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Age and Productivity of Academics: A Case Study of a Public University in Malaysia

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Abstract: This study examines the relationship between age and productivity measured based on key performance indicators (KPI) amongst academic staff at Universiti Sains Malaysia (USM). Three models were used in the analysis: linear, quadratic and piece-wise spline. The linear model indicates that age is negatively related to KPI. The quadratic model shows an inverted-U shaped relationship where KPI peaks at age 41 years. The piece-wise spline model indicates academic staff reach the peak of their productivity between ages 46-50 years with another productive age interval between 36-40 years implying 10 golden years when KPI could be harvested fruitfully. There is a significant downtrend in the KPI after 50 years of age. Other factors that have significant influence on KPI are gender, academic rank and discipline. The sub-models show that the influence of age on KPI is more significant amongst academic staff in the arts compared to the science stream. Age influence on KPI is significant amongst female staff but not male staff. We conclude that assessing performance in the workplace with regard to age requires complex methodological engagement and also needs to be based on a wider lens which recognises and includes within the discussion, the intangible and social dimensions of performance.

Keywords: Academics, age, key performance indicators, life-cycle productivity
JEL classification: D91, J24, J45

1. Introduction

Studies have shown that certain abilities decline with age, but not necessarily certain skills. Research has demonstrated that different abilities tend to follow relatively independent paths over the life cycle. Productivity potential in the workplace generally depends on one's physical and mental abilities, education, and job experience. These abilities and experiences are widely thought to eventually influence job performance and the productivity of employees. The outcomes of studies on the relationship between age and productivity depend on how the job performance dimension is measured. Issues of

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a methodological nature and the tools we use to assess data with regard to performance have an impact on how we view the results.

Productivity which generally depends on one's physical abilities, for example, declines constantly with age for virtually all types of measures (Stones and Kozma 1985). For productivity that depends on mental abilities, outcomes vary (Ng and Feldman 2008); there are various studies that indicate a positive relationship with age (Waldman and Avolio 1986; McEvoy and Cascio 1989; Sturman 2003; Autor *et al.* 2003). Accelerating technological progress can increase the importance of being able to learn and to adjust to new ways of working, while a long work experience may become less important. This is particularly problematic for older employees, due to age-related declines in the processing speed and in learning capacities (Baltes and Lindenberger 1997; Hoyer and Lincourt 1998). For example, for firms that use ICT intensively, the productivity of older employees may be reduced relatively as they are less able to cope with the specific demands of ICT (Lallemand and Rycx 2009; Bertschek and Meyer 2009). However, even this finding is open to argument since its impact relies to an extent on the ways and depth of usage of new technology in the workplace and the assumptions made about the impact of technology on productivity. These assumptions have been challenged most famously in the argument of Robert Solow and his 'productivity paradox' which has severely drawn into question the 'assumed' productivity dividends in many workplaces with improved ICT (Solow 1987). Furthermore the extent to which ICT technology especially in teaching and research is in fact underused and oversold in the famous phrase coined by Larry Cuban needs to be factored into any full and robust discussion of technology, age and productivity in the workplace (Cuban 2001).

Remery *et al.* (2003) analysed a survey of 1007 Dutch business leaders and personnel managers and found that older individuals are more likely to be perceived as less productive when the share of senior employees is higher. Research shows that while job experience improves productivity for several years, there does come a point at which further experience no longer has a positive effect. Ilmakunnas *et al.* (1999) assessed a broad sample of Finnish manufacturing employees, and found that job duration improves job performance for only up to 3.8 years. On the other hand, other studies based on different research designs have found that professional expertise, developed over years of practice and experience, can attenuate potential negative relationships between age and performance dimensions (Hess and Auman 2001; Thornton and Dumke 2005; Wilson *et al.* 2006). Also there is a general recognition that greater education can lead to better productivity in old age.

Some literature suggests that there are multiple factors which indicate higher job performance amongst younger workers. Most of these studies argue that workers' health tends to deteriorate over the life cycle (e.g. diseases, absenteeism, body strength, depression, etc.) and cognitive abilities also generally decrease with age which may result in a lower productivity level of older workers. Young people are thought to be more motivated to exert increased and higher effort at work since they want to impress their employer (Grund and Westergaard-Nielsen 2005). In contrast, older people might be less enthusiastic in on-the-job training or skills improvement since the incentives in terms of promotion and so forth diminish with age. Those closer to retirement may have less incentive to learn work related skills and at the same time the ability to learn new skills also appears to deteriorate with age (Hayward *et al.* 1997). Employers might be more reluctant to invest in training for older workers because they have a shorter period of time to benefit from on-the-job training (Brooke 2003; Prskawetz *et al.* 2006). Moreover, when older employees take part in training, their participation seems to be less effective than for younger employees (Göbel and Zwick 2010). Thus, a decline in relative productivity of older employees is expected in sectors that need continuous training efforts.

