Morningness-evenigness pay gap in creative R&D jobs

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Abstract:

People differ from one another in their daily sleep and wake regimes. Various social norms, regulations and other institutional factors imply on the behaviour and equality of treatment of individuals with different morningness-eveningness patterns. We provide some insight on the existence of morningness-eveningness pay gap. We present fully observed recursive structural equation estimates as well as ordered probit regression estimates of the drivers of salary levels, based on data from our original repeated survey of Estonian creative R&D employees on a sample of 149 individuals from eleven entities. Employees of evening type appear to have a lower probability of getting higher levels of salary, compared to employees with no distinct morningness-eveningness profile. Simultaneously, we find support to a strong gender pay gap, with female employees having an average 13-15% lower probability of earning the higher levels of salary. Age is another strong determinant of the salary level.

Keywords: *pay gap, morningness-eveningness, working arrangements, R&D jobs, Estonia*
JEL codes: *O32, M50, D02, D63, J70*

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Background

Circadian rhythmicity or the alteration between sleep and wakefulness has a huge influence on human behaviour and physiological processes. For various known and hypothetical reasons, discussed in previous literature, people are different in their morningness-eveningness patterns. Many of those reasons are difficult to change for the individual. Statutory and company level working time regulations, operating times of entities, norms regarding the timing of events, as well as many other formal and informal institutions have an impact on the behaviour of individuals, regardless of their morningness-eveningness. This may give rise to morningness-eveningness driven inequality among people. Gender pay gap is a rather thoroughly investigated phenomenon of inequality that has attracted attention in both academic and public debate. Age has proved to be among other important determinants of the pay gap. Our paper is primarily concerned with the drivers of salary levels of creative R&D employees. Favourable and fair working conditions for R&D employees help to improve the use of their creative potential, supporting knowledge intensification in the economy at large. Morningness-eveningness related institutional aspects is a potentially promising path for exploratory research.

Data

The empirical analysis is based on data from our online electronic survey. The questionnaire comprised total 90 questions in the areas of organisation of work, work satisfaction, work results, sleepiness, sleep patterns, tiredness, health, and other socio-demographic information. The survey asked participants' name, gender, age, educational level, salary level and profession. Compilation of the sample was based on the 2012 Statistics Estonia data on R&D employees. Over 2010-2014, the number of creative R&D employees in Estonia in full time equivalent has ranged between 4,100 and 4,600, with the 5-year average of 4,400. We have excluded from the population those approximately 2,400 creative R&D employees who were working in the field of higher education as well as healthcare because teaching schedules at educational institutions and schedules of appointments and procedures at medical institutions significantly interfere with the working time and working place choices that our research is focused on. Also, we have excluded from the population the approximately 1,000 employees (in full time equivalent) working at microenterprises and research institutes with less than 15 creative R&D employees. We believe that working arrangements are substantially different at microentities compared to larger organisations. As a result of the above exclusions, the population of creative R&D employees of interest for our study totals approximately 1,000. That population represents total 23 employers including both private companies and public research institutes. We have proposed all these employers to take part in our study. Total 11 employers accepted to participate in the study – 8 in the first wave in Spring-Summer 2015, and further 3 employers joined for the identical second wave in Winter 2016. For the study presented in this paper, we have pooled the data from both waves of the survey, selecting randomly which of the recurring participants' response will be used for the analysis. Further eliminations from the unique participants' completed surveys were made to exclude contradictory and irrelevant responses. Our final sample of 149 employees whose responses to the survey were taken into account thus represents approximately 15% of the total population of one thousand (Table A1). We note that the employees in the population were not approached randomly but on a company basis. Individuals in the population had a possibility of being included in the sample only if their employer agreed to participate in the study. Moreover, completion of the survey by a respondent might incur some selection bias. We address the related selection biases to some extent by weighting of the sample to bring it into alignment with the population characteristics in terms of the respondent's gender and the employer's field of activity. In addition, we employ clustering of standard errors by employers in the econometric models to account for dependencies in clusters by employers.

