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## Conference Paper

# Towards the alternative measurement: Discovering the relationships between technology adoption and quality of life in Indonesia

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Ibrahim Kholilul Rohman, Erik Bohlin

**Towards the alternative measurement:  
Discovering the relationships between technology adoption and  
Quality of Life in Indonesia**

The vast majority of the studies investigating telecommunication development (diffusion of mobile phone, Internet, the broadband, etc.) that have been carried out in the literatures aim at assessing the impact on economic indicators, mainly the Gross Domestic Product (GDP), whereas little attention has actually been paid to investigate the other measurement which reflects a more direct linkage to the individual welfare, for instance the quality of life (QOL) indicators. Following the current counterargument for using the GDP as the goal of economic development, this paper investigates a survey data in Indonesia, observing the relationships between the experience to technology (the length of mobile phone ownership) and technology adoption (internet access) in affecting quality of life (QOL) at individual level. The QOL index is proxied by two indicators which are equally weighted; the objective measurement represented by income level and subjective perceived QOL following the study by Costanza et al., (2007). To operationalize these aims, the model is investigated in two sequential ways; first by determining binomial probit on the Internet access demand equation and then putting the predicted probability of the first equation into second equation of the ordered probit model. The model is further analyzed through the return to education-type equation (Card, 2001) to see the impact of experience to technology and internet access on the QOL index. The results indicate that whereas the access to the Internet is not statistically significant affecting QOL, experience to technology plays an important role. Additionally, the experience of technology (measured at its mean value of 3.5 years) affects the likelihood to have a lower QOL index around 49% and to achieve a higher QOL index in Indonesia around 12%. A year additional of ownership reduces the likelihood on a lower QOL by 3.6% and increases the likelihood to obtain a higher QOL by 2%.

**JEL codes:** O11, O14, O32, O33, N84

**Keywords:** technology, quality of life, ordered-probit, Internet.

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**1. Introduction**

Previous empirical studies have been devoted for investigating the role of technology in general and Information and Communication Technology (ICT) sector in particular to be capable of enhancing the growth of economy. The macro level analysis is supported by the studies that stress the importance of investment infrastructure in telecommunication represented by the penetration rates to the Gross Domestic Product (GDP) growth (for instance Nadiri & Nandi, 1999; Roller & Waverman 2002). Additionally, at industry and firms level, the studies analyze the chain of economic performance through the impact of efficiency by increasing utilization of ICT products (Brynjolfsson & Hitt, 2000). The bottom line of both analyses strengthens the conclusion that there is a strong positive relationship between the development of telecommunications and economic growth (Madden & Savage (1998), Dutta (2003), Chakraborty & Nandi (2003) and Shiu & Lam (2008)).

Table 1 summarizes the existing literature on the study investigating the role of telecommunication development (infrastructure) to the GDP

**Table 1**

Previous studies on the relation between telecommunication infrastructure and growth

Authors	Methodology	Data used	Results <sup>1</sup>
Cronin et al. (1991)	Granger causality and modified Sims test	USA; 1958-1988	Telecoms investment ↔ GDP
Cronin et al. (1993.a)	Granger causality and modified Sims test	Pennsylvania, USA; 1965-1981	Telecoms investment ↔ employment
Cronin et al. (1993.b)	Granger causality and modified Sims test	USA; 1958-1990	Telecoms investment → aggregate and sectoral productivity growth
Madden & Savage (1998)	Granger causality	27 CEE countries; 1990-1995	Telecoms investment ↔ GDP
Dutta (2001)	Granger causality	15 developing and 15 industrial countries; 1960-1993	Telecoms investment → per capita GDP
Chakraborty & Nandi (2003)	Granger causality	12 Asian countries; 1975-2000	Degree of privatization; High : Teledensity ↔ GDP Low : Teledensity → GDP
Cieslik & Kaniewsk (2004)	Granger causality	Regional panel data, Poland; 1989-1998	Teledensity → Retail sales per worker
Yoo & Kwak (2004)	Granger causality	Korea; 1965-1998	IT investment ↔ GDP
Wolde & Rufael (2007)	Granger causality	USA; 1947-1996	Telecom investment ↔ GDP
Shiu & Lam (2008)	Dynamic panel data model	Regional panel data, China; 1978-2004	Overall : GDP → Teledensity High income region: Teledensity → GDP  Other region : no causality or GDP → Teledensity

<sup>1</sup> Unidirectional causality is denoted by a one way line direction between two variables, while bi-directional causality is shown by two ways line direction.

Zahra, Azim & Mahmood (Punjab Planning and Development Department)	Dynamic fixed and random effect on the panel dataset. The Granger causality	The regional study comprising 24 low income, middle income and high income countries during 1985-2003	The return of telecommunications investment is increasing in the sense that countries gain more and more with the increase in telecommunications investment. One way direction from telecommunications → GDP
Ding & Kingsley (2006)	Dynamic fixed effect model	The inter regional study in China which is conducted in 17 years period from 1986-2002 in 29 regions	The telecommunications infrastructure has a significant role in driving economic growth. The magnitude is diminishing, suggesting that those regions which are in the early stages of development will enjoy the larger impact. The Supporting Convergence hypothesis: regions with higher level GDP per capita tend to have a slower rate of growth.
Karner & Onyeji (2007)	Panel data	14 African and 13 European countries during 1999-2005	The study found that the impact of telecommunications development was not significant. This might be due to the lower level of telecommunications infrastructure, especially in African countries
Datta & Mbarika (2006)			Countries with a higher per capita income are experiencing a slower growth rate

Source: Shiu & Lam (2008), and extended studies collected by the author

Table 1 shows the existing literatures investigating the impact of telecommunication infrastructure development which mainly focus on the GDP impact. The results show various directions of the causality depend on time and countries investigated.

In the different domain of discussion, it has been a long debate questioning the reliability of the GDP to reflect the level of wealth and happiness at individual basis. This is especially due to the reason that many intangible values of QOL are yet been captured by the single indicator of GDP. Early economists and philosophers ranging from Aristotle, Bentham, Mill and Smith incorporated the pursuit of happiness as an approach to assess welfare. Yet, as economist grow more rigorous and quantitative, more parsimonies definition of welfare took hold hence utility is only influenced on income as mediated by individual choices or preferences within rational monetary budget constraint. It is generally not realized though that even within the more orthodox mindsets, focusing on income can led to missing the element of measurement because people have different perspective and preferences for material and non-material goods. For instance, they choose less-paid but more personally rewarding jobs, yet still in an attempt to maximizing utility in the neoclassical economics sense (Graham, 2009).