In general, strong decreases in productivity are observed after the age of 50 (Dostie 2006; Grund and Westergaard-Nielsen 2005; Hellerstein and Neumark 2004; Prskawetz *et al.* 2006). Boot (1995) studied age-earnings profiles of British workers in physically demanding jobs during the first half of the 19th century. His study indicated that men reach their peak earnings in their early 30s, and wages decrease substantially from around 40 years of age. Dostie (2006), Lallemand and Rycx (2009), and Van Ours and Stoeldraijer (2010) investigated the impact of the firm's worker composition on production which include the correlations between the firm's age composition and its production. Various studies find an inverted U-shaped work performance profile. Workers in their 30s and 40s have the highest productivity levels, while workers above the age of 50 have lower productivity levels than their younger colleagues in spite of their higher wage level (De Hek and Van Vuuren 2011). Daveri and Maliranta (2007) indicate that the impact of these age-related factors also have an inverse U-shaped relationship with productivity in the Finnish electronics industry and this U increases in prominence in the forest industry and the production of machinery and equipment industry. Examples of the earlier proposition of an inverted U-shaped relationship between age and productivity are Sturman (2003), Avolio *et al.*(1990), McEvoy and Cascio (1989) and Rhodes (1983). Other studies do not find support for an inverse U-shaped form of the age-productivity profile. These studies include Aubert and Crépon (2006), Malmberg *et al.* (2008), Göbel and Zwick (2009), Van Ours and Stoeldraijer (2011) and Göbel and Zwick (2012).

Empirical literature also suggests that there might be differences in the age-productivity relationship between economic sectors. Cardoso *et al.* (2011) show separate age productivity profiles for the Portuguese manufacturing and service sector; they also found that productivity of older workers is slightly higher in services than in manufacturing. Van Ours and Stoeldraijer (2011) show separate age productivity profiles for the construction, wholesale trade, retail trade, commercial services and manufacturing sectors in the Netherlands. Their findings show that for manufacturing sector, value added increases until the age group 50–56 and for all other industries the age-productivity patterns are essentially flat. Aubert and Crépon (2006) separately consider the impact of age groups on productivity for the French manufacturing, trading, and services sectors. Their findings indicate that relative productivity increases until age 35 in all three sectors. In manufacturing, there is no statistically significant difference between the age group 35–39 and older workers. In trading, workers aged 40–59 are significantly more productive, whereas in services, only workers aged 45–54 are more productive than younger workers. Daveri and Maliranta (2007) argue that the usage of ICT leads to a stronger increase in productivity of young employees than of older employees. The electronics industry which is more ICT usage intensive may negatively affect the relative productivity of older employees. Other industries which adopt higher ICT intensity may lead to a similar age-productivity pattern in the future although this is not without dispute. Lallemand and

Rycx (2009) found that ICT intensive firms suffered more from an increase in the share of older workers. Vandenberghe and Waltenberg (2010) found a stronger productivity disadvantage of older workers aged 50–65 in the Belgian service industry; however, the productivity nexus with age in service industries is not clear given diverse and at times contradictory findings in regard to the productivity of older workers. In South Korea, labour productivity reached the peak in the workers' late 30s, and declined as workers moved into their 40s and 50s. The degree of productivity reduction was higher in the manufacturing industry compared to service industry (Rhee *et al.* 2011). Rhee *et al.* (2011) employed input-output analysis in order to evaluate the economic ripple effect (indirect effect) of the mandatory retirement age extension system via inter-industry analysis. When mandatory retirement age was extended from 55 to 60, industries that benefited most or suffered lesser loss based on value-added effects were the public administration and education service sectors.

Another interesting literature on age and productivity is with regard to the connection with happiness. Oswald et al. (2009) found that happier workers were 12 per cent more productive and unhappier workers were 10 per cent less productive. Research pertaining to the U-shape of happiness in age is also gaining interest. Using data on approximately 500,000 Americans and Europeans, Blanchflower and Oswald (2004) found that happiness or well being is U-shaped through the life cycle. Well being reaches a minimum amongst those in their mid to late 40s. The global average is 46. This study is consistent with that of Frey and Stutzer (2002). A study on happiness amongst American men and women by Pragnol and Easterlin (2008) showed early in adult life, overall happiness is higher in women than men. Overall happiness was measured based on material goods and family life aspirations and satisfaction in these domains was correspondingly higher in women. However, in later life men come closer than women to fulfilling their material goods and family life aspirations, are more satisfied with their financial situation and family life, and are the happier of the two genders.

1.1 Productivity amongst Academic Staff

Some college and university administrators tend to believe that as academic staff become older they will be less productive, less creative, less innovative, less willing to adapt to a changing environment, and less effective as teachers. Verhaegen and Salthouse (1997) present a meta analysis of 91 studies and conclude that the cognitive abilities, reasoning, speed and episodic memory declines significantly before 50 years of age and more thereafter. Stephan and Levin (1988) studied the performance of researchers within the disciplines of Physics, Geology, Physiology and Biochemistry. The number of publications and the standard of the journals they appear in is found to be negatively associated with the researchers' age. Similar evidence is found in the field of economics, where Oster and Hamermesh (1998) concluded that older economists publish less than younger ones in leading journals at 17 American top-universities. Further evidence in earlier studies where older researchers were found to have decreased research output is found in Bayer and Dutton (1977), Ripple and Jaquish (1981) and Bratsberg *et al.* (2003).

There is evidence that, on average, scientists become less productive as they age as stated in a study by Levin and Stephan (1991). They used longitudinal data that allows the identification of pure aging effects and showed that aging effects were found in five out of six areas studied. Similar longitudinal studies on mathematicians and scientists also showed a decreasing trend in quality and quantity of research output with age (Diamond 1986). Bratsberg *et al.* (2003) also found a similar pattern of decreasing productivity of the economics faculty at five research universities over a 21-year period. On the other hand, a study by Hammel (1980) showed a continuous increase in productivity with age amongst university chemists. Van Ours (2009) indicated that the productivity of academic researchers remains quite constant at older ages compared to other professions.

