Antecedents of Health IT Roll Back

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Abstract

The adoption of Health IT has been argued to bring about improvements in adopting hospitals. However, examining a panel of hospitals for the adoption of IT, we find that close to 50% of hospitals that adopt a health IT system go on to stop using it during the duration of our panel.\(^1\) We find that smaller hospitals and hospitals that are located in areas that have low IT-Intensity are more likely to roll-back IT systems. Additionally, we find that advanced IT systems (that are more complex to implement) are more likely to be rolled back in the absence of complementary services and in smaller organizations. Additionally, we discuss further research that we hope to undertake where we examine the effect of other factors on the probability of roll-back. We hope that reducing this roll-back can reduce the unnecessary costs that hospitals may have to incur as they implement IT systems.

Keywords: Health IT, Roll-back of IT systems, Hospitals.

Introduction

The adoption of Health IT is being pushed by the US government as a mechanism to reduce costs and medical errors. Towards this objective, the US government provided $34 billion in the 2009 Health Information Technology for Economic and Clinical Health Act (HITECH Act). The act works by providing financial incentives to digitize records as well as imposing penalties on the providers that do not comply. This push towards the adoption of IT is not without justification from previous research. Scholarship has argued that the adoption of Electronic Medical Record systems is associated with an increase in adherence to guideline based care (Overhage et al. 1997), fewer medical errors (Chertow et al. 2001), a reduction in the utilization of care (Tierney et al. 1990) as well as a reduction of operating cost in neighboring hospitals (Atasoy et al. 2014).

\(^1\) These numbers vary among the different software systems that we consider. For example, due to differences in how many hospitals report data for the systems for the different years, 1517 hospitals are considered in our panel for an analysis of the PD software systems out of which 831 hospitals (55%) report a roll-back of the system.
IS in Healthcare

The usefulness of investing in Health IT systems is currently being debated (Chaudhry et al. 2006; Sidorov 2006). Installation cost of these systems is astronomically high with costs ranging between $3 million for a 250 bed hospital to $7.9 million for a 500 bed hospital (CBO 2008). Additionally, the adoption of health IT systems take a lot more than just plugging in a computer. The adoption of these systems requires modification to a number of different processes and tasks to link up to the deployment of the new infrastructure (Bresnahan et al. 2002). Moreover, the adoption of these systems does not imply an infinitely long commitment to continue using the system. As a result of all these challenges, over time, the systems can be rolled back, replaced or redeployed, as the management of the organization seems appropriate. However, although studies have examined the effects of the adoption of health IT (and the effect of IT on productivity), studies have yet to examine the rationale behind when these IT systems are rolled-back or when these systems are switched for another system. Reducing these costly frictional costs due to roll back or switch could translate into huge cost savings for hospitals and the society.

In this study, we examine data for a panel of hospitals in the US between 1998 and 2010, where we focus on five main Electronic Medical Record (EMR) systems. Astoundingly, we find that close to 50% of the hospitals report the rolling back of IT for at least one of five systems at some point in our panel. This is evidence that even with high investment costs, the adoption of IT is often not straightforward and that hospitals often have to roll back their implementation of Health IT. The goal of this research is to explore the rationale behind the roll-back of IT and characteristics of hospitals that make it more likely to stop using IT systems. The roll-back of these IT systems may be temporary as we find in the vast case of the hospitals that we consider. These hospitals may roll-out a new system eventually but our data set shows a temporary duration during which the hospital does not the particular system. In the paper, we examine if the access of hospitals to complementary services and the size of the hospital can have any impact on the probability that the hospital will go on to roll-back IT. Additionally, we outline other variables such as the managerial experience with IT, the IT skill of the workforce as how we plan to subset our data on the basis of hospitals that re-adopt IT systems versus those that do not go on to re-adopt.

This paper proceeds as follows: In the section 2, we outline previous research in this topic and develop hypothesis. In section 3, we introduce our data set, discuss the model that we use and present our results. In section 4 we conclude.

Literature Review and Theory Development

Electronic Medical Records

We consider five main EMR technologies in our analysis. These have been categorized as basic IT and advanced IT according to the data and previous literature (Agha 2014; Dranove et al. 2012; HIMSS 2011). Basic IT consists of the Clinical Data Repository (CDR), the Clinical Decision Support System (CDSS) and the Order Entry (OE) system. The CDS system is a database for keeping up to date records of the patients. The Clinical Decision Support System is a tool that practitioners can use to diagnose patients and their conditions. The third component of the EMR system is the Order Entry system, which is tasked with the replacing paper documents in a hospital environment.