Therefore, GDP which more emphasizes on the achievement of material aspects, have received many criticisms since couple of decades ago (Among others, Kuznets (1941), Hicks (1948), Galbraith (1958), Samuelson (1961), Mishan (1967), Nordhaus & Tobin (1972), Easterlin (1974), Hueting (1974), Hirsch (1976), Sen (1976), Scitovsky (1976), Daly (1977), Frank (1985, 2004), Hartwick (1990), Tinbergen & Hueting (1992), Arrow et al. (1995), Weitzman & Löfgren (1997), Dasgupta & Mäler (2000), Dasgupta (2001), Ng (2003) and Kahneman, Krueger, Schkade, Schwarz, & Stone (2004). It is also conceived that the GDP aggregates all monetary measurement of economic activities based on a clear methodology enabling comparison between countries and times but it does not measure environmental sustainability and social inclusion (European Commission, 2009). Besides that, GDP does not capture all social costs as it omits external costs, supporting another reason that the variable was never been developed for the purpose of welfare measurement (Van den Bergh, 2008). In addition, GDP is not meant to be an accurate gauge of longer term of economic and social progress and more importantly the ability of society to tackle the issue in relation to climate change, resource efficiency and social inclusion (European Commission, 2009).

Having found the drawback for using (only) GDP as the target of development, yet the assessment of the impact of ICT to QOL is still limited partly due to the complexities of measuring the QOL index itself. For instances, Roco & Sims (2003) stated that the recent development of mobile phone and Internet have eroded the traditional way of communicating. The paradox behind the revolution is that technology is steadily eroding the time and attention to be devoted to communication with people in immediate vicinity, particularly driven by the fact that the cost for sending an email and/or SMS is becoming very close to zero. Shortly, the technology has conquered geographical separation anytime anywhere thus communication will possibly change in every aspects of quality of life.

Bullock (2004) investigated the impact of technology use by examining proposed variables of the QOL for a selected sample of students, parents, and other adults in Littlefield, Texas. The respondents were asked to fill the QOL report profile. The study aims at relating the use of Internet and computer to QOL index controlling demographic background (ages, education, occupation and salary). The study concluded that few relationships can be drawn between demographic background, technology usage and QOL. However, an important conclusion suggested that having the broadband access at home improves perceived QOL.

When investigating the impact of ICT on QOL for elderly, Gilhooly, Gilhooly, & Jones (2009) argued that wealth, health and social relations have all been found to be the most important determinants of subjective quality of life. Thus, the ICT is able to enhance QOL for older people if they can mediate the relationships between these three important factors. The study shows little evidence that ICT has improved the QOL for elderly. Among the reasons is that older people remain in a minority in relation to access to technology, thus there will always be a skewing of data picturing the relationship between technology, ageing and QOL. As the results, there is only few elderly using the latest version of some kind of ICT to demonstrate a statistically beneficial impact on QOL.

Lee & Leung (2005) investigate the impact of Internet adoption to QOL in three largest cities in China; Beijing, Hongkong and Taipei. The study stated that the development of technology, in particular Internet, has also brought undesirable consequences. With the Internet, people work harder than ever which causes rather than creates time for leisure; it creates circumstances that force people to undertake more work at home. Therefore, it raises consciousness that besides the positive impacts generated; the Internet also contributes to or detracts from societal point of view. While the statistical analysis shows that Hongkong is the city that enjoys the highest QOL index thanks to the Internet usage, it also suggests that excessive usage on Internet features are deteriorating QOL, especially computer games.

Rohman (2010) tries to relate the long-term relationship between the telecommunication sector and other socio-economic variables in an attempt to answering whether the contribution of the ICT sectors exists for supporting these variables. A data set comprising 35 countries from 1985-2005 is investigated employing two steps analysis: the panel unit root test and cointegration analysis. The socio-economic variables chosen in this study are education (primary education attainment and the ratio between male and female in the primary education) and health (life expectancy rate) while the ICT variables comprises the penetration rate of telephony and TV. The first analysis on the unit root tests shows that in most cases, the series of socio-economic variables and the penetration rates are not stationer in all simulation lags, except for the life expectancy rate. While the later investigation using cointegration analysis scrutinizes no evidence of the long-term relationship between ICT development and education and health except only the weaker cointegration between the primary education and TV penetration rate.

Having acknowledged the need for pointing out QOL as the goal of development and given limited literatures addressing this issue, this paper has the view that there is a need to investigate the influence ICT development to the QOL index, in particular the Internet, not only relying on the vast majority of studies which emphasize on the GDP impact. To enable this investigation, the study measures QOL at individual level proxied by wages and perceived subjective measurement of QOL to fill the gap that the previous studies of QOL mainly implemented only on subjective measurement. Moreover, assuming that QOL has a positive relationship to individual productivity (Kingpadund & Phusavat, 2009; Dalgaard, Schultz, Sørensen, 2009; Dabirian, Rezvanfar & Asadi, 2010) , this study is also a better way to picture individual productivity indirectly at the micro level since this domain remains very much a measure of the ignorance (Serneels, 2005). Therefore, the research question to be answered: have the mobile phone and the Internet adoption affected the quality of life (QOL)? If so, how much have they contributed? Regarding the country being analyzed, Indonesia is chosen because they have a very rapid diffusion and adoption on the recent ICT gadgets and services. The country is the second largest Facebook users<sup>2</sup>, one of the most addicted Twitter users<sup>3</sup>, and a big market for Blackberry<sup>4</sup>. The analysis will bring the message whether such the adoption really affect the QOL in the country.

The paper is presented in the following sections: Section 1 is an introduction; Section 2 presents the literature review on QOL measurement. The econometrics model and data analysis are presented in section 3, while the results are elaborated in Section 4. Section 5 concludes the study. There are also three appendices explaining the derivation of theoretical literature and econometrics formula used in this study.

## 2. Quality of Life (QOL) Indicator

Quality of Life (QOL) has been part of an interesting topic to investigate as a prominence study in social research since it reflects a major explicit or implicit life-style and policy goal for individuals, communities and nations (Schuessler & Fisher, 1985; Sen, 1985). As the mindsets that assume equating more income and consumption leads to a better welfare have been challenged (Sen, 1985; Nusbaum, 1995; Diener & Lucas, 1999; Easterlin, 2003), it becomes clear that QOL is a crucial element in the ongoing discourse on economic prosperity and sustainability even though during the evolvement of the study, the definition and measurement are elusive.

Recent research on measuring quality of life is centered into two approaches (Costanza, et al., 2007). The first aspect is related to subjective well-being focuses primarily on self-reported levels of happiness, pleasure, and fulfillment (Diener & Lucas, 1999; Easterlin, 2003). The other approach which utilizes the more objective measurement, deals with quantifiable indices. It usually covers economic production, literacy rates, and life expectancy so that the data can be gathered without directly surveying the individuals being assessed. Costanza, at al. (2007) argued that despite the objective indicator provides a snapshot of how well physical and social needs are met, they are more narrow, opportunity based and unable to incorporate many issues contribute to QOL, for instance identity, participation, and psychological security. In comparison, subjective indicators are usually gathered through survey or interview tools to collect respondent view or assessment on their life experience in the forms of self-report satisfaction, happiness and well-being. Diener & Suh (1999) also agreed with this aspect adding the superiority of subjective indicator as the means for measuring people perception.