Experience has been considered one of the most important factors influencing the productivity of academics. Other than age, academic rank and years of working are directly related to experience. Senior professors have already accumulated a certain degree of academic capital and momentum in order to write and publish (Cole 1979). Tenured professors also tend to publish more than the non-tenured ones (Zhou and Volkwein 2004). Some literature focuses on career age, which is measured by years in academia after one receives academic credentials usually a doctorate, as a key measure. Fabel *et al.* (2008) indicated that journal article publication decreases with career age, which could be due to senior academics being more likely to publish books later in their career. Jung (2012) studied academics research productivity across disciplines in Hong Kong and found academic's rank correlates positively with research productivity and professors who have post-doctoral experience published more than those who do not. Post-doctoral experience added opportunities to participate in academic exchange and network with international peers (Horta 2009). The importance of social networks and the ability of older academics to draw upon these may ameliorate the perceived diminution of capacities that some researchers argue attend old age.

Gender may be one of the factors that could influence research productivity amongst academics. Women academics tend to publish less than their male counterparts. Sheehan and Welch (1996) explained that women's social roles may impede their research productivity. On the other hand, Teodorescu (2000) objected and asserted that women scholars do not necessarily publish less than the male scholars. Other factors related closely to research productivity such as, women receiving fewer grants than men and the fact that they are employed more in disciplines with low averages for article productivity, such as humanities could be the cause. Research productivity instead is influenced by other factors such as workload, teaching and other academic activities. Teodorescu (2000) also showed that time spent teaching is negatively correlated with research productivity while time spent on research shows a positive correlation. Jung (2012) indicated that male professors tend to publish more books or articles than female professors. Males also receive more research funding and present their research at more scholarly conferences which may be attributed to the fact that there are more men than women in the higher academic ranks and hard disciplines such as engineering or natural science (Ramsden 1994).

Academics in hard disciplines (natural sciences, engineering, and medical science) when compared to those in soft disciplines (humanities, social sciences, and business) publish more journal articles. Those in hard disciplines also tend to receive more research funding and have more opportunities to present their work at scholarly conferences. However, academics in soft disciplines tend to publish more books than academics in hard disciplines (Jung 2012). The extent to which age and gender combined have an impact on productivity is also an interesting issue.

This study examines the relationship between age and productivity based on key performance indicators (KPI) amongst academic staff at Universiti Sains Malaysia (USM). Comparisons were made among the outcomes generated using three different models: linear, quadratic and piece-wise spline. This study also explores other factors such as whether the academics are from the arts or science stream, their academic ranking and years of working experience as well as gender which could contribute to the KPI of the academic staff.

2. Method and Data

A total of 376 academic staff from three campuses, the Main Campus of USM, Engineering Campus and Health Campus constituted the sample. The sample size was decided on based on the population size at a precision level of 5 per cent and a confidence interval (CI) of 95 per cent which gave a figure of 350. The random stratification of academic staff was done based on the number of academic staff in each school with further sampling within the schools being conducted based on the classifications of professor, associate professors, senior lecturers and lecturers.

The mean age of the academic staff was 43.2 years with minimum being 24 years and the maximum 65 years. About 26 per cent of the staff were aged 50 years and above. Fifty five per cent were male with 62.8 per cent being from the Science stream and 37.2 per cent from the Arts stream. As shown in Table 1, about 25.5 per cent of the staff had been working at the university for more than 16 years, 36.4 per cent less than 5 years, 26.1 per cent between 6-10 years and 11.2 per cent between 11-15 years. The majority of the

Table 1. Descriptive statistics

		Minimum	Maximum
KPI (n=344)	Mean=28.33	0.30	126.30
Age (n= 365)	Mean=43.2 years	24 years	65 years
		Frequency	Percent
Gender (n= 370)	Male	201	54.3
	Female	169	45.9
Discipline (n= 376)	Arts	140	37.2
	Science	236	62.8
Rank (n=373)	Professor	26	6.9
	Assoc. Professor	94	25.0
	Senior Lecturer	211	56.1
	Lecturer	42	11.2
Work experience (n=373)			
	Less than 5 years	137	36.4
	6-10 years	98	26.1
	11-15 years	42	11.2
	more than 16 years	96	25.5

staff were senior lecturers (56.1%) while the rest consisted of professors (6.9%), associate professors (25%) and lecturers (11.2%).

Key Performance Indicators (KPI) was measured based on research and publications, post-graduate supervision, innovation and consultancy. These indicators will be used to gauge the level of productivity of the academic staff. Respondents were required to list down the number of research projects and publications, post-graduates supervised, innovations and consultancy projects achieved over the last 3 years. The KPI was calculated based on the template of the KPI calculation of the Malaysian Research University (MRU) grant applications. For example, the quality of publications was taken into account by assigning different scores for publications in citation-indexed journals, non-citation-indexed journals, chapters in books, refereed proceedings and other publications. Of the 376 respondents, only 344 respondents gave complete information. The minimum KPI recorded amongst the academic staff was 0.30 while the highest was 126.30 with the average being 28.33. For further analysis, data on KPI was transformed into LnKPI with a few outliers being removed in order to normalise the data.

3.1 Model Specification

Three models were estimated based on different assumption of the effect of age on KPI. The first model which is the linear model assumes that the marginal effect of age is constant over the life-cycle. The second model which is the quadratic model assumes that marginal effect of age is non -linear over the life-cycle. The possible outcome could be a 'U' shaped relationship or an inverted 'U' shaped relationship between age and productivity. Most of the past studies had adopted this approach to gauge the relationship between age and productivity.

We incorporated the third method using the piece-wise spline model. We hypothesised that KPI may have a linear effect within a certain range of age values as well as different linear effects at a different range of age. The piece-wise spline regression model allows for changes in slope even though the line estimated is continuous; that is, it consists of two or more straight line segments. Based on the assumption that marginal effect of age varies across different intervals of life-cycle, the piece-wise spline model is represented in equation (3).

