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Consideration the Effect of E-health system on Economic in Iran†

Sadr, Seyed Mohammad Hossein[1] Goodarzi, Yazdani[2 *]

1. Ph.D student in Management Information Technology, Department of Management and accounting, University of Allame Tabataba'I (ATU), Tehran, Iran.

2. M.A. student from Economics, Tehran, Iran.

* E-mail of the corresponding author: sadr.mba@gmail.com.

ABSTRACT

The purpose of this paper is to examine the relationships between Ehealth expenditure and economic growth in the case of Iran; with this regard we use annually data (1970-2011). E-health is one of the most important assets a human being has. It permits us to fully develop our capacities. If this asset erodes or it is not developed completely, it can cause physical and emotional weakening, causing obstacles in the lives of people. The results show that variables of the ratio of E-health expenditure to GDP, the ratio of investment to GDP and Growth rate of graduates have positive effect on growth rate.

Keywords: E-health expenditure, Economic growth, Vector Autoregressive Model (VAR).

1. Introduction

E-health is an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies. In a broader sense, the term characterizes not only a technical development, but also a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology (Eysenbach, 2002).

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E-health is one of the most important assets a human being has. It permits us to fully develop our capacities. If this asset erodes or it is not developed completely, it can cause physical and emotional weakening, causing obstacles in the lives of people (Lilliard and Weiss 1997; Smith 1998; Smith 1999, Aguayo-Rico, Andrés and et al 2005).

With regard to costs, the researchers discussed the impact of eHealth on health care costs generally. They indicated that there is currently not a good course of data on eHealth costs so that costs of non-health care

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technology (such as iPads being used in hospitals) could be used as an immediate proxy for eHealth costs. The desire of innovators in the field is that eHealth reduce health care costs overall, but without data this is only a hope.

Proxy data can help demonstrate if costs are going up or down. Thus, all the mobile devices and their related plans floating around in the pockets of patients and practitioners in various health care organizations worldwide could be viewed as health care costs. This seems to work best for devices that are dedicated to a health care role versus those which are used for calling home and calling patients. Their services are not free so they generate health care costs for the rural area which may not have existed otherwise.

Next, the authors discussed the drivers of eHealth costs. They stated that infrastructure was a key driver of costs and those efforts should be made to decrease these costs. One counterargument to this notion is that the infrastructure – such as wireless Internet connections may already exist for other purposes and health care use of the infrastructure may not pose any new financial burden. For example, if patients are able to provide information to a physician using data on their mobile phone instead of filling out paper, they could simply use any existing infrastructure they purchase to provide the information. The infrastructure does not incur a new cost.

Health systems in low- and middle-income countries continue to face considerable challenges in providing high-quality, affordable and universally accessible care. In response, policy-makers, donors and programs implementers are searching for innovative approaches to eliminate the geographic and financial barriers to health. This has resulted in mounting interest in the potential of e-health (the use of ICT for health) and m-health (the use of mobile technology for health, a subset of e-health) in low- and middle-income countries.

E-health is relatively a new term in e-healthcare and has no clear definition to date. It was first used in 1999 at the 7th International Congress on Telemedicine and Telecare in London by John Mitchell from Sidney, Australia who spoke about a national government study whose main result was the recognition that "cost-effectiveness of telemedicine and tele-health improves considerably when they are part of an integrated use of telecommunications and information technology in the e-health sector”. Eysenbach (2001) asserts that this term was apparently first used well before 1999 by industry leaders and marketing people rather than academics. These industry and marketing people created and used this term in line with other "e" buzzwords such as e-commerce, e-business, e-solutions and many others, in an attempt to convey the promises, principles, excitement (and hype) around e-commerce (electronic commerce) to the e-health sector and to provide a picture of the new possibilities the Internet is opening up to the e-health care. In this paper, we define e- health as consisting of all Information and Communication Technologies (ICT) tools and services in e-health care that link or interface patients and providers of e-health services including e-health professionals and it covers the transmission of data related to e-health between institutions.

However, the development of e-health is challenged by a number of issues that appear to be inhibiting its deployment. Among the greatest of these barriers are legal and regulatory issues such as privacy, licensure and reimbursement policies; delivery of care difficulties arising from limitations of the technology, and the changes in the relational component of provider-patient interactions that can influence patients’ trust (Deloitte, 2006).