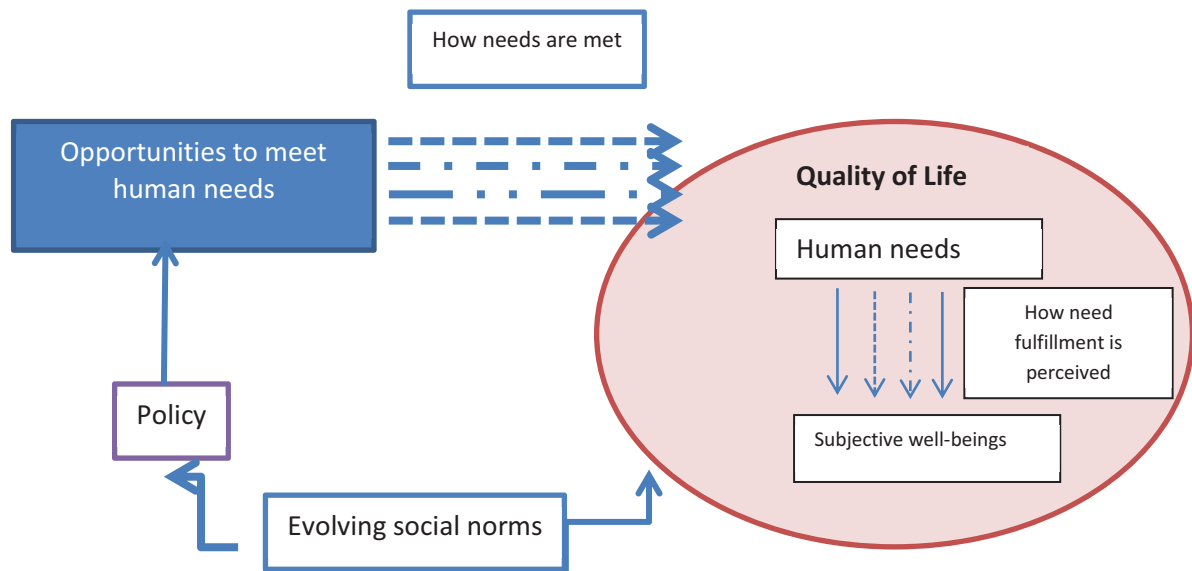
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<sup>2</sup> [www.checkfacebook.com](http://www.checkfacebook.com). Retrieved 23 February 2011.

<sup>3</sup> [http://articles.cnn.com/2010-11-23/tech/indonesia.twitter\\_1\\_twitter-nation-social-media-social-networking?\\_s=PM:TECH](http://articles.cnn.com/2010-11-23/tech/indonesia.twitter_1_twitter-nation-social-media-social-networking?_s=PM:TECH). Retrieved 23 February 2011

<sup>4</sup> [http://articles.cnn.com/2009-12-28/tech/indonesia.blackberry\\_1\\_blackberry-phones-iphone-mobile-phone?\\_s=PM:TECH](http://articles.cnn.com/2009-12-28/tech/indonesia.blackberry_1_blackberry-phones-iphone-mobile-phone?_s=PM:TECH). Retrieved 23 February 2011.

To operationalize this measurement, Costanza, et al. (2007) framed the following framework (Figure1) picturing the combination of both objective and subjective measurements to assess QOL. This framework is also influenced by previous studies related to this discourse, for instance the Matrix of Human Needs (Max-Neff, 1992), the Basic Human Functional Capabilities (Nassbaum & Glover, 1995), the Hierarchy of Needs (Maslow, 1954), the Need Hierarchy Measure of Life Satisfaction (Sirgy, 1995), the Quality of Life Questionnaire (Greenley, Greenberg, & Brown, 1997) and the Quality of Life Inventory (Frisch, 1998).



**Figure 1** Theoretical framework of QOL

Source: Costanza et al., (2007)

Figure 1 shows that the QOL is the extent to which objective well-being is achieved through the personal or group perception on subjective well-being. Therefore, human needs are basic needs for subsistence, reproduction, affection, etc., whereas subjective well-beings are assessed from individual responses to question about happiness, life satisfaction, utility or welfare. The relationship between specific human needs and perceived satisfaction can be affected by mental capacity, cultural context, and information. With regards to this aspect, the role of policy is to create opportunities that human needs can meet; by understanding that a diversity of ways exist in order to achieve such needs and also an attempt to increase the likelihood that people will take the opportunity.

Another approach states that the QOL measurement aims at achieving people goals and their ideal life style which is thus beyond the living condition approach that focuses on material resources to individuals. Three characteristics of quality of life concept (Fahey, Nolan, & Whelan, 2003) can be addressed in the following aspects:

1. The concept requires micro perspective where the perception of individuals plays an important role. It means that the macroscopic features of economic and social situation within the society are not the center of measurement.
2. The concept covers multidimensional aspects. Several areas of life broaden the narrow focus on income. Not only does the concept require a description of several aspects, it also explains the interplay between domains as they contribute altogether in the measurement.



3. The measurement combines both objective and subjective indicators, individual goals and orientation. It is also more valuable when the subjective measurement is linked to objective living condition.

From the theoretical perspective, the importance of quality of life is similar to those reflected in the measurement of Total Factor Productivity (Davis & Ortalo-Magne, 2007). In other words, it is a multiplicative factor in the production function which affects different levels of equilibrium in the economy. Different areas with different levels of quality of life contribute to different wages and rent and the value of consumption of goods and services. Davis & Ortalo-Magne (2007) build a strong foundation of theoretical literature proving that QOL plays an important role at the level of individual behavior. In conclusion, QOL enters the utility function at the individual level which at the end contributes to a different willingness to pay between individuals on different types and bundles of consumption. It can also be inferred that the higher QOL in a specific region, the greater the willingness to pay is. Appendix 1 gives a clear theoretical framework behind this argument.

At the meso level when analyzing the impacts at the firm's level, the relationship between productivity and QOL is clearly visible especially in relation to working conditions (Cascio, 1993). Quality of (work) life (QWL) as the concept related to this discussion deals with two analyses; on one hand it equates QWL with objectives of the firms and the other equates QWL with employee perceptions on human aspects (particularly that they are safe, well satisfied and able to grow up and develop human beings). Moreover, QWL is subjective and closely related to employees' perception of their physical and mental well-being at work. Cascio (1993) shows a case study that QWL needs 3-10 years or even more years of implementation to enable the fully integrated impact into business.

How QWL affects productivity is also well described comparing two largest automobile producers; General Motors (GM) and Ford. GM in 1980 experienced a tense relationship between employees which influenced the lower productivity (only a modest gain in productivity) partly because of management inconsistency. Ford on the other hand, built a placid relationship with the worker union that made them feel rewarded, secure and involved in its resources that at the end contributed to significant increases in productivity. The impact is different substantially; while the inception of workers into business in Ford, they improved assembly productivity by 36% in comparison to 11% of GM.

### ***The issue on Self-reported data***

As the consequence for using the subjective measurement, the data employed on measuring QOL indicators is based on self-reported qualitative aspects which become part of criticism. The term of self-reported data refers to data obtained from surveys containing items that ask the respondents to report something about themselves and are completed by the respondents themselves. The questions vary widely including demographic variables, personality traits, values, beliefs, attitudes, affects and behaviors. Chan (2009) summarizes that the common criticism of self-reported data usually deals with two types of validity associated with the data collection process; (i) construct validity issues that are related to the measurement of the variables, and, (ii) the interpretation of substantive relationships inferred from the relationship between self-reported variables (also known as mono-method bias).