Equations (1), (2) and (3) present the linear, quadratic and piece-wise spline model respectively of the following form:

$$\ln KPI = \beta' Z + \alpha' X + u \qquad (1)$$

Linear model where:

Ln *KPI* = natural log of KPI

Z= a vector which consists of variable age

X= a matrix which consists of other variables

Quadratic model where: (2)

where

Z= a matrix which consists of variable age and age2 (squared of age)

Piece-wise spline model where: (3)

where
Z= a matrix which consists of six age group variables: age 24-26, age 27-35, age 36-45, age 46-50, age 51-55, and age 56 & above

The age variables were constructed as follows:

Age 24-26= min(age, 26)

Age 27-35=max(min(age,35),27)-27

Age 36-45=max(min(age,45),36)-36

Age 46-50=max(min(age,50),46)-46

Age 51-55=max(min(age,55),51)-51

Age 56& above=max(min(age,64),56)-56

In addition to age, other variables (such as gender, academic rank, years of working experience and disciplines) were included as control variables.

3. Results

Table 2 presents the estimated coefficient (marginal effect) of age on KPI based on the three models. The linear model indicates that age is negatively related to KPI. Thus, the overall, KPI decreases as the academic staff get older. The marginal effect of age is also found to be significant for the quadratic model. Allowing the non-linear effect of age, we found that the KPI of academic staff had an inverted U-shaped relationship with age. Based on the quadratic model, KPI increases gradually from age 30 years and reaches a maximum at age 41 years. After the age of 41, KPI of the academic staff begins to decrease.

The piece-wise spline model gave a more realistic picture of how KPI varies with the age of the academic staff. In terms of estimated coefficient, from Table 2, it is found that the KPI decreases between age 24 and 26. The effect of age on KPI is positive from age 27 to 50, turning negative from age 51 onwards. The most productive age of academic staff in terms of KPI is age 46 to 50 (as illustrated in Figure 1).

As shown in Table 2, the age variables from 24-50 are insignificant and likely due to the aggregation of negative and positive effects of age between 24 and 50. In particular, as suggested by the literature on happiness, the effect of age is a U-shaped with the minimum point at age of around 46 (Oswald 1997; Blanchflower and Oswald 2004). The minimum point occurs at middle age, that is around the 40s perhaps due to people encountering pressures from ageing parents, problems related to growing-up children, and being at the bottom net of their own career development. This minimum point of happiness life-cycle is reflected in the age effect of KPI. Thus, guided by the life-cycle of happiness, we modified the age groups into: 24-26, 27-35, 36-40, 41-45, 46-50, 51-55, and 56 and above (please refer to Appendix 3 for details). Table 3 presents the estimated results and Figure 2 depicts the effects of these different age groups on KPI.

From Table 3, the marginal effect of age is now found to be significant from age 36 and onwards. We can also use the happiness life-cycle argument to explain the outcome. A downtrend in productivity between ages 41 and 45 years could be related to the level

Table 2. The effect of age on KPI

	Estimated coefficient	P-value
Linear model		
Age	-0.0153	0.0950
Quadratic model		
Age	0.1564	0.0110
Age2	-0.0019	0.0050
Piece-wise spline model		
Age24-26	-0.3654	0.2350
Age27-35	0.0218	0.5400
Age36-45	0.0033	0.8790
Age46-50	0.0445	0.3490
Age51-55	-0.0946	0.0850
Age56 & above	-0.1080	0.0300

Note:

1. Linear model: R^2=0.1557; adj-R^2=0.1262; Overall fit test (P-value)=0.0000
2. Quadratic model: R^2=0.1768; adj-R^2=0.1454; Overall fit test (P-value)=0.000
3. Piece-wise spline model: R^2=0.1881; adj-R^2=0.1553; Overall fit test (P-value)=0.0000

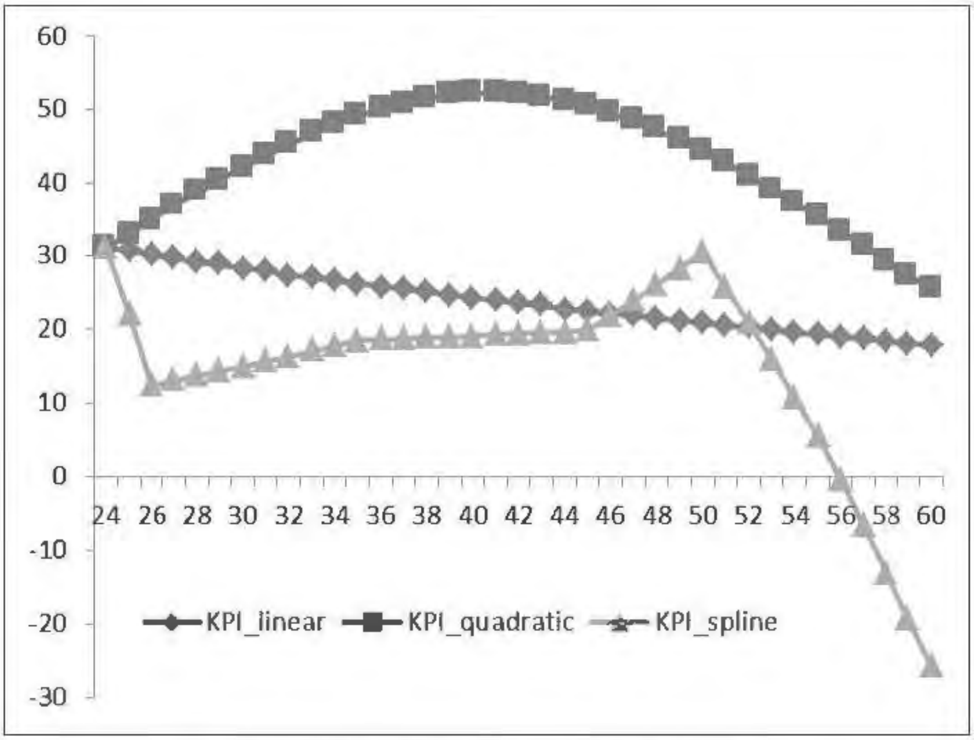

Figure 1. Age and key performance indicators (KPI)

