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Leisure time and labor productivity: a new economic view rooted from sociological perspective

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Abstract
Most economists measure labor productivity based on activities conducted at places of work and do not consider leisure time in their calculations. In contrast, psychologists and sociologists argue that leisure has a positive role in the production process: leisure can improve individuals' labor productivity by affecting their self-development. Using empirical data from 21 OECD countries, this study finds that leisure time has a dual effect on labor productivity in terms of per capita per hour GDP. Moreover, leisure time is nonlinearly associated with labor productivity (inverted U-shaped). When leisure time reaches the optimal level (5,813 hours), leisure has a compensatory effect on work and can positively influence labor productivity, but when leisure time exceeds the optimal value, leisure has a substitution effect on work and can negatively influence labor productivity.

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Keywords Leisure time; labor productivity; per capita per hour GDP; dual effect; curvilinear relationship

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1 Introduction

Labor productivity, is the workforce productivity, and refers to actual labor output per labor hour (Hu, 2001; Koch and Mcgrath, 1996). The growth of labor productivity is directly attributed to the fluctuation of physical capital, new technology and human capital. Human capital, is the quality of labor force, and refers to the knowledge, skills and physical strength (health status) that labors intend to invest in improving their quality, ability and productivity (Nie, 2017; Schultz, 1961; Stiglitz, 2001). Human capital as a determinant of labor productivity growth includes education, health, and aspects of "social capital" (Barro and Lee, 2001). Hanushek and Kimbo (2000) suggested that labor force quality has a stable, strong and consistent relationship with labor productivity growth. Economists are concerned about the quality of workforce, however, too much attention has been paid to how formal schooling affects the quality of human capital and labor productivity (Dolton, 2010; Grossman *et al.*, 2017; Klinov, 2005; Lucas, 1988; Rangazas, 2002). Indeed, leisure can also indirectly account for the human capital quality, and thus affect labor productivity.

Leisure has impacts on the formation and accumulation of human capital (Wei *et al.*, 2016). Leisure as a context can help individuals to realize and utilize their strengths and resilience, and more important is to help people to improve their quality and pursue for a meaningful life (Iwasaki, 2007). Beatty and Torbert (2003) proposed that leisure is associated with ongoing personal development during adulthood through intentional awareness-expanding inquiry, not just growing older and losing attraction. And leisure is intrinsically rewarding, due to its promotion of personal transformations and increasing extrinsic economic value.

However, although some economists suggest that leisure is effective in the economic aspects (Farahani *et al.*, 2016), most neoclassical economists assume that leisure time has no influence on the quality of human capital. For example, the neoclassical inter-temporal substitution model (Eichenbaum *et al.*, 1985; Ioannides and Taub, 1992; Keane, 2011; Mankiw *et al.*, 1985) considers leisure time as a pure substitute for working hours and has no influence on labor productivity. As a result, they took more account of the negative impact of leisure on productivity and economy (Buchanan and Yoon, 1994a; Hendee, 1971; Kydland and Prescott, 1982; Mankiw *et al.*, 1985) but ignore the possibility that leisure time could have positive effects on labor productivity.

Fortunately, most psychologists and socialists argue that individuals' happiness and labor productivity tend to increase along with their self-esteem, self-awareness, determination, creativity, and exploration of various leisure activities (Csikszentmihalyi, 1975; Gould *et al.*, 2008; Hills and Argyle, 1998; Nimrod, 2007; Xie *et al.*, 2018). This implies that leisure activities can create positive externalities and improve the human capital accumulation of individuals, which will enhance their labor productivity when they return to work (Eschleman *et al.*, 2014; Monte., 2008; Psarianos, 2007; Suarez, 2007).

This leads to the following question: Does leisure have a dual effect on labor productivity? To enrich the literature on the effects of leisure, this study investigates the relationship between leisure and labor productivity. Specifically, the study extends the classic endogenous growth model (Lucas, 1988; Mankiw *et al.*, 1992) by including leisure in the assessment of production and examines the role of leisure in determining labor productivity both theoretically and empirically.

Furthermore, this study differs from most previous studies (Gould *et al.*, 2008; Kirchmeyer, 1992; Melamed *et al.*, 1995; Nimrod, 2007; Pagano *et al.*, 2006; Spreitzer and Snyder, 1974; Xie *et al.*, 2018) by considering leisure at the time level instead of taking leisure as activities. Leisure time, is the time when the individual does not work (Robinson and Godbey, 1998). Due to its objective, and neutral definition, leisure time is amenable to quantitative testing, although its loopholes lead to ambiguity (Beatty and Torbert, 2003). Using a sample of 21 OECD countries, this study conducts empirical tests on the impact of leisure time on labor productivity at the national level. The results have the potential to enable generalizations about the relationship between leisure and work, specifically the contribution of leisure time to labor productivity.

The rest of this paper is organized as follows. First, the relevant literature is reviewed. And then the theoretical model is laid out to investigate the relationship between leisure time and labor productivity. Subsequently, the database is described and the empirical analysis is present to estimate the model. Finally, the study’s major findings and limitations are discussed and concluded in the last two sections.