On the other hand, advanced IT systems include the Computerized Physician Order Entry (CPOE) system and the Physician Documentation (PD) system. The CPOE system contains information about the specific need of the patient and can be useful in reducing prescribing errors. The PD system keeps an electronic database of the past conditions that have been reported to the doctor and can help with better diagnosis.

The analysis of these systems has been examined for their effect on outcomes. Although some studies find that the adoption of EMR systems is not associated with any change in operational characteristics or even an increase in costs (Agha 2014; Dranove et al. 2012; McCormick et al. 2012) other studies have found that the adoption of EMRs is associated with positive outcomes. These studies have found that the adoption of these systems can save babies (Miller et al. 2011), have spillover effects to reduce operational costs of neighboring hospitals (Atasoy et al. 2014), increasing productivity (Lee et al. 2013), increase

\[\text{We refer to the roll-back as the act of reversing the adoption of an IT system. The definition has been derived from the Merriam-Webster dictionary.}\]
adherence to guideline based care, decrease in the utilization of care as well as keep a better track of the vaccinations that patients were getting (Chaudhry et al. 2006).

Although a vast body of literature exists that examines the effect of the adoption of these five systems on the operation of hospitals, in this study we concentrate on the antecedents of the roll-back of these health IT systems. We focus on these five systems individually which allows us to identify software level effects and examine factors that may be affecting different groups of systems (such as basic IT systems versus advanced IT systems).

**Issues with IT Adoption**

The adoption of IT has been argued to have productivity increases on the organizations that adopt it (Brynjolfsson et al. 1996; Brynjolfsson et al. 2003). This line of research has argued that the adoption of IT systems is accompanied by an increase in the productivity of the firm that is as high as other capital related expenses and as high as non-IS related labor expenses.

However, this line of research often does not delve into more granular issues with the adoption of IT – such as the fact that the process of adoption of IT often involves massive changes to the manner in which organizations function and the processes that are embodied in the organizations (Bresnahan et al. 1996; Bresnahan et al. 2002). Additionally, the adoption of IT systems in organizations is not as easy as unwrapping a computer and plugging it in. Studies have argued that the adoption of IT is often accompanied by modifications to the processes and routines that the organization typically undertakes (Bresnahan et al. 2002). The process of creation of these new processes and their impact on the success of the implementation of IT has not been as yet explored by extant research.

On the other hand, research into the widely popular Technology Acceptance Model (TAM) (Davis 1989; Venkatesh et al. 2000) place the success of the adoption of IT on the perception of metrics of the system (such as perceived ease of use and the perceived usefulness). In this paper, we explore characteristics that are external to the perceived ease of use and the perceived usefulness of the system and study factors that can lead to the roll-back of the system. This includes factors such as the local environment that the hospital exists in and characteristics of the manner in which the system was implemented in the hospital.

Additionally, research has not delved in to the fact that IT systems are occasionally rolled back, replaced by other systems or modified in a manner in which the organization thinks it will it in a better manner. Hence, we seek to understand one of the most basic questions – what are the antecedents to IT roll-back? Why are some hospitals more prone to roll back than others? Additionally, if we assume that the roll-back is a consequence of the failure of the implementation of the IT system, what makes hospitals more prone to IT failure? And what makes hospitals less likely to fail in implementation of IT?

This has been the subject of analysis for a number of studies that have documented the often complex changes in packages in the software and the processes in the organization (e.g. Soh et al. 2004). However, till date, there has been a lack of empirical research on factors that can lead to the roll-back of IT. We hope to address this gap in the literature by looking at a set of hospitals that drop their use of an expensive health IT system at some point. Figure 1 presents a framework that we wish to use for our analysis. The figure presents a number of factors such as the resources within a hospital (such as the IT skill of employees), complementary resources outside a hospital (such as availability of local IT skill), if hospitals are early versus late adopters, past experiences of the hospital with the adoption of IT as well as preparation before the adoption of the system. We use this framework in studying the antecedents to the roll-back of IT. In the next sections, we outline preliminary analysis that we have conducted to answering this research question and discuss further metrics that we wish to study for their effect on the probability of roll-back.
Availability of Complementary Services

Studies have argued that there is significant variation in US for the presence of complementary services to IT such as skilled labor (Forman 2005; Forman et al. 2012) and infrastructure (Atasoy 2013; Greenstein et al. 2011). The availability of these services and skills would be especially useful for the adoption of large IT systems which is often not as easy as simply implementing a system (Bresnahan et al. 1996; Bresnahan et al. 2002). The adoption of health IT systems is associated with a need to tailor the system to the processes that are unique to the institution. However, organizations occasionally have to modify their processes to better fit the system that has been adopted as well (Soh et al. 2004).