Note: The negative values of KPI (for KPI_spline, from age 55 onwards) are due to the negative effects of age 51-55 and age above 55, which significantly reduce the KPI to below zero. Practically, it should equal to zero.

of happiness which may have an adverse effect on productivity (Blanchflower and Oswald 2004; Oswald *et al.* 2009). An overall increasing trend in KPI is recorded between age 36 and 40 years. Based on the coefficient estimated, academic staff are most productive between age 46 and 50 years. A significant downtrend trend in productivity of the staff is recorded after the age of 51 years. This is indicated by a significant negative coefficient estimated for the variable age 51-55 and age 56 & above.

As illustrated in Figure 2, the 'golden' KPI age of academic staff is between age 36-40 years, and between age 46-50 years, indicating a 10-year golden age period. Comparing the life-cycle effect which is measured by the quadratic model (a model that is popularly used to measure the life-cycle effect) and the piece-wise spline model, the quadratic effect (which is significant at 5% level) could have over-estimated the effect of age on KPI.

From the magnitude and significant levels (at least 10% level) of the marginal effects of the piece-wise spline model shown in Figure 3, between 46-50 years, academic staff reach the peak of their productivity in their life-cycle, followed by the an age interval of 36-40 years. Thus, the academic staff have a 10-year golden age when their KPI could be harvested fruitfully. Between age 51-55 years, there is a significant downward trend in the KPI of the academics.

Based on the piece-wise spline model, we also included other possible variables such as gender, academic rank, years of working experience, and discipline (arts/science). However, the estimated results especially the effect of age on KPI might be subjected to the problem of endogeneity. We performed a Durbin-Wu-Hausman endogeneity test

Table 3. The estimated model

	Coefficient	P-value
Piece-wise spline of age:		
Age24-26	-0.3506	0.250
Age27-35	-0.0068	0.854
Age36-40	0.1020**	0.018
Age41-45	-0.1134**	0.021
Age46-50	0.1147**	0.034
Age51-55	-0.1188**	0.032
Age 56 & above	-0.1057**	0.032
Other independent variables:		
Science stream[1]	-0.3340***	0.0010
Male	0.3827***	0.0000
Professor[2]	0.9153***	0.0000
Assoc Professor[2]	0.5836***	0.0000
Work experience 6-10 yrs[3]	-0.0842	0.5570
Work experience 11-15 yrs[3]	-0.2701	0.1610
Work experience >15yrs[3]	-0.0398	0.8450
Constant	12.2693	0.1330

Note:

1. Comparison group: Arts stream.
2. Comparison group: Lecturer & Senior Lecturer.
3. Comparison group: working experience of less than 6 years.
4. Dependent variable: LnKPI (natural log on key performance indicators).
5. ***, ** and * significant at 1%, 5% and 10% levels, respectively.
6. R^2=0.2056; adj-R^2=0.1709; Overall fit test (P-value)=0.0000

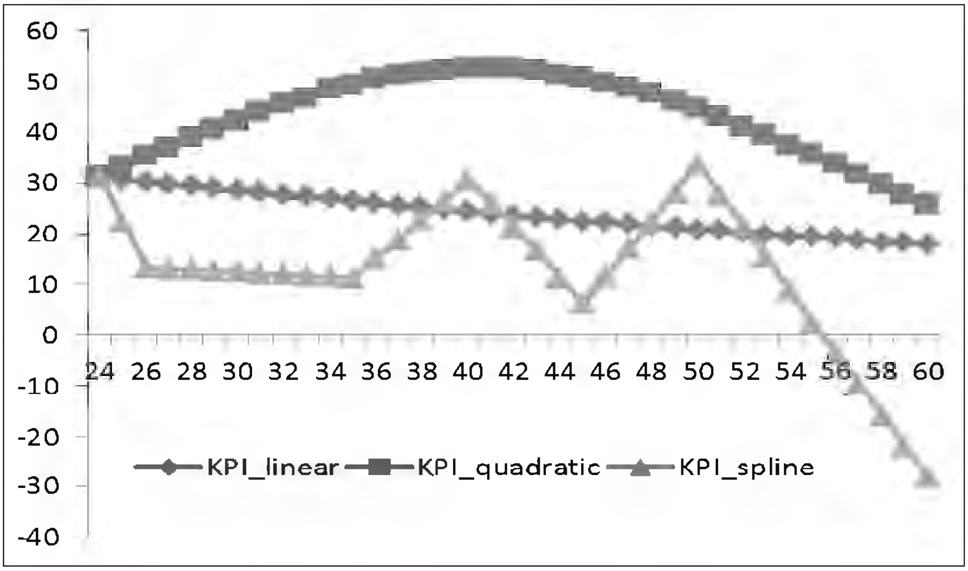

Figure 2. Age and key performance indicators (KPI)

Note: The negative values of KPI (for KPI_spline, from age of 55 onwards) are due to the negative effects of age 51-55 and age above 55, which significantly reduces the KPI until below zero. Practically, it should equal to zero.