Methodology

We employ the employee reported monthly gross salary as the dependent variable (Table A2). Selection of independent variables derives from our research hypotheses and control variables based on extant literature. Score of the Reduced Morningness-Eveningness Questionnaire (rMEQ, by Adan and Almirall, 1991) captures the type of the sleep regime of the employee. Age, gender, number of family members and educational level have been incorporated as key control variables of socio-demographic characteristics, and the health factor controls for the general health condition of the employee. The remaining explanatory variables reflect various aspects of the arrangement of work. Our starting point was Ordinary Least Squares (OLS) estimations where the 5-level Likert type scale dependent variable was estimated as continuous. Since our dependent variables are ordered discrete categories, we proceeded with ordered probit maximum likelihood estimations. The ordered probit estimations led to better descriptive power for the dependent variable with skewed and highly non-normal patterns of distribution (refer to Table A2 and Figure A6). A coupling selection mechanism arising from certain employees opting for flexible working time (cf *flextime*) and creativity intensive positions (cf *creatime*) led us to set up a three dimensional model with the salary level as the final stage dependent variable (refer to Figure A3). Our recursive Structural Equation Model (SEM) estimates the dependencies between the following two selection choices and work outcome. First, certain type of employees tend to select positions with a flexible working time option, while we expected flexibility in working time in turn to have a potential effect on the salary level. Second, many employees choose their positions based on creative work intensity (as opposed to administrative and other non-creative tasks), whereas salary level may in turn be impacted by the creativity intensity of work. In our fully observed recursive SEM model the simultaneous regression model is comprised of (1) monthly gross salary level as an ordered probit estimate of the main equation containing the two endogenous selection and mediator variables (*flextime* and *creatime*) as explanatory variables among others; (2) *flextime* as a probit estimation, and (3) *creatime* as an OLS estimation. Only the final stage regression is therefore structural. Standard errors have been adjusted for the 11 clusters based on employers (Table A1) to control for employer specific dependencies among the observations. We use the Stata14 cmp (Conditional Mixed Process) module for the estimations. The cmp module overall addresses Seemingly Unrelated Regressions (SUR) models, however it also fits for recursive SEM models like ours where all endogenous variables are observed. Our ongoing research on quantifying the effects of the morningness-eveningness pay gap will follow the line of methodology proposed by Bauer and Sinning (2008) in extending the Blinder-Oaxaca decomposition to nonlinear models.

Results

The monthly gross salary level variable (*salary*) was subjected to both ordered probit (Models 1 and 2) and SEM (Models 3 and 4) estimates, including (Models 2 and 4) and excluding (Models 1 and 3) the number of working hours as a potentially endogenous explanatory variable (Table A4). The models show qualitatively similar results in coefficient estimates and model fit. Gender is an important and statistically significant determinant of the salary level in all the models. Based on the analysis of average marginal effects, compared to a male colleague, a female employee has on average a 13% lower probability of earning a monthly gross salary of 3 to 5 thousand euros, i.e. the second highest salary level (while the small number of observations prohibited us doing the analysis for the highest gross salary level of over 5 thousand euros per month). A female creative R&D employee had on average a 15% lower probability of earning the third highest salary level (2 to 3 thousand euros per month) in comparison to males. At the lower salary levels (below 2 thousand euros per month) the results are the opposite, with females having average 15% higher probabilities of earning these in comparison to males. Age is another statistically significant driver of the salary level (refer to Figure A4). At higher salary levels (above 2 thousand euros per month) the effect is inverse-U-shaped, with younger and older employees having lower probabilities of earning higher salaries, compared to their middle-aged colleagues. The age effect on the salary level is stronger among male employees, especially at the above 3 thousand euros per month level. At lower salary levels age does not appear to have any strong impact. A novel and statistically significant result in all the models is the role that the employee's sleep regime has on his/her salary level. We find employees of evening type (rMEQ<11 – moderately to definitely evening type) to have a lower probability of getting salaries of above 3 thousand euros compared to employees with neither strongly morning nor evening type. At lower levels of salary, morningness-eveningness does not appear to have a significant impact. A small but interesting finding is that those who work as part of a team, which comprises mostly of non-R&D employees receive higher salaries. Other individual control variables like educational, family and health characteristics as well as the availability of flexibility in working time and working place arrangements do not appear significant drivers of salary level in creative R&D work. We find however that higher educational level is an important driver of selection into jobs with higher creativity intensity, and gender is a significant determinant of opting for jobs with the availability of fixed working schedules.