2 Literature

2.1 Traditional (economic) view on leisure time and labor productivity

Few researches have specifically studied the relationship between leisure time and labor productivity, although some have analyzed the indirectly impact of leisure on human capital and labor productivity. Economists have developed several methodologies to create a formal framework to deal with leisure, human capital and labor productivity. For example, Ladro´n-de-Guevara *et al.* (1999) have constructed a model in which leisure time had no effect on the quality of human capital, but personal productivity would improve when education time increases. Eichenbaum *et al.* (1985) and Ioannides and Taub (1992) using the inter-temporal substitution model found that leisure time ‘‘crashes out’’ working time and have no contribution to enhance human capital and improve labor productivity. In addition, Kydland (1995) and Pintea (2010) assumed that technological shocks have a significant negative impact on leisure time based on the classic real business cycle model (RBC), and they suggested that aggregate production is notably negative correlated with leisure time in the long run. However, some economists also argued that although leisure time as a pure substitute for working time, reading professional literature in leisure time or surfing the Internet (selecting useful information) can also lead to a greater or lesser increase in work efficiency (Ioan and Ioan, 2016). Even though, the literature in the traditional economics reflects the viewpoint that leisure time has no or little positive effects on labor productivity.

2.2 Sociological view on leisure time and labor productivity

However, the studies of psychology and sociology have demonstrated that individuals with high feelings of well-being[1] perform better than those with low feelings of well-being, and leisure participation can improve personal competency and work performance, which will then enhance their labor productivity. Firstly, some studies have reported a positive correlation between leisure and psychological well-being and health (Chen, 2014; Coleman, 1993; Fernandez-Ballesteros *et al.*, 2001; Laukka, 2007; Liu *et al.*, 2016; Reich and Zautra, 2010). The more important concern is that to some extent leisure can improve quality of life of individuals. Csikszentmihalyi (1997) argued proposed that flow[2] experience generates individual spiritual fulfillment. When individuals participate in leisure activities, they would have the flow experience (Stebbins 2000), which could improve self-awareness, and creativity (Nimrod, 2007), strengthen skills (Andrew and Withey 1976; Chen 2010; Cunha and Heckman 2009), and thus improve their efficiency. Iwasaki (2007) reviewed studies of major pathways or mechanisms through which leisure can facilitate meaning-making and enhance quality of life, including (1) happiness and positive emotions brought by leisure, (2) self-respect and positive identity obtained from leisure, (3) social and cultural ties and harmonious development promoted through leisure, and (4) the contribution of leisure to human's learning and human's development throughout human life. Hills and Argyle (1998) found that sports, music, church, and watching soap operas are four common leisure activities that can bring positive emotions. Therefore, people who participate in more leisure activities are happier than those who do not, and their working efficiencies are more efficiently (Vogel *et al.*, 2016; Zhao and Fang, 2013). However, there is some evidence that TV can produce a drowsy and passive state (Kubey and Csikszentmihalyi, 1990; Wei *et al.*, 2015). Also, people who watch more TV are less happy than those who watch less TV (Böhnke, 2005; Lu and Argyle, 1993; Smeets *et al.*, 2018).

Additionally, Li and Tsai (2013) explored the relevance between specific leisure activities and particular personality traits. They argued that individual personality differences may affect

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[1] Well-being refers to a series of joyful and pleasant emotions produced subjectively by human beings based on their own sense of satisfaction and security (Gao and Fei, 2019).

[2] Csikszentmihalyi referred to "flow" as a psychological state and means that a person taking part in an activity is totally immersed in a feeling of energized focus, full involvement, and enjoyment in the process of activity.

leisure choices. Hills and Argyle (1998) also found that these personality differences could also influence the degree of happiness experienced. Melamed *et al.* (1995) elucidated the differences in the benefits individuals gain from different types of activities, assuming that the choices of leisure activity are the manifestation of an individual's personality. Additionally, Xie *et al.* (2018) investigated the leisure participation of knowledge workers and found the compensatory effect of leisure congruence on individual well-being and people engaged in congruent leisure activities exhibiting significantly better profiles with higher work satisfaction, less burnout, and so forth. And individuals' labor productivity tends to increase along with their self-esteem, self-awareness (Gould *et al.*, 2008; Nimrod, 2007; Xie *et al.*, 2018).

Furthermore, researchers have examined the role of leisure as compensation for and recuperation from work. Leisure and work are main parts of a person's life (Snir and Harpaz, 2002; Waring, 2008). Leisure experiences have attributes such as aesthetic appreciation, companionship, enjoyment, escape, and relaxation (Ji, 2017; Pan, 2013), whereas work experiences have attributes of accomplishment, responsibility, external rewards, boredom, and stress (Cohen, 2010; Watkins and Subich, 1995). According to the compensation model, workers who experience deprivation at work would compensate for this when they choose non-work activities (Miller and Weiss, 1982; Wilensky, 1960). Blekesaune (2005) examined a sample of people who were employed full-time in 100 occupations and found that leisure participation in non-work domains (e.g. family and recreation) can help individuals buffer the strains of work and develop useful working skills and perspectives. These positive outcomes of leisure may enhance a person's ability to satisfy the work requirements and his or her importance to the organization.

Despite the plethora of literature on the effects of leisure activities on personal performance and human capital, but few focuses on the relationship between leisure time and labor productivity directly. In this paper, we will use the leisure time to explore its influence on labor productivity. The estimated production functions are used to investigate the impact of leisure time on OECD countries' labor productivity. As most economic growth models investigate the impact on per capita GDP or growth rate, this study uses the per capita per hour GDP to measure productivity. The hypothesis is that leisure time has a significant positive effect on labor productivity.

3 Theory

Labor productivity is increased through two channels: the first is applying advanced technology to tasks during work hours; and the second is the possibility that the self-fulfillment and self-realization individuals establish through leisure will positively affect their productivity (Farahani *et al.*, 2016; Fogel, 2000). Assuming that leisure time has a positive impact on human capital, growth, and labor productivity, we include it as an input to the calculation of the production function.

