How do economic incentives and regulatory factors influence adoption of cardiac technologies? Result from the TECH project

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Abstract

The TECH research network collected patient-level data on three procedures for treatment of heart attack patients, (catheterization, coronary artery by-pass grafts and percutaneous transluminal coronary angioplasty), for seventeen countries over an eighteen year period to examine the impact of economic and institutional factors on technology adoption. Specific institutional factors are shown to be important to the up-take of these technologies. Health care systems characterized as public contract systems and reimbursement systems have higher adoption rates than public integrated health care systems. Central funding of investments was negatively associated with adoption rates. GDP per capita also has a strong role in initial adoption. The impact of income and institutional characteristics on the utilization rates of these procedures diminishes over time.

Running title: Adoption of new medical technologies

Key words: Diffusion of technologies, Technological change, economic incentives and regulation

JEL classification: I1; I18; O33

1. Background[b]

Rapid technological change is one of the most salient features of the health care sector. The continuous increase in the cost of the health care services recorded over the past decades in many developed countries has raised a major concern among policy makers who have been forced to adopt restrictive measures in order to curb health care spending. The adoption of increasingly sophisticated and expensive medical technologies is one distinct factor related to the rising cost of health care services (Cutler & McClellan 1998;Newhouse 1992;Okunade & Murthy 2002;Weisbrod 1991) New technologies bring benefits to patients in terms of reduced morbidity and mortality.

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However, the financial pressure from these new technologies also threatens the financial sustainability of health systems and public health care budgets (Reinhardt et al., 2004). Rising costs of health care services have been attributed to the implementation of costly new technologies rather than increasing prices of existing technologies (Cutler et al. 1998;Cutler, McClellan, & Newhouse 1998;Cutler & McClellan 1996). Advances in medical technologies generally expand what is possible and thus lead to increasing demand and supply with even cost-reducing technologies increasing aggregate costs by extending the range of patients treated (Cutler & Huckman 2003;Weisbrod 1991). Differences in the rate of adoption of new technologies may therefore help explain differences in health expenditure growth across countries.

While technological change is argued to be one of the major causes of increasing costs in developed countries around the world, little work has been devoted to exploring the mechanism of how the process works. There is little knowledge of whether adoption of medical technology differs across different health care systems. A number of comparative studies have shown that there are large variations both between and within countries in the treatment of the same medical condition at a given point in time (see e.g. (Blais 1993;Garg et al. 2002;Hall & Tu 2003;Mcpherson et al. 1982;Wennberg & Gittelsohn 1973). However, few studies have analyzed how differences in economic and regulatory factors across health care systems influence the adoption of new technologies. In this study, we investigate the effect of economic incentives and regulatory factors on the propensity to adopt technologies, by comparing the development of the treatment of acute myocardial infarction (AMI) in seventeen countries around the world.

This study analyzes the adoption of three specific procedures applied to AMI patients. There are a number of reasons for the choice of patients with AMI and these three procedures. Firstly, AMI or heart attack is a relatively common and well-defined clinical condition around the world. Secondly, most AMI patients are initially hospitalized for treatment providing reliable inpatient data across countries relating to the acute care for heart attacks. Thirdly, acute care of AMI patients has changed rapidly in recent years. Fourthly, the three technologies 1) cardiac catheterization (CATH), 2) coronary artery bypass grafting (CABG) and 3) percutaneous transluminal coronary angioplasty (PTCA) are high-tech procedures involving high fixed costs for provision and high marginal costs with each use. CATH is used for diagnostic purposes and is a necessary prerequisite to perform CABG or PTCA. The CATH procedure requires hospitals to hire specialized personnel and specialized equipment. CABG and PTCA are revascularization procedures performed to increase blood flow to and from the heart in response to damage from an AMI and to cardiac vessel blockage. These procedures require multiple specialized personnel, and costly equipment such as heart-lung bypass filters. These technologies therefore involve substantial cost of treatment potentially contributing to health care expenditure growth (McClellan & Kessler 1999;McClellan & Kessler 2002;Tech Research Network 2001). Fifthly and finally, the utilization of these technologies has proven impact on health outcomes (Hoffman et al 2003).

The specific purpose of the present study is to identify variables that capture economic and regulatory modulators of technological change with respect to the care of AMI patients, and to explore the association between these variables and the adoption of these new technologies. This will inform health policy decisions through providing information on individual country responses in the up-take and dissemination of new technologies to the specific economic incentives and regulatory factors embodied in a countries' health care system. The analysis is based on specifically collected data on health care system characteristics and comparable data on the treatment of heart attack patients across counties. A longitudinal cross-country comparison of diffusion of AMI procedures is undertaken. The design differs from the existing literature on diffusion of technologies which explores diffusion rate within a single country or region over time or cross-country differences at a point-in-time. The unique longitudinal cross-country data used in this analysis provides a distinctive opportunity to study the influence of economic incentives and regulatory factors both across countries, as the degree of variation in these dimensions is much greater across countries rather than within countries, and while also detecting any trends over time.

The remainder of this paper is organized into four sections. Using selected theoretical and empirical studies Section 2 provides background information on how international variations in technological change may be influenced by the economic incentives and regulatory factors within a health care system. This is, however, not an attempt to review comprehensively the vast literature in this area but rather to give an impression of findings to-date and highlight unresolved issues. This helps to specify the analysis presented here. The data sources and the econometric approach adopted by this study are described in section 3. Section 4 provides results from the analysis which is performed in two steps. Firstly, the three technologies used to treat AMI are analyzed as three independent procedures. Secondly, the interdependence between these three AMI procedures will be modeled in a pseudo 2SLS procedure. In section 5 the results are discussed and the main conclusions are summarized in section 6.

2. Previous findings and unsolved issues

A considerable number of studies have explored the relationship between aggregate per capita income, total health care spending per capita and overall characteristics of health care systems (for a review see Gerdtham & Jönsson 2000). Of specific interest to this study is the small number of studies which confirm the economically intuitive relationship between GDP per capita and availability and utilization of medical technologies (Dickson & Jacobzone 2003;Lazaro & Fitch 1995;Moïse 2003a;Moïse 2003b;Slade & Anderson 2001). In a study of the relationship between GDP per capita and availability and utilization of five medical technologies (MRI scanners, CT scanners, kidney transplants, liver transplants, and hemodialysis) in 23 OECD countries over the period 1975-1995, it was concluded that GDP per capita is an important determinant of the availability; however, GDP per capita is less important in explaining the long-term availability of specific medical technologies because technologies tend to become less costly as they are improved and become more common (Slade & Anderson 2001). High income countries seem to adopt new technologies earlier. However, as technology ages increased GDP becomes less important as a determinant of utilization of the technology. Similar conclusions can be found in a cross-country comparison study of pharmaceutical use for cardiovascular disease in 12 OECD countries (Dickson & Jacobzone 2003) and in a cross-country study exploring the number of cardiac surgery facilities and CATH facilities, CT and MRI scanners, and PTCA and CABG procedures (Moïse 2003b).

This general relationship between GDP per capita and technology utilization is confirmed in (Gratwohl et al. 2002). This study compares the transplant rates of haematopoietic stem cell transplant in 35 European countries between 1990 and 1999. Simple statistical correlation analyses reveal that GDP per capita and total health care expenditure per capita influence the transplant rate positively. The correlation between transplant rate and GDP per capita is positive and significant below a certain level of GDP (<$14,000 US$) whereas the correlation disappears for countries with a GDP beyond this level of GDP (>$14,000 US$). The authors conclude that, while national income is important to initial up-take, above a certain level of GNP higher national income does not promote technological use. (op.cite., p. 458).

One study of 14 western European countries contrasts the above conclusions by finding no relationship between the number of angioplasties performed and GDP per capita (Van Den Brand & The European Angioplasty Survey Group 1993). Neither is the number of angioplasties per million inhabitants related to the age-standardized mortality of ischaemic heart disease nor the number of cardiologists. The sole predictor of the procedure rate in this study is the number of catheterization laboratories available which may capture the effects of underlying determinants, such as regulation of health capital facilities.

In a longitudinal study of three technologies (Statins, coronary stents and MRI scanners) in a single region in England, patterns of diffusion varied for the different technologies and various factors were held to influence the adoption and diffusion of the technologies (Booth-Clibborn, Packer, & Stevens 2003). These technologies had varying rates of diffusion with those involving a significant capital outlay (such as MRI scanners) having a slower diffusion within this particular health system.

The time trends in the rates of adoption of ‘big ticket’ technologies across countries also seem to differ significantly (Rublee 1989;Rublee 1994). Rublee (1989; 1994) studied the adoption rates of the six technologies in Canada, Germany, and the United States, and showed that the United States had the highest availability of the technologies whereas Canada and Germany were equally restrictive with respect to adoption compared with the United States. The author notes that Canada, which is a sole-purchaser system, does not seem to have tighter control of the adoption rates than the multi-purchaser system in Germany. However, given the small number of countries involved no clear conclusions about the influence of various health system characteristics can be reached. Similarly, procedure rates for a specific technology, carotid endarterectomy, have been shown to be high in the US with traditionally a relatively less restrictive financing system, low in Sweden, which is characterized by global budgets and salaried doctors, while Canada, characterized by global budgets and fee-for-service (FFS) remuneration of physicians, occupies an intermediate position (Nystedt & Lyttkens 2003).

The specific influence of the remuneration scheme to the adoption rate is illustrated in a theoretical study by (Greenberg et al. 2001) and it is tentatively documented in earlier work from the TECH network, which suggests that the speed of diffusion of high-tech procedures (such as CABG and PTCA) is particularly susceptible to the remuneration of providers – countries with fixed provider payment (e.g. global budgets) having experienced relatively little growth in the use of invasive procedures (McClellan, Kessler et al., 1999; TECH research network, 2001). Some studies have also explored how the adoption rate in a cross-country comparison is influenced by hospital remuneration schemes (Escarce 1996;Oh, Imanaka, & Evans 2005;Slade & Anderson 2001). The study by (Slade & Anderson 2001) reveals that the impact of such remuneration on technology adoption varies for different technologies. However, it is found that fee-for-service tends generally to increase the utilization of new and expensive technologies.