Discussion

We find morningness-eveningness to be a potential addition to sources of unfair pay gaps. This phenomenon may be due to the deeply rooted institutional framework of work arrangements, whereby employees present and actively contributing to work during the normal working hours are regarded as better performers. Another explanation can be the higher sacrifices in salary that the strongly evening and strongly morning type employees are ready to make due to their "abnormal" working and sleeping time preferences in order to meet the employers' and broader societal expectations. The sleep regime driven pay gap appears simultaneously with the gender pay gap, an expected result on our sample given that Estonia features the widest gender pay gap among the European Union countries. The age related pay gap is an expected result, in line with extant literature. We find that the flexible working time option functions as an important driver of job selection, particularly for men. In the post selection context, flexible working time has however no evident impact on the salary level. Jobs with higher creativity intensity attract more highly qualified creative employees, but higher creativity intensity itself has no impact on the employee's salary level. The above novel findings, particularly on the morningness-eveningness pay gap, are statistically significant but are based on a relatively small sample of 149 Estonian creative R&D employees. We also note that the employees in the population were not approached randomly but on a company basis. Individuals in the population had a possibility of being included in the sample only if their employer agreed to participate in the study. Moreover, completion of the survey by a respondent might incur some selection bias. We address the related selection biases to some extent by weighting of the sample to bring it into alignment with the population characteristics in terms of the respondent's gender and the employer's field of activity. In addition, we employ clustering of standard errors by employers in the models to account for dependencies in clusters by employers. However, some selection biases cannot be excluded. Similar studies on larger samples in different countries or on different professions would be an interesting path for expanding the topic in future research.

Acknowledgements

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Appendix: Tables and Figures