Using Lucas (1988) production function and treating education time as exogenous (Mankiw *et al.*, 1992)[3], we specify the production function as follows:

$$Y=AK^{\beta}(uH)^{1-\beta} \tag{1}$$

where K is aggregate capital, H is human capital, β is the output elasticity of physical capital, u is education time (total time volume is normalized to 1), and A represents the technical level. When considering the positive effects of leisure time, the accumulation path for A is

$$A=\bar{A}K^{\alpha}l^{1-\alpha} \tag{2}$$

where $\bar{A}$ is the parameter of the technical level and l denotes leisure time. α indicates the elasticity of K to A, and $1-\alpha$ indicates the elasticity of l to A.

Equation (2) shows that technical accumulation combines two processes: the process of "learning by doing" (K^{α}) and the process of "learning through leisure" ($l^{1-\alpha}$)[4], as we call it. The former process has been clearly elaborated by Romer (1986). The latter implies that "creative" leisure produces technological externalities for society. In other words, if activities performed during leisure time are enjoyable and constructive, they benefit individuals' and their counterparts' physical strength, willpower, and creativity. Although the effect of an individual's participation in such leisure on the whole economy may be too weak to notice, the accumulated aggregate effect can be a huge and "unexpected" knowledge accumulation that generates further positive externalities and increases the overall level of technology in the economy (Romer, 1990). Assuming that human capital accumulation follows an exponential path (Mankiw et al., 1992), after introducing leisure time into the model, the new path takes the following form:

$$H=e^{\psi_1 u+\psi_2(\varepsilon l)}L \tag{3}$$

where L represents the untrained labor force and ψ_1 denotes the magnitude of education time (u)'s effect on the formation of human capital ($dlnH/du=\psi_1$). Similarly, ψ_2 denotes the

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[3] By treating human capital as an endogenous variable (Lucas, 1988), we can measure an endogenous accumulating path of human capital. This treatment does not affect the main conclusion about the optimal path of labor productivity in our study. For simplicity, we do not pursue this issue here.

[4] 1-α is the technological elasticity of leisure time. Leisure time has a decreasing marginal return to the technological level, i.e., 0<1-α<1. However, there are two situations in which 1-α<0. First, if leisure time has not been constructively used (i.e., there are sharp increases in such leisure activities as crime, drug use, and illegal sex activities), the formation of new knowledge and creativity will be inhibited (Fogel, 2000). Second, when the income of laborers in low-income countries increases, the substitute effects of leisure time may offset the positive effect of "learning by leisure." In these two cases, 1-α< 0.

magnitude of leisure time's (l) effect on the formation of human capital ($dlnH/dl=\psi_2$), which is termed the "advancing through leisure" effect. In other words, various instructive leisure activities will increase individuals' self-fulfillment and self-realization, creativity, exploration, and productivity (Barnett, 2006; Csikszentmihalyi, 1975; Nimrod, 2007). Note that ε, as a parameter, denotes the proportion of leisure time involved in the formation of human capital, $0 < \varepsilon < 1$.

Substituting Equation (2) into Equation (1), we obtain the production function with leisure time:

$$Y=\bar{A}K^{\alpha+\beta}(uH)^{1-\beta}l^{1-\alpha} \tag{4}$$

To measure the labor productivity, we divide both sides of Equation (4) by $(365 * 24 - u - l) \times L$. As $\hat{x}$ represents the variable x divided by "per capita per hour", we obtain

$$\hat{y}=\bar{A}\hat{k}^{\alpha+\beta}\left(u\hat{h}\right)^{1-\beta}l^{1-\alpha}(365*24-u-l)^{\alpha}L^{\alpha} \tag{5}$$

where $\hat{y}$ measures the labor productivity, defined as the output per capita per hour worked.

Equation (5) shows that physical capital per capita and human capital per capita per hour have a direct ratio relationship with labor productivity. Thus, increasing capital accumulation can improve productivity (e.g., advanced technology, "learning by doing"). Moreover, increasing the size of L with an elasticity of α has a positive effect on $\hat{y}$ (per capita per hour GDP), as more people means more human capital.

Based on Equation (5), the theoretical proposition is reformulated as two components, as empirical test hypotheses in this study:

H1: leisure time has a positive effect on human capital and labor productivity ("learning by playing"), as studied in sociology and psychology literature;

H2: leisure time also has a negative effect on education time and work hours ("crashing out" the working hours), which could lead to a decline in production and have a negative effect on productivity.

These hypotheses are tested by assessing whether the impact of leisure time in each OECD country is significant and positive. In addition, the linear, and quadratic terms of leisure time were included in the regression test equations to explore the potential curve relationship between leisure time and labor productivity.

4 Data and variables

This study's sample includes 21 OECD countries: Australia, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Italy, Japan, Korea, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Turkey, the United Kingdom, and the United States. The 21 countries spread all over the world, from North America to Europe to the Asia-Pacific region. They include not only many of the most developed countries in the world, but also some emerging countries, such as Turkey.

Data from all 21 countries for the 1980–2013 period (34 years) are taken from the database of the World Bank (www.OECD.org) and the Barro-Lee Educational Attainment Dataset. Thus 714 sample observations (21 countries multiplied by 34 years) can be used for the main analysis of this study.