Studies by Cronbach (1946), Couch & Keniston (1960), Nisbett & Wilson (1977) are among those who define self-reported data containing sources of random and systematic measurement error that adversely affect the construct validity. Sudman, Bradburn & Schwarz (1996) added that a larger variety of measurement errors would affect the construct validity of responses. In contrast, other studies demonstrate reasonable criterion-related validities of self-report predictor measures where the criteria are not self-report measures and there are theoretical reasons behind that. It can be found in Barrick & Mount (1991) on ratings of job performance, Becherer & Maurer (1999), Grant (1995), on



entrepreneurial behavior and career success as well as Brett & VandeWalle (1999) on training and sales performance.

Yonghon & Yingyiao (2009) give a detailed argument on self-reported data in a more theoretical way stating that the existence of problem posed by self-reporting data can be addressed by estimating a latent variable of the observed data. The analysis concluded that self-reported data is well-posed in the sense that the reliability remains high as long as the probability reporting trustfully is non-zero. Appendix 2 explains the detailed argument concerning this conclusion.

### 3. Econometrics model

There are two steps analysis employed in this study. The first equation is run by the probit model to estimate the demand for internet access (e.g., see Kridel & Taylor, 1993). The second equation is to investigate the impact of Internet adoption and experience to technology on QOL index which is measured by Ordered Probit (Appendix 3 gives the detail analysis on the probit and ordered probit analysis). The equation to be estimated in the first step is in the following equation:

$$Prob(Y = 1|x) = G(\beta_0 + \beta_1 age + \beta_2 age^2 + \beta_3 gender + \beta_4 household\ size + \beta_5 specific\ occupation + \beta_6 education + \beta_7 dummy\ of\ employment) \quad (1)$$

From eq. 1,  $y = 1$ , if the respondent is an internet user, 0 otherwise. The second analysis puts the composite QOL index as the dependent variables taken from the subjective and self-reported questions and income which are weighted proportionally. The regression equation on the latent data of QOL index is run as follows:

$$QOL\ index_i = \alpha_1 Age + \alpha_2 Age^2 + \alpha_3 Gender + \alpha_4 Marital\ status + \alpha_5 Higher\ education + \alpha_6 Middle\ education + \alpha_7 Household\ size + \alpha_8 specific\ occupation + \alpha_9 Region + \alpha_{10} Experience\ to\ technology + \alpha_{11} Internet\ access + e_i \quad (2)$$

The QOL is not directly observed; instead the data is gathered and collected through an interview that comprises perceived opinion about subjective well-being and objective measurement on the income data enables the advantage for combining both quantitative and qualitative measurement of the QOL index (Fahey, Nolan, & Whelan, 2003). These indicators are weighted proportionally to obtain the composite QOL index. The index is then classified into three ranks (lower QOL, medium QOL and higher QOL) and further regressed with return to education type of equation following Card (2001) without instrument variable on education variable. As discussed earlier, internet access is obtained from predicted probability from the first step of probit estimation (eq. 1).

Table 2 shows the question related to subjective well-being of QOL.

*Now we would like to talk to you about your personal values; that is things that act as the guiding principles in your life and that give meaning to your life. For each value in the list below, please decide how important it is to you in the way you live your life. Please tick one answer for each value, showing how important the value is to you. Please use a 7-point scale, where 1 means you do not agree at all, 4 means that you neither agree nor disagree and 7 means you agree completely. You can use any number in between.*

**Table 2** Quality of life questions

<b>Subjective well-being</b>	Not at all important	←————→		Average importance	←————→		Extremely important
	1	2	3	4	5	6	7

Subjective well-being	Not at all important	←→		Average importance	←→		Extremely important
	1	2	3	4	5	6	7
1. <b>WEALTH</b> Having material possessions, a lot of money	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. <b>CREATIVITY</b> Being creative, imaginative	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. <b>SOCIAL RESPONSIBILITY</b> Working for the welfare of society	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. <b>EFFICIENCY</b> Getting things done effectively and on time	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. <b>ENJOYING LIFE</b> Doing things because I like them	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. <b>DUTY</b> Fulfilling obligations to family, community and country	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. <b>PRESERVING THE ENVIRONMENT</b> Help preserving nature	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. <b>KNOWLEDGE</b> Being well-educated about things	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Even though the questions are not fit exactly with the QOL indicators developed by Costanza et al., (2007), it is believed that some aspects related to material wellbeing, family life, community life, and job security have been captured in the questions. In addition, this study tries to obtain the impact of technology on QOL by adding up two variables representing the diffusion of technology into the ordered probit equation:

- (1) Experience to technology; the duration on how long does the respondent have the mobile phone.
- (2) The (predicted probability of) demand for access to Internet

### **Sampling method**

To determine the size of sample in this study, the following formula by Cochran (1977) will be employed:

$$n = \left( n - \frac{n}{N} \right) x \frac{t^2(p x q)}{d^2} \quad (3)$$

The formula can be verified that:

N = the sample size

N = the size of population

$t^2$ = the squared value of the standard of deviation that refers to the area under a normal distribution of values

p = percentage of category for which we are computing the sample size

q=1-p

$d^2$  = the squared value of one half the precision interval around the sample estimate

It can also be explained in the other expression that

$$n = \text{finite population correction} \times \frac{\text{probability level} \times \text{variance}}{\text{confidence interval}} \tag{4}$$

As indicated in the formula (eq. 4), the first part is a so called finite population correction (fpc) which shows the indication that as the number of population increases, fpc goes to one or, in other words, it does not affect the decision for determining the number of sample. Therefore given the number of observation is 3469, the counterfactual analysis for determining the margin of error is explained below:

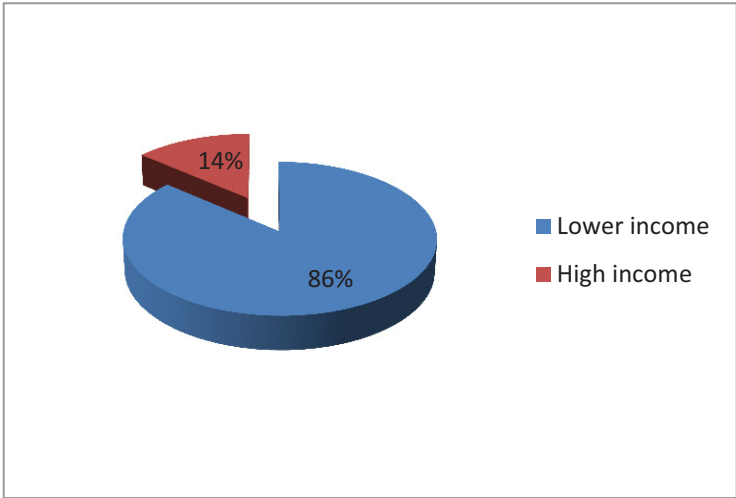
**Table 3** Scenario on the size of sample

No	Confidence level	Z <sub>statistics</sub>	Probability <sup>5</sup>	Sample size	Margin of error
1.	99%	2,330	62%	3469	1,92%
2.	95%	1,645	62%	3469	1,36%
3.	90%	1,285	62%	3469	1,06%

Table 3 shows very small margin of error in comparison to the benchmark of +/- 4% sampling error.