Yet another influencing factor may be the proportion of specialist versus generalists because countries with a higher proportion of specialists may be presumed more likely to have higher rate of adoption of new technologies. This is the conclusion reached in a national survey among U.S. physicians in which they were asked about their use of laboratory procedures in the management of outpatients with congestive heart failure, with the level of education and the degree of specialization suggested as particularly important (Fleg et al. 1989).

The only study, to the authors' knowledge, which provides a cross-country comparison applying rigorous econometric analysis of the determinants of the diffusion of technology including both GDP and institutional factors is the OECD Ageing-Related Disease study performed in consultation with the TECH network (Moïse 2003b). This study analyzes the determinants of CABG and PTCA utilization including GDP per capita, mortality rate of ischaemic heart disease, the hospital remuneration scheme and regulatory constraint of the availability of facilities. All institutional specific factors seem to have a significant influence on the utilization of CABG and PTCA. However this study has only a limited number of observations and variables and uses basic econometric techniques to analyze the data. The present TECH study extends this previous work by providing a rigorous econometric analysis of the utilization of the three technologies defined above based on a unique longitudinal cross-country data which includes a multiplicity of explanatory variables allowing a wider range of hypotheses to be explored.

3. Data and methods

Based on this review of the international and country-specific literature along with extensive discussions held within the TECH research group, a set of economic incentives and regulatory factors hypothesized to influence medical treatment are identified. These factors range from general measures of countries' wealth, health system classifications and payment schemes to indices of specific health sector regulation policies. The specific variables and the data used to identify them are described below followed by a description of the econometric regression methods applied to test the specified hypothesis relating to these factors.

The countries included in this analysis are Australia, Belgium, Canada, Denmark, England, Finland, France, Germany, Israel, Italy, Japan, Norway, Scotland, Sweden, Switzerland, Taiwan and USA. Australia is represented by two regions, Victoria and Perth; Canada is represented by three regions, Alberta, Ontario and Quebec and USA is represented by data sources from California and from the Medicare system, respectively. These countries form the core of the TECH research network and represent a wide range of health care systems in terms of their arrangements for funding, provision, reimbursement and regulation. The aggregate data set provided by these countries forms an unbalanced panel as not all countries have data on procedure rates for the whole period 1985-1999. The maximum total number of observations is 188 for the 21 units of observation (geographic regions).

3.1 Data

Data from a number of sources are collected for this study. The dependent variables, the proportion of AMI patients having one of the procedures (CATH, CABG, PTCA), are aggregated proportions calculated from unique micro level data collected at the individual patient level on hospitalized AMI patients over the period 1985-1999 and in a standardized fashion from each of the participating countries.[c] The explanatory variables characterizing individual health care systems originate largely from a number of variables recorded in the OECD Health Database (2003) and from a questionnaire to the participating researchers from each country.[d] The variables are described in detail below.

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[c] An AMI hospitalized patient was defined precisely in accord with pre-agreed protocols. For specific definition see TECH Investigators (2001)

[d] Details of the questionnaire are available from the authors on request.

Dependent variables

The analysis explores the proportion of the AMI population undergoing one of the three procedures by year during the time period 1985-1999. This proportion indicates to what extent the three technologies are adopted and diffused in each of the countries. The dependent variable is an indicator of the degree of technological change. However, it is obviously only a proxy for technological change and does not include all the elements of the process. The problem is that it is difficult to conceptualize and to measure all aspects of technological change (Cutler & McClellan 1998;Moïse 2003b;Okunade & Murthy 2002). Technological change relates the change in the input factors applied in the production including both quantitative changes such as discretionary investment in equipment and increasing labor input, as well as qualitatively better (and more expensive) input factors as they added value to the final good or outcome. Focusing on the proportion of a patient group undergoing specific procedures, this study can neither take full account of the variations in quantities nor the added value of quality of the input factors.

The number of the three procedures performed each year in the period 1985-1999 in each country is aggregated from unique and much larger databases containing individual patient data from representative national or regional micro-data of AMI patients. The proportion of AMI patients undergoing one of the three procedures (referred to here as procedure rates) are calculated as the number of AMI patients receiving one of the three procedures divided by the number of patients diagnosed with

AMI by year. The procedure rates are age- and gender adjusted and standardized to the AMI population in United States in 1995.

The proportion of AMI patients receiving one of the three procedures is calculated from two types of data sources. The first data set (tier 1) consists of unlinked, event-based, cross-sectional administrative or observational epidemiological data measuring the proportion of AMI patients undergoing one of the procedures during the hospital admission period in which AMI is diagnosed. Given the limited time horizon for a given patient, event-based data can only provide part of the picture in terms of actual utilization of the three procedures. However, the trends in technology diffusion over time identified by these unlinked patient data generally accord with those identified by the linked data (McDonald et al. 2006). This linked data is based on a second data set (tier 2) which consists of linked person-based, administrative or observational epidemiological data measuring the proportion of patients undergoing one of the procedures within a predefined period (365 days) after the admission in which AMI is diagnosed. The last data set (tier 2) includes a smaller number of observations from a smaller number of countries.

The data are collected applying a standard protocol to identify acute myocardial infarction cases during initial hospitalization (tier 1 cohorts) and during subsequent time periods (tier 2). Definitional details are provided in TECH Investigators (2001). The origin of the procedure rates is presented in details in Table1.

TABLE1 HERE

The three procedures are not independent. The diagnostic procedure CATH is a prerequisite for CABG and PTCA whereas the two treatment procedures CABG and PTCA are (partially) substitutes. The potential simultaneity and substitutability of the procedures rates will be taken into account in the econometric analyses.

Explanatory variables

The explanatory variables are collected from two primary sources. The first source is the OECD Health Database (2003) describing each countries' real economic potential measured as Gross Domestic Product (GDP) and the degree of public financing. OECD data were not available from non-members of OECD (Israel and Taiwan) and these data were therefore collected from other national sources.

The second source of data originates from a survey of TECH research members and relate to the vital institutional parameters that describe the economic and regulative incentives embodied in each individual countries health care system. The respondents were asked to characterize their health care system by a number of institutional characteristics. Inevitably, as those familiar with the problems of classifying health care systems will immediately recognize, this entails a series of not-so-easy generalizations. In addition, most variables are coded as dichotomies, resulting in further simplifications in the classification of a country's health care system. We should point out that the health system characteristics that our collaborators report pertain specifically to AMI patients in the different countries (which potentially may differ from overall system characteristics).[e] The explanatory variables are listed in Table 2.

Given these characterizations of countries' health care system this paper does not attempt to provide a comprehensive theoretical model of the diffusion of new technologies but draws upon theoretical arguments and relationships suggested by the literature. The hypothesized relationships of the explanatory variables are commented on below and the general hypothesized signs of the coefficients are summarized in Table 2.

TABLE 2 HERE

Real economic potential is measured by GDP per capita in US$ and is adjusted for purchasing power parities (PPP). Wealthier countries are expected to adopt and to utilize new and expensive medical technologies at a greater rate than less wealthy countries.

In many health care systems, a large proportion of the health care expenditure is publicly financed, i.e. financed by taxes or compulsory social insurance contributions. It is debated in the theoretical and the empirical literature of international comparisons of

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[e] Some of the variables from the literature on determinants of health care expenditure, for instance, are less relevant in our specific context. As an example, the gatekeeper function – which seems important as a determinant of health care expenditure in general (Gerdtham & Jönsson 2000) – is unlikely to be important for an acute condition such as AMI.

health expenditure whether a higher degree of public financing increase or restrain health expenditure, see (Gerdtham & Jönsson 2000). Following, Slade & Anderson's (2001) study of technology diffusion it could be argued that the public proportion of total health spending is a proxy for the level of regulatory constraints. A greater degree of public financing is therefore hypothesized to influence the diffusion of medical technologies negatively, all else equal.

The overall organization of health care systems has been classified into three categories: the reimbursement, the public contract, and the public integrated model (Hurst 1991;OECD 1994;van de Ven, Schut, & Rutten 1994). Following this taxonomy the countries in the present study will be classified by two dummy variables either based on a reimbursement model (REIMB) or a contract model (CONTR) with countries having an integrated health care system being the reference category. Countries with a health care system classified as a public integrated model have a monopsonic third party payer and they are hypothesized to depart from countries having competition between third party payers. Countries having one dominating third party payer are expected to have a slower adoption of new expensive technologies because the monopsony power enables a tighter adoption control whereas competition between competing third party payers will tend to drive up technology adoption. The monopsonistic third party payers may be able to control health care expenditure and the providers' possibility to implement expensive technologies through effective budget ceilings. The firmness of the budget control may, however, depend on the remuneration of hospitals as described below. Furthermore, budget constraints can also be soft (Kornai 1979), and deficits may merely lead to more resources being allocated to the activity.

In the public contract model as well as in the public integrated model, there is one dominating third party but they differ in the degree of vertical integration between payers and providers (i.e. hospitals). The degree of vertical integration influences the agency relation between the payer and the provider and consequently influences the payers' possibilities to manage and control the providers' behavior and in particular control the providers' costs. When the payer(s) and the providers are integrated, a tighter contractual arrangement may enable the payer(s) to manage the providers through hierarchical means, i.e. orders or fiats (Evans 1991;Forder 1997), and this is hypothesized to increase the third party payer(s)' ability to slow adoption of new technologies. Following these arguments it is hypothesized that countries classified as a public integrated health care system (the reference category) have lower utilization rates as compared to countries classified as a public contract system (CONTR) or reimbursement system (REIMB). Furthermore, it is expected that countries classified as having a reimbursement system will have a higher utilization rate compared to countries classified as a public contract system because of an a priori expectation that there will be a more intensive 'medical arms race' competition between third party payers in reimbursement health care systems with competing third party payers, all else equal.