In this study, the dependent variable is labor productivity, measured by per capita per hour GDP (*GDPpp*):

$$GDPpp=\frac{\text{per capita GDP}}{\text{average annual worked hours}} \tag{6}$$

The most important independent variable is annual average leisure time per capita l. Most economists thought that leisure time is a pure substitute for working time (Farahani *et al.*, 2016; Keane, 2011). Gronau (1977) argued that leisure time should be calculated by deducting work time and home production time from the total available time, while home production time is relatively constant. While Ramsay and Francis (2009) suggested that leisure time should be calculated by subtracting work time, school time and home production from the total available time. Due to these variations and considering the focus of 21 OECD countries, to keep consistency, we calculated leisure time by subtracting average worked hours and schooling hours from total hours in a year (see Formula 7).

$$l=365\times 24-(\text{average annual schooling hours})-(\text{average annual worked hours}) \tag{7}$$

The other independent variables, according to the theoretical framework, are total population L, fixed capital per capita $\hat{k}$, and average annual schooling hours u.

The variable $\hat{k}$ is computed as follows:

$$\hat{k}=\frac{\text{Gross fixed capital}}{(\text{Total population})\times(\text{average annual worked hours})} \tag{8}$$

In addition, u measured as average annual schooling time of the population over 25 years, is another control variable.

The summary statistics of all of the variables used in this study are reported in Table 1. *GDPpp* ranges from 1.78 to 47.22, and has a mean of 16.27; l ranges from 4,803.61 to 6,401.60 with a mean of 5,916.84 and a standard deviation of 296.96. And while L is varying from

364,100 to 316,000,000, and has a high standard deviation of 59,916,127. u is ranging from 432.72 to 1,509.96 and also has a high standard deviation of 218.52. $\hat{k}$ ranges from 0.32 to 11.22 with mean of 3.83 and a standard deviation of 1.97.

Table 1: Summary statistics

	GDPpp	*L*	$\hat{k}$	*u*	*l*
Mean	16.27	43,581,462	3.83	1,083.61	5,806.84
Maximum	47.22	3.16E+08	11.22	1,509.96	6,401.60
Minimum	1.78	364,100	0.32	432.72	4,803.61
Std. Dev.	7.13	59,916,127	1.97	218.52	296.96

5 Empirical analysis

This study uses a panel data test to explore the impact of leisure time on labor productivity. As a panel data set can contain both cross-sectional and time series dimensions, it can not only reflect the differences between subjects (cross-sectional), but also reflect the changes of subjects over time (time-series) (Chen, 2015). The regression equation is as follows:

$$GDPpp = \mathrm{a}_1 + \mathrm{a}_2 l + \mathrm{a}_3 L + \mathrm{a}_4 u + \mathrm{a}_5 \hat{k} + e_1 \tag{9}$$

Thus, the linear relationship between the independent variables and labor productivity exists only if a_i (i= 2…5) are obviously different from zero. For instance, if the coefficient of l on *GDPpp* is different from zero ($\mathrm{a}_2 \neq 0$), there is a linear relationship between l and *GDPpp*, and l has a significant effect on *GDPpp*.

As the theoretical model indicates a potential curvilinear relationship between leisure and labor productivity, we also examine this prediction. The curvilinear regression equation is given as follows:

$$GDPpp = \mathrm{b}_1 + \mathrm{b}_2 l + \mathrm{b}_3 l^2 + \mathrm{b}_4 L + \mathrm{b}_5 u + \mathrm{b}_6 \hat{k} + \varepsilon_1 \tag{10}$$

Here, Equation (10) indicates a curvilinear relationship between l and labor productivity if the coefficient of l^2 on *GDPpp* is obviously different from zero ($\mathrm{b}_3 \neq 0$).

Generally, three methods can be used to estimate panel data models: pooled OLS, the fixed-effects (FE) and the random-effects (RE) methods (Asteriou and Hall, 2013). Accordingly, three models are considered in this study: (a) a model with a common intercept, (b) a FE model, and (c) a RE model.

Table 2: The results of F-Test and Hausman specification test

A: The null hypothesis is that the RE model is more appropriate than the FE model	Hausman specification test	Test results	B: The null hypothesis is that the OLS is more appropriate than the FE model	F-statistic	Test results
GDPpp (Equation 9)	*chi2(3)*=14.19*** (p=0.003)	Fixed effects	*GDPpp* (Equation 9)	F=74.30*** (p=0.000)	Fixed effects
C: The null hypothesis is that the RE model is more appropriate than the FE model	Hausman specification test	Test results	D: The null hypothesis is that the OLS is more appropriate than the FE model	F-statistic	Test results
GDPpp (Equation 10)	*chi2(2)*=17.97*** (p=0.000)	Fixed effects	*GDPpp* (Equation 10)	F=79.59*** (p=0.000)	Fixed effects

Notes: *** Significant at the 1% level

The Hausman (1978) test can effectively determine whether the RE model is more appropriate than the FE model. The results of the Hausman specification test (Table 2, A and C) show that panel data regressions based on Equations (9) and (10) are positively significant at the 1% level for the dependent variable *GDPp*p. Therefore, the FE model is more appropriate for analyzing the dependent variable *GDPpp* in Equations (9) and (10). Note that after establishing that the FE model is more appropriate than the RE model, it is essential to use the F-test to examine whether the FE or OLS method can be used to perform the panel data regressions. As a result, the null hypothesis of the test is that holding all other things constant, the OLS method is appropriate. The F-test results in Table 2 (B and D) indicate that panel data regressions based on Equations (9) and (10) are positively significant at the 1% level for the dependent variable *GDPpp*, and reject the null hypothesis. Overall, these results indicate that the FE model is more appropriate for our data structure than the OLS or RE approaches.