The rest of the paper is organized into four main sections: Section 2 describes the data and the econometric methodology. Section 3 discusses the results that emerge from the estimations. The conclusions of this paper are then presented in section 4.

2. Data and Methodology

Structural form equation is introduced to describe the analytical framework in this section.

$$G(L)Z_t = e_t$$

Where G(L) is a matrix polynomial in the lag operator L, Z_t is an $n \times 1$ data vector, and e_t is an $n \times 1$ structural disturbance vector. e_t is serially uncorrelated and $\mathrm{var}(e_t) = \Lambda$. Λ represents a diagonal matrix where diagonal elements are the variances of structural disturbance; hence structural disturbance are assumed to be mutually uncorrelated.

Then reduced form equation (VAR) can be estimated as,

$$Z = B(L)Z_t + \varepsilon_t$$

Where B(L) is a matrix polynomial (without the constant term) in lag operator L and $\mathrm{var}(u_t) = \sum$.

Bernanke(1986) and Sims(1986) suggest structural VAR in which non-recursive structures are allowed while still imposing restrictions to contemporaneous structural parameters only.

Set G_0 be the non-singular coefficient matrix on L^0 in G(L), which represents the contemporaneous coefficient matrix in the structural form, and $G^0(L)$ be the coefficient matrix in G(L) without contemporaneous coefficient G_0.

$$G(L) = G_0 + G^0(L)$$

Therefore the parameters in the reduced form equation and those in the structural form equation can be described as,

$$B(L) = -G_0^{-1}\Lambda G_0^{-1'}$$

Only Through sample estimates of $\sum$, the maximum likehood estimates of Λ and G^0 can be obtained. The right side of the above equation has $n \times (n+1)$ free parameters to be estimated. Since $\sum$ contains $n \times (n+1)/2$ parameters, hence here at least $n \times (n+1)/2$ restrictions are necessary. Therefore, at least $n \times (n+1)/2$ restrictions on G_0 are needed to achieve identification. In the VAR modeling with Cholesky decomposition, G_0 is supposed to be triangular. Whereas in the structural VAR approach G_0 can be any structural as long as it has enough restrictions for achieving identification

3.1. Theoretical Principles

The model which is used for investigating the effect of E-health expenditure on economic growth in Iran inspired from the propounded model in Bartolini and Labiri'S Paper (2006) and Safdari and et al (2011).
This model is defined as following:

$$DGDP = \beta_1 + \beta_2 E - HEL + \beta_3 INV + \beta_4 DL + \beta_5 DGOV + \beta_6 DSTUDENT$$

Where:
DGDP: Gross domestic product growth rate
E-HEL: The ratio of E-health expenditure to GDP
INV: The ratio of investment to GDP
DL: Population growth
DGOV= the ratio of government expenditure to GDP
DSTUDENT: Growth rate of graduates

3. Findings/Discussion

We use the above formulation to estimate a VAR model containing five variables.

3.1 ADF Unit Root Test

Nelson and Plosser (1982) argue that almost all macroeconomic time series typically have a unit root. Thus, by taking first differences the null hypothesis of nonstationarity is rejected for most of the variables. Unit root tests are important in examining the stationarity of a time series because nonstationary regressors invalidates many standard empirical results and thus requires special treatment. Granger and Newbold (1974) have found by simulation that the F-statistic calculated from the regression involving the nonstationary time-series data does not follow the Standard distribution. This nonstandard distribution has a substantial rightward shift under the null hypothesis of no causality.

Thus the significance of the test is overstated and a spurious result is obtained. The presence of a stochastic trend is determined by testing the presence of unit roots in time series data. Non-stationarity or the presence of a unit root can be tested using the Dickey and Fuller (1981) tests.
The test is the t statistic on φ in the following regression:

$$\Delta Y_t = \beta_0 + \beta_1 . trend + \rho Y_{t-1} + \sum_{i=0}^{\infty} \varphi_i \Delta y_{t-i} + \varepsilon_t$$

Where Δ is the first-difference operator, ε_t is a stationary random error.
The results of the unit root tests for the series of bank's financing and GDP variables are shown in Table 1. The ADF test provides the formal test for unit roots in this study. The p-values corresponding to the ADF values

calculated for the two series are larger than 0.05. This indicates that the series of all the variables are non-stationary at 5% level of significance and thus any causal inferences from the two series in levels are invalid.

