilities, workplace practices and organization are considered due to the positive impact on productivity from ICTs adoption [31].

Management knowledge absorptive capacity [32] was included to model the need companies have for a process of learning and adaptation during which skills are acquired and changes made [23],[33]. This treatment considers the human capital as an active cause of adoption due to its readiness to learn and apply the new technologies and implement process changes, and not merely as a resource factor. The capacity of absorbing a new technology is related to education and training [1],[28],[34].

Other additions to the model include external factors from perceived regulatory and cultural variables that have a potentially positive effect on technology adoption according to Jaworski and Kohli (attitudes of suppliers and customers, preferences, obstacles to adopt changes, etc.) [35]; attitudes towards innovation (degree of collaborative work and sales from new services and products); and, clustering effects (multiple interrelated diffusion processes contribute to the evolution [36],[37],[38].

Finally, we estimate the postulated model with several types of adoption measures as dependent variables (e.g. intensity of ICT adoption in general and uses of ICT applications) in order to discriminate robust relationships and to identify differences in the pattern of explanation for the various types of adoption variables. We expect, for example, that the use of basic elements of ICT (with a broad range of applications, e.g. general personal computer technology and applications) is driven by somewhat different forces than the introduction of collaborative and supply-chain applications.

\[ H1: \] Perceived short term earnings and savings opportunities drive the adoption of ICTs and their uses.

\[ H2: \] Firm specific knowledge absorption capacity and cultural attitudes towards change and risk drive the adoption of ICTs and their uses.

\[ H3: \] Externalities, including innovation opportunities and environmental factors such as perception of competitive forces can tip order-effects increasing the perceived benefits and reducing obstacles in the adoption of ICTs and their uses.

3. Methodology

3.1. Research Goal
To determine the importance of multiple decision factors at firm level to adopt ICTs and invest in new uses and applications 500 Latvian firms were surveyed. There was a limited (n=5) pilot of the instrument to for quality purposes. A corroboration survey was conducted in 2011 to evaluate whether ICT practices (adoption and use) had changed since the beginning of the economic crisis.

3.2. Sample and Data Collection

The survey of this study was conducted on 505 middle and senior managers of economically active firms operating in a cross-section of industries in Latvia, in 2008. The first sets of interviews were conducted in Latvian and Russian via phone covering 505 firms from a pre-selected sample of 3,000 companies. The second set of interviews included 97 respondents and was administered as a paper instrument and entered into a web service for initial descriptive analysis. Data obtained from the 500 questionnaires were analyzed through the SPSS statistical package program and the proposed relations were tested through an ordered logistic regression analyses. The 97 corroboration responses were tabulated and primarily analysed using an Item Response Theory Model in SPSS.

3.3. Measures

The ICT adoption measures include two categories. The first category of measures refers to the intensity of use of ICTs at a given point in time measuring what are regarded as the general applications and tools of ICT in recent index benchmarking studies and recent empirical studies [10]. In addition, there is information on the actual and planned use of the Internet for e-mail, online sales and online purchases. The information on the within-firm diffusion of certain technologies is used to construct the variable for adoption intensity (ICTINTENSE). The results refers to the adoption of ICTs which is calculated in a four level ordinal measure of the overall ICT adoption, defined as the number of ICT elements, ranging from value three for the highest adoption (up to all fifteen ICTs) to value zero for firms adopting three or less ICTs. The second category of measures reflects another dependant variable (ICTUSES).

The adoption explanatory variables in the basic model include the measures of benefits, obstacles and the effect of firm size and industry. Benefits are interpreted as proxies for anticipated revenue increases due to the use of new ICTs. The evidence to support this interpretation can be justified on grounds of the research references discussed above. The seven benefits measures are factor scores resulting from a principal component factor analysis of twenty one objectives of the use of ICTs included in the questionnaire. The first four factors are related to anticipated benefits on the revenue side; in addition to higher sales in general, ICTs are expected to yield benefits from higher quality, more variety, the supply of complementary services, stronger presence at the market and stronger customer-orientation. The fifth factor is related to the expected cost reduction and efficiency gains. The sixth and seventh factors refer to advantages from improving relationships on the input side (labour and cooperation with suppliers, and internal efficiencies).