The regression analyses are conducted using the Stata 12. However, in the estimation process, the disturbances are both heteroskedastic (Modified Wald test) and contemporaneously correlated (Breusch-Pagan LM test) across panels, with autocorrelation (Wooldridge test). In this condition, Stata provides two methods: panel-corrected standard error (PCSE) estimates and full feasible generalized least squares (FGLS) estimates. Beck and Katz (1995) argued that the full FGLS variance–covariance estimates are generally unacceptably optimistic (anti-conservative) when used for the analysis of data types of 10–40 periods per panel. They suggested that the Prais–Winsten estimates with PCSEs or OLS have closer nominal coverage probabilities. PCSE refers to heteroskedastic and cross panel contemporaneous correlation models, with or without autocorrelation.

In Table 3 we report the results for the two different estimation methods for Equations (9) and (10).

Table 3: Results of the panel data regression

Variables	Equation (9) FE	Equation (9) PCSE	Equation (10) FE	Equation (10) PCSE	Equation (11) PCSE
l	0.007*** (3.01)	0.010*** (14.47)	-0.062* (-2.01)	0.013* (1.66)	0.231*** (16.55)
l^2			6.20e-06** (2.18)	-1.92e-06** (-2.75)	-0.0000199*** (-16.36)
L	3.76e-08** (2.59)	1.18e-08*** (4.09)	3.74e-08*** (2.96)	9.57e-09*** (3.21)	
u	0.014*** (4.98)	0.020*** (16.13)	0.017*** (6.22)	0.021*** (16.71)	
$\hat{k}$	2.542*** (6.83)	1.421*** (14.28)	2.50*** (7.40)	1.408*** (14.16)	
Constant	-53.778*** (-3.32)	-68.510*** (-14.37)	136.786 (1.69)	-3.115 (-0.15)	-653.696*** (-16.49)
F or Wald statistic	*F*=142.62***	chi2(4)=715.89***	*F*=220.240***	chi2(5)=856.68***	chi2(2)=90.56***
R^2	0.828	0.930	0.816	0.933	0.156
Wald Test	chi2(21)=7569.52***		chi2(21)=5403.52***		
Wooldridge Test	*F*=186.02***		*F*=188.10***		
LM Test	Chibar2(01)= 1,359.52***		Chibar2(01)= 1,307.23***		
Number of observations	714	714	714	714	714
Number of countries	21	21	21	21	21

Notes: (1) Figures in parentheses are t-statistics (FE) and z-statistics (PCSE)
(2) *** Significant at the 1% level; ** significant at the 5% level; * significant at the 10% level
(3) Modified Wald test for group heteroskedasticity in FE regression model
(4) Wooldridge test for autocorrelation of panel data
(5) Breusch-Pagan LM test of independence

The results for Equation (9), presented in Table 3, show that the coefficient of l on *GDPpp* is obviously different from zero at the 1% level (z=14.47, $p \leq 0.001$), which indicates that l has a significantly positive effect on labor productivity. In other words, one percentage point increase in leisure time can raise labor productivity in terms of per capita per hour GDP by 0.01%.

Moreover, the total population L also has a significantly positive impact on *GDPpp* (z=4.09, $p \leq 0.001$), but the coefficient of L indicates that an increasing population has a weak influence on labor productivity. However, both education time u and fixed capital per capita per hour $\hat{k}$ have stronger positive effects on *GDPpp*, and one percentage point increase in u and $\hat{k}$ would lead to an increase in *GDPpp* by 0.02% and 1.421%, respectively.

Additionally, the results of the panel data regression for the effects of *l* and l^2 on labor productivity are also summarized in Table 3. The curvilinear relationship between *l* and *GDPpp* (labor productivity) exists only when the coefficients for both *l* and l^2 are statistically different from zero. The results for Equation (10) show that the coefficients of both *l* and l^2 are 0.013 and –1.92e–06 respectively, which are significantly different from zero. Specifically, the coefficient of *l* on *GDPpp* is positively significant at the 1% level (z=1.66, $p \leq 0.1$), while the coefficient of l^2 is negatively significant at the 5% level (z=–2.75, p<0.05). These results indicate that the relationship between *l* and *GDPpp* is an inverted U-shaped, which implies that there is an optimal point of *l* in relation to *GDPpp*.

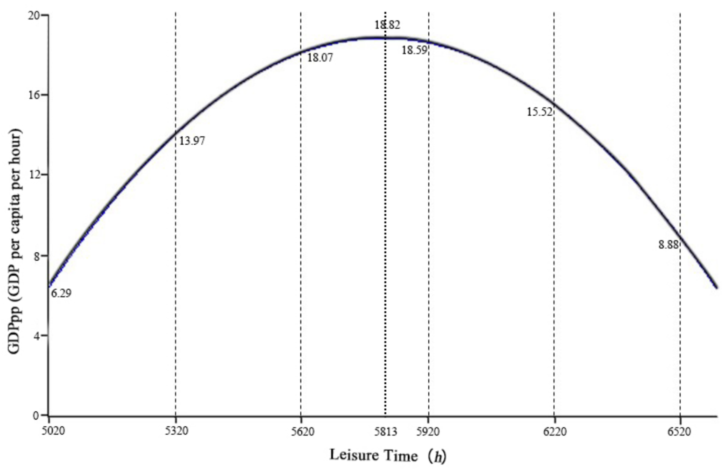
Figure 1 plots the inverted U-shaped relationship between *l* and *GDPpp*. *GDPpp* initially increases with *l*, but this positive effect reverses after *l* reaches the optimal level of leisure time. When *l* exceeds the optimal level, *GDPpp* begins to decline. The results of the regressions of *l* and l^2 on *GDPpp*, showed in last two columns of Table 3, give the curvilinear relationship between *l* and *GDPpp* as follows:

$$GDPpp = -653.6955 + 0.2313696 * l - 0.0000199 * l^2 \tag{11}$$

$$\frac{dGDPpp}{dl} = 0.2313696 - 2 * 0.0000199 * l = 0 \tag{12}$$

By using the derivative of the equation with respect to *l*, this study computes the value of *l* that maximizes *GDPpp* as in Equation (12), and the value of *l* that maximizes *GDPpp* is about 5813 hours.

Figure 1: Curvilinear Relationship between *l* and *GDPpp*



Notes: Figure 1 is a curve representing *l* and *GDPpp* based on Equation (11)

6 Discussion

Before discussing the results of our empirical test, we convert the results into a ranked list of countries to highlight the dual effect of leisure time on labor productivity and economic development.

The rankings include 21 countries that have been ranked separately by GDP, per capita GDP, per capita per hour GDP, and leisure time. According to Table 4, the country with the highest GDP is the United States, followed by Japan and Germany. The GDP of these three countries account for 60% of the total GDP of all OECD countries. It is interesting to examine whether a higher GDP always means higher per capita GDP and labor productivity. Table 4 reports

Table 4: Rankings of average GDP, per capita GDP, per capita per hour GDP (*GDPpp*), and leisure time of OECD countries in the 1980–2013 period.

Country	Ranking	GDP (billion dollars)	Ranking	per capita GDP (dollars)	Ranking	*GDPpp* (dollars)	Ranking	Leisure time (hours)
Australia	10	651.20	6	33,062.31	10	19.02	16	5,732.72
Belgium	13	367.30	11	31,276.98	7	19.85	9	6,048.63
Canada	7	1,076.50	5	33,645.06	9	19.27	15	5,765.84
Denmark	16	247.95	7	32,034.93	5	22.21	4	6,167.74
Finland	18	186.33	13	29,219.45	13	17.00	11	6,016.38
France	5	2,082.93	14	29,045.08	11	18.99	3	6,203.14
Germany	3	2,827.83	8	31,966.98	6	22.07	7	6,104.63
Greece	17	216.76	19	22,226.38	19	10.72	18	5,692.88
Italy	6	1,758.61	15	28,090.64	15	15.40	10	6,022.84
Japan	2	4,426.70	12	29,631.70	14	16.46	17	5,728.57
Korea	9	830.44	18	22,473.63	20	9.56	21	5,029.63
Luxembourg	21	33.79	1	61,427.67	1	37.39	12	5,964.70
Netherlands	11	642.10	4	35,672.75	3	25.30	6	6,124.22
New Zealand	20	103.85	17	23,599.54	17	13.11	19	5,640.28
Norway	15	283.23	2	44,290.79	2	30.77	8	6,074.86
Portugal	19	185.42	20	21,017.15	18	11.76	1	6,235.52
Spain	8	1,046.46	16	25,625.01	16	15.07	5	6,125.24
Sweden	14	361.64	9	31,733.53	8	19.57	13	5,947.36
Turkey	12	448.38	21	10,713.03	21	5.64	2	6,218.27
United Kingdom	4	2,213.60	10	31,683.66	12	18.81	14	5,927.38
United States	1	11,992.28	3	41,157.61	4	22.75	20	5,482.89

Note: Data are in constant 2005 U.S. dollars and computed with Comprehensive PPP (Purchasing Power Parity).

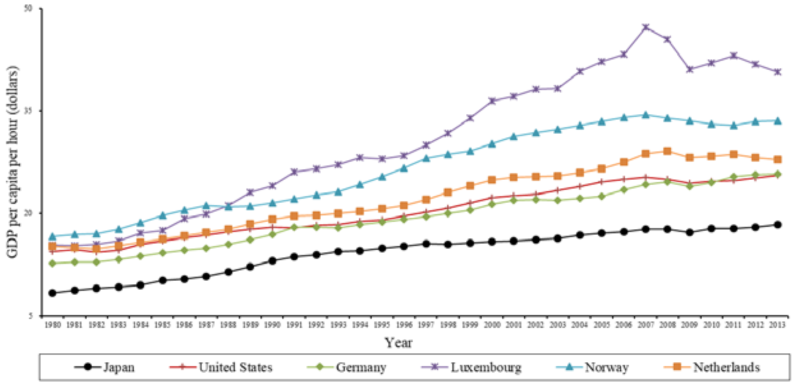
that United States and Germany are ranked 3rd and 8th in per capita GDP and 4th and 6th in labor productivity (per capita per hour GDP) respectively. However, Japan is ranked 12th in per capita GDP and 14th in labor productivity. Figure 2 also shows that the labor productivity of the top three GDP countries is far lower than that of Luxemburg, Norway and Netherlands.