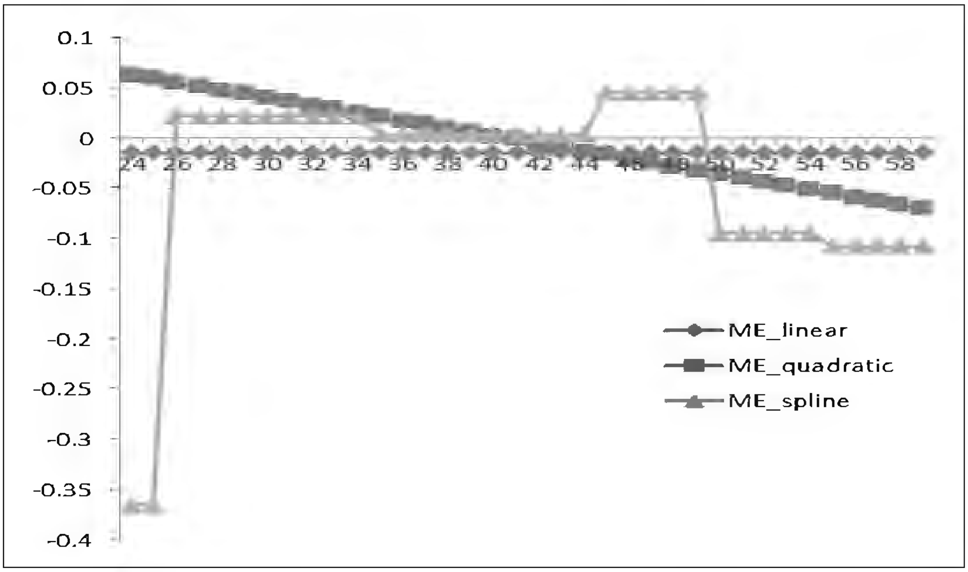

Figure 3. The marginal effect of age

Note: the negative values are due to the negative effect of age (51-55, 56 and above) on KPI; this represents the negative marginal effect of age on KPI.

(Davidson and MacKinnon 1993) on the variables of ages 24-30, 31-35, 36-40, 41-45, 46-50, 51-55, above 55 and age 24 and above, using work experience as the instrumental variable (since this variable has no significant effect on KPI (see Table 3) and has a significant effect on age (please refer to Appendix 1). The test reveals that statistically, there is no evidence of endogeneity problem (*p*-values are 0.719, 0.321, 0.406, 0.930, 0.891, 0.504, 0.402 and 0.851 for ages 24-30, 31-35, 36-40, 41-45, 46-50, 51-55, above 55 and age 24 and above, respectively. In addition multicollinearity among the independent variables especially age with work experience and ranking could play an influential role. We calculated the Variance Inflation Factor (VIF) and found that the values of VIF for age with work experience were 3.61 (work exp >15years), 1.83 (work exp 11-15 years) and 1.72 (work exp 6-10 years). There is moderately high collinearity among the age variables (ranging from 1.12 to 5.82, see Appendix 2); however, the values are still far below 10 (the rule of thumb for high multicollinearity (see Gujarati 2004: 362)). Thus, the influence of endogeneity and multicollinearity on the estimated results should be at a minimal level.

Other factors besides age that are found to have a significant impact on the achievement of KPI of the academic staff are gender, academic rank and discipline (Table 3). Male academic staff seem to have 38.27 per cent higher KPI compared to the female staff. Academic staff from the science stream (or the hard discipline) have 33.40 per cent lower KPI compared to those from the arts. This outcome is contradictory to the findings of most other studies that showed otherwise. It is also obvious that professors have much higher KPIs compared to the lecturers and the senior lecturers. Professors have 91.53 per cent higher KPI compared to lecturers and senior lecturers, whereas, they (professors) have 33.17 per cent (91.53 - 58.36 %) higher KPI than the associate professors. Associate professors have 58.36 per cent higher KPI than the lecturers and senior lecturers. However, number of years of working experience does not have a significant impact on KPI of the academic staff.

As shown in Table 3, gender and discipline seemed to have relatively strong significant effects on the KPI of the academic staff. To gain further insights, we estimated the models based on the sub-sample of female, male, arts and sciences. Table 4 describes the breakdown of the sub-sample based on gender, academic rank and discipline. Similar to other studies, more male staff are in the science stream (hard discipline) and more female staff are in the arts stream (soft discipline). More male staff hold higher academic rankings compared to their counterparts.

Table 4. Descriptive statistics based on gender, discipline and academic rank

		Discipline		Academic rank			
Gender	Total	Arts	Sciences	Professor	Assoc Prof	Senior Lecturer	Lecturer
Female	169	76	93	5	32	106	26
Male	200	59	141	20	61	103	16
Total	369	135	234	25	93	209	42

Note: The number of observations here are larger than in Tables 2 and 3 because estimation of regression models deletes any observation from the sample that has missing values in the dependent or independent variables (listwise deletion).

Table 5 shows that the influence of age on KPI is more significant amongst female staff compared to male staff. The pattern of how KPI of female staff is influenced by age has a significant influence on age and KPI relationships in the overall data given in Table 3. On the other hand, age does not impact the productivity of male academic staff except for a significant downtrend among those 56 years and beyond. Female staff in the arts stream were also found to significantly outperform female staff in the science stream by 49.1 per cent whereas no significant difference in KPI was found amongst the male staff between arts and science stream. Female associate professors had a 69 per cent higher KPI than female senior lecturers and lecturers but surprisingly, female professors do not seem to have significant difference in their KPI compared to female associate professors and senior lecturers/lecturers. This could be the low number of female professors who took part and gave information on their KPI in this study.