Obstacles measures reflect impediments to the use of ICT, from a cost and technology sufficiency points of view. These measures are the result of a principal component factor analysis that explained 63% of the variance. The four measures reflect implementation costs and investments reflect people abilities, uncertainties, and adjustment costs, related to the introduction of ICTs.

Firm size is measured by dummy variables related to four size classes based on the number of employees with large firms (250 and more employees) as reference group. A negative sign thus, with reference to the large firm group, would indicate a positive effect of smaller firms. Industry dummies are introduced using the financial services sector as the reference category. This last element of the basic
empirical model, captures differences with respect to opportunities and demand prospects (more scope for ICTs in industries using technologies intensively e.g. banking) and other not explicitly specified factors determining a firm’s propensity to adopt ICTs.

The firm’s ability to absorb and use knowledge from external sources for its own innovativeness is a major determinant of innovation performance in general and of ICTs adoption in particular. These “absorptive capabilities” [32] consist of the endowment with human and knowledge capital (for example, the accumulated earlier experience with simpler versions of processes and ICTs; the education level of the labour; training, etc.). Evidence for the importance of learning effects is presented, for example by [1],[34],[39],[40]. Technology absorption capacity is measured by four variables, resulting from scores of a principal component factor analysis of the importance of seven factors in the questionnaire. The first two variables used to measure the availability of human and knowledge capital are general measures of the firm’s attitude to assess technological opportunities and to use external knowledge for own innovative activities. The variables measure on a five-point scale the attitudes towards change (from “avoid change at all cost” to “change is normal and we adapt to it”). The third and fourth variables are more directly linked with ICTs understanding and capability to implement the changes; they measures the practices of training and the use of third party resources as a proxy for the firm’s specific availability or ability to get knowledge in ICT.

Market competitiveness is measured by four variables resulting from scores of a principal component factor analysis of the importance of six factors. The first variable measures the effect of predictability of the environment. It is measured on a four point scale (from “regular and predictable developments”, “somewhat irregular and not easy to anticipate”; “very irregular and impossible to predict”; to “none”). The second variable measures the effect of other firms in the market being perceived as having more ICTs. The variable is measured on a three point scale (from “more prepared”, “similarly prepared”; “less prepared”). Variables three and four measure the level of competition on the product market, in the country, and as a result of the entry in the EU, is measured indirectly by the firm’s assessed level of competitive pressure and position export propensity.

The innovativeness is measured by two variables, resulting from scores of a principal component factor analysis of the importance of four factors. The first variable measures the importance of collaboration relationships that would positively influence the adoption and use of ICT enabled processes. It takes into account the collaboration with suppliers and with clients, measuring the proportion of new products and services derived from collaborative efforts on a five point scale (from “almost all”, “above 50% of new products”; “about 50%”; “less than 50%”; to “none”). The second variable indicates what proportion of sales came respectively from new products or services, respectively from product or service modifications, and from innovations based on new processes, measured in five categories (0%, up to 10%, 11-20%, 21-30%, 31% or more of sales). This takes into account the finding of Cohen and Levinthal according to which internal innovative activity is a precondition for successfully using external knowledge [32].

The last element of the model is the consideration of cultural and environment variables identified in theory measured by three variables, resulting from scores of a principal component factor analysis of the importance of 4 factors. The first variable of market culture measures the preferences of the suppliers and customers for personal contact in a dichotomous variable. The variables two and three, also dichotomous, measure the presence or absence of sufficient clients and suppliers with whom to conduct online processes.
The second survey was a 41 item Likert (5 point scale) survey. The questions were grouped into categories of ICT use:
1. The importance of ICT use (how it has changed;
2. How ICT efficiency benefit goals have changed;
3. How obstacle to investments in software and hardware have changed (at firm level);
4. How ICT absorption methods have changed.