Regulation of the availability of facilities is another factor potentially influencing the adoption of health care technology. The regulatory environment is described in this study by two elements. The percentage of total hospital beds owned by the private sector (P_BEDS) is used as a proxy for the public authorities' direct influence over the providers and a higher percentage is hypothesized to be associated with a higher utilization rate. The existence of for profit hospitals may – under certain market circumstances – lead to a lowering of costs even in public or non-profit hospitals through a spill-over effect (Kessler & McClellan 2002). Thus a second influence on general procedure rates arising from the proportion of private sector beds in a health care sector can be postulated.

The second measure of the regulatory environment is whether the payer(s) control larger investments (INV) directly through separate granting arrangement. Technological change requires capital inputs and the control of capital investments may therefore be an important means through which control of the diffusion of new technologies is exercised. In some health care systems, hospitals have to apply separately for funds for large scale investments. In other health care systems, large investments are funded through the general remuneration of the hospitals, as part of the overheads. Direct control through regulation of separate grants for larger investments is expected to have a negative influence on the utilization.

The demand side of the health care systems as it relates to technology up-take and diffusion is described by three variables. Patients' co-payment varies widely between health care systems. This study measures the patients' co-payment for the specific procedures (COPAY) varying in the range 0-50%. Higher co-payment is hypothesized to be negatively associated with utilization rate. The possibility to buy supplementary insurance covering the expenses of the specific procedures (SUPPL) in some health care systems may on the other hand drive up the adoption of new expensive technology. If patients are given the opportunity to choose provider (CHOICE), providers are encouraged to compete for patients and may attract patients with new and expensive technologies. Health care systems enabling patients' choice of provider are hypothesized to have a higher utilization rate of the new expensive technologies.

As discussed in a number of studies health care providers' remuneration systems will provided incentives with respect to the adoption of various technologies (Greenberg, Peiser, Peterburg, & Pliskin 2001;Moïse 2003b;Slade & Anderson 2001). Given the potential importance of these variables the hospitals' remuneration scheme is described by two dummy variables (H-FFS and H_CASE). In H_FFS, health care systems applying fee-for-service (FFS) remuneration systems are compared relatively to countries applying fixed remuneration schemes, i.e. global budgets and capitation. In H_CASE, per case remuneration (e.g., DRG-based) is compared relatively to countries applying fixed remuneration schemes. Fee-for-service and per case remuneration systems are hypothesized to have a higher utilization rate than systems applying fixed remuneration schemes. The physicians' incentives are described by their remuneration scheme (PRS). Physicians reimbursed by FFS tend to have a higher volume of services per physician than those reimbursed by other methods. Therefore FFS physicians are hypothesized to have a higher utilization rate than salaried physicians.

3.2 Econometric model

Two types of analyses are performed. Firstly, the determinants of the utilization of specific procedures are analyzed in a number of models in which the procedure rates are assumed to be independent of each of other. Secondly, the analysis takes the interdependence of the procedures into account in a simultaneous equations system using a two-stage least square (2SLS) estimator.

Independent procedure rates

The dependent variable is the proportion of patients in country *i* at time *t* receiving one of the three treatments and can thus be thought of as the unconditional probability that a patient receives the treatment in question. Assuming a logistic distribution over these probabilities, the model is given as:

$$y_{\text{int}} = \Lambda(x'_{\text{int}}\beta_i) + \varepsilon_{\text{int}} = \pi_{\text{int}} + \varepsilon_{\text{int}} \quad \text{i = 1,2,3; n=1,…N; t=1,..,T} \qquad (1)$$

where y_{int} is the proportion of acute myocardial infarction cases that were treated by the specific treatment *i* in country *n* in the year *t*. Analyses are made separately for i = 1 (CATH), i = 2 (CABG), and i = 3 (PTCA). The vector of explanatory variables x_{nt} includes *K* descriptive characteristics for each country during each year.

Upon a logit transforming of (1), the model can be estimated using linear regression. Specifically,

$$\Lambda^{-1}(y_{\text{int}}) = x'_{\text{int}}\beta_i + \nu_{\text{int}} \quad \text{i = 1,2,3; n=1,…N; t=1,..,T} \qquad (2)$$

Considering (1) to be an outcome of a Bernoulli population, a further heteroscedasticity problem enters, as $\mathrm{var}(\varepsilon_{\mathrm{int}}) = \frac{\pi_{\mathrm{int}}(1-\pi_{\mathrm{int}})}{n_{nt}}$, where n_{nt} is the number of patients. This heteroscedasticity problem is transferred to (2), so that

$$\mathrm{var}(v_{\mathrm{int}}) = \frac{\Lambda(\pi_{\mathrm{int}})(1-\Lambda(\pi_{\mathrm{int}}))}{n_{nt}\lambda(\pi_{\mathrm{int}})} = \frac{1}{n_{nt}\Lambda(\pi_{\mathrm{int}})(1-\Lambda(\pi_{\mathrm{int}}))} \tag{3}$$

where λ is the logistic density function. Thus, a Weighted Least Squares (WLS) iterative approach is applied. Specifically, for iteration *m*+1

$$\hat{\beta}_i^{(m+1)} = \left(\sum_{n,t} \frac{1}{\hat{w}_{\mathrm{int}}^{(m)}} x_{\mathrm{int}} x_{\mathrm{int}}^{'}\right)^{-1} \left(\sum_{n,t} \frac{1}{\hat{w}_{\mathrm{int}}^{(m)}} x_{\mathrm{int}} y_{\mathrm{int}}\right) \tag{4}$$

with $w_{\mathrm{int}}^{(m)} = \frac{1}{n_{nt}\Lambda_{\mathrm{int}}^{(m)}(1-\Lambda_{\mathrm{int}}^{(m)})}$ and $\Lambda_{\mathrm{int}}^{(m)} = \frac{\exp(x_{\mathrm{int}}^{'}\hat{\beta}_i^{(m)})}{1+\exp(x_{\mathrm{int}}^{'}\hat{\beta}_i^{(m)})}$. To initiate the iterations, $\hat{w}_{\mathrm{int}}^{(0)} = 1$ and $\Lambda_{\mathrm{int}}^{-1(0)} = \ln\left(\frac{y_{\mathrm{int}}}{1-y_{\mathrm{int}}}\right)$.

From (2), it is evident that β_i represents the marginal effect on the logit of y_{int}, which is not very convenient for interpretational purposes. Rather, the marginal effect on y_{int} itself is interesting. This is derived as

$$m_i = \frac{\partial\Lambda(x_{\mathrm{int}}^{'}\beta_i)}{\partial x_{\mathrm{int}}^{'}} = \lambda(x_{\mathrm{int}}^{'}\beta_i)\beta_i \tag{5}$$

Thus, the interpretation of the marginal effect m_{ik} of the *k*'th explanatory variable, $x_{\mathrm{int}\,k}$, is that if $x_{\mathrm{int}\,k}$ is increased with one unit, then the procedure rate y_i is increased with m_{ik} units. If for example $x_{\text{int}\,k}$ is measured in percentage points, then an increase of $x_{\text{int}\,k}$ with one percentage point leads to an increase of the procedure rate with m_{ik} percentage points. If $x_{\text{int}\,k}$ is a dummy variable, then the difference in procedure rate between those with the value 0 and the value 1 is m_{ik} percentage points. For the case of ln(GDP), the interpretation is that an increase in GDP of one percent leads to an increase in the procedure rate of $100 \times m_{ik}$ percent. As an example, if the procedure rate is 0.2, and if the marginal effect for ln(GDP) is 0.05, then a 1 percent increase in GDP will increase the procedure rate to 0.21. When, in addition to an explanatory variable x_k, an interaction variable is constructed as an interaction between the variable and time, $x_k \times t$, the marginal effect of the variable x_k is $m_{ik} + t \times m_{ik}$ for t = 1,2,3,…,T.

For matter of inference, $\text{cov}(\beta_i) = \left(\sum_{n,t} \frac{1}{w_{\text{int}}} x_{\text{int}} x_{\text{int}}^{'} \right)^{-1}$, so that, using the Delta method the covariance matrix of m_i is obtained as $\text{cov}(m_i) = G(\text{cov}(\beta_i))G'$ where G is obtained as the K by K matrix of partial derivatives to m_{ij} with respect to β_{ik}, whereby the jk'th element of G is equal to

$$g_{jk} = \frac{\partial m_{ij}}{\partial \beta_{ik}} = \frac{\partial \lambda(x_{\text{int}}^{'}\beta_i)}{\partial \beta_{ik}} \beta_{ik} + i_{(j=k)} \lambda(x_{\text{int}}^{'}\beta_i), \tag{6}$$

or,

$$g_{jk} = \Lambda(x_{\text{int}}^{'}\beta_i)(1 - \Lambda(x_{\text{int}}^{'}\beta_i))(1 - 2\Lambda(x_{\text{int}}^{'}\beta_i)) x_{\text{int}\,k} \beta_{ij} + i_{(j=k)} \Lambda(x_{\text{int}}^{'}\beta_i)(1 - \Lambda(x_{\text{int}}^{'}\beta_i)) \tag{7}$$

where $i_{(j=k)}$ is an indicator function assuming the value 1 if $j=k$, and 0 otherwise.

Interdependent procedure rates

As an alternative to the above model it may be assumed that the utilization rates of the three procedures are not independent but rather determined sequential. The diagnostic procedure, CATH, is a prerequisite for CABG and PTCA. This implies CATH is expected to be positively associated with CABG and PTCA. Increasing the utilization of CATH enables higher utilization of CABG and PTCA and intentions to increase CABG and PTCA necessitates increasing rate of CATH. The two treatment procedures, CABG and PTCA, are (partially) substitutes, so that the signs of the effect of CABG on PTCA and vice versa are ambiguous, as these effects are composed of negative substitution effects in addition to an expected positive association caused by "economy of scope" effects (i.e. the build-up of technology, know-how and capacity caused by increasing one procedure rate also facilitates increases in the other procedure rate).