**Descriptive statistics**

The data in this study is collected from the survey conducted by Ericsson Consumer Lab, Regional South East Asia office in Kuala Lumpur, Malaysia, which was launched in 2009. The survey comprises answers by 3469 respondents on the four main islands of Indonesia (Java, Sumatera, Kalimantan, and Sulawesi) to more than 800 questions. The survey was carried out using a face-to-face method between the interviewer and the respondents. The dependent variable in this study is composite QOL index that equally weights income and perceived value of QOL. The household income in Indonesia is measured from monthly expenditure due to the reason that it can reflect a better picture of income. Figure 2 shows the classification of the respondent based on the income level.

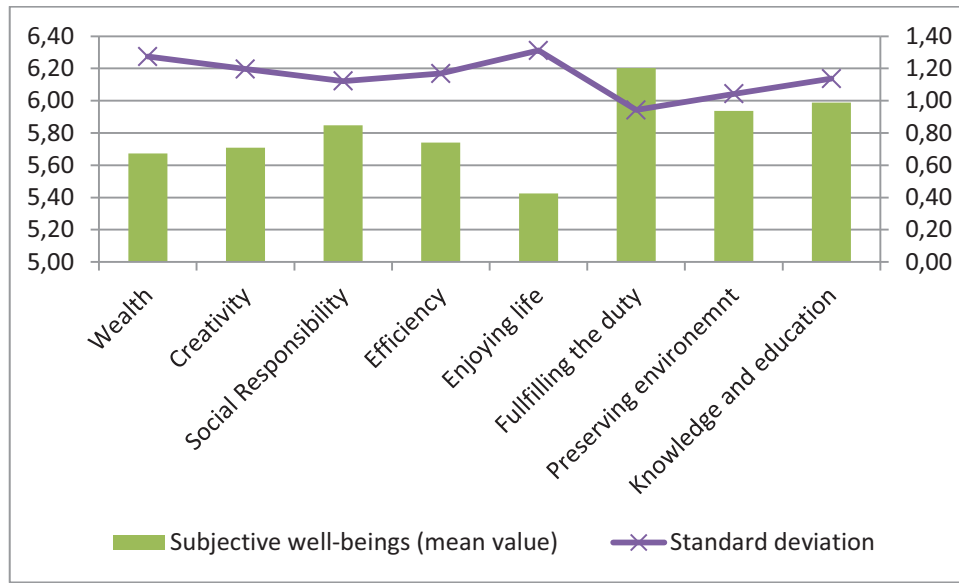


<sup>5</sup> The survey was conducted mainly to understand the characteristics of mobile phone users where the question regarding the use of Internet is part of the questionnaire asked. Therefore the probability refers to the actual penetration rate of mobile phone (not internet penetration rate).

**Figure 2** Incomes in Indonesia

Figure 2 presents the distribution of respondent in terms of income (expenditure) level. It shows that 86% of respondent is categorized as a lower income respondent (less than IDR 1.25 million) while 14% of respondent is an upper middle income user.

The remaining aspect the quality of life indicators deal with self-reported personal values upon some questions (Table 1) which the results can be seen in the following Figure 3.



**Figure 3** Self-reporting personal values upon QOL indicators

In general, Figure 3 indicates that the respondents are more positive upon the personal values related to fulfilling the duty, environmental awareness and knowledge and education whereas wealth, creativity, social responsibility, efficiency and, moreover, life enjoyment are valued less. The standard deviation of these aspects is around 1-1.3 where life enjoyment is the most disperse factor among others.

**The other interesting point in this study is the fact that income and perceived QOL have a very small correlation coefficient. The correlation between two indicators is about 13.87% indicating a lower relationship between income and perceived QOL. This leads the presumption that the endogeneity issue is avoided.**

In addition, the description of independent variables in this study is shown in the following Table 4.

**Table 4** Independent variables

No	Variable	Definition	Remarks
1.	Geographical area	The distinction of urban and rural area	The data is based on a question asking about urban and rural area.
2.	Ages	Continuous variable of age	
3.	Dummy of gender	Shows male-female category. Thus, if gender=1, respondent is a male.	
4.	Size of household	Number of household members	
5.	Marital status	If the status =1, the respondent is a married respondent,	
6.	Education attainment	The data is regrouped from the global	

		category of education (primary, high school, college, and post graduate)	
7.	Specific occupation	The dummies refer to a particular type of occupation.	Studies by Varian (2001, 2002) concluded that some kinds of occupations (mainly technicians and managers) have a likelihood of working at home after office hours; hence, they have a higher likelihood for using the gadgets more than others

The descriptive statistics of the independent variables can be seen in the following Table 5

**Table 5** Descriptive statistics of independent variables

Independent Variables	Indonesia		
	Obs	Mean	Std. Dev.
Age	3469	34,387	12,660
Gender	3470	0,486	0,500
Married	3469	0.698	0,008
Higher education	3470	0,089	0,284
Middle education	3470	0,318	0,466
Household size	3469	4,253	1,661
Specific occupation	3470	0,154	0,361
Region	3469	0,595	0,491
Experience to technology (length of mobile phone ownership)	1770	3,542	2,593
Access to Internet (predicted probability)	3451	0,049	0,054

Table 5 shows the characteristics of the respondent in Indonesia. Average age of respondent is 34 years while 48,6% are male and nearly 70% are married respondents. In terms of education level, only 5.7 percent obtained the higher education degree in Indonesia, which means that they have at least graduated from high school (Sekolah Menengah Atas/SMA).

Many studies are important in terms of geographical area when determining the demand for access towards ICT gadgets (Steinburg, 2009; Roston & Savage, 2010). Steinberg stressed that the availability of connection largely depends on the urbanization rate, whereas for instance ubiquitous broadband is also supported by a sufficient number of businesses and households to justify the cost of extending broadband services to that region. The distribution of the sample in this survey is centered on Java Island and its main cities (Jakarta, Bandung, Semarang, and Surabaya). This is understandable, considering the distribution of the population in Indonesia, which is also concentrated in these areas. The other cities investigated in this study are Medan, which represents the western part of Indonesia (Sumatera Island), and Makassar and Balikpapan, which represent the eastern part of Indonesia (Sulawesi and Kalimantan Island). Of the respondents in the survey, 65 percent live in Java. This gives the best proxies concerning the actual distribution of the population. Apart from disproportion of the sample, this study is able to picture the actual population distribution in Indonesia. The Indonesian Statistics Central Bureau, BPS (2004) reported that the distribution of the population over 32 provinces is not even. Almost 59 percent of the total population inhabits Java, an island which only covers 7 percent of the total land area of the country. The rest, 41 percent, inhabits the other islands. In contrast, Papua with an area covering about 19

percent of the total land area is inhabited by only 1 percent of the total population. Having found that the data capture 65 percent of the respondents in Java, the conclusion is that the study has a relatively representative sample.