For each category the managers were asked rate changes with regards to specific areas of improvement in those general categories (for example use of technology to improve supply chain or increasing client numbers).

4. Analyses and Results

The Principal Factor Analysis was used based on the advantages it offers for relatively small samples and multi-item constructs [41]. The analysis was performed using the SPSS Data reduction Factor procedure (Principal Axis Factoring) with Varimax rotation, performed separately for each multi-item construct. The extracted factors correspond to those with Eigenvalues greater than 1.0. The analysis showed few cross-loadings of factors thus proving high discriminant validity for the extracted factors. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was calculated to show how much of every item can be explained by other items, to indicate the reliability of the results. A KMO value above 0.60 is considered acceptable.

Analysis of convergent validity (Table 1) of the multi-item constructs supported the findings of the reliability analysis, that some constructs offer weaker quantitative support for the model. These constructs are those primarily measuring the capacities to absorb technology (knowledge in employees and management, and training practices); the importance of competition drivers (perceived level of competition, predictability of future needs); and, the influence of the environment (disposition of suppliers and clients to accept changes in ICTs compared to face to face dealings, use of ICTs by sufficient suppliers and clients, effect of regulations).

| Constructs                                      | Number of factors | N (sample size) | KMO (reliability) | Variance Explained |
|------------------------------------------------|-------------------|-----------------|-------------------|--------------------|
| ICT INTENSE                                    |                   |                 |                   |                    |
| Intensity of use (number of technologies in use)| 4                 | 505             | .845              | 58%                |
| ICT USES                                       |                   |                 |                   |                    |
| Client web services                            | 4                 | 447             | .851              | 63%                |
| Business processes                             | 5                 | 447             | .807              | 55%                |
| Resources planning applications                 | 3                 | 268             | .786              | 63%                |
| BENEFITS                                       |                   |                 |                   |                    |
| Market improvement and sales increase           | 4                 | 447             | .726              | 59%                |
| Cost reduction and input efficiency             | 4                 | 447             | .662              | 63%                |
4.1. ICT adoption intensity

The explanatory factors for adoption intensity used an ordered logistical regression to allow predicting a discrete outcome like the adoption of ICTs in the presence of a set of variables that may be continuous, discrete, dichotomous, or a mix of any of these [42]. The core of the adoption model is confirmed, and allows concluding that a multidimensional modelling of anticipated benefits and costs of ICT adoption, applies even in a country characterized by a generally low level of adoption.

Among the anticipated benefits, those related to market and customer orientation are the most important ones. Innovation and change absorption capacity, as predicted, is very strong and explains the importance of the learning, know-how and readiness to adapt to change. The direction of the prediction is opposite and is thus interpreted as an obstacle to adoption (lack of capacities); this however creates a problem of interpreting the information. Cost and technical challenges did not show any relationship, and were eliminated from the core model. The firm size dummies, with companies employing 250 or more persons as reference group, show a negative relation to adoption, signifying a higher propensity to adopt in case of large firms.

A closer look at these size effects based on a comparison of the results of models A3 and A4 (no size dummies), with those reported for models A1 and A2 (size variables included), points to a certain interaction between firm size and some variables of the model. For example, when firm size is included in the model, the influence of anticipated market benefits decreases, as does the importance of clients using also online systems, while competition from EU entrance increases; small firms expect thus lower market benefits from adoption of ICTs than large ones, and are more likely to adopt ICTs in response to new EU competitive threats. In spite of these interactions, the basic pattern of the results remains quite the same pointing to the robustness of the rank effects explicitly modelled. Interestingly, there is significant loss of explanatory power when firm size dummies are dropped. Hence, there is evidence for independent size effects which would cover effects not explicitly specified in the model. The industry dummies (finance sector as reference group) are not statistically significant. The other explanatory variables as well as the model fit are hardly influenced when industry variables are dropped, independent of the adoption variable used (see models A1 vs. A2).