Thus, the three procedure rates may be specified through a simultaneous system of three equations. For identification and consistent two-stage estimation, it is necessary to identify instrumental variables in a systematic pattern. Specifically, letting i=1 refer to CATH, i=2 to CABG and i=3 to PTCA, and suppressing for ease of notation the subscript *nt*, the system may be written as

$$y_1 = \Lambda(\alpha_1^{(2)} y_2 + \alpha_1^{(3)} y_3 + X\beta_1^{(1)} + X_1^{(2)}\beta_1^{(2)} + X_1^{(3)}\beta_1^{(3)} + \varepsilon_1) \quad (8)$$

$$y_2 = \Lambda(\alpha_2^{(1)} y_1 + \alpha_2^{(3)} y_3 + X\beta_2^{(2)} + X_2^{(1)}\beta_2^{(1)} + X_2^{(3)}\beta_2^{(3)} + \varepsilon_2) \quad (9)$$

$$y_3 = \Lambda(\alpha_3^{(1)} y_1 + \alpha_3^{(2)} y_2 + X\beta_3^{(3)} + X_3^{(1)}\beta_3^{(1)} + X_3^{(2)}\beta_3^{(2)} + \varepsilon_3) \qquad (10)$$

where $\alpha_i^{(h)}$ refers to the coefficient for y_h in the equation for y_i, X to the exogenous variables entering all three equations, $X_i^{(h)}$ to the exogenous variables which enters the equation for y_i but not the equation for y_h, and $\beta_i^{(h)}$ to the relevant partitioning of the coefficient vector β_i.

The key for identification and (pseudo-)consistent estimation of the equation for y_i are the exogenous variables $X_h^{(i)}$, which can be used as instruments for y_h $(h \neq i)$. A specific request on $X_h^{(i)}$ is that its variables should be correlated with y_h but not with y_i. Obvious "candidates" are variables which are found to be significant for the former but insignificant for the latter in one or more of the WLS logit regressions without interdependence, the WLS logit regression with interdependence but without instrumentalisation (these models are not reported here), or the instrumentalised WLS logit regression.

Thus a 2SLS approach for (pseudo-)consistent estimation of the equation for procedure rate *i* is suggested as follows:

Step 1: Perform a WLS logit estimation of y_h on $X_h^{(i)}$ and obtain the estimated procedure rates $\hat{y}_h = \Lambda(X_h^{(i)}\hat{\beta}_h^{(i)})$ $(h \neq i)$.

Step 2: Perform a WLS logit estimation of y_i on $\widehat{y}_h$, $X_i^{(h)}$ $(h \neq i)$, and X.

We denote the procedure as "pseudo-consistent" in the sense that although $X_h^{(i)}\widehat{\beta}_h^i$ consistently instrumentalises $\Lambda^{-1}(y_h)$, it is not formally guaranteed that this consistency properly fully carries over to a consistent instrumentalisation of y_h by $\Lambda(X_h^{(i)}\widehat{\beta}_h^{(i)})$. However, in the lack of a formal solution, we rely on the assumption that the consistency of $X_h^{(i)}\widehat{\beta}_h^i$ does in fact reflect consistency of $\Lambda(X_h^{(i)}\widehat{\beta}_h^{(i)})$.

The coefficient of $\widehat{y}_h$ in the logit equation for y_i shares the interpretational properties of the coefficients for the exogenous variables, i.e. $\hat{\alpha}_i^{(h)}$ measures the effect on the logit of y_i. To measure the effect on the procedure rate itself, the marginal effect, defined previously by

$$m_i^{(h)} = \lambda(\sum_{g \neq i} \alpha_i^{(g)} \widehat{y}_g + X\beta_i^{(i)} + \sum_{g \neq i} X_i^{(g)} \beta_i^{(g)}) \times \alpha_i^{(h)} \tag{11}$$

is appropriate: If y_h increases with one percentage point, then y_i increases with $m_i^{(h)}$ percentage points.

4. Results

4.1. Descriptive analysis

In an earlier descriptive analysis by the TECH Research Network, a picture emerged of different patterns of diffusion of intensive technology in cardiac care during the 1990s seemingly related to health care systems' characteristics (McClellan & Kessler 1999;McClellan & Kessler 2002;Tech Research Network 2001). The simple descriptive statistics in Table 3 reveal major differences in level of the utilization rates across countries. The mean utilization rates should be compared with some caution however as the observations from each country originate from different time periods (cf. Table 1).

The mean utilization rate of the diagnostic procedure CATH varies from 1.22% (Finland) up to 76.82% (Japan) in this sample of AMI patients. For CABG the mean utilization rate varies from 0.08% (Norway) up to 11.79% (US-California). The utilization rate of PTCA varies from 1.06% (Finland) up to 52.57% (Japan). The mean utilization rates are logically higher for tier 2 compared to tier 1 for most countries. However, for some countries the tier 2 data is from a different time period than the tier 1 data, (cf. Table 1), and this may result in the mean for tier 2 data being lower than the tier 1 mean.

TABLE 3 HERE

Such results are presented as a baseline comparison for the analysis undertaken below which presents the results from the more rigorous econometric analyses following the framework presented above.

4.2. Econometric analysis

Results from three models will be presented. The first model includes only a simple time trend (t) as an explanatory variable. The second model includes a simple time trend (t) and the *K* explanatory variables cf. Table 2. The third model further adds the *K* explanatory variables interacted with a time trend. The coefficient on the simple time trends model presents the unconditional increase in the utilization of the three technologies over time. The β_i coefficients generally relate to the impact of the economic and institutional variables on the *level* of the utilization of the three technologies[f]. The coefficients on the interaction terms present information on whether the variables have an increasing or decreasing impact over time on the utilization rate.

Assuming the three technologies to be independent, results from the three types of models are presented separately for the three technologies and separately for tier 1 and tier 2 data in Tables 4-6. Assuming interdependence, inclusion of the utilization rates of the two procedures directly in the regression as determinants of the third procedure is pursued. As noted above, since the utilization rates are determined jointly the endogenous variables are all correlated with the error terms and the OLS estimators

[f] One should note that the various independent variables are measured in different units. The variables PEH, P_BEDS, and COPAY are measured in percentages while the rest are dummy variables, except for t and ln(GDP).

with endogenous variables on the right-hand side will provide inconsistent estimates (simultaneous-equation bias). Thus instrumental variable estimation, based on the insignificant factors from the first regressions assuming independence together with the insignificant factors from a simple OLS with the endogenous variables on the right side as instruments, is undertaken. The results from the simultaneous equation system with instrumental variables are reported in Table 7. The first two rows with results in Table 7 report the impact of the utilization rates of the two other procedures.

TABLES 4-7 HERE

A log-likelihood test is performed to examine the performance of the various models. These results are also reported in Tables 4-7.[g] With the exception of the analyses relating to catheterisation (CATH), the models including the institutional and economic incentives and interaction terms (Model 3) seems to better explain the diffusion rates than the model with institutional and economic factors alone (Model 2) for both tier 1 and tier 2 data.

In general, as seen from Tables 4 – 7, the majority of the dependent variables have the expected sign (when they are significant), but there are several notable exceptions. For ease of interpretation, the average rates of the dependent variables have been inserted in

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[g] The log likelihood tests are based on comparing the constrained models with the unconstrained models where LogL is the model's log-likelihood, and Log0 is the likelihood that would be obtained in the absence of any explanatory variables. The LRI statistics for the analyses is an index which is calculated as 1 minus (LogL/Log0). The index is not necessarily restricted to the range 0 - 1. The higher the index, the better the model explanation.

the first row in the tables. The simple time trend (t) is, as expected, positive in nearly all models meaning that the utilization of the three procedures is increasing over time. As an example, the utilization rate of CATH, which on average is 0.1988, increases by 0.0076 per year. For tier 2 data, the utilization of CATH is decreasing over time, though, according to model 2 in Table 4, and the change over time is zero according to the 2SLS model in Table 4.

The impact of GDP per capita is positive and significant in most analyses. According to expectations, GDP had a correct sign in 16 out of 18 results presented in Tables 4 – 7, in particular in the 2SLS analyses (Table 7) with all five significant results having the expected sign. As an example of interpretation, a 1 percent increase in GDP results in an increase in the CATH rate by 0.0731 according to model 2, tier 1 data in Table 4. Moreover, the interaction terms in model 3 regularly show that effect of GDP per capita decreases over time for both tier 1 and tier 2 data. Most other variables show no consistent time pattern; the effect of physician remuneration scheme, PRS (tier 1) and investments, INV (tier 2), diminishes consistently over time, though, as well as CONTR and REIMB in the 2SLS analyses reported in Table 7.

No specific hypothesis was formulated with respect to public expenditure on health care (PEH). The variable appears to have different associations with the three procedures, and the associations vary between tier 1 and tier 2 data. According to Model 2 in Table 4, a 1 percentage point increase in PEH decreases the procedure rate with 0.00222.[h]

Both variables representing the type of system (contract (CONTR) and reimbursement (REIMB)) both have the expected positive effects on utilization rates of CATH and PTCA, while the effect is ambiguous for CABG. When referring to Table 4, tier 1 data, countries characterized as public contract systems (CONTR) have a 0.1567 higher utilization level compared to countries characterized as public integrated systems (reference level) while countries characterized as reimbursement systems have a 0.2349 higher utilization rate. The coefficients are almost exclusively positive (when they are significant, which occurs in 14 and 16 analyses out of all 18 analyses, respectively for CONTR and REIMB). This indicates that countries with publicly integrated systems (the reference category) have lower utilization rates compared to other institutional arrangements. Furthermore, it was expected that countries characterized as a reimbursement system would have the highest utilization rates (REIM). Our results indicate that this might well be the case, as the coefficient for REIMB is almost invariably larger than that for CONTR. Looking specifically at the results in Table 7 the impact seems to diminish over time, cf. the negative signs of t×CONTR and t×REIMB.