Age influence on KPI is more significant amongst academic staff in the arts compared to the science stream. There is a significant downtrend in productivity between ages 41-45 years and after 51 years amongst academic staff in the arts stream. In the arts stream, those between age 46-50 years are the most productive with KPI peaking at age 51 years. In the science stream only those between ages 36-40 years seem to have a significant and positive impact on KPI. Gender does not matter in the KPI scores amongst staff in the arts stream. However, in the science stream, the male staff have about 54 per cent higher KPI compared to the female staff. Academic ranking has a strong influence on productivity for both arts and science streams. Number of years of work experience does not seem to have an impact on KPI in all the sub-sample models.

4. Discussion and Conclusion

Critically the kind of model used to analyse data from our research instrument has a significant effect on how we understand the relationship between age and productivity. Linear regression over simplifies the relationship between the two variables indicating a gradual decline in productivity amongst academic staff as they grow older. The quadratic model which is a slightly improved analysis shows that productivity gradually increases and reaches a peak at age 41 years and declines thereafter. This model shows an inverted-U shape relationship between age and performance which is in accordance with other studies such as Sturman (2003) and Avolio *et al.* (1990). Both linear and quadratic models suggest that the marginal effect of age is predominant in determining productivity but the outcomes may not be able to capture the specific age group that is the most productive or otherwise.

The piece-wise spline model provides us with a more nuanced and complex insight into the life-cycle of productivity amongst academic staff. Academic staff in USM are found to be most productive between ages 36-40 and 46-50. There is a drop in productivity around the middle 40s. This drop is consistent with the happiness life-cycle and understanding the relationship between productivity and life cycle issues suggests that management understanding of the complexity and dynamic nature of productivity among staff is critical in engaging the issue of productivity and performance in the workplace. Workplace strategies which take into account life cycle issues and the social aspects of productivity could help in increasing productivity. Our research found a significant decrease in productivity after the age of 50. This outcome is in line with findings which

Table 5. The estimated model by gender and discipline

	Female		Male		Arts		Sciences	
	Coeff	P-value	Coeff	P-value	Coeff	P-value	Coeff	P-value
Piece-wise spline of age:								
24-30 yrs	-0.5055	0.1490	n.a.	n.a.	n.a.	n.a.	-0.3345	0.3320
31-35 yrs	0.0116	0.8430	-0.0201	0.6560	0.0910	0.1540	-0.0331	0.4830
36-40 yrs	0.1936***	0.0050	0.0118	0.8210	0.0641	0.2760	0.1082*	0.0630
41-45 yrs	-0.2366***	0.0020	-0.0012	0.9850	-0.1204*	0.0610	-0.1087	0.1100
46-50 yrs	0.1844**	0.0360	0.0242	0.7230	0.1473**	0.0190	0.0748	0.3620
51-55 yrs	-0.0309	0.8480	-0.0502	0.3900	-0.1647**	0.0310	-0.0840	0.2970
56 and above	-1.0432	0.2210	-0.0952**	0.0370	-0.1603**	0.0440	-0.0833	0.1900
Other independent variables:								
Science stream	-0.4909***	0.0040	-0.1262	0.3290	n.a.	n.a.	n.a.	n.a.
Male	n.a.	n.a.	n.a.	n.a.	0.1729	0.1850	0.5379***	0.0000
Professor	0.7038	0.2930	0.8730***	0.0010	1.2518***	0.0020	0.7758**	0.0190
Assoc Professor	0.6863***	0.0020	0.5226***	0.0010	0.4717***	0.0100	0.6495***	0.0000
Work exp 6-10 yrs	-0.1376	0.5340	-0.0578	0.7500	0.1543	0.4340	-0.1443	0.4620
Work exp 11-15 yrs	-0.2502	0.4240	-0.2710	0.2450	-0.1814	0.5040	-0.2741	0.2880
Work exp >15yrs	0.1962	0.5430	-0.3145	0.2240	0.0221	0.9330	0.0221	0.9400
Constant	16.1965*	0.0820	3.3737***	0.0000	2.1067***	0.0000	11.6082	0.2080
Sample size (n)	157		179		121		215	
R^2	0.2967		0.1324		0.2503		0.2144	
Adj-R^2	0.2327		0.0697		0.1670		0.1636	
Overall fit (p-value)	0.0000		0.0187		0.0012		0.0000	

Note: ***, ** and * significant at 1%, 5% and 10% levels, respectively.

indicate strong decline in productivity, in general, after the age of 50 (Dostie 2006; Grund and Westergaard-Nielsen 2005; Hellerstein and Neumark 2004; Prskawetz *et al.* 2006) and also some other studies which have observed academic staff (Stephan and Levin 1988; Levin and Stephan 1991; Oster and Hamermesh 1998; Bratsberg *et al.* 2003).

Our findings indicate that productivity amongst academics declines from age 51. Could academics still contribute effectively to the economy after 55, as the retirement age is now extended to 60? Earlier the Malaysian civil servants' retirement age was 55 and was raised to 56 in 2005 and to 58 in 2009. In 2012, the civil servants' retirement age which also includes academics from public universities was raised to 60. The overall extension of retirement age from 55 to 60 allows more civil servants to continue to work and the wage levels of workers over the age of 55 will usually be higher. Wage increment should be countered with higher productivity or in this case, a lower reduction in their productivity in order to reduce economic loss. It would be useful if future studies could gauge the value added effects of the extension of retirement age in all sectors in Malaysia. Implementation of a seniority-based salary system as in the case of most civil services appears to be counter productive when the retirement age is extended. The economic ripple effect of the extension of mandatory retirement age can be quite immense but the social benefits from the extended retirement age are equally huge (Rhee *et al.* 2011). Thus, the government should take great care in calibrating the associated regulations related to these issues.