4.2. ICT Uses and applications

The explanatory power of the model explaining the use of ICTs (ICTUSE) is significantly lower than for the case of the overall ICT technology adoption (ICT intensity). The pattern of explanation is also different. Firstly, the factors for cost reduction and input efficiency show a higher relevance compared to market and customer orientation. This is particularly noticeable
when the firm size dummies are dropped (Model B3 vs. B1), which indicates that smaller firms embark on more complex uses of ICTs for these reasons. It is to be noted that for this variable, the correlation to firm size is much weaker, and seems not to play a role after the size of 50 employees or more. Secondly, among the obstacles to adoption, learning capacity to absorb and implement changes are a bigger problem indicating that in case of an already larger ICT infrastructure investment needs are increasing (transition to more complex, network-oriented technologies). Thirdly, the interaction between firm size and some of the explanatory variables (compare the results of model B1 including size dummies vs. Models B3-B4 where these variables are dropped), shows that the model fit in case of the measure of uses of ICTs is not significantly better when size dummies are included. The lack of evidence for an independent impact of firm size (representing not explicitly specified influences) was further analysed and confirmed.

4.3. Overall explanatory power of the adoption model

The results of the tests (Table 5) prove that the model adequately and significantly adds to the baseline, and thus the coefficients can be analyzed for their meaningfulness. The structure of the tables, presents four regression models (specifications) for ICT intensity, and five models for ICT uses. Firstly, a -2 log-likelihood test was used to compares the values for the intercept only (baseline) model and the final model (with the predictors). Secondly, a test of parallel lines (slope) was calculated to reject the null hypothesis that the individual coefficients do not significantly add to the explanatory power of the model. While the log-likelihood statistics themselves are suspect due to the large number of empty cells in the model, the difference of log-likelihoods can usually still be interpreted as chi-square distributed statistics [47]. The chi-square reported in the table is just that: the difference between -2 times the log-likelihood for the intercept-only model and that for the final model, within rounding error.

Additionally, a pseudo R2 (McFadden) measure is also calculated for purposes of comparing the various regression models. This measure is not a true least square distances R2 as in OLS regression, and it is most useful when comparing competing models for the same data. Lastly, the percentages of correct predictions (correctly classified firms) is computed comparing to the sample, to estimate the ability the model offers to predict correctly firms belonging to each level of ICT adoption and use. On this account, the model is notably more accurate for the lower adoption and use categorization, which is to be expected given the higher presence of low adopters and users in the sample. The analysis also reveals that the more complex drivers of high adoption and use are less clearly defined, and point to differences not captured by the model.

Table 5. Uses of ICTs model fit

| Independent variable ICT Uses | Ordered Logistical Regression Models |
|------------------------------|-------------------------------------|
|                              | 1   | 2    | 3    | 4    | 5    |
| N                            | 505 | 505  | 505  | 505  | 505  |
| Slope Test sig.              | 138 (*) | 80 (**) | 130 (*) | 109 (*) | 41 (*) |
| McFadden R2                  | 0.154 | 0.142 | 0.139 | 0.132 | 0.278 |
| 2Log Likelihood Chi2 sig.    | 210 (*) | 193 (*) | 190 (*) | 179 (*) | 378 (*) |
4.4. Effect of the Financial crisis and validation of conclusions

We performed a validation survey to enquire to what degree had the importance of the variables identified in the regression model changed as a result of the financial crisis using a five point Likert scale. The responses were coded for no change, some change, or significant change and compared in firms reporting high ICT use, medium use or low use. An Item Response Theory model was created by which to test the responses. Overall, there were no significant changes in use of ICT reported by Latvian firms. Intergroup (comparing high with medium or low for example) did show that high use groups reported significantly more changes than did low intensity use groups, but still the intensity of use did not change from 2008-2011. Generally, it can be stated that ICT use has changed very little in the time period 2008-2011. For all the variables the conclusion is that their importance was somewhat increased. The results showed that the high users of ICTs in general perceived greater increased opportunities from ICTs to respond to the challenges of the financial crisis.

