Essays in behavioural economics

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Chapter 2

The Impact of the Menstrual Cycle and Hormonal Contraceptives on Competitiveness[1]

2.1 Introduction

Selection procedures for high paying jobs, promotions, and wage increases are often based on tournament-like competition which is believed to select the highest performers for the task at hand. A growing literature, however, demonstrates that there are individual differences in competitiveness that determine selection in and out of tournaments independently from performance. Some individuals simply seem to dislike being in competitive situations. The strongest evidence comes from the experimental literature on gender and competitiveness which finds that women tend to dislike competition while men actively seek it. The aim of this study is to determine whether the menstrual cycle and intake of hormonal contraceptives have an impact on the competitiveness of women. As both lead to predictable hormonal fluctuations, such an impact would be an indication that individual differences in competitiveness are at least partially caused by biological factors.

Most experimental studies on competitiveness have subjects perform a simple task whereby the compensation scheme is varied between a non-competitive piece rate and a competitive tournament scheme. Niederle and Vesterlund (2007) find that, when given a choice, 73 percent of men but only 35 percent of women opt to compete. Gneezy et al. (2003) moreover find that men significantly increase effort when the compensation scheme for a task becomes more competitive while

[1]The research in this chapter has been published in Buser (2011).

women show no reaction.[2] There is evidence that nurture can explain at least part of these gender differences. Gneezy et al. (2009) conduct the same compensation choice experiment with subjects from a patriarchal society (the Maasai of Tanzania) and subjects from a matrilineal society (the Khasi of India). While the Maasai exhibit the same gender gap in competitiveness found in Western societies, the roles are reversed in the Khasi sessions, though the authors explicitly mention the possibility that nature, as well as nurture, may play a role in this reversal. Further evidence comes from Cardenas et al. (2011) who find that gender differences in competitiveness vary across countries and may be correlated with gender stereotypes.

How much of a role nature plays in determining attitudes towards competition is still largely an open question. In a rare study on the impact of hormones, Apicella et al. (2011) find no effect of testosterone on tournament entry in men. But in other areas of economic behaviour, testosterone has been associated with lower offers and more rejections in the ultimatum game (Burnham, 2007; Zak et al., 2009), increased financial risk taking (Apicella et al., 2008), and the likelihood for MBA students to seek out a career in finance (Sapienza et al., 2009). Also, the hormone oxytocin increases giving in the trust game (Kosfeld et al., 2005) and the ultimatum game (Zak et al., 2007).[3] Zethraeus et al. (2009), on the other hand, find no impact of testosterone and oestrogen levels in a range of games measuring altruism, trust, fairness, and risk aversion.

The impact of the menstrual cycle on economic decision making has so far only been analysed in the context of sealed bid first-price auctions. Chen et al. (2009) find that bidding fluctuates over the menstrual cycle for users of hormonal contraceptives only. In a replication, Pearson and Schipper (2011b) also find significant, but partially contradictory, fluctuations. Since the first version of this study has been released, one other study concerned with the impact of the menstrual cycle on competitiveness has appeared (Wozniak et al., 2010). We will provide a more detailed discussion of these studies and a comparison of results in Section 2.5.

We hypothesise that competitiveness is related to fluctuations in female sex hormones and that it consequently fluctuates over the menstrual cycle and with contraceptive intake. Moreover, we expect competitiveness to fall when sex hormone levels are high and to rise when they are low. Such a finding would indicate that innate differences can explain a significant part of the gender gap in competitiveness. If the divergence between the competitive behaviour of men and women is due solely to nurture, on the other hand, we would expect to observe no effects.

Our results strongly confirm our hypotheses. Making use of the diverging patterns of oestrogen and progesterone secretion over the menstrual cycle, we also find that the fluctuations in competitiveness are most strongly correlated with fluctuations in progesterone levels. We consider three

[2] See Croson and Gneezy (2009) for a review of gender differences in lab and field experiments covering the areas of risk aversion, competitiveness, and social preferences.