Table A1. Entities and employees in the sample

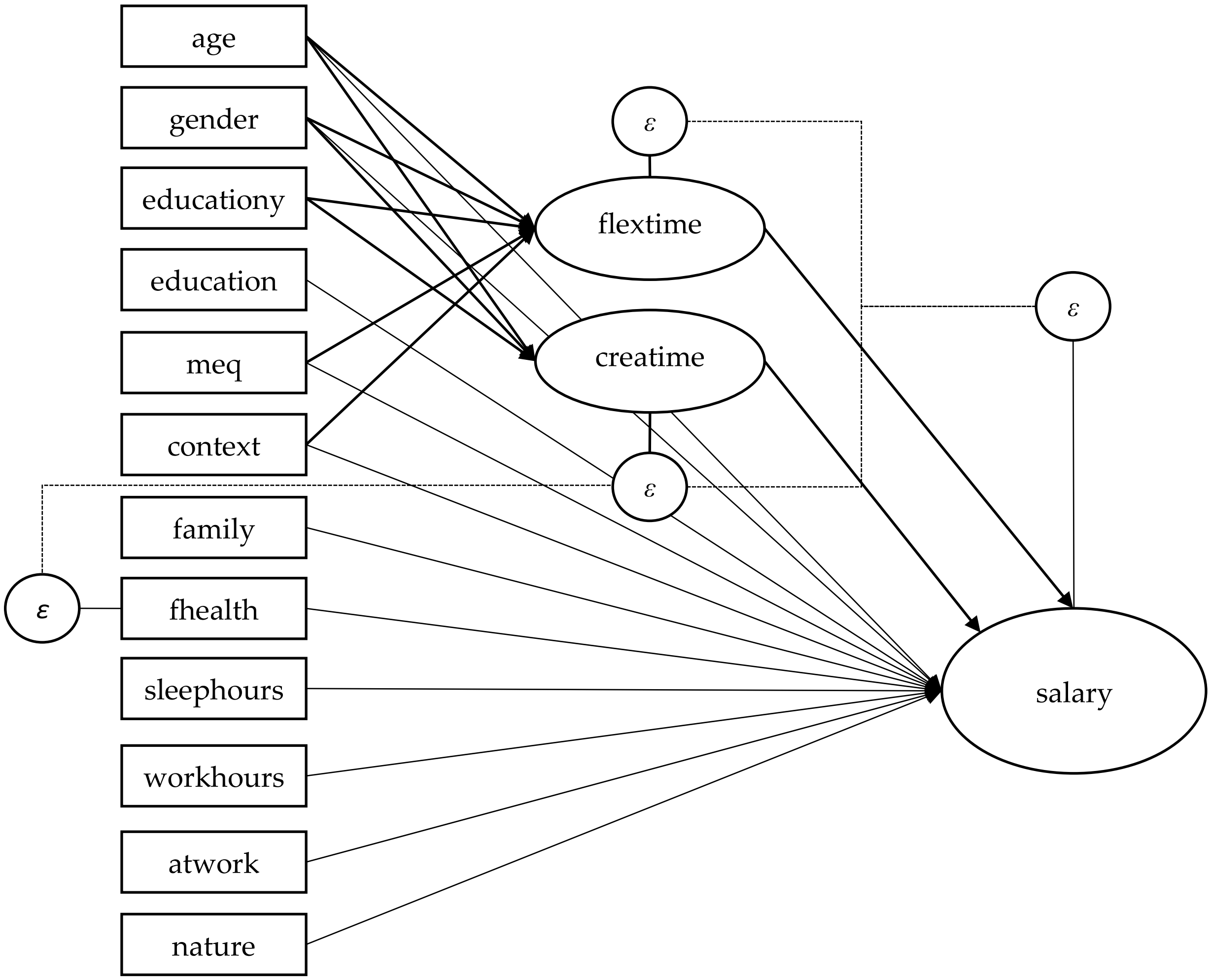
No	Sector	Industry	Response rate	Number of employees in the final sample	Percent
1	Private	Technology	21%	35	23.49%
2	Private	Banking	44%	27	18.12%
3	Private	IT	9%	20	13.42%
4	Public	R&D	18%	11	7.38%
5	Public	R&D	14%	10	6.71%
6	Public	R&D	13%	10	6.71%
7	Private	R&D	20%	9	6.04%
8	Private	Banking	50%	8	5.37%
9	Private	R&D	33%	8	5.37%
10	Private	Banking	27%	7	4.70%
11	Private	R&D	28%	4	2.68%
	Total			**149**	**100.00%**

Table A2. Model variables and description of the subjects *(mean and standard deviation shown for continuous and ordered variables; percentage of respondents shown for binary and categorical variables)*

Variable	Description	All: Mean/% (Std.Dev.)	Males: Mean/% (Std. Dev.)	Females: Mean/% (Std. Dev.)
	N	**149 (100%)**	**85 (57%)**	**64 (43%)**
Dependent				
salary	Employee reported monthly gross salary on the scale:			
	"Below 1000 euros" (=1, base)	7%	1%	14%
	"1000 - 2000 euros" (=2)	58%	59%	56%
	"2000 - 3000 euros" (=3)	23%	24%	23%
	"3000 - 5000 euros" (=4)	11%	15%	6%
	"above 5000 euros" (=5)	1%	1%	0%
Explanatory				
flextime	Flexible (=1) vs fixed (=0) working time arrangement of the employee	75%	82%	67%
creatime	Employee reported share of creative work in total working time of the employee (%)	52.71 (21.41)	52.05 (21.05)	53.59 (22.01)
age	Age in years	38.76 (11.51)	37.72 (12.19)	40.12 (10.48)
gender	Male (=1) vs female (=0)	57%	100%	100%
family	Employee reported number of people living together with the employee	1.66 (1.46)	1.72 (1.54)	1.58 (1.36)
educationy	Years of education starting from primary education	16.58 (2.66)	15.96 (2.85)	17.39 (2.14)