The presence of complementary services that are provided by a skilled labor pool and the availability of complementary services should also allow the hospitals to adopt systems that are more complex in an easier manner. We posit:

H1a: Hospitals located in areas having less complementary services will have a higher probability of rolling back health IT systems.

Additionally, Health IT systems may be different in the scope, scale and complexity that they require for adoption. HIMSS (2011) designates Clinical Physician Order Entry (CPOE) and Physician Documentation (PD) as advanced IT systems that are more difficult to implement due to higher levels of physician training required for the roll out of the system. We argue that this additional complexity that is required for the successful adoption of complex IT systems will increase the likelihood of their roll-back in areas that have lower levels of complementary services. Hence we posit:

H1b: Hospitals located in areas having less complementary services will have a higher probability of rolling back advanced health IT systems.

Size of Hospitals

In a number of other studies, larger businesses have been found to be more likely to have the resources to adopt innovations (Dewar et al. 1986; Moch et al. 1977; Utterback 1974). This is symptomatic of the fact that smaller organizations face barriers related to the financial resources, a lack of IS expertise and short range management perspective (Ein-Dor et al. 1978; Ein-Dor et al. 1982). Additionally smaller firms tend to be found in areas that are not as resource rich as larger firms (Keats et al. 1988). Larger firms are also associated with higher degrees of slack that allows them to take larger risks (Bourgeois 1981; Rhyne 1985).

This line of research has shown that the size of the firm plays a role in the probability that an innovation will be adopted by the firm. This has been extended to IT adoption and studies have argued that larger firms will be more likely to adopt IT (Thong 1999). We argue that many of the same factors (such as access to skills, financial slack and access to IT expertise) that allows larger firms to adopt innovative practices will also help with the roll-out of these innovative practices. This roll out of IT by larger firms that are financially richer and endowed with a larger skill set will lower the probability of IT having to be rolled-
back by these hospitals. Hence, argue that larger hospitals would have a lower probability of rolling-back IT:

**H2a: Smaller hospitals will have a higher probability of rolling back health IT systems.**

Additionally, as advanced IT systems are more complex to implement, smaller hospitals will probably have a more difficult time implementing these complex systems. The financial resources and access to skills of larger hospitals will allow them to implement complex IT systems in an easier manner. Hence, we expect that smaller hospitals will be more likely to roll-back the more complex advanced IT systems and posit:

**H2b: Smaller hospitals will have a higher probability of rolling back advanced health IT systems.**

**Data**

<table>
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<th>Table 1. Summary Statistics 1</th>
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<tbody>
<tr>
<td>Number of hospitals having the software at some point</td>
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<tr>
<td>CDR 2401</td>
</tr>
<tr>
<td>CPOE 1370</td>
</tr>
<tr>
<td>CDSS 2356</td>
</tr>
<tr>
<td>OE 2381</td>
</tr>
<tr>
<td>PD 1517</td>
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</table>

To conduct the analysis, we use the HIMSS database. The database contains detailed information about the IT adoption of hospitals around the United States. We used data of hospitals for which we had less than 4 years missing for years between 1998-2010. By doing this, we erred on the side of caution as it would allow us a more complete set of years to have a complete dataset. We examined the number of hospitals that have an IT failure. Table 1 shows the number of hospitals that have an IT failure in the panel. We find that the proportion of hospitals that drop the IT system at some point ranges between 33% - 55% (of the hospitals that have the system at some point). Additionally, the average number of times that a hospital drops the IT system ranges between 1.06-1.68 times (indicating that most of the hospitals drop the IT system once). However, some hospitals drop different IT systems 2 or 3 times. Table 2 provides descriptive statistics for hospitals that go on to readopt. As is clear, approximately less than 50% of the hospitals that drop IT go on to readopt it. Additionally, the number of re-adoptions is usually not higher than 3 times in our period.

For operational data, we made use of the Medicare Cost Reports database. The database contains information on data reported by hospitals as part of their contractual relationship with Medicare to allow Medicare to calculate costs and rates to reimburse them. This data has been used in a number of different studies and allows researchers to estimate the operational characteristics of hospitals. From this database, we obtain the number of employees in the hospital which we use as a proxy for the size of the hospital.