[3] Fehr (2009) reviews further evidence of biological and other factors influencing trusting behaviour.

possible indirect pathways for the effect of the menstrual cycle and contraceptives on competitiveness: via an impact on risk aversion, via an impact on maths performance, and via an impact on overconfidence. None of these hold up to the data.

The next section of this chapter describes which variables we use to capture the relevant features of the menstrual cycle and of hormonal contraceptives. Section 2.3 provides further details about the experimental design, and Section 2.4 describes the sample. Section 2.5 presents the main results and Section 2.6 reports the findings regarding possible pathways. Section 2.7 concludes.

2.2 Measurement of menstrual cycle phases and hormonal contraceptives

The medical literature commonly divides the menstrual cycle into five phases across which the levels of female sex hormones fluctuate according to a predictable pattern (see e.g. Richardson, 1992).[4] These phases and the fluctuations of oestrogen and progesterone assuming a regular 28-day menstrual cycle are illustrated in Figure 2.1. Women using hormonal contraceptives are subject to a different 28-day cycle wherein a 21-day intake period, which is characterised by constant daily doses of an artificial oestrogen and an artificial progestin[5], is followed by a 7-day break. Oestrogen excretion by the body is markedly reduced in women taking hormonal contraceptives and progesterone excretion ceases almost completely (Rivera et al., 1999). This leads to a regular pattern whereby hormone levels are high during the 21-day intake period and low during the 7-day pill break.

We elicit the expected beginning of the next menstruation and use this to allocate subjects experiencing a natural cycle to one of the five cycle phases. Cycle length varies across individuals whereby the follicular phase is the most variable while the length of the ovulatory, luteal, and premenstrual phases is relatively fixed (Hampson and Young, 2008). Allocation between phases 2 to 4 should therefore be less affected by varying cycle lengths. Moreover, we ask subjects whether they are currently experiencing menstrual bleeding and use this to allocate subjects between phases 1 and 2. We also construct two continuous variables representing the expected oestrogen and progesterone levels given the day of the cycle a subject is currently in.[6] As the pill break coincides with the menstrual period for hormonal contraceptive takers, we define as pill break subjects those who are 20 or more days away from their next menstruation. This means that subjects are counted

[4] Levels of testosterone are virtually constant over the cycle.

[5] A progestin is a synthetic hormone that has effects similar to progesterone.

[6] The average daily plasma hormone levels over the menstrual cycle are obtained from Chabbert Buffet et al. (1998) and are illustrated in Figure 2.1. We did not take any direct hormone measurements.

Figure 2.1: Hormone Levels over the Menstrual Cycle

Hormone levels are obtained from Chabbert Buffet et al. (1998); oestrogen levels have been reduced by a factor of thirty.

as high-hormone from the day after they take the first pill of a new package and as on the break from the day after they take the last.

For our analyses using the whole pooled sample, we divide subjects into high-oestrogen and low-oestrogen, as well as high-progesterone and low-progesterone individuals. The high oestrogen phase corresponds to cycle phases two and four while the high progesterone phase coincides with the fourth phase. For subjects taking hormonal contraceptives, the high-oestrogen and high-progesterone phases are congruent and coincide with the pill-intake phase.

Using self-reported menstrual cycle data introduces measurement error. Women often misestimate their cycle length (Small et al., 2007) and cycle length tends to vary around the mean over time (Creinin et al., 2004). Moreover, while the follicular phase varies most with the length of the cycle, there is some variability in the length of other phases too (Stern and McClintock, 1998). As women estimate their cycle length correctly on average (Creinin et al., 2004), this leads to classical measurement error, introducing random noise which biases any of the estimated effects towards zero. Measurement error is less of a problem for our estimates based on the sample of contraceptive takers for whom a regular 28-day cycle is virtually guaranteed and whom are divided into only two groups. Also, the core of our analysis is not based on the five phases but divides the whole sample into a high and a low hormone group. The robustness checks reported in Section 2.5 confirm that these estimates are unlikely to be strongly affected by misallocations. Conversely, we expect that the division into five cycle phases and the constructed continuous hormone variables are the measures most affected by measurement error as an error of only a few days can change expected levels a lot. But it is also important to stress that we observe the same patterns irrespective of which indicator – cycle phase dummies, contraceptives, or daily levels and changes – we use.