Variable	Description	All: Mean/% (Std.Dev.)	Males: Mean/% (Std. Dev.)	Females: Mean/% (Std. Dev.)
fhealth	General health condition factor (with overall Kaiser-Meyer-Olkin measure of sampling adequacy of the factor 0.6), comprising:	0.00 (0.81)	0.05 (0.81)	-0.07 (0.81)
	(1) "Do you have high blood pressure or have you ever used medicine for high blood pressure?" (yes=1)	20%	22%	18%
	(2) "Do you suffer or have you suffered from diseases that significantly affect your mental fatigue?" (5-level Likert type scale, "Never"=1, "Often"=5)	1.71 (0.95)	1.75 (0.97)	1.67 (0.93)
	(3) "Does your disease or injury interrupt you while doing your daily job?" (5-level Likert type scale, "No obstacles"=1, "Not able to work"=5)	1.58 (0.73)	1.57 (0.77)	1.58 (0.68)
	(4) "How many workdays have you been absent from work due to disease or medical examination in the past 12 months?"(5-level scale, "None" = 1, "100-365 days" = 5)	1.75 (0.72)	1.77 (0.69)	1.71 (0.76)
	(5) Body-Mass Index (continuous)	24.65 (3.90)	25.35 (3.11)	23.72 (4.61)
meq	rMEQ score, 1…25 scale ranging from "Definitely an evening type" to "Definitely a morning type"	14.73 (3.53)	14.98 (3.57)	14.39 (3.49)
sleephours	Employee reported average sleeping hours per day on the scale:			
	"Less than 6 hours" (base)	7%	6%	8%
	"6-7 hours" (=2)	50%	49%	50%
	"7-8 hours" (=3)	38%	39%	36%
	"8-9 hours" (=4)	6%	6%	6%
	"over 9 hours" (=5)	0%	0%	0%
workhours	Employee reported average working hours per working day	10.10 (1.67)	10.10 (1.44)	10.11 (1.95)
atwork	Employee reported share of working hours at the workplace out of total working hours per working day	0.82 (0.13)	0.81 (0.14)	0.84 (0.11)
context	"Work as part of a R&D team" (base)	78%	76%	80%
	"Work as part of a team, which comprises mostly of non-R&D employees" (=2)	16%	18%	14%
	"Individual employee in the R&D area" (=3)	6%	6%	6%
nature	"Permanent work" (base)	90%	92%	87%
	"Non-permanent work, with a duration of more than 1 year" (=2)	7%	5%	11%
	"Non-permanent work, with a duration of less than 1 year" (=3)	3%	3%	2%

Figure A3. SEM model path diagrams



Note: some explanatory variables in case of which a non-linear pattern was present are included in the models in both linear and squared terms, refer to Table A4.