Table 6. Changes in importance of factors in response to the financial crisis

| Explanatory Variable                      | Overall | Low ICT Users | Medium IC Users | High ICT users |
|-------------------------------------------|---------|---------------|-----------------|---------------|
|                                           | Mean    | Std.          | Mean            | Std.          | Mean        | Std.          |
| Change in market gain opportunities       | 3.31    | .61           | 3.21            | .59           | 3.23        | .65           | 3.42         | .57           |
| Change in cost reduction opportunities    | 3.32    | .59           | 3.17            | .52           | 3.26        | .56           | 3.43         | .62           |
| Change in efficiency gain opportunities   | 3.39    | .49           | 3.22            | .35           | 3.29        | .43           | 3.54         | .52           |
| Change in employee learning attitude      | 3.14    | .58           | 2.97            | .61           | 3.16        | .59           | 3.19         | .54           |
| Change in technology absorption capacity  | 3.10    | .55           | 2.98            | .69           | 3.08        | .59           | 3.15         | .46           |
| Change in collaboration for innovation    | 3.36    | .58           | 3.15            | .32           | 3.36        | .59           | 3.44         | .61           |
| Change in online suppliers & clients      | 3.35    | .66           | 3.31            | .55           | 3.09        | .63           | 3.58         | .62           |
| Change in environment towards ICT use     | 3.30    | .50           | 3.21            | .43           | 3.16        | .49           | 3.46         | .48           |
In accordance with the regression analyses results, the research model is as in Figure 1 below:

![Proposed Adoption Model](image)

**Figure 1 Proposed Adoption Model**

### 5. Conclusions

The most important conclusion coming from this work is that the postulated model is valid (H1, H2, and H3 are accepted). The validated model creates a link between understandings of the importance of ICT to firms and the economy as a whole and the individual adoption decisions made at firm level. Previous work has focused on what are primarily diffusion related issues such as barriers to e-business. These are perceptions about the environment at large (macro) while the validated model is a micro/firm level approach to understanding adoption. The understanding of the forces associated with adoption leads to the ability of managers to understand where their firm is strong or weak and take realistic decisions on where improvement is needed that will more likely assure successful adoption decisions. While conceptually it is easy to cast a general message of technology as some sort of panacea based on random examples, in practice, the very simple indexes used internationally to compare relative development, showed to lack any power to compare the qualitative impact of the use of ICTs.

The model, further, allows separate consideration of those actions that could promote adoption or intensity of use. For example, while perception of implementation costs as high is associated with decreased use, it is not associated with adoption decisions. This suggests that managers should understand that if they are most interested in improving or intensifying use of ICT that they would help subordinates change their perception of the costs. They could help subordinates understand the concomitant benefits associated with the costs and so decrease the perception of those costs.

The statistical model specifically considered the factors that are related to individual firms adopting of ICTs and implementing more complex uses of these technologies, and how these in turn are related to measures of perceived net benefits in sales, costs and general efficiency, following the factors identified in previous studies. The general conclusion found all the variables to have significant explanatory power,
therefore allowing the use of the model to explore the fundamental research questions related to the adoption in emerging countries.

These findings are consistent with the literature on ICT adoption and technology diffusion in general. Results oriented firms are primarily concerned with top line and bottom line productivity improvements, utilizing personnel and resources efficiently, and maintaining orderly reliable operations [1],[2]. The availability of opportunities to innovate and a favorable environment to change stimulate adoption in early stages of technology diffusion offering greater advantages to firms in such conditions [3],[4].

The value of ICTs for Latvia should reside mainly in developing new business processes that increase the productivity and scale of its internal market and enable it to participate in international value chains with more advanced ICT users in the region, as indeed has been the tendency in response to the financial crisis. The empirical model was expanded then to include the human absorptive capacity [32]. The examination of externalities and their tipping effect on the collective disposition to learn and change, to create new business opportunities, differentiates this study from other more general studies carried out before.