2.3 Experimental design

The design of the competition part closely follows the methodology of Niederle and Vesterlund (2007). Subjects are divided into groups of four and are given 5 minutes to solve as many sums of five two-digit numbers as they can, a task for which no gender differences have been observed. In a first round, subjects receive a piece rate of 1€ for each correct answer. In a second round, they compete in a tournament where the highest performer of each group receives 4€ per correct answer while the rest receive nothing. Being informed about her absolute but not her relative performance, each subject then decides which of the two compensation schemes she wishes to apply in a third round. Subjects going for the tournament in round three receive 4€ per correct answer if they score higher than the best of their group mates did in round two. A random pick of one of the rounds is

relevant for payment. Finally, we elicit subjects' beliefs concerning their group rank for each task, paying 2€ for each correct guess.

To measure attitudes towards risk, we conducted a simple lottery choice experiment which follows the methodology of Eckel and Grossman (2002). Subjects make a single choice between a sure payoff of 8 Euros and four 50/50 lotteries with linearly increasing riskiness and expected payoffs: 12/6, 16/4, 20/2, 24/0. The choice of lottery then serves as an indicator of the risk aversion of the subject, yielding a discrete variable ranging from 1 (sure thing) to 5 (highest expected payoff/highest risk option).[7]

Our study is conducted on an all-female sample. Given that women compete against both sexes in the labour market, a mixed sample may seem more natural. On the other hand, there is a large literature showing that women react differently to men at different points of their cycle for reasons not exclusively linked to competitiveness. Women are, for example, more attracted to masculine features during the fertile part of the menstrual cycle (Penton-Voak and Perrett, 2000) and less when progesterone levels are high (Jones et al., 2005). Reactions to male body odour (Thornhill and Gangestad, 1999) and the likelihood of extra-pair copulations (Bellis and Baker, 1990) also vary over the cycle. The presence of male subjects would consequently introduce a confounding factor, making it less clear whether fluctuations in behaviour over the cycle can be interpreted as changes in underlying competitiveness, the main interest of this study.

Menstrual cycle details are sensitive information to ask and a female assistant was therefore present at all sessions and was responsible for all interactions with the subjects concerning the post-experimental questionnaire. In the end, selective non-response turned out not to be a problem as all subjects chose to answer the questions. Subjects were paid for one randomly selected part and received a fixed fee of €10.[8] Seven sessions were conducted at the CREED computer lab at the University of Amsterdam in June 2009 and the experiment was programmed and conducted with the software z-Tree (Fischbacher, 2007).

[7] We also measured risk attitudes through the methodology designed by Holt and Laury (2002). The two risk measures are highly correlated. But since the Holt-Laury measure is more complicated for subjects to grasp – leading some subjects to make inconsistent choices – we only use the results obtained with the Eckel-Grossman methodology in this study. Using the Holt-Laury measure instead or eliminating the subjects who made inconsistent decisions does not change any of our conclusions concerning risk attitudes.

[8] Apart from the competitiveness and risk parts, subjects also participated in a social preference and public goods part. The social preference games were all one-shot and sample sizes – with only half of the subjects being a giver and half a receiver – were therefore too small to be useful. The results of a follow-up study concentrating on social preferences are contained in the following two chapters.

Table 2.1: Descriptive Statistics

	Sample	Natural cycle	Pill takers
Age	23.2	24.0	22.5
Economics	42.1%	50.0%	34.0%
Female	100%	100%	100%
Nationality			
Dutch	47.7%	29.6%	66.0%
Other European	43.0%	57.4%	28.3%
Latin American	3.7%	3.7%	3.8%
Other	5.6%	9.3%	1.9%
N	107	54	53

The binary indicator Economics is equal to one for subjects majoring in economics, econometrics or finance.