Table A4. Ordered probit and SEM estimates of monthly gross salary level

Variable	Model 1: Ordered probit	Model 2: Ordered probit	Model 3: SEM	Model 4: SEM
Main equation				
Estimation			*oprobit*	*oprobit*
flextime (Yes=1)	0.078	0.095	0.013	-0.003
	(0.40)	(0.40)	(0.50)	(0.48)
creatime	0.003	0.003	0.007	0.006*
	(0.00)	(0.10)	(0.01)	(0.00)
gender (Male=1)	1.235***	1.251***	1.254***	1.240***
	(0.49)	(0.48)	(0.45)	(0.47)
age	0.311***	0.318***	0.315***	0.309***
	(0.10)	(0.10)	(0.10)	(0.10)
age^2	-0.003***	-0.003***	-0.004***	-0.003***
	(0.00)	(0.00)	(0.00)	(0.00)
meq	0.425*	0.451*	0.449*	0.425*
	(0.22)	(0.24)	(0.24)	(0.22)
meq^2	-0.014*	-0.015*	-0.014*	-0.014*
	(0.01)	(0.01)	(0.01)	(0.01)
family	0.056	0.057	0.057	0.056
	(0.09)	(0.09)	(0.09)	(0.09)
education=3	0.478	0.505	0.477	0.452
	(0.59)	(0.57)	(0.53)	(0.60)
education=4	0.154	0.196	0.163	0.123
	(0.35)	(0.32)	(0.29)	(0.36)
education=5	0.258	0.312	0.261	0.210
	(0.37)	(0.35)	(0.30)	(0.38)
education=6	-0.006	0.062	-0.022	-0.085
	(0.20)	(0.16)	(.)	(0.21)
Scores for factor fhealth	0.139	0.137	0.136	0.139
	(0.18)	(0.18)	(0.18)	(0.18)
sleephours	-0.096	-0.119	-0.119	-0.096
	(0.20)	(0.19)	(0.19)	(0.20)
atwork	1.106	1.083	1.081	1.105
	(1.10)	(1.08)	(1.07)	(1.09)
context=2	-0.340***	-0.325***	-0.349***	-0.364***
	(0.09)	(0.09)	(0.07)	(0.07)
context=3	-0.968***	-0.979***	-0.994***	-0.984***
	(0.37)	(0.35)	(0.36)	(0.38)
nature=2	-1.043***	-1.082***	-1.076***	-1.038***
	(0.34)	(0.34)	(0.34)	(0.34)
nature=3‡	-1.091**	-1.154**	-1.153**	-1.090**
	(0.52)	(0.51)	(0.50)	(0.52)
workhours		0.110*		0.041
		(0.06)		(0.06)

Variable	Model 1: Ordered probit	Model 2: Ordered probit	Model 3: SEM	Model 4: SEM
creatime, *Estimation*			*OLS*	*OLS*
age			0.087 (0.25)	0.087 (0.25)
gender (Male=1)			1.704 (3.77)	1.704 (3.77)
educationy			2.379*** (0.64)	2.379*** (0.64)
constant			11.435* (6.52)	11.435* (6.52)
flextime, *Estimation*			*probit*	*probit*
age			-0.016 (0.01)	-0.016 (0.01)
gender (Male=1)			0.543*** (0.19)	0.543*** (0.19)
educationy			0.069* (0.04)	0.069* (0.04)
meq			0.009 (0.03)	0.009 (0.03)
context=2			-0.854** (0.41)	-0.854** (0.41)
context=3			-0.664 (0.56)	-0.665 (0.56)
constant			-0.194 (0.59)	-0.195 (0.59)
cut_1_1, constant	9.583 (3.194)	9.520 (3.10)	9.579** (3.22)	9.651*** (3.22)
cut_1_2, constant	12.241 (3.41)	12.176 (3.32)	12.225*** (3.42)	12.301*** (3.43)
cut_1_3, constant	13.084 (3.49)	13.019 (3.40)	13.065*** (3.50)	13.141*** (3.52)
cut_1_4, constant	14.392 (3.44)	14.325 (3.35)	14.366*** (3.45)	14.446*** (3.47)
lnsig_3, constant			2.972*** (0.04)	2.972*** (0.04)
atanhrho_12, constant			0.028 (0.17)	0.029 (0.17)
atanhrho_13, constant			-0.076 (0.14)	-0.072*** (0.03)
atanhrho_23, constant			0.245** (0.12)	0.245** (0.12)
pseudo-log-likelihood	-125.07***	-125.22***	-873.07***	-872.93***
Number of obs	149	149	149	149

*Notes: Estimated coefficients with employee clustered standard errors below in parentheses, ‡ only 4 observations in this category, no contextual significance; * p<0.10, ** p<0.05, *** p<0.01; significance of pseudo-log-likelihoods is based on the Wald's chi²*