References

[1] Gibbs, J., Kraemer K., Dedrick, J. (2003), Environment Policy Factors Shaping global E-Commerce Diffusion: A Cross-Country Comparison, Information Society, 19 (1), pp. 5-18.
[2] Kiiski S., Pohjola M. (2002), Cross-country diffusion of the Internet, Information Economics and Policy, 14, pp. 297-310.
[3] Mahmood, M. A., S. K. Soon (1991), A Comprehensive Model for Measuring the Potential Impact of Information Technology on Organizational Strategic Variables, Decision Sciences, 22 (4), pp. 869-897.
[4] Bonaccorsi, A., Piscitello, L. and Rossi, C. (2005), The ICT Diffusion: A Spatial Econometric Approach, (February 14, 2005).
Available at SSRN: http://ssrn.com/abstract=666848.
[5] OECD (2000), Information Technology Outlook, Paris: OECD.
[6] Joseph, K. J. (2002), Growth of ICT and ICT for Development Realities of the Myths of the Indian Experience, Discussion Paper No. 2002/78, UNU/WIDER Conference on the New Economy in Development, 10-11 May 2002, Helsinki.
[7] Roah, S. (1987), America’s Technology Dilemma: A Profile of the Information Economy, New York: Morgan Stanley.
[8] Roah, S. (1988), White-collar Productivity: A Glimmer of Hope?, New York: Morgan Stanley.
[9] Strassman, P. (1997), Computers Are Yet to Make Companies More Productive, Computerworld, September 15, 1997 p. 92.
[10] Rogers, E. M. (1995), The Diffusion of Innovations, New York, The Free Press.
[11] Jovanovic, B., Rousseau, P.L. (2005), General Purpose Technologies, Handbook of Economic Growth, Volume 1, Part 2, 2005, pp. 1181-1224.
[12] Bresnahan, T., Trajtenberg, M. (1995), General Purpose Technologies: ‘Engines of Growth’?, Journal of Econometrics, pp. 8, 9, 18, 65, 83-108.
[13] Keen, P. G. W. (1995), Every Manager’s Guide to Information Technology, Harvard Business School Press, YU and the University of Chicago, and Vanderbilt University, p. 9.
[14] Forman, C., Goldfarb, A. (2005), ICT Diffusion to Businesses, Handbooks in Information Systems, Vol.1, Chapter 1.
[15] Battistia, G., Hollenstein, H., Stoneman, P. and Woertera, M. (2007), Inter And Intra Firm Diffusion of ICT in the United Kingdom and Switzerland, an Internationally Comparative Study Based on Firm-Level Data, Economics of Innovation and New Technology, Volume 16, Issue 8, 2007, pp. 669-687.
[16] Blackman, A. (1999), The Economics of Technology Diffusion: Implications for Climate Policy in Developing Countries, Discussion Paper 99-10, Resources for the Future, Washington, D.C., pp. 8, 9, 11.
[17] Roah, S. (1987), America’s Technology Dilemma: A Profile of the Information Economy, New York: Morgan Stanley.
[18] Roah, S. (1988), White-collar Productivity: A Glimmer of Hope? New York: Morgan Stanley.
[19] Ireland, N., Stoneman, P. (1985), Order Effects, Perfect Foresight, and Intertemporal Price Discrimination, Recherche Economique de Louvain, 51, pp. 7-20.
[20] Fundenberg, D., Tirole, J. (1985), Pre-emption and rent equalisation in the adoption of new technology, Review of Economic Studies, No. 52, pp. 383-401.
[21] Panagriya, A. (2000), E-Commerce, WTO and Developing Countries, The World Economy 23 (8), pp. 959-978.
[22] Malairaja, C. (2003), Learning From the Silicon Valley and Implications for Technological Leapfrogging, International Journal of Technology Management & Sustainable Development, 2003, Vol. 2 Issue 2, pp. 73-95.
[23] Hobday, M. (1995), East Asian latecomer forms: Learning the technology of Electronics, World Development, Washington, DC, Vol. 23, No.7, pp. 1171-1193.