Other factors that were found to have a significant influence on KPI amongst USM academic were gender, academic rank and discipline. Male academic staff tended to have higher KPI compared to the female. This can be attributed to the fact that there are more men than women in the higher academic ranks. Not surprisingly, professors were more productive compared to associate professors, and associate professors more productive than senior lecturers and lecturers. One possible explanation for this might be that higher ranked positions result in more opportunities to supervise post graduate students, secure more research funding and present their work at more scholarly conferences, and get more invitations to write articles and book chapters. In other words the social relations that underpin productivity may be critical in understanding productivity as much as presumed individual attributes. The extent to which productivity can be understood as a discrete number ascribed to an individual and explained by an aspect of their personal identity or the extent to which productivity must be viewed as an effect of a particular type of social relation is one of the most difficult and critical issues to assess in how we actually understand performance. Is productivity a result of discrete human capital attributes which arguably diminish as ageing progresses or is productivity related to aspects of social capital which may positively influence productive capacities in older workers?

One interesting finding with regard to our research is that academic staff from the arts stream tend to have higher KPI than those from the science. This outcome contradicts most other findings which indicate otherwise. This could be attributed to how we have defined discipline. Staff from medical schools were categorised as science. They consisted about 30% of the respondents in the science stream. Higher KPI from hard disciplines are believed to be mainly from engineering schools and science schools such as physics, chemistry, biology and mathematics. Another reason, as shown in the sub-sample models, could be the significant contribution from female staff in the arts compared to female staff in sciences. However, such outcomes may again point to the social, definitional and methodological issues that plague studies in this area.

KPI in USM and most of the universities is measured in terms of tangible products such as publications, supervision of post-graduate students, research, innovation and consultancy. KPI does not necessarily measure less tangible products or processes that go into the creation of KPI. For example, teaching, which is the core duty of the academic staff, is not included in KPI measurement. This 'blindness' to intangibles such as commitment, leadership, and mentoring constitutes a significant potential problem in understanding the deep and fundamental influences and nature of productivity or performance. This opens up some significant questions. One important issue is the extent to which there is a difference between performance indicators and performance itself. If for example, we understood performance to include the positive contributions that older staff play in being role models, providing leadership, mentoring and opening doors to social networks built over time, then we may end up with a very different view of the relationship between age and performance in the workplace. The reduction in performance to a simple measurable metric may exclude from vision the intangible and social dimensions to performance. Specifically the importance of age and performance, understood through a reductive and simplistic linear method of assessing performance, could compound the possibly misleading nature of what performance is, what is important in relation to it and ultimately how to map our directions for organisations in an effort to increase performance. Our research points to the fact that assessing performance in the workplace with regard to age requires complex methodological engagement. It also needs to be based on a wider lens which recognises and includes in the discussion the intangible and social dimensions to performance. Failure to do this could lead organisations having a rather reductive, simplistic and ultimately erroneous view of the relationships between an organisation's performance and age with possibly highly negative consequences.

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Appendix 1. Choice of instrumental variables

Source	SS	df	MS		Number of obs	= 365
					F(3, 361)	= 136.52
Model	13472.9507	3	4490.98356		Prob > F	= 0.0000
Residual	11875.1863	361	32.8952529		R-squared	= 0.5315
					Adj R-squared	= 0.5276
Total	25348.137	364	69.637739		Root MSE	= 5.7354
age	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
Work Exp_2	5.091856	.7693279	6.62	0.000	3.578929	6.604783
Work Exp _3	7.393939	1.016084	7.28	0.000	5.395752	9.392127
Work Exp _4	15.50271	.7716685	20.09	0.000	13.98518	17.02024
_cons	36.93939	.4992058	74.00	0.000	35.95768	37.92111

Appendix 2. Variance inflation factor (VIF)

Variable	VIF	1/VIF
age41_45	5.82	0.171799
age46_50	5.58	0.179144
age36_40	3.80	0.263370
Work Exp_4	3.61	0.277086
age51_55	3.35	0.298531
Work Exp_2	1.83	0.545809
Work EXp_3	1.72	0.579909
age27_35	1.68	0.596100
age56_60	1.66	0.600714
Assoc_Prof	1.56	0.639409
Prof	1.40	0.714960
male	1.14	0.877476
Stream	1.13	0.885288
age24_26	1.12	0.889506
Mean VIF	2.53	

Appendix 3. Re-grouping of age variables

Since the insignificance of age variables from 24 to 50 years (see Table2) could be due to the aggregation of negative and positive effects of age between 24 and 50, re-grouping of the age variables was found to be necessary. Guided by the finding of 'U' shape life-cycle of happiness (assuming that happiness could influence one's productivity) with the minimum point at age of around 46 (Oswald 1997; Blanchflower and Oswald 2004), we regrouped the age variable of 36-45 into two age variables of 36-40 and 41-45. Other age variables remained unchanged. The re-group age variables were:

age24-26= min(age, 26)
age27-35=max(min(age,35),27)-27
age36-40=max(min(age,40),36)-36
age41-45=max(min(age,45),41)-41
age46-50=max(min(age,50),46)-46
age51-55=max(min(age,55),51)-51
age56 &above=max(min(age,64),56)-56