The higher labor productivity can be increased by two types of processes: (1) working and learning process—"learning by doing" (Romer, 1986) and (2) allocating leisure time to improve production—"learning through leisure" (Wei *et al.*, 2016). Apparently, the process of learning by doing plays a crucial role in the improvement of labor productivity in the United States, Germany, and Japan. The education time in the United States is much higher than that of other countries (see Figure 3). The educational time in Germany has increased year by year since 1985, and the most striking increases were from 888.95 hours in 1985 to 991.02 hours in 1989 and from 1,177.34 hours in 2000 to 1,237.56 hours in 2002. This is mainly attributable to the educational reforms in Germany in 1970 and the end of 1990. For example, the comprehensive education program was issued in 1973. In the late of 1990s, Germany has established the e-learning research center throughout the country (Li and Yang, 2004). The increase of German education time has played a crucial role in the improvement of German labor productivity (Chen, 2016; Liu and Wang, 2005). For Japan, it has vigorously developed education after World War II, and the total investment in education has exceeded the proportion of gross national product and national income growth (Institute of Local Administration of the Empire, 1962). This has led to the rapid development of technology and economy in Japan (Liang, 1979; Lv, 2017).

Although the progress of science and technology caused by education has improved labor productivity in the United States and Japan, workaholics (Kuroda, 2010) still obtain relatively less leisure time (Table 4). The ranking of leisure time is No. 20 in United States and No. 17 in Japan (see Table 4), and in 2013, the average annual leisure time of the United States and the Japanese were 5,462 and 5,790 hours respectively, far lower than most other OECD countries (Figure 4). According to Figure 5, leisure may have positive effects on labor productivity (per capita per hour GDP), and the less leisure time, the lower labor productivity, which is consistent with the result of empirical analysis (see Table 3). Thus, the positive effect of leisure on labor productivity in United States and Japan is very small. Furthermore, the inability to leisure due to overtime work may lead to an additional reduction in work efficiency (Rau and Triemer, 2004).

In contrast, in some European countries, labor productivity (*GDPpp*) is ranked relatively higher than the GDP. For example, the top three countries in labor productivity are Luxembourg, Norway, and the Netherlands, even though their GDPs are not in the top 10 (Table 4). Moreover, Germany and Denmark also have the higher labor productivity, enjoy comparatively more leisure time. Why? It may be partly due to the accumulation of education time in northern European countries (see Figure 3), as higher human capital contributes to economic develop-

Figure 2: Comparison of *GDPpp* in six countries



Note: United States, Japan and Germany are the top three countries in the GDP, while Luxembourg, Norway and Netherlands are the top three countries in the *GDPpp*.

Figure 3: Comparison of education time in six countries

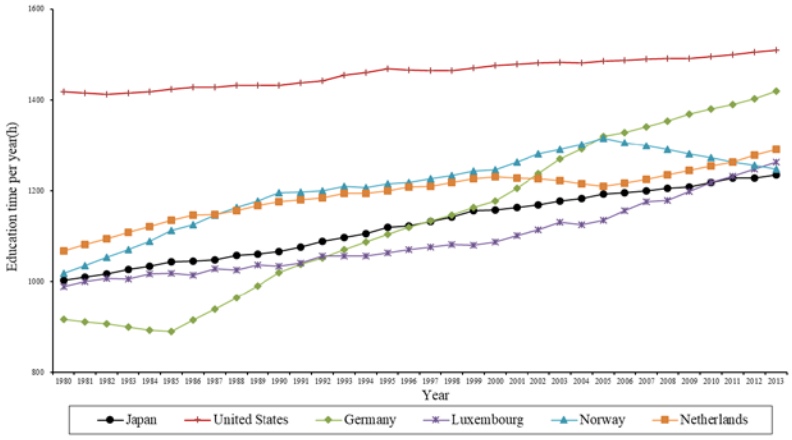


Figure 4: Comparison of leisure time in six countries

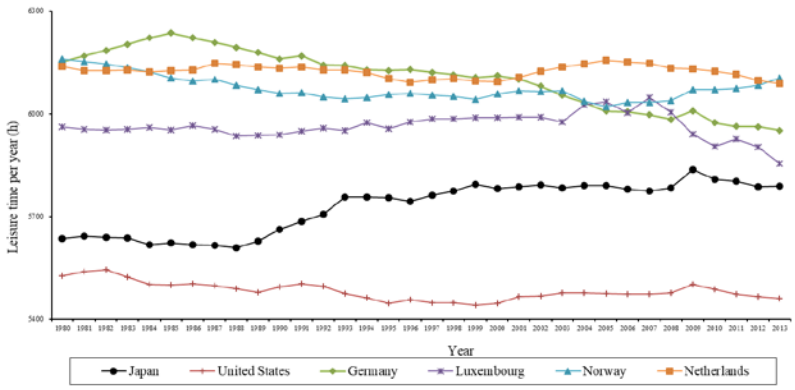
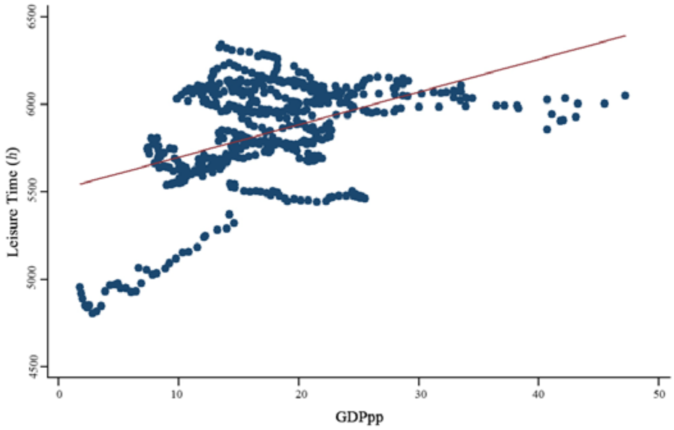
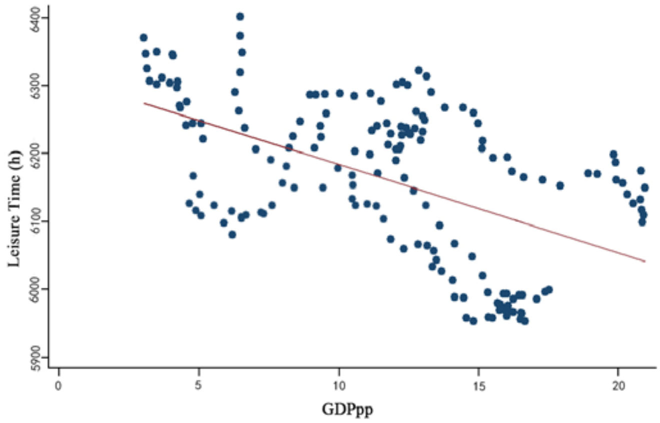