[24] Panagriya, A. (2000), E-Commerce, WTO and Developing Countries, The World Economy 23 (8), pp. 959-978.
[25] Malairaja, C. (2003), Learning From the Silicon Valley and Implications for Technological Leapfrogging, International Journal of Technology Management & Sustainable Development, 2003, Vol. 2 Issue 2, pp. 73-95.
[26] Tan, Z., Wu, O. (2002), Global and National Factors Affecting E-Commerce Diffusion in China, Center for Research on Information Technology and Organizations, University of California, Irvine.
[27] Quirmbach, H. (1986), The diffusion of new technology and the market for an innovation, Rand Journal of Economics, No. 17, pp. 33-47.
[28] Reinganum, J. F. (1981), Market Structure and the Diffusion of New Technology, Bell Journal of Economics, No. 12, pp. 618-624.
[29] Caselli, F., Coleman, W. J. II. (2001), Cross-Country Technology Diffusion: The Case of Computers, American Economic Review, May 2001, 91(2), pp. 11, 12, 25, 53.
[30] Galia, F., Legros, D. (2004), Complementarities between obstacles to innovation: Evidence from France, Research Policy, No. 33, pp. 1185-1199.
[31] Karshenas, M., Stoneman P. (1995), Technological Diffusion, in P. Stoneman (ed.) Handbook of the Economics of Innovation and Technological Change, Oxford: Blackwell. pp. 11, 59.
[32] Bresnahan, T., Brynjolfsson, E., Hitt L. (2002), Information Technology, Workplace Organization, and the Demand for Skilled Labor: Firm-Level Evidence, Quarterly Journal of Economics, pp. 177, 339-376.
[33] Cohen, W. M., Levinthal, D. A. (1990), Absorptive capacity: A new perspective on learning and innovation, Administrative Science Quarterly (Ithaca, NY), Vol. 35, No. 1, pp. 103-128.
[34] Jaworski, B. J., Kohli, A. K. (1993), Market Orientation: Antecedent and Consequences, Journal of Marketing, 57(July), pp. 53-71.
[35] Lavie, D. (2006) The Competitive Advantage of Interconnected Firms: An Extension of the Resource-Based View. Academy of Management Review, Vol. 31, No. 3, pp. 638-658.
[36] Seebregts, A., Bos, S., Kram, T., Schaeffer, G. (2000), Endogenous Learning and Technology Clustering: Analysis with MARKAL Model of the Western European Energy System, International Journal of Global Energy, Issues 14(1/2/3/4), pp. 289-319.
[37] Silverberg, G. (1991), Adoption ad Diffusion of Technology as a Collective Evolutionary Process, Technological Forecasting and Social Change, No. 39, pp. 67-80.
[38] Kahneman, D., Knetsch, J. L., Thaler, R. H. (1991), Anomalies: The Endowment Effect, Loss Aversion, and Status Quo Bias, Journal of Economic Perspectives, 5, 1, pp. 193-206.
[39] Lim, H. F., Lee, G. G. (2005), Impact of Organizational Learning and Knowledge Management factors on e-business adoption, Management Decision, 43(2), pp. 171-188.
[40] Snook, S. C., and Gorsuch, R. L. (1989), Component Analysis Versus Common Factor-Analysis - a Monte Carlo Study, Psychological Bulletin, 106(1), 148-154.
[41] Tabachnick, B., Fidell, L.S. (1996), Using Multivariate Statistics, New York: Harper-Collins College Publishers.
[42] McCullagh, P., Nelder, J. (1989), Generalized Linear Models (Second ed.), Chapman & Hall.
[43] Gordon, R. (2000), Does the new economy measure up to the great innovations of the past?, Journal of Economic Perspectives, pp. 14, 48-74.
[44] Carr, N. G. (2003), IT doesn’t matter, Harvard Business Review, May, 2003, pp. 41-49.