The analysis of the first differenced variables shows that the ADF test statistics for all the variables are less than the critical values at 5% levels (Table 2). The results show that all the variables are stationary after differencing once, suggesting that all the variables are integrated of order I(1).

After investigation of persistent of variables, one of the important stages in evaluation of vector regression model is choosing rank of pattern.

For choosing optimum rank of pattern, we can use criterion of Akaike or Schwarz. The most lag which is given to model is 2, and considering table (3), the least quantity of Schwarz, Akaike statistic is prepared in second lag, we can indicate that the optimum lag of VAR model is equal to 2.

In this article we follows vectors and accumulated vector among variables of gross domestic product growth rate, the ratio of E-health expenditure to GDP, the ratio of investment to GDP, population growth, Growth rate of graduates by the use of Johansson's method. In Johnson's method after doing necessary calculations for studding existence of convergence we use two criterions consist of λ_{max} and λ_{trace}

If existence of convergence among variable is verified, we can say that balance and long term relation among variable is established.

Results which are concluded from effect's examination and examination of maximum specific values for determination of accumulated vectors among model's variables are presented in following tables.

Results of maximum of specific values for determination magnitude of accumulated vector are reported in Table 4.

Engle and Granger (1981), note that if two time-series variables are not cointegrated there may be unidirectional or bidirectional Granger causality in the short-run. Short-run causality is determined by test on the joint significance of the lagged explanatory variables, using an F-test or Wald test. The traditional practice in testing the direction of causation between two variables has been to use the standard Granger causality test (i.e. pair wise Granger causality tests for bivariate time-series). As an alternative, the short-run Granger causality can be tested by the Wald test.

Under the Wald test, the maximum likelihood estimate of the parameters of interest is compared with the proposed value, with the assumption that the difference between the two will be approximately normal. Typically the square of the difference is compared to a chi-squared distribution. The Block Exogeneity Wald test in the VAR system provides chi-squared statistics of coefficients on the lagged endogenous variables, which are used to interpret the statistical significance of coefficients of the regressors. In this way, Wald test statistics can be used to find out the Granger causal effect on the dependent variable. In the VAR system, Granger causality is done to glimpse the short-run causality running from independent variables to a dependent variable, using asymptotic t-statistics that follow chi-squared distribution instead of F distribution. The hypothesis in this test is that the lagged endogenous variable does not Granger causes the dependent variable. For Iran, to answer the question regarding the direction of causation in the short-run, the Granger causality tests by unrestricted VAR models are performed.

Engle and Granger (1981) and Granger (1988) note that if two variables are cointegrated there always exists a corresponding error correction representation in which the short-run dynamics of the variables in the system are influenced by the deviation from equilibrium. For the Iran, the existence of a long-run equilibrium relationship between ICT development and economic growth implies that the two variables are causally related, at least in one direction. The VECM implies that changes in one variable are a function of the level of disequilibrium in the cointegrating relationship, as well as changes in the other explanatory variable. The VECM is a technique that facilitates to capture both the dynamic and interdependent relationships of the said variables and is a special type of restricted VAR to correct a disequilibrium that may shock the whole system.

The long-run causality is implied through the significance of the t-statistics of the lagged error correction terms. In this case, it estimates the asymptotic variance of the estimator, and then the t-statistics will have asymptotically the standard normal distribution. Therefore, asymptotic t-statistics in this test can be interpreted in the same way as t-statistics, which are used to interpret the statistical significance of coefficients of the lagged error correction terms, which contain the long-run information because it is derived from the long-run cointegrating relationship. The short-run Granger causality can be tested by the Wald test. The Block Exogeneity Wald test in the VECM system provides chi-squared statistics of coefficient on the lagged endogenous variables, which are used to interpret the statistical significance of coefficients of the regressors. In this way, Wald test statistics can be used to find the Granger causal effect on the dependent variable. The hypothesis in this test is that the lagged endogenous variable does not Granger causes the dependent variable.