Private hospital beds (P_BEDS) as a proportion of total beds was expected to be positively associated with procedure rates. It appears though that this variable has ambiguous effect. The coefficients should be interpreted as the change in a procedure

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[h] The variables PEH, P_BEDS and COPAY are measured on a scale 0.00 - 1.00. This means that the coefficient (m_i) for these variables indicates an increase from 0% to 100%. In order to have the incremental effect of a 1% increase in these variables, m_i has to be divided by 100.

rate by a one percentage point increase in private beds as share of total. The direct control of funding for investments (INV) has as expected a positive impact on utilization rates with one exception (when significant). Thus, the level of utilization of these procedures seems higher in countries in which the funding of investments is included in the general remuneration scheme for hospitals (INV=1) compared to countries where the funding is controlled separately from the general remuneration. This effect seems, however, to diminish over time. Health care systems allowing patients to make a choice of hospital (CHOICE) was expected to be positively associated with procedure rates. It was omitted in several of the analyses in Table 7 due to collinearity problems, and the effect of CHOICE in the rest of the analyses was ambiguous. In general, the effect, whether positive or negative, seems to diminish by time.

The impact of the remuneration of hospitals (H_FFS & H_CASE) and the remuneration of physicians by fee-for-service (PRS) were expected to be positive. Again, results are ambiguous, but most analyses show negative effects, and there appears no consistent change over time. The last two variables, COPAY and SUPPL, and their interaction with time t×COPAY and t×SUPPL, were dropped in some of the regressions because of perfect singularity problems. In the remaining regressions these variables seem to have ambiguous and very small impact on the utilization rates.

Turning to the relation between CATH, CABG and PTCA (Table 7), the results seem consistent with expectations. There appears a positive association between CATH on the one hand and CABG/PTCA on the other, and overall CABG and PTCA are substitutes for each other. Thus, the results for the tier 1 data show in the column for

CATH that the association with the utilization rates for CABG and PTCA are positive. This means that the utilization of CATH is as expected to be complementary to utilization of CABG and PTCA. This positive relationship between CATH and the other procedures are confirmed in the regressions with CABG and PTCA as dependent variables. In the regression of the utilization of CABG, the utilization of PTCA seems negatively associated with CABG implying that these are substitutes which is confirmed in the regression of the utilization of PTCA. With respect to size of the effects, several coefficients seem relatively large compared to the average value, and interpretation is complicated by inclusion of the interaction term in model 3

In summary, procedure rates increase over time. Income and general system characteristics (public contract systems or reimbursement systems versus public integrated systems) behave according to expectations. Other characteristics behave according to expectations for either tier 1 or tier 2 data. The effects of income and investment characteristics decrease over time. CATH and CABG or PTCA appears to be complimentary while CABG and PTCA appear to be substitutes.

5. Discussion and conclusion

Despite the importance of technological change in the health care sectors globally there is strikingly little evidence on the role that the economic incentives and regulatory factors embodied in individual health care systems have on patterns of technological adoption and diffusion. The understanding of the role of economic and regulatory influences on technological change is often more speculative than based on empirical findings. The present econometric analysis of longitudinal cross-country data provides unique insights into the impact of such institutional factors for a range of major technological procedures in a major disease area.

At this level of analysis the explanatory factors included in this study are considered to be exogenous describing the incentives embodied in the health care system. The number of AMI facilities and physicians would probably have been very good predictors for the utilization rates. However, these factors are considered to be endogenous results of the economic incentives and regulatory factors and they are therefore not analyzed. Arguably some of the included variables may be considered as endogenous to the diffusion of medical technologies. However given the level of analysis, based on seventeen different countries, and the eighteen year time period over which the analysis was performed this is not consider to be a major issue.

Theoretically, the model with simultaneous equation systems (2SLS) is preferable to the ones with independent procedure rates. Tier 2 data, which goes beyond the initial hospital episode, provides arguably the best representation of the actual use of the three procedures (though we have fewer observations and the model is less stable). It is therefore worth noting that the 2SLS model run with Tier 2 data is the one that provides the results that are most in accordance with a priori expectations when considering the coefficients without interaction with time.

As expected, the model shows catheterization to be complementary to both CABG and PTCA. PTCA is seen to be a substitute for CABG.[i]

5.1 Impact of institutional characteristics

One of major conclusions is that the institutional factors characterizing health care systems do seem to have an impact on the utilization of new and expensive medical technologies. However, the impact is often differs across the three procedures and differs for the procedures rate when measured at hospitalization (tier 1 data) and at 365 days after diagnosing AMI (tier 2 data).

The countries' economic capability measured by GDP seemed in previous studies to have a positive impact on the adoption of new and expensive technologies. This conclusion seems confirmed in the present study. Moreover the coefficients on the interaction term $t \times \ln(GDP)$ are negative for all three procedures implying that the positive impact of GDP on the level of utilization of the procedures diminishes over time. The diminishing impact of GDP may be caused by decreasing unit costs for the technologies but it may also be caused by the impact of other non-economic factors as discussed below.

The overall classification of health care systems into public integrated, public contract and reimbursement system has not been used in previous studies but some of these have

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[i] This is in line with Cutler and Huckman's (2003) broad finding, but the level of aggregation employed here does not allow investigation of the accompanying broadening of the patient pool which they found and which is consistent with overall expenditure increasing even with the introduction of a new less costly technology.

confirmed that countries with different types of health care system have different utilization of new technologies, e.g. (Rublee 1989;Rublee 1994). The results from this study indicate that countries classified as public integrated are the most restrictive followed by public contract and reimbursement health care system. The public contract and reimbursement systems have a higher level of utilization of CATH and PTCA (cf. CONTR and REIMB) compared to public integrated systems but the impact diminishes over time (cf. the negative sign of t×CONTR and t×REIMB for tier 1 data). One interpretation of the coefficients for CONTR and REIMB is that new and expensive technologies are adopted and diffused faster in health care systems with competition between providers (public contract system and reimbursement system) and competition between third party payers (reimbursement system).

Providers' remuneration has previously been indicated to have an impact on the utilization rates in the more descriptive analysis in TECH (McClellan & Kessler 1999;McClellan & Kessler 2002;Tech Research Network 2001) and in other studies (Escarce 1996;Oh, Imanaka, & Evans 2005;Slade & Anderson 2001). These indications are not confirmed here, though, as the results were ambiguous or not fully feasible to explore (i.e., the 2SLS model run with Tier 2 data).

Perhaps the most striking result is the positive effect on utilization rates of not having to apply directly for large investment funding. This is apparently an important and perhaps sometimes overlooked (compared to its evident importance) parameter for technology diffusion. The effect of having investments funded through general hospital revenue (INV) is almost invariably significantly positive (14 out of 17 analyses). Furthermore, the effect is comparable to that of having a reimbursement system rather than a publicly integrated system. It should perhaps come as no surprise that regulating the actual physical capacity to perform procedures is a strong determinant of technology use, whereas regulation of, e.g., financial capacity still leaves considerable leeway for decisions at the micro level, even if these decisions may in the aggregate lead to budget deficits.

Three variables describe conditions concerning patients' demand. All three variables, patients' possibility to choose hospital (CHOICE), the presence of supplementary insurance (SUPPL) and co-payment (COPAY) have ambiguous effects, but it should be noted that the impact on the utilization is very small.

Given the severity of AMI as a health problem, it is not necessarily surprising that supply side variables seem to explain procedure rates better (more in accordance with theoretical expectations) than demand side variables, and hence that variables such as CHOICE and COPAY show very mixed results. Indeed, they may measure something else than we intended them to do. Intuitively, one would expect SUPPL to be the most adequate demand side variable, since the decision to purchase supplementary insurance is taken beforehand and by healthy persons, and not when someone has already experienced a heart attack. Four out of the five times when SUPPL is significant, it has the expected sign. The effect of SUPPL seems to vanish when we move to Tier 2 data, which could be a sign that supplementary insurance primarily has the effect of ensuring speedier access to a technology, rather than increasing access in general.

One of the important findings in this study is that the inclusion of interactions between time and the explanatory variables provide important insights into the diffusion of medical technologies. Almost consistently, the time interactions of income (GDP), system characteristics (CONTR and REIMB versus public integrated) and direct funding of investments (INV) reveal that the main effect of these explanatory variables seems to diminish over time. This finding may be explained by the non-economic dynamics of the diffusion of technologies as they mature to the point where medical standards, guidelines and so forth would play a more significant role.

Assuming that the three technologies are interdependent, results from tier 1 data are consistent with expectations. There appears a positive association between CATH on the one hand and CABG and PTCA on the other which means that CATH is complementary to the utilization of CABG and PTCA as expected. Overall, CABG and PTCA are substitutes for each other. Some unexpected signs might be due to measurement of something else than intended for each variable, or the same characteristic is measured twice. For example, the unexpected signs of H-FFS and H_CASE with global budgets suggest that the budget constraints in global budget remuneration systems are soft in the present case

5.2 Limitations to this study

In health economics we are still grappling with methods for characterizing health care systems according to built-in incentives. One problem is that no health care system seems to be characterized by a pure standard model as described by others, e.g. (Hurst 1996) but contain mixtures of various standard models. Accounting for a vast number of characteristics would demand a large number of variables that would make an econometric analysis inefficient due to a limited number of countries and observations included. In our survey we focused on a selected number of dimensions and this may have been too limited. The selected dimensions may also suffer from being very crude classifications of the countries. Countries often have combinations of various economic incentives and regulatory factors for various parts of the health care sector. To facilitate the regression, the collaborators were asked to simplify the diversity into what were the main characteristics of their health care systems, as they related to AMI care. The simplifications were necessary but may have caused insignificant coefficients in the regression because the diversity resulted in noise around the dummy variables. It should be noted that we were not able to include some relevant variables like health status, in particular co-morbidities, and distance to hospital. Unlike Cutler and Huckman (2003) our data did not allow a detailed analysis of the effect in different time periods. We are not able to analyze and answer whether there is a change in the degree of substitution or complementarity between the three procedures over time.