2.4 Data

The sample consists of 120 female university students of which we have to drop 13 who state not to experience a menstrual cycle at all.[9] Of the remaining 107 subjects, 53 use hormonal contraceptives. Table 2.1 shows descriptive statistics including age, nationality, and study major. It is apparent that contraceptive takers and non-takers differ along most dimensions. This does not affect our results as we only compare high and low hormone subjects within each group.

Table 2.2 contains the actual and expected distribution of subjects across menstrual cycle phases and between the pill-intake and pill-break phases. Selective attrition due to menstruating subjects staying away is not a significant problem: a χ^2-test cannot reject equality of the observed distribution and the theoretical distribution (p=0.50). Only subjects in the premenstrual phase, in which premenstrual symptoms such as cramps can occur, are underrepresented. But this does not affect our conclusions as our regression results are robust to the exclusion of phase five subjects. There is no attrition problem for subjects using hormonal contraceptives: the number of subjects on the pill-break is exactly equal to the expected number.[10] We cannot reject the null hypothesis of subjects being randomly distributed across the different phases of the cycle with respect to their age (Kruskal-Wallis test: p=0.46) and nationality (Fisher's exact test: p=0.48). The same is true for users of hormonal contraceptives when it comes to assignment to the pill break (p=0.95 and p=1.00 respectively).

[9] Subjects gave a range of reasons for not experiencing a menstrual cycle including using intra-uterine devices (which completely suppress menstruation and make menstrual cycle assessment impossible), transsexuality and pregnancy.

[10] Neither do subjects on the pill break differ from subjects in the pill-intake phase in the characteristics of the contraceptives they take: Fisher's exact test returns a p-value of 0.99 with respect to progestin type and the Wilcoxon rank-sum test returns a p-value of 0.90 with respect to oestrogen dosage.

Table 2.2: Subjects by Menstrual Cycle Phase

Menstrual Cycle or Pill Cycle Phase	Number of Subjects	Expected Number of Subjects
Menstrual Phase (5 days)	11	10
Follicular Phase (7 days)	15	13
Peri-Ovulatory Phase (3 days)	9	6
Luteal Phase (8 days)	15	15
Premenstrual Phase (5 days)	4	10
Pill Break (7 days)	13	13
Pill Intake Phase (21 days)	40	40

2.5 Results

The proportion of subjects opting for competition in round three is 44.9 percent. If our hypotheses are correct we can expect competitiveness to vary across the five menstrual cycle phases. Also, we can expect competitiveness to be lower during the luteal phase when both progesterone and oestrogen levels are particularly high. Competitiveness should also be lower for subjects currently on the pill.

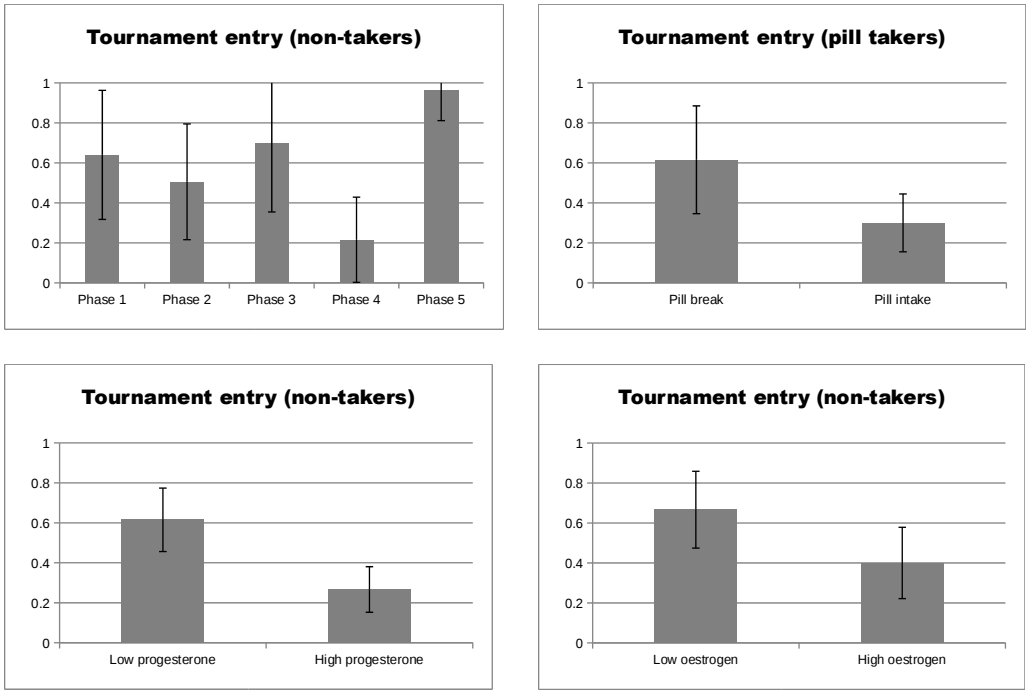
Tournament entry rates indeed vary significantly across cycle phases (ANCOVA with demographic controls[11]: p=0.03). Competitiveness is particularly low for subjects in the high-progesterone luteal phase (Wilcoxon rank-sum test: p=0.02) and is also lower in phases two and four combined, which represents the high-oestrogen period (p=0.05). Effects are equally strong for the sample of contraceptive users, who are significantly less competitive during the pill-intake phase (p=0.04).[12] Both samples approximately exhibit a doubling in the entry rate between the high to the low hormone phase. These results are illustrated in Figure 2.2.