Figure A5. Probabilities of an employee getting a monthly gross salary of less than 1,000 euros (salary=1, left column), 2,000-3,000 euros (salary=3, middle column) or more than 3,000 euros (salary=4, right column) for different morningness-eveningness (meq) and age levels (adjusted estimates at means)

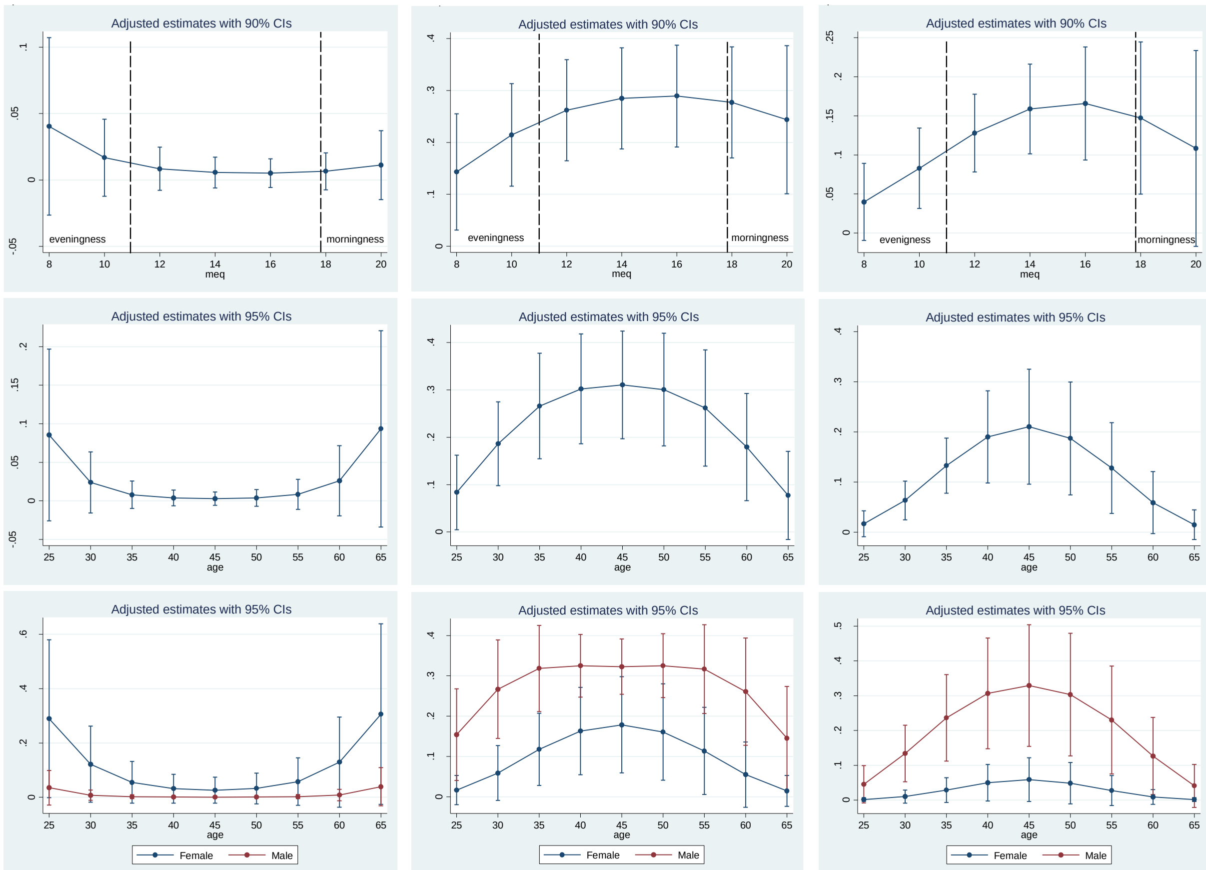


Figure A6. Histograms