In contrast to the hypotheses concerning influence of general characteristics of the health care system, the development in use of intensive care may be influenced by political decisions as witnessed by the Danish “heart plan” which in essence was an initiative to increase the activity in a particular area of health care. Hence, over the period the technology activity increased from a low to a relatively high level. Only two cases were found with a large one time grant but it was not possible to find any significant effects of such a variable (not reported) and the variable has not been included in the list of variables.

The data are longitudinal cross-sectional observations of the utilization rates but the panel structure cannot be fully exploited because it is an unbalanced panel data set and because most of the explanatory variables are time invariant. The loss in the number of degrees of freedom by the use of a fixed effects regression model would have been too extensive due to the limited data (even though more data were assembled than has usually been available for such analyses). The main reason for not applying a fixed effects regression is, however, due to insufficient 'within' variation across time and due to the potentially high correlation between the country-specific fixed effects and the explanatory variables. Due to time invariance of most of the explanatory variables many of the explanatory variables would have dropped out of the regressions and the country-specific fixed effects would have picked up most of the variation in the data set providing no insights to the impact of economic incentives and regulatory factors. A random-effect specification has been tested (not reported) but the random country effects were not significant meaning that the variance component related to intra-country variation is insignificant. The regressions techniques have deliberately been kept simple because of the imperfect, however, still unique data set. The results should be treated as indicative rather therefore.

6 Conclusion

Using rigorous econometric analyses of longitudinal cross-country data this study shows that differences in the utilization rates of three technologies for treating AMI can be explained by country income and a number of institutional factors. Health care systems being characterized as public contract or reimbursement systems have generally higher utilization compared to public integrated systems. Funding of investments through a general remuneration scheme rather than through investment funds granted by third party payer is associated with higher utilization rates. The main effects of these variables seem, however, almost consistently to diminish through time. Thus, a positive main effect will typically have a negative interaction with the time trend which means that income and institutional variables explain less and less of the variation as technologies mature. Even though the data for the present project are unique, the imperfection of these data results in some limitations. Future work may involve collecting longer time series for each country enabling application of more advanced econometric methods.

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Table 1: Data sources of the procedure rates

Country (region)	Years	Data source and content
Australia (Perth)	1988-1996	WHO MONICA; and linked hospital death records. Treatment during AMI is only in the MONICA data set, which is for persons under 65 years, from 1991-1993.
Australia (Victoria)	1987-1996	The Victorian Inpatient Minimum Dataset (The Victorian State Government acute hospital summary dataset); The Victoria dataset includes all acute public hospitals from 1987/88, and all private hospitals from 1993/4 with some private hospitals from 1991/92.
Belgium	1993-1998	Ministry of Public Health (includes all Belgian hospitals); National Hospital Admissions; Health Insurance Data Base.
Canada (Alberta)	1989-1998	Hospital Discharge Data.
Canada (Ontario)	1985-1999	Hospital Discharge Data. Ontario did not exclude patients coded as 410.x2, or most other patients specified for exclusion in the protocol because of coding inconsistencies in the data. Tier 2 data: 1992-1999
Canada (Quebec)	1988-1999	Hospital Admission Files and Physicians Claims.
Denmark	1989-1999	Public administrative registration including all AMI patients.
England	1989-1998	Oxford Record Linkage Study; Hospital Episode Statistics; and Heart Attack Register.
Finland	1989-1997	Finnish National Hospital Discharge Register linked with National Death Register; Finnish Heart Association; WHO MONICA. Finland changed from ICD-9 to ICD-10 coding in 1996. Tier 1 cohort excluded cases whose hospital stay was longer than 90 days, indicating long term care.
France	1995-1997	Nationwide database containing all the information for the AMI admissions.
Germany	1985-1999	MONICA data (only if surviving at least 24h within the hospital admission)
Israel	1993-1997	National Hospital Discharge Register, which covers approximately 80% of all acute care hospital admissions in the country; National Death Register; MONICA/AMI registry; Biennial 2-month survey of CCU admissions. Tier 2 data:1994-1998
Italy	1985-1993	MONICA data; patients under 65 years
Japan	1996-1999	MED (Medical Economics division of the Ministry of Health and Welfare; IPSS (National Institute of Population and Social Security Research; SMTS (Social Medical Treatment Survey).
Norway	1992-1999	Norwegian Patient Registry- the entire population and all admissions for AMI. Norway does not have data for 1993 and 1995
Scotland	1985-1999	Information Service Division, National Health Service.
Sweden	1987-1997	Swedish National Hospital Discharge Register, linked with PTCA register. Sweden excludes AMI patients with a hospital length of stay greater than 100 days.
Switzerland	1986, 1990, 1993	WHO MONICA data; patients under 65 years
Taiwan	1995-1998	Hospital Claim File.
USA (California)	1991-1996	California discharge database (Office of Statewide Health Planning and Development) for the under-65 population only.
USA (Medicare)	1985-1999	Inpatient Medicare data (Medicare Provider Analysis and Review and Health Insurance Skeleton Eligibility Write-off) for ages 65 and over

Table 2: Explanatory variables

Variables	Descriptions	Coding	Hypothesized influence
GDP	Gross domestic product per capita, US$ PPP	-	+
PEH	Public expenditure on health as % total expenditure on health	0.00 – 1.00	÷
CONTR	Health care systems classified as public contract system	0='Public integrated system' 1='Public contract system'	+
REIMB	Health care systems classified as reimbursement system	0='Public integrated system' 1='Reimbursement system'	+
P_BEDS	Percentage of total number of hospital beds owned by the private sector	0.00 – 1.00	+
INV	Does the third party grant larger capital investments separately?	0='Larger investments are granted and controlled by the third party(ies)' 1='Investments are funded through the general remuneration scheme to the hospitals'	+
COPAY	Patients' co-payment as percentage of the total cost of the procedure	0.00 – 1.00	÷
SUPPL	Do patients purchase supplementary insurance providing access to one of the procedures?	0=No 1=Yes	+
CHOICE	Do patients have choice of provider and do patients actually use their opportunity to choose among hospitals?	0='No choice or very limited extent of patients choosing among hospitals' 1='Yes can and do choose among hospitals'	+
H_FFS	Hospital remuneration scheme	0='Fixed remuneration schemes (global budgets/capped budgets)' 1='Fee-for-service or per-diem payment'	+
H_CASE	Hospital remuneration scheme	0='Fixed remuneration schemes (global budgets/capped budgets)' 1='Payment per admission (DRG)'	+
PRS	Physician remuneration scheme	0='Salaried physicians' 1='Fee-for-service physicians'	+

Table 3: Simple descriptive statistics of the dependent variable – mean (standard deviation)

Countries	CATH Tier 1		CATH Tier 2		CABG Tier 1		CABG Tier 2		PTCA Tier 1		PTCA Tier 2	
Alberta	0.2354	(0.0357)	0.3503	(0.0396)	0.0181	(0.0056)	0.0126	(0.0067)	0.0763	(0.0313)	0.1122	(0.0376)
Belgium	0.2186	(0.0498)	-	-	0.0119	(0.0026)	-	-	0.0633	(0.0298)	-	-
Denmark	-	-	-	-	0.0025	(0.0019)	0.0030	(0.0020)	0.0348	(0.0251)	0.0204	(0.0268)
England	0.0253	(0.0135)	-	-	0.0022	(0.0009)	-	-	0.0127	(0.0124)	-	-
Finland	0.0122	(0.0152)	0.0991	(0.0129)	0.0023	(0.0014)	0.0129	(0.0053)	0.0106	(0.0051)	0.0338	(0.0157)
France	0.3201	(0.0294)	-	-	0.0285	(0.0096)	-	-	0.1223	(0.0376)	-	-
Germany	0.4149	(0.1567)	0.3985	(0.1483)	0.0624	(0.0393)	0.0619	(0.0400)	0.1444	(0.0959)	0.1429	(0.0962)
Israel	0.3587	(0.0567)	0.3298	(0.0719)	0.0098	(0.0055)	0.0166	(0.0052)	0.3556	(0.0562)	0.1941	(0.0681)
Italy	0.1779	(0.0795)	-	-	0.0200	(0.0147)	-	-	0.0188	(0.0222)	-	-
Japan	0.7682	(0.0576)	-	-	0.0637	(0.0127)	-	-	0.5257	(0.0540)	-	-
Norway	0.0177	(0.0196)	-	-	0.0008	(0.0004)	-	-	0.0124	(0.0109)	-	-
Ontario	0.0387	(0.0142)	0.1715	(0.0550)	0.0040	(0.0019)	0.0137	(0.0057)	0.0121	(0.0065)	0.0541	(0.0261)
Perth	0.1412	(0.0649)	0.2695	(0.1012)	0.0110	(0.0086)	0.0262	(0.0100)	0.0430	(0.0302)	0.0821	(0.0466)
Quebec	0.2206	(0.0637)	0.3394	(0.0644)	0.0088	(0.0039)	0.0971	(0.0017)	0.0772	(0.0499)	0.1244	(0.0723)
Scotland	0.0459	(0.0394)	0.0639	(0.0541)	0.0044	(0.0029)	0.0127	(0.0124)	0.0127	(0.0124)	0.0455	(0.0357)
Sweden	-	-	-	-	0.0049	(0.0032)	0.0054	(0.0036)	0.0265	(0.0282)	0.0413	(0.0429)
Switzerland	0.3542	(0.1236)	-	-	0.0488	(0.0028)	-	-	0.1239	(0.0431)	-	-
Taiwan	0.2175	(0.0389)	0.3174	(0.0551)	0.0297	(0.0070)	0.0352	(0.0056)	0.1498	(0.0397)	0.2310	(0.0528)
US – California	0.5232	(0.0333)	0.4939	(0.0161)	0.1179	(0.0194)	0.0862	(0.0076)	0.2498	(0.0329)	0.2168	(0.0236)
Victoria	0.1162	(0..0618)	-	-	0.0146	(0.0082)	-	-	0.0212	(0.0218)	-	-
US - Medicare	0.2535	(0.1113)	0.2614	(0.1162)	0.0569	(0.0270)	0.0505	(0.0247)	0.0855	(0.0518)	0.0843	(0.0533)
Overall	0.1988	(0.1807)	0.2775	(0.1488)	0.0219	(0.0309)	0.0253	(0.0293)	0.0842	(0.1108)	0.0981	(0.0790)