<table>
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<tr>
<th>Table 2. Summary Statistics of IT re-adoptions</th>
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<tr>
<td>Number of hospitals having the software</td>
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<tr>
<td>CDR 2401</td>
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</table>
To identify the county level IT intensity level, we made use of the County Business Patterns data from the US Census website. The data gives the number of establishments of various employee sizes for different countries in the US by the SIC number that these firms belong to. We aggregate the number of firms that fall in IT intensive sectors and divide this by the total number of firms in the county in the given year. We then use this proportion of the IT intensity of that county.

**Empirical Model**

In order to examine the antecedents of Health IT roll-back, we use a survival model analysis. The class of survival models allows us to examine the time to the roll-back of the IT system. Additionally, as the models allow for censored data, we allow for the fact that our panel ends at 2010 and we account for this. However, as hospitals can have multiple instances of roll-back of IT, it is important to be able to take this into account. Models that allow for multiple roll-back are divided into two categories – one category assumes that failure types are unordered in nature, such as when a patient suffers a number of outcomes of interest in a random order. On the other hand, a set of models looks at cases when failures are ordered. Here, the assumption that is made is that the failures are equal or indistinguishable from each other.

We make use of the methodology that has been proposed by Prentice et al. (1981) that is known as the conditional risk set model for multiple failures. The model makes the assumption that the subject is not at risk of a second failure until the first failure has taken place. This method is appropriate as it can be used to model the fact that a hospital may have multiple roll-backs of the same IT system. Additionally, we calculate the time to the next event as measured from the time to the previous event. The model that we adopt is represented by

$$\lambda(t|N(t),Z(t)) = \lambda_0(t - t_{n(t)}) \exp\{z(t)\beta\}$$

where $\lambda(t)$ is the instantaneous rate of failure at time $t$, $n(t)$ is the number of failures up to time $t$, $\{N(t), Z(t)\}$ represent other covariates value up to time $t$, $n(t)$ represent the number of failures prior to time $t$ and $z(t)$ are the value of covariates at time $t$. $\lambda_0$ represents baseline failure rates given by the stratum $s$ that the observation is in.

**Preliminary Results**

We run the models for the different software and present the results in Table 3(a) and Table 3(b). What we find is that hospitals that have smaller number of employees are more likely to roll-back their investment in IT. This is especially true for advanced systems such as CPOE and PD. Additionally, what we find is that a lower IT intensity in the county that the hospital is situated in leads to a higher chance of IT roll-back – and this is especially true for advanced IT systems. Hence, we find evidence to support H1a, H1b, H2a and H2b. This has implications on how IT should be rolled out – and that the size of the hospital and the presence of complementary services can impact the probability of roll-back of the IT system.

<table>
<thead>
<tr>
<th>Table 3(a): Effect of Number of Employees</th>
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<td>VARIABLES</td>
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<tr>
<td>VARIABLES</td>
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<tr>
<td>Number of Employees</td>
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We are not able to conduct a statistical test to see if IT intensity and size of hospitals have a stronger effect for advanced IT systems due to the difficulty in doing such a test for the class of survival models. However, due to the significance that we obtain for advanced IT, we argue that our results are stronger for these systems.
### Table 3(b): Effect of Regional IT Intensity

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>CDR</th>
<th>CDSS</th>
<th>OE</th>
<th>CPOE</th>
<th>PD</th>
</tr>
</thead>
<tbody>
<tr>
<td>IT Intensity</td>
<td>0.6755</td>
<td>-4.4883**</td>
<td>6.5699***</td>
<td>-5.2586*</td>
<td>-4.8507**</td>
</tr>
<tr>
<td></td>
<td>(2.0749)</td>
<td>(2.0167)</td>
<td>(2.2314)</td>
<td>(2.7953)</td>
<td>(2.2735)</td>
</tr>
<tr>
<td>Observations</td>
<td>3,326</td>
<td>3,270</td>
<td>1,605</td>
<td>2,857</td>
<td>1,847</td>
</tr>
</tbody>
</table>

Standard Errors in parenthesis.

*-Significance at 10%, **-Significance at 5%, ***-Significance at 1%

### Conclusion

In this research-in-progress we outline the rationale for studying the roll-back of IT systems. We argue that due to the high investment cost of these systems, it is important to understand factors that could ultimately play a part in hospitals having to eventually roll-back their investments. We find that hospitals in counties that have lower IT intensity are more likely to roll-back their investments (and they are more likely to roll back advanced IT systems). Additionally, smaller hospitals are more like to roll-back their IT systems (especially advanced systems). We hope to extend this analysis to examine other variables that have an effect on the probability of the investment eventually being rolled back.