#### 4. Results

The econometrics result is presented in the following Table 6<sup>6</sup>.

**Table 6** Ordered Probit of QOL index

Dependent variable : 1-3 QOL index	
Independent Variables	Coefficient
Age	0,0008
Age square	0,0001
Gender	0,0164
Married	-0,1879 ***
Higher education	0,2739
Middle education	0,0705
Household size	0,1512 *
Specific occupation	0,0826
Region	-0,1934 **
Experience to technology	0,0911 *
Access to Internet (predicted probability) <sup>7</sup>	-0,1057

There are some evidences inferred from Table 6 that neither ages (both at the level and square of age) are statistically significant determining the likelihood of QOL index. Likewise, the educational status and gender are also insignificant. Household size is significant that tells the likelihood for obtaining a higher QOL is greater as the household size bigger. Moreover, specific occupation (technician and manager) whom are hypothesized as a first adopter of Internet technology is also statistically insignificant in this case. The remaining two variables which show the impact of technology indicate that experience to technology is significant which sheds a light on the conclusion that the longer the experience, the greater the magnitude is for obtaining higher QOL. The (predicted probability of) access to Internet is not significant.

#### ***Marginal effect***

While the ordered probit output gives the direction of the impact (sign of the magnitude) the percentage impact of each independent variable to dependent variable is explained by marginal effect not the coefficient of probit regression. In addition, it has to be explained that, the statistical

<sup>6</sup> For the whole analysis \*, \*\* and \*\*\* denotes significant level at 1%, 5% and 10% respectively

<sup>7</sup> From Probit estimation based on equation (1)



significant of marginal effect could be different than that in the regression coefficient of ordered probit since the standard errors are calculated separately using an approximation (Cornelißen, 2005). The following Table 7 presents the marginal effect for each level of QOL index.

**Table 7** Marginal effect for QOL index

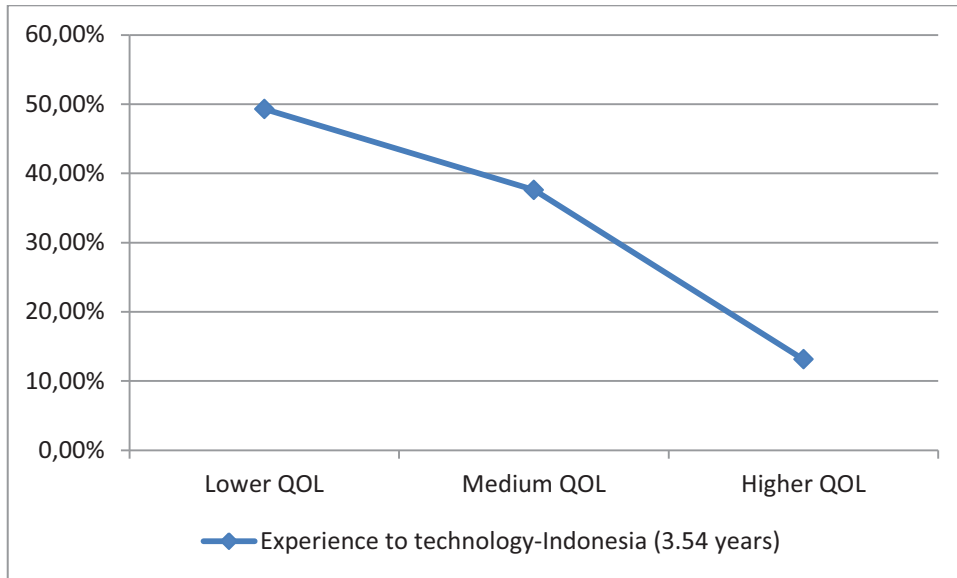
Independent Variables	Lower	Medium	Higher
Age	-0,0003	0,0002	0,0002
Age square	0,0000	0,0000	0,0000
Gender	-0,0065	0,0033	0,0032
Married	0,0749 ***	-0,0381 ***	-0,0368 ***
Higher education	-0,1087	0,0478	0,0610
Middle education	-0,0281	0,0141	0,0140
Household size	-0,0602 *	0,0306 *	0,0296 *
Specific occupation	-0,0329	0,0163	0,0166
Region	0,0770 **	-0,0381 **	-0,0389 **
Experience to technology	-0,0363 *	0,0185 *	0,0178 *
Access to Internet (predicted probability)	0,2078	-0,1057	-0,1022

The inference from Table 7 tells us that for the lower QOL index: marital status contributes 7.5% likelihood in Indonesia means that the likelihood for having lower QOL is higher for married respondent. Household size prevents the likelihood for obtaining the lower QOL having found that the greater size of household, they become less likely to be at the lower level of QOL. It might be supported by the reason to share the expenditure between the household members. Region is negative means that the respondents inhabiting rural region are obtaining a higher QOL that might be supported by the reason that they usually live in a more peaceful condition: less stress, cheaper living cost and lower degree of street congestion. Experience to technology is significant that brings the conclusion the longer the duration of owning technological gadgets (mobile phone) the smaller likelihood to have lower QOL is.

At medium level of QOL, marital status leads to a lower likelihood but household size is positive with 3% higher likelihood as the size increases by a person. Experience to technology contributed 1.8% greater likelihood for obtaining medium QOL. Region has the same conclusion that people in big cities are less likely to have the medium level of QOL in comparison to those in rural area.

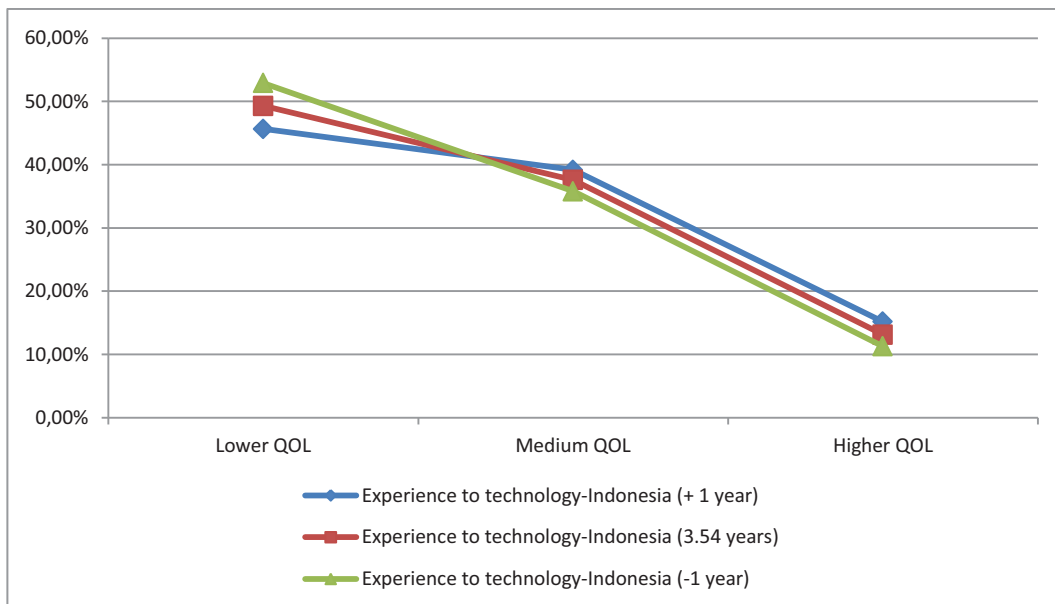
When investigation moves to the higher level of QOL, marital status corresponds to a lower likelihood for obtaining the higher QOL Household size plays important role with similar marginal effect to the medium level. Experience to technology contributes to a higher QOL with marginal effect of 1.78%.