Table 4: Marginal effects (m_i) of the determinants for the utilization of CATH

Variables	Tier 1						Tier 2					
	m_i	**s.e.**	**m_i**	**s.e.**	**m_i**	**s.e.**	**m_i**	**s.e.**	**m_i**	**s.e.**	**m_i**	**s.e.**
Average rate	0.1988		0.1988		0.1988		0.27755		0.27755		0.27755	
t	0.0239***	0.0001	0.0076***	0.0002	0.1760***	0.0018	0.0292***	0.0001	-0.0294***	0.0007	0.3789***	0.0052
ln(GDP)	-	-	0.0731***	0.0041	0.01464***	0.0057	-	-	1.1536***	0.0164	0.7846***	0.0211
PEH	-	-	-0.2220***	0.0036	-0.1742***	0.0200	-	-	0.5335***	0.0168	2.0938***	0.0592
CONTR	-	-	0.1567***	0.0025	0.5518***	0.0076	-	-	0.3565***	0.0053	0.1187***	0.0456
REIM	-	-	0.2349***	0.0028	0.6508***	0.0078	-	-	0.5096***	0.0054	0.3574***	0.0455
P_BEDS	-	-	0.0145**	0.0061	-0.6765***	0.0178	-	-	0.5645***	0.0140	1.0182***	0.0469
INV	-	-	0.0239***	0.0018	0.0192***	0.0070	-	-	0.7606***	0.0117	0.8758***	0.0291
H_FFS	-	-	-0.0775***	0.0034	-0.4420***	0.0134	-	-	0.0155**	0.0065	0.1698***	0.0489
H_CASE	-	-	-0.0472***	0.0017	-0.1734***	0.0099	-	-	-0.6450***	0.0107	-0.5936***	0.0502
PRS	-	-	0.0385***	0.0018	0.2640***	0.0072	-	-	-0.5839***	0.0118	-0.1636***	0.0239
SUPPL	-	-	0.0087***	0.0015	0.0753***	0.0137	-	-	Dropped		Dropped	
COPAY	-	-	-0.0398***	0.0074	0.0704**	0.0308	-	-	Dropped		Dropped	
CHOICE	-	-	-0.0906***	0.0052	0.2371***	0.0175	-	-	-0.2562***	0.0067	-0.0259	0.0194
t×ln(GDP)	-	-	-	-	-0.0160***	0.0002	-	-	-	-	-0.0169***	0.0006
t×PEH	-	-	-	-	0.0129***	0.0019	-	-	-	-	-0.2332***	0.0068
t×CONTR	-	-	-	-	-0.0356***	0.0008	-	-	-	-	0.0133***	0.0041
t×REIM	-	-	-	-	-0.0396***	0.0008	-	-	-	-	0.0006	0.0041
t×P_BEDS	-	-	-	-	0.0537***	0.0018	-	-	-	-	-0.1143***	0.0052
t×INV	-	-	-	-	0.0021***	0.0007	-	-	-	-	-0.0752***	0.0033
t×H_FFS	-	-	-	-	0.0207***	0.0011	-	-	-	-	-0.0071	0.0046
t×H_CASE	-	-	-	-	0.0076***	0.0009	-	-	-	-	0.0468***	0.0049
t×PRS	-	-	-	-	-0.0219***	0.0007	-	-	-	-	0.0118***	0.0025
t×SUPPL	-	-	-	-	-0.0042***	0.0013	-	-	-	-	Dropped	
t×COPAY	-	-	-	-	0.0141***	0.0031	-	-	-	-	Dropped	
t×CHOICE	-	-	-	-	-0.0099***	0.0016	-	-	-	-	-0.0092***	0.0024
Constant	-0.4070***	0.0005	-0.8759***	0.0375	-1.8430***	0.0612	-0.4229***	0.0005	-12.005***	0.1616	-10.055***	0.2168
N_{it}	163		163		163		99		99		99	
LRI	-0.0397		0.9938		1.0468		1.001		2.5120		1.8097	
$\lambda\left(\bar{x}'\hat{\beta}\right)$	0.1695		0.0684		0.0701		0.2053		0.1713		0.1693	
LogL/Log0	76,724,416 / 73,811,753		455,100 / 73,811,753		-3,565,355 / 73,811,753		-4,686 / 4,827,562		-7,337,510 / 4,827,562		-3,908,686 / 4,827,562	

Notes: * denotes significance at the 10% level. ** denotes significance at the 5% level. *** denotes significance at the 1% level.

Table 5: Marginal effects (m_i) of the determinants for the utilization of CABG

Variables	Tier 1						Tier 2					
	m_i	s.e.	m_i	s.e.	m_i	s.e.	m_i	s.e.	m_i	s.e.	m_i	s.e.
Average rate	0.0219		0.0219		0.0219		0.0253		0.0253		0.0253	
t	0.0029***	0.0000	0.0003***	0.0000	0.0083***	0.0003	0.0039	0.0000	0.0003***	0.0001	0.0263***	0.0009
ln(GDP)	-	-	0.0039***	0.0005	-0.0002	0.0007	-	-	0.0266***	0.0024	0.0014	0.0029
PEH	-	-	0.0007***	0.0005	-0.0042*	0.0025	-	-	0.0132***	0.0029	-0.0285***	0.0095
CONTR	-	-	-0.0111	0.0004	-0.0006	0.0012	-	-	0.0154***	0.0020	-0.0168***	0.0054
REIM	-	-	-0.0083***	0.0004	0.0043***	0.0012	-	-	0.0164***	0.0019	-0.0046	0.0054
P_BEDS	-	-	0.0332***	0.0008	0.0998***	0.0031	-	-	-0.0646***	0.0046	0.0424***	0.0089
INV	-	-	0.0089***	0.0004	0.0039***	0.0013	-	-	0.0564***	0.0029	-0.0045	0.0055
H_FFS	-	-	-0.0107***	0.0008	0.0057**	0.0029	-	-	-0.0948***	0.0053	0.0422***	0.0067
H_CASE	-	-	-0.0100***	0.0005	-0.0105***	0.0021	-	-	-0.0511***	0.0031	0.0022	0.0060
PRS	-	-	-0.0060***	0.0003	0.0032**	0.0013	-	-	-0.0452***	0.0027	0.0144***	0.0048
SUPPL	-	-	0.0145***	0.0005	0.0031	0.0031	-	-	0.0062***	0.0017	Dropped	
COPAY	-	-	0.0031**	0.0015	-0.0579***	0.0057	-	-	0.1846***	0.0081	Dropped	
CHOICE	-	-	0.0007	0.0011	-0.0695***	0.0038	-	-	0.1144***	0.0054	-0.0102***	0.0039
t×ln(GDP)	-	-	-	-	-0.0008***	0.0000	-	-	-	-	-0.0026***	0.0001
t×PEH	-	-	-	-	0.0004*	0.0002	-	-	-	-	0.0026**	0.0011
t×CONTR	-	-	-	-	0.0003**	0.0001	-	-	-	-	0.0005	0.0005
t×REIM	-	-	-	-	0.0000	0.0001	-	-	-	-	-0.0003	0.0005
t×P_BEDS	-	-	-	-	-0.0084***	0.0003	-	-	-	-	-0.0044***	0.0009
t×INV	-	-	-	-	-0.0001	0.0001	-	-	-	-	-0.0015**	0.0006
t×H_FFS	-	-	-	-	-0.0022***	0.0002	-	-	-	-	-0.0009	0.0007
t×H_CASE	-	-	-	-	0.0003	0.0002	-	-	-	-	0.0028***	0.0006
t×PRS	-	-	-	-	-0.0003**	0.0001	-	-	-	-	0.0016***	0.0005
t×SUPPL	-	-	-	-	-0.0001	0.0003	-	-	-	-	Dropped	
t×COPAY	-	-	-	-	0.0076***	0.0006	-	-	-	-	Dropped	
t×CHOICE	-	-	-	-	0.0073***	0.0003	-	-	-	-	0.0021***	0.0005
Constant	-0.1232***	0.0003	-0.0657***	0.0049	-0.0299***	0.0077	-0.1425***	0.0003	-0.3479***	0.0241	-0.0808***	0.0294
N_{it}	185		185		185		128		128		128	
LRI	0.0300		0.1714		0.1729		0.0312		0.1021		0.1037	
$\lambda\left(\bar{x}'\hat{\beta}\right)$	0.0286		0.0041		0.0043		0.0333		0.0131		0.0129	
LogL/Log0	-1,206,570 / -1,243,914		-1,030,690 / -1,243,914		-1,028,802 / -1,243,914		-937,020 / -967,184		-868,465 / -967,184		-866,930 / 967,184	

Notes: * denotes significance at the 10% level. ** denotes significance at the 5% level. *** denotes significance at the 1% level.