### Further Research

In this subsection, we present some variables that we wish to examine for their effect of their roll-back on IT: namely the amount of skill the organization is endowed with, the level of preparation of the organization and potential differences that may be present between hospitals that drop the system and hospitals that go on to readopt a system at a later date. Although we have not been able to explore the effect of these variables as yet, we hope to examine these variables to develop a more complete understanding of the antecedents of system roll-back. Additionally, we discuss possibilities of subsetting the sample into different categories such as hospitals that go on to readopt the IT system and hospitals that switch IT system and discuss how these also have the potential for an interesting research questions that can be asked.

### Skill Endowment

Studies have argued that a higher level of IT skills in organizations has a positive effect on the productivity of the organization after the IT system is implemented (Black et al. 2001; Caroli et al. 2001). Hence, although there has been extensive research on the notion that the presence of complementary skills can impact the adoption of IT in a firm, we wish to study if the presence of IT skills in the hospital can have an impact on the probability that an IT system will be rolled back after it has been adopted. To do this, we examine how skilled the employees of a hospital are in the use of IT and its impact on the probability of roll back. We hope to do this by collecting data on the number of employees that has IT skills and are employed by the hospital, the training of the management of the organization or the previous experience that the employees have with working with ICT. We posit that hospitals that have higher IT skills of their workers will find it easier to roll out their ICT systems and have a lower probability of having to roll back their systems. Hence, we wish to explore the relationship between the IT skills of employees and the roll back of IT systems in hospitals.

### Preparation for Adoption of IT System

Previous research has argued that it is not always the adoption of an IT system that leads to an increase in the level of productivity but how the process is implemented that leads to an increase in the productivity of the organization (Black et al. 2001). This is especially important for large organizations where the
adoption of these systems involves a process of training and co-creation of new processes (Bresnahan et al. 2002).

We wish to examine if the time spent in rolling out the system (before it goes live) has any impact on the probability that the system will be rolled back eventually. We argue that the period between the system being contracted and it being implemented could be used to lay the groundwork to train staff to smoothly roll out the system. We argue that this would be especially useful to implement complex IT systems in hospitals – and hence it is important for hospitals to roll out their IT systems in a systematic manner. We would like to study the relationship between the length of the roll out period and the probability of it having to eventually being rolled back.

**Subsetting hospitals based on re-adoption of IT**

We also seek to differentiate between the hospitals that go on to readopt and those that do not go on to readopt. Hospitals that go on to readopt the IT system may not be characterized as having lower access to IT services – but may be a bad fit of an IT system to the hospital. Additionally, hospitals may readopt systems to be more in line with neighboring hospitals that use the same IT system. This has been widely referred to in the economics literature as network externalities (Katz et al. 1985). The research on network externalities having an impact on IT investment has been previously documented (Markus et al. 2006; Zhu et al. 2006). Previous research has also argued that hospitals that are co-located and adopt the same IT system may be able to achieve a reduction in their operating costs (Atasoy et al. 2014).

Hence, the rationale for dropping IT may be very different for the set of hospitals that go on to readopt IT systems. We wish to analyze if there is any difference in the factors that influence a hospital to drop using an IT system versus factors that influence if a hospital ultimately goes on to readopt an IT system.

**Discussion**

In continuation with other studies, we extend research that has examined the effect of complementary services on the adoption of IT. Studies have argued that the presence of IT intensity in co-located areas can lead to a reduction in the costs (Dranove et al. 2012). In this study we find that the effect of IT intensity is not just in the costs but it also has an impact in the ultimate use of the system. We find that a lower IT intensity leads to a lower chance of the IT system being used for a long time. This is especially true for systems that are harder to implement such as advanced health IT systems. Additionally, we find that smaller hospitals (that is hospitals that have fewer number of employees) are more likely to roll back the implementation of IT. This could be due to the lack of availability of employees with skills or the financial constraints in these organizations.

In addition, as the project progresses, we hope to study the effect of other metrics on the probability of roll-back of systems. These include the length of the roll-out of the system, the IT skill set of employees and the difference in the rationale behind when a system is readopted and when it is exclusively rolled back. As the cost of implementation of these systems is extremely high (with implementation costs often exceeding $3 million), it is important to be able to identify effects that could influence the probability of roll-back of the system and guard against these to the best of our abilities. We find that hospitals in locations with lower access to IT skills and smaller hospitals seem to be more likely to roll-back the IT system that they have adopted. This has a number of policy implications as it seems that to minimize the roll-back of these systems, policy makers should also focus on the provision of complementary services that can allow the hospitals to overcome a potential roll-back in the IT system.
References