Moreover, as the objective of the study is to investigate the impact of technology adoption to the QOL as Figure 4 emphasizes the marginal effect of this variable



**Figure 4** Marginal effect of experience to technology

From Figure 4, it is shown that the impact of the experience towards the technology decreases to the likelihood for achieving the higher QOL. At the mean level investigation (3.5 years), it is found that the likelihood for the respondent to have a higher QOL is only 13%. If the simulation continues to +/- 1 year from the mean values, the following Figure 5 shows the results of investigation.



**Figure 5** Simulation of the impact of the experience to technology

The simulation is conducted by comparing the marginal effect of +/- 1 year from its mean value. It means that the predicted probability of the outcome is investigated comparing the range between 2.5-4.5 years. The results shows the positive impact of the experience to technology confirming the

conclusion that as the year increases the greater the likelihood for obtaining higher level QOL is as well as the lower likelihood to obtaining lower level QOL is.

## 5. Conclusion

This study is intended to answer the question whether the adoption to technology corresponds to a better quality of life (QOL). As the criticism towards GDP as the indicator of economic development, QOL becomes more relevant to be measured representing the level of welfare at individual level. The data is investigated to scrutinize the relationship between the adoption of technology measured by the experience for using technology gadget (mobile phone) and the access to the Internet and QOL index. The index is equally weighted between income level and subjective perceived value of QOL enables the investigation from both objective and subjective measurement. The correlation between income level and QOL is very low indicating the endogeneity problem (that QOL is affected by income) does not exist.

Two steps econometrics testing are applied assuming that decision for accessing the Internet is not an exogeneous variable thus it has to be first estimated through the probit model. The predicted probability of demand for access is then used to estimate the ordered probit model in the second step to investigate the determinants affecting the level of QOL index. The important results from the study are:

- Age variables (in terms of the level and square) are not statistically significant at all level indicating that QOL index is neutral towards age.
- Gender is also not significant.
- Marital status has the negative impact on QOL in Indonesia. Married respondents have a 4% lower likelihood to have a higher QOL.
- The impact of education in determining QOL is not visible in Indonesia.
- Household size contributes to a higher QOL. An additional of household member contributes to 3% greater likelihood for having a higher level of QOL.
- Region has the negative impact to the QOL index where generally people in big cities in Indonesia have a lower QOL which might be due to a higher cost of living, congestion and tighter competition, worse public infrastructure, etc.

The aim of the study is to investigate the impact of technology adoption and Internet access to the QOL index. It is found that, the (predicted probability of) Internet access is not statistically significant affecting QOL index. The results suggesting the lower connection between technology and QOL are consistent with previous studies, for instance Gilhooly, Gilhooly, & Jones (2009) and Bullock (2004). In addition, the experience towards technology (measured by the length of mobile phone ownership) plays more roles in this case. At mean level of mobile phone ownership (3.54 years), the impact is positive but decreasing as the level of QOL increases.

The future research will be conducted to answer why internet access is not significant affecting the QOL index. To enable this analysis, future study should be emphasized on the usage adoption explaining variety of the usage which does (does not) support the achievement of the higher QOL. The direction for the future study will also try to relate QOL at individual level analysis and the productivity as the framework has been developed but the empirical studies has yet been carried out (Kingspadund & Phusavat, 2009; Dalgaard, Schultz, Sørensen, 2009; Dabirian, Rezvanfar & Asadi, 2010).

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## Appendix 1

### Quality of life and perceived individual willingness to pay

The theoretical literature is based on Davis& Ortalo-Magne (2007). Consider the economy with  $N$  regions indexed by  $i = 1, \dots, N$ . The economy is populated by a measure of  $\mu$  identical agent. Since it is assumed that the decision problem of agents in the economy is static, time subscripts is suppressed. Moreover, it is also assumed that there are only two goods consumed denoted by  $X$  which represents food and  $Y$  as a bundle of non-food. Agent behaves competitively in the market at the numeraire consumption level of food. Bundle of other non-food good is consumed for each  $N$  region with the price denotes by  $\{p_i\}_{i=1, N}$ . Agent choose region  $i$ , food consumption of food at  $c$  (numeraire) and other goods  $y$  with respect to its price. The maximization problem solves the following equation:

$$\max_{i,c,y} z_i c^{1-\alpha} y^\alpha \quad (1)$$

Subject to  $c + p_i y < X$

From eq.1,  $0 < \alpha < 1$ .  $z_i$  denotes region  $i$ 's quality of life. All agents who choose to live in the same region  $i$  have the same numeraire and consumption level at  $c_i = (1 - \alpha)X$  and  $y = \frac{\alpha X_i}{p_i}$

An equilibrium in economy is a set of prices in each region  $\{p_i\}_{i=1, N}$  and allocation such that : (1) agent maximizes the utility, taking the price level as given, (2) in each region, non-food goods are at an equilibrium where  $n_i y_i < Y_i$  if  $n_i > 0$ . (3) No household want to move where all agents have the same utility whatever region they live in. When each region is occupied in equilibrium, we have such a condition in the following eq.2.

$$\sum_{i=1}^N n_i = \sum_{i=1}^N \frac{Y_i}{y_i} = \mu \quad (2)$$

The agent is indifferent to live wherever region they want to live in, for instance between region  $i$  and  $j$  as shown in eq.3.

$$z_i [(1 - \alpha)X_i]^{1-\alpha} [y_i]^\alpha = z_j [(1 - \alpha)X_j]^{1-\alpha} [y_j]^\alpha \quad (3)$$

Consumption of food using the agent maximization problem yields the following eq.4

$$\frac{y_i}{y_j} = \left(\frac{X_i}{X_j}\right)^{\frac{\alpha-1}{\alpha}} \left(\frac{z_i}{z_j}\right)^{\frac{-1}{\alpha}} \quad (4)$$

Equilibrium of non-food goods can be derived as following eq.5.

$$y_i = \frac{\left( \sum_{j=1}^N Y_j z_j^\alpha X_j^{\frac{1-\alpha}{\alpha}} \right)}{\mu z_i^\alpha X_i^{\frac{1-\alpha}{\alpha}}} \quad (5)$$