Table 6: Marginal effects (m_i) of the determinants for the utilization of PTCA

Variables	Tier 1						Tier 2					
	m_i	s.e.	m_i	s.e.	m_i	s.e.	m_i	s.e.	m_i	s.e.	m_i	s.e.
Average rate	0.0842		0.0842		0.0842		0.0981		0.0981		0.0981	
t	0.0106***	0.0000	0.0064***	0.0001	0.0769***	0.0013	0.0142***	0.0000	0.0000***	0.0000	0.1248***	0.0028
ln(GDP)	-	-	-0.0087***	0.0024	0.0067**	0.0033	-	-	0.0009***	0.0001	-0.0177***	0.0069
PEH	-	-	-0.1092***	0.0024	-0.2050***	0.0119	-	-	-0.0012***	0.0001	0.1439***	0.0268
CONTR	-	-	0.0845***	0.0014	0.1373***	0.0063	-	-	0.0009***	0.0001	0.0966***	0.0155
REIM	-	-	0.1258***	0.0016	0.1819***	0.0066	-	-	0.0012***	0.0001	0.1881***	0.0155
P_BEDS	-	-	-0.1058***	0.0038	-0.3122***	0.0124	-	-	0.0162***	0.0010	0.2272***	0.0219
INV	-	-	0.0105***	0.0012	0.0377***	0.0056	-	-	0.0059***	0.0004	0.1375***	0.0120
CHOICE	-	-	0.0588***	0.0036	0.1559***	0.0124	-	-	-0.0094***	0.0006	-0.0371***	0.0114
H_FFS	-	-	-0.0949***	0.0025	-0.1793***	0.0091	-	-	-0.0075***	0.0005	0.0058	0.0179
H_CASE	-	-	-0.0263***	0.0010	-0.0319***	0.0056	-	-	-0.0065***	0.0004	-0.1865***	0.0181
PRS	-	-	-0.0050***	0.0012	0.0294***	0.0053	-	-	-0.0051***	0.0003	0.0490***	0.0097
SUPPL	-	-	0.0011	0.0008	-0.0251***	0.0067	-	-	0.0000	0.0000	Dropped	
COPAY	-	-	0.0582***	0.0052	0.1889***	0.0218	-	-	0.0037***	0.0004	Dropped	
t×ln(GDP)	-	-	-	-	-0.0076***	0.0002	-	-	-	-	-0.0094***	0.0003
t×PEH	-	-	-	-	0.0158***	0.0011	-	-	-	-	-0.0080**	0.0031
t×CONTR	-	-	-	-	-0.0052***	0.0006	-	-	-	-	-0.0057***	0.0014
t×REIM	-	-	-	-	-0.0068***	0.0006	-	-	-	-	-0.0107***	0.0014
t×P_BEDS	-	-	-	-	0.0189***	0.0011	-	-	-	-	-0.0144***	0.0024
t×INV	-	-	-	-	-0.0034***	0.0005	-	-	-	-	-0.0144***	0.0014
t×CHOICE	-	-	-	-	-0.0046***	0.0011	-	-	-	-	0.0014	0.0012
t×H_FFS	-	-	-	-	0.0046***	0.0007	-	-	-	-	0.0019	0.0017
t×H_CASE	-	-	-	-	-0.0004	0.0005	-	-	-	-	0.0163***	0.0019
t×PRS	-	-	-	-	-0.0018***	0.0005	-	-	-	-	0.0017	0.0011
t×SUPPL	-	-	-	-	0.0029***	0.0007	-	-	-	-	Dropped	
t×COPAY	-	-	-	-	-0.0043**	0.0020	-	-	-	-	Dropped	
Constant	-0.2620***	0.0004	0.0028	0.0224	-0.1745***	0.0331	-0.3056***	0.0004	-0.0099***	0.0007	-0.3635***	0.0646
N_{it}	162		162		162		117		117		117	
LRI	0.0724		0.2979		0.2981		0.0859		0.1865		0.1990	
$\lambda\left(\bar{x}'\hat{\beta}\right)$	0.0689		0.0348		0.0316		0.0790		0.0004		0.0519	
LogL/Log0	-2,348,125 / -2,531,460		-1,777,281 / -2,531,460		-1,776,899 / -2,531,460		-1,897,718 /-2,076,105		-1,688,925 /-2,076,105		-1,662,903 /-2,076,105	

Notes: * denotes significance at the 10% level. ** denotes significance at the 5% level. *** denotes significance at the 1% level.

Table 7: Marginal effects (m_i) in the 2 SLS regression models

	Tier 1						Tier 2					
	CATH		CABG		PTCA		CATH		CABG		PTCA	
Variables	m_i	*s.e.*	m_i	*s.e.*	m_i	*s.e.*	m_i	*s.e.*	m_i	*s.e.*	m_i	*s.e.*
Average rate	0.1988		0.0219		0.0842		0.2775		0.0253		0.0981	
$X_h^{(i)}$, i=CABG, PTCA, CATH	1.8951***	0.5121	0.0085	0.0516	0.0927	0.0576	-2.4455	1.7928	-0.6679***	0.1633	0.2064	0.2985
$X_h^{(i)}$, i=PTCA, CATH, CABG	1.4424***	0.1526	0.0404	0.0365	-1.9036***	0.2516	-0.0337	1.1791	0.2871***	0.0460	-3.3052***	0.6347
t	0.2301***	0.0025	0.0101***	0.0004	0.0743***	0.0013	0.4016***	0.0055	0.0277***	0.0011	0.1530***	0.0032
ln(GDP)	0.3356***	0.0077	0.0004	0.0011	0.0376***	0.0037	0.8518***	0.0225	0.0786***	0.0033	0.1570***	0.0138
PEH	-	-	-	-	-0.1593***	0.0128	2.1639***	0.0631	-	-	0.5010***	0.0334
CONTR	0.4666***	0.0101	-0.0011	0.0014	0.1247***	0.0064	0.1370***	0.0485	0.0151***	0.0042	0.0632***	0.0137
REIM	0.6068***	0.0104	0.0038***	0.0015	0.1669***	0.0069	0.3913***	0.0486	0.0347***	0.0043	0.1783***	0.0145
P_BEDS	-0.5551***	0.0145	0.1101***	0.0031	-0.3102***	0.0111	1.0288***	0.0502	-	-	0.3014***	0.0172
INV	-0.1293***	0.0076	0.0094***	0.0009	0.0425***	0.0056	0.9159***	0.0309	-	-	0.2164***	0.0069
CHOICE	-	-	-0.0691***	0.0019	0.1704***	0.0109	-	-	-	-	-	-
H_FFS	-0.3048***	0.0087	-	-	-0.1781***	0.0071	0.1848***	0.0522	0.0309***	0.0071	-	-
H_CASE	0.0329***	0.0099	-0.0175***	0.0013	-	-	-0.6122***	0.0535	-	-	-0.1805***	0.0140
PRS	0.2827***	0.0084	-	-	0.0304***	0.0057	-0.1538***	0.0256	0.0120***	0.0035	-	-
SUPPL	-	-	-	-	-	-	Dropped	-	Dropped	-	Dropped	-
COPAY	-	-	-0.0367***	0.0031	0.1838***	0.0205	Dropped	-	Dropped	-	Dropped	-
t×ln(GDP)	-0.0204***	0.0003	-0.0009***	0.0000	-0.0070***	0.0002	-0.0186***	0.0006	-0.0029***	0.0001	-0.0092***	0.0004
t×PEH	-0.0184***	0.0008	0.0004**	0.0002	0.0086***	0.0012	-0.2384***	0.0073	0.0027***	0.0004	-0.0497***	0.0038
t×CONTR	-0.0209***	0.0010	0.0005***	0.0001	-0.0031***	0.0006	0.0135***	0.0044	-0.0007***	0.0004	0.0014	0.0011
t×REIM	-0.0256***	0.0010	0.0003*	0.0002	-0.0044***	0.0006	-	-	-0.0021***	0.0004	-0.0044***	0.0011
t×P_BEDS	0.0367***	0.0015	-0.0093***	0.0004	0.0182***	0.0010	-0.1145***	0.0056	-	-	-0.0252***	0.0024
t×INV	0.0137***	0.0008	-0.0006***	0.0001	-0.0033***	0.0005	-0.0768***	0.0035	0.0022***	0.0004	-0.0182***	0.001334
t×CHOICE	0.0038***	0.0003	0.0074***	0.0003	-0.0092***	0.0010	-0.0095***	0.0026	0.0023***	0.0004	-	-
t×H_FFS	0.0066***	0.0007	-0.0019***	0.0001	0.0072***	0.0006	-0.0083***	0.0049	-0.0006	0.0007	-0.0010	0.000811
t×H_CASE	-0.0124***	0.0010	0.0008***	0.0001	-	-	0.0465***	0.0052	-	-	0.0124***	0.001272
t×PRS	-0.0253***	0.0008	-	-	-0.0017***	0.0005	0.0094***	0.002722	-0.0027***	0.0004	-	-
t×SUPPL	-	-	-	-	-	-	Dropped	-	Dropped	-	Dropped	-
t×COPAY	-	-	0.0062	0.0004	-0.0076***	0.0019	Dropped	-	Dropped	-	Dropped	-
Constant	-5.4609***	0.1791	-0.0720	0.0171	0.4129***	0.1241	-9.5743***	0.9027	-0.6917***	0.0979	-0.8376***	0.2931
N_{it}	149		149		148		96		96		96	
LRI	1.0572		0.1307		0.2869		1.8563		0.0724		0.1758	
$\lambda(\bar{x}'\hat{\beta})$	0.1104		0.0054		0.0310		0.1795		0.0190		0.0693	
LogL/Log0	-3,656,577 / 63,959,281		-1,017,289 / -1,170,280		-1,745,838 / -2,448,400		-3,912,881 / 4,569,258		-851,690 / -918,212		-1,619,957 / -1,965,465	

Notes: * denotes significance at the 10% level. ** denotes significance at the 5% level. *** denotes significance at the 1% level.