Table 5 displays the results of Granger causality tests with annual data. The null hypothesis regarding no causation leading from e-health expenditure to economic growth in the short-run cannot be rejected for the country. The null hypothesis regarding no causation leading from economic growth to ICT development in the short-run can be rejected only for Iran at the 5% significance level. The results are consistent with different lag selections, but the numeric values of the results of different lag selections are not reported in this study. Considering the results of the Granger causality test in Table 5, this study concludes that Hypothesis 2 *"e-health expenditure leads to economic growth"* is supported for this country in this study. Hypothesis 3 *"Economic growth leads to e-health expenditure"* is supported for Iran. In other words, due to the presence of one-way directional causal relationship from economic growth to e-health expenditure for Iran this finding suggests that economic growth leads to e-health expenditure in Iran.

4. Conclusion

From the previous empirical evaluation, e-health capital has a significant effect on economic growth, especially with a variable that captures all the determinants of e-health. This result is very important due to the ostensible importance of e-health as a determinant of growth and for the robustness shown with the growth model specification. Plus, even if it was expected that the e-health services determinant was of greater significance than the rest of the determinants, it is interesting to see that the environment determinant is rejected in most of the specifications compared with lifestyles. In addition, it is seen that lifestyles, which have an impact on e-health status, have a higher impact on economic growth.

A higher awareness of the e-health of the people is necessary if sustainable growth is pursued, especially for the Third World. As demonstrated in this paper, factors like productivity and schooling are as important as e-health for the development of a country, where this last factor is sometimes not taken care of with the importance that it deserves. For policy implications, it is notorious how e-health can affect not just the economic e-health of a person, but of an entire nation. It is important to include investment in e-health as a tool of macroeconomic policy, due to the fact that differences in economic growth rates between countries have been significantly explained by e-health differences, showing that investment in e-health improves economic growth and is one of the few feasible options to destroy poverty traps (World E-health Organization 1999).

In sum, the results of the causality test can help the government set priorities regarding where and how to use limited resources for national economic growth. If empirical results support the e-health expenditure led growth hypothesis in the short-run, more resources should be allocated to the nation's e-health expenditure as a priority rather than to other sectors. To detect the causal relationship, this study performed Granger causality tests following the cointegration approach, which has been the typical method favored in studies of this kind. The current study discovered mixed results between e-health expenditure and economic growth in this country. The mixed results indicate that the direction of causality between e-health expenditure and economic growth may be determined by various factors of the country.

The mixed results of this study further point to several research directions for the future. First, the simple bivariate VAR and VECM models were used in this study. The important and critical roles that other microeconomic factors play in model specifications were not fully considered. This can be improved by adopting an approach of using multivariate Granger causality tests to include important variables such as foreign direct investment, exports. Second, the limitations of this study may be related to data availability.

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Table 1: Variable Definitions and Descriptions (Safdari and et al, 2011)

variable	Description
DGDP	Gross domestic product growth rate
HE	The ratio of E-health expenditure to GDP
INV	The ratio of investment to GDP
DPOP	Population growth
DGOV	the ratio of government expenditure to GDP
DSTUDENT	Growth rate of graduates

Table 2: Results of unit root test

	ADF t-statistic		PP t-statistic	
	Trend and Intercept	first difference	Trend and Intercept	first difference
ln(E-HEl)	-3.97	-4.36	-3.74	-4.38
ln(GDP)	-2.51	-5.72	-2.59	-5.93
Ln (INV)	-2.07	-4.27	-2.12	-4.89
Ln (L)	-1.87	-4.32	-2.56	-4.90
Ln (STUDENT)	-1.99	-4.14	-2.35	-4.66
Ln (GOV)	-2.05	-5.02	-2.59	-5.03
Critical values (5%)	-2.13	-4.14	-3.03	-3.58

Note: The optimal lags for the ADF tests were selected based on optimising Akaike's information Criteria AIC, using a range of lags. We use the Eviews soft ware to estimate this value.

Table 3: Determination of magnitude of lag of VAR model

Schwarz information	Akaike information	lag
-14.90	-14.45	0
-16.59	-16.89	1
-18.12	-19.35	2

Table 4: Results of the Johansen cointegration test

	Trace test		Maximum Eigenvalue test	
	$r = 0$	$r \leq 1$	$r = 0$	$r \leq 1$
Data	15.69	2.21	14.64	2.21

Table 5: Results of Granger causality tests (Block Exogeneity Wald tests)

	"Y"	$\Delta\ln GDP$		$\Delta\ln E-HEL$	
	Method "X"	$\Delta\ln E-HEL$	ECT	$\Delta\ln GDP$	ECT
Data	VECM	0.56	3.53	0.81	1.23