Therefore, the price for non-food goods in equilibrium is shown in eq.6

$$p_i = \frac{\mu \alpha z_i^\alpha X_i^{\frac{1}{\alpha}}}{\left( \sum_{j=1}^N Y_j z_j^\alpha X_j^{\frac{1-\alpha}{\alpha}} \right)} \quad (6)$$

The number of households for each region is then formulated as in eq.7:

$$n_i = \frac{\mu Y_i z_i^\alpha X_i^{\frac{1-\alpha}{\alpha}}}{\left( \sum_{j=1}^N Y_j z_j^\alpha X_j^{\frac{1-\alpha}{\alpha}} \right)} \quad (7)$$

The ratio of price between two regions depends only to the ratio of quality of adjusted income as shown in eq.8

$$\frac{p_i}{p_{i'}} = \left( \frac{z_i X_i}{z_{i'} X_{i'}} \right)^{\frac{1}{\alpha}} \quad (8)$$

It then becomes clear that quality of life enters the utility function at individual level which at the end contributes to a different willingness to pay between individuals on different type and bundle of consumption. It can also be inferred that from eq.8, the higher QOL in a specific region, the greater the willingness to pay is.

## Appendix 2

### The reliability of self-reported data

The analysis on the latent variable  $X^*$ ,  $f_{X^*}(\cdot)$ , from an observed sample of  $X$  (Yonghong & Yingyao, 2009) is used as the basis justification answering whether such the data is reliable . A contaminated measurement error of  $X^*$  in self-reported data is explained in the following equation (Yonghong & Yingyao, 2009)

$$f_{X^*}(x) = \int f_{X|X^*}(x|x^*)f_{X^*}(x^*) dx^* \quad (9)$$

The conditional density of  $f_{X|X^*}$  , as in eq.9, shows that behavior of the measurement errors are defined as  $X - X^*$ . Therefore, the estimation of true model  $f_{X^*}$  gives the measurement error structure  $f_{X|X^*}$  and a sample of  $X$  is a so called Fredholm integral equation which is ill-posed. Meaning that it fails to provide three requirements (Hadamard, 1923) : (i) the solution should exist; (ii) the solution is unique, and, (iii) it depends continuously on the data. If any of the three conditions are violated then the problem is ill-posed. But Yonghong and Yongyao (2009) found that the problem can be solved by assuming that the probability of reporting trustfully is non-zero. Deriving the theoretical foundation as well as testing the data obtained from Chen, Hong and Tarozzi (2008) (Chen, Hong, & Tarozzi, 2008) and Bollinger (1998) (Bollinger) this study find the well-posedness of self-reporting data.

### Appendix 3

#### Probit and Ordered Probit derivation

The binary model of probit is derived as follows. Letting  $y$  denote the binary dependent variable, the probability of a success event can be explained by the following relation

$$\Pr(y = 1) = E(y) = \frac{\sum_i y_i}{N} \quad (10)$$

where  $N$  represents the number of observations in the sample. The probit model would have the form:

$$\Pr(y = 1|x) = G(\beta_1 + \beta_2 X_2 + \dots + \beta_k X_k) \quad (11)$$

$$\Pr(y = 1|x) = G(x\beta) \quad (12)$$

where  $G$  is a function taking on values strictly between zero and one:  $0 < G(z) < 1$ , for all real numbers  $z$ . In general terms, the model is often referred to as an index model, because  $\Pr(y = 1|x)$  is a function of the vector  $x$  only through the index. Therefore,  $0 < G(x\beta) < 1$  ensures that the estimated response probabilities are strictly between zero and one, which thus addresses the main worries of using the linear probability model (LPM).  $G$  is a cumulative density function (cdf) that monotonically increases the index  $z$ , with the probit model defined as:

$$G(x\beta) = \Phi(x\beta) = \int_{-\infty}^{x\beta} \delta(u) du \quad (13)$$

$$\text{Where } \delta(u) = \frac{1}{\sqrt{2\pi}} \exp\left(-\frac{u^2}{2}\right) \quad (14)$$

is the standard normal density. This choice of  $G$  also ensures that the probability of success is strictly between zero and one for all the values of the parameters and the explanatory variables.

The second analysis puts the composite QOL as the dependent variables taken from the following subjective and self-reported questions and income which are weighted proportionally using the ordered probit model. Let  $y$  is the ordered probit response taking the value of  $\{0, 1, 2, \dots, J\}$ . The derivation of the ordered probit from a latent variable model, for instance a binary choice of probit can be presented below:

$$y^* = \beta_1 X_1 + \dots + \beta_k X_k + e \quad (15)$$

$$y^* = x\beta + e \quad (16)$$

The error terms,  $e$ , is normally distributed with the variance normalized to zero. The  $J$  cut-off points or threshold parameters of  $J$  values latent variable as follows:

$$\alpha_1 < \alpha_2 < \alpha_j \quad (17)$$

The observed choice of  $J$  is decided according to the following:  $y = 0$  if  $y^* < \alpha_1$

$$y = 1 \text{ if } \alpha_1 < y^* < \alpha_2$$

$$y = 2 \text{ if } \alpha_2 < y^* < \alpha_3$$

(... ..)

$$y = J \text{ if } \alpha_j < y^* \quad (18)$$

Therefore if  $y$  takes on three values 0, 1, 2 as example in Wooldridge (2002, pp.504-508), it can be derived that:

$$y = 0 \text{ if } \mathbf{x}\boldsymbol{\beta} + e \leq \alpha_1$$

$$y = 1 \text{ if } \alpha_1 < \mathbf{x}\boldsymbol{\beta} + e < \alpha_2$$

$$y = 2 \text{ if } \alpha_2 < \mathbf{x}\boldsymbol{\beta} + e \quad (19)$$

Then the probability of observing  $y = 0, 1, 2$  is similar to the probit model for the smallest and the largest value:

$$\Pr(y = 0|x) = \Pr(\mathbf{x}\boldsymbol{\beta} + e < \alpha_1)$$

$$\Pr(y = 0|x) = \Pr(e \leq \alpha_1 - \mathbf{x}\boldsymbol{\beta})$$

$$= 1 - \Phi(\mathbf{x}\boldsymbol{\beta} - \alpha_1) \quad (20)$$

$$\Pr(y = 2|x) = \Pr(\mathbf{x}\boldsymbol{\beta} + e \geq \alpha_2)$$

$$= \Phi(\mathbf{x}\boldsymbol{\beta} - \alpha_2) \quad (21)$$

$$\Pr(y = 1|x) = \Pr(\alpha_1 < \mathbf{x}\boldsymbol{\beta} + e < \alpha_2)$$

$$= \Pr(e > \alpha_1 - \mathbf{x}\boldsymbol{\beta}, e \leq \alpha_2 - \mathbf{x}\boldsymbol{\beta})$$

$$= \Phi(\mathbf{x}\boldsymbol{\beta} - \alpha_2) - \Phi(\mathbf{x}\boldsymbol{\beta} - \alpha_1) \quad (22)$$

Where  $\Phi(a) = 1 - \Phi(-a)$