Figure 5: The correlation between leisure time and labor production in these 16 countries in 1980–2013



Note: the 16 countries are Luxembourg, Norway, Netherlands, United States, Denmark, Germany, Belgium, Sweden, Canada, Australia, United Kingdom, Finland, Japan, New Zealand, Greece, and Korea

Figure 6: The correlation between leisure time and labor production in these 5 countries in 1980–2013



Note: the 5 countries are France, Italy, Portugal, Spain, and Turkey

ment (Kazmi *et al.*, 2017; Lucas, 1988; Romer, 1990). However, based on our regression results (Table 3) and the correlation between leisure and labor productivity in Figure 5, we argue that may be the time they spend on trips and entertainment refreshes and recharges them, and thus improve their productivity. In other words, "learning by playing" increases labor productivity in these countries (see Figure 5).

However, as reported in Table 4 and in Figure 6, there are notable outliers, such as Portugal, Spain, Turkey, Italy and France suggesting that leisure time is not always positively related to labor productivity, and this is consistent with the results of the panel data regression (Table 3). The decline in productivity efficiency in these southern Europe countries may be due to two reasons. One is that the slower advancement of technology in these countries may reduce labor productivity at work. The other is that too much leisure time "crashes out" work time and leisure has a negative effect on labor productivity.

Additionally, according to Equation (11), the optimal value of l that maximizes *GDPpp* is about 5813 hours. These results have important political implications. Some of the OECD countries, such as Luxembourg (5,964.70 hours) and Sweden (5,947.36 hours), have leisure time that is around the optimal point, and these countries also have high labor productivity (*GDPpp*). In contrast, some other countries, such as Japan (5,728.57 hours), United States (5482.89 hours) and Korea (5,029.63 hours) with leisure time below the optimal value and hardly to obtain the beneficial effects of leisure time on labor productivity, they should increase people's leisure time to a level that is closer to the 5,813 hours level to optimize efficiency. However, it is obvious that too much leisure time may "crash out" work hours. For this reason, Portugal (6,235.52 hours), Turkey (6218.27 hours), France (6,203.14 hours), Spain (6,125.24 hours), and Italy (6,022.84 hours) should consider reducing leisure time to a level closer to the optimal point.

7 Conclusion

This study examines the impact of leisure time on labor productivity and the results confirmed the hypotheses in the theoretical part. The results of the panel data regression test indicate a curvilinear relationship between leisure time and labor productivity, implying that leisure time has a dual influence on labor productivity. When leisure time l reaches the optimal level (5,813 hours), leisure has a compensatory effect on work and can positively influence labor productivity in terms of per capita per hour GDP. Specifically, it shows that leisure time is positively related to labor productivity in some OECD countries. This is not consistent with the view of leisure time in neoclassical economics, but are in according with sociological perspectives on leisure time, which suggest that if activities engaged in during leisure time are positive and constructive (e.g. reading or mountain climbing, for instance), they benefit individuals' physical strength, willpower, and creativity (Barnett, 2006; Nimrod, 2007; Whiting and Hannam, 2015; Xie *et al.*, 2018).

But when leisure time l is far below the optimal level, the positive effect of leisure time on labor productivity is relatively small, or even almost zero. However, when leisure time l exceeds the optimal value, leisure time has a substitution effect on work hours and can negatively influence labor productivity. That is, as leisure time increases, work hours are "crashed out" and the accumulation of human capital is reduced, which leads to a decline in labor productivity.

Additionally, education time is also found to have a significant positive impact on labor productivity in terms of per capita per hour GDP. These findings are consistent with those reported in Barro and Lee (2001), Rukumnuaykit and Pholphirul (2016) and Hermannsson and

Lecca (2016). A higher average educational attainment indicates more skilled and productive workers, who in turn increase the output of goods and services in the economy.

The empirical results have important implications for policy makers. The positive effect of leisure time on work efficiency cannot be ignored, although work remains the central mechanism for distributing goods and benefits at the social and individual levels. However, as in all studies, our study had some limitations. Because of the non-availability of the data, this paper did not consider the impact of subjective feelings, and future studies can consider extending the theoretical model to increase subjective variables to further explore the impact of leisure on productivity from the sociological point of view. Additionally, it is worth noting this study's findings may not be applicable to non-OECD countries, especially considering the national differences in social and financial structures. Future studies can consider to extend this model to other countries. It would be interesting to examine the impact of leisure time on labor productivity in different contexts.

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