Figure 2.3 and Table 2.3 show regression results for differences in competitiveness between the high and low hormone phases for the whole sample including pill takers and non-takers. We can see that tournament entry is about twice as high during the low progesterone phase than during the high progesterone phase with the difference between the low and high oestrogen phases being similarly large. These effects are robust to the inclusion of controls and significant at the 0.01-level throughout. As a robustness check, we ran the same regressions changing the lower and upper boundaries of the high progesterone, high oestrogen and pill-intake phases by up to three days in either direction. The hormone effects always stay significant and we conclude that the estimates are robust to cycle phase misallocations. The oestrogen results are also robust to the

[11] Demographic controls in all our analyses consist of age, educational background (as defined in Table 2.1), and nationality.

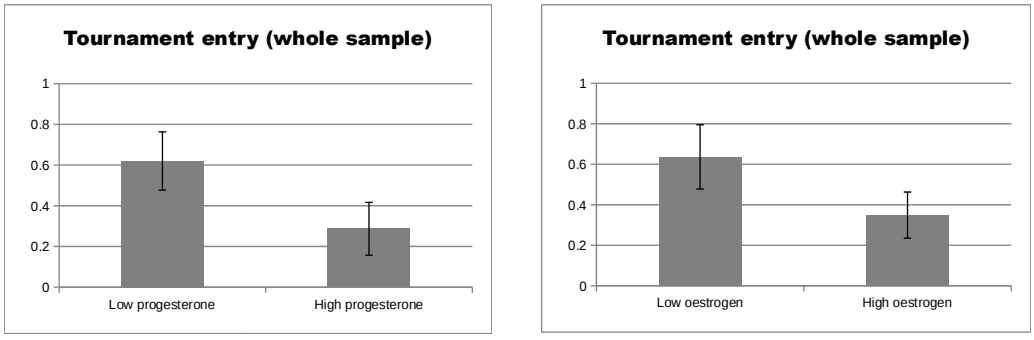
[12] The significance of this difference is confirmed by an ANCOVA model with demographic controls (p=0.04).

Figure 2.2: Hormones and Tournament Entry Rates for Pill Takers and Non-Takers (with 95%-confidence intervals)



All coefficients and 95%-confidence intervals are obtained from OLS regressions with robust standard errors. The phase-dummy regression controls for age, educational background, and nationality.

Figure 2.3: Hormones and Tournament Entry Rates for the Pooled Sample (with 95%-confidence intervals)



All coefficients and 95%-confidence intervals are obtained from OLS regressions with robust standard errors. The regressions control for a contraceptive taker dummy.

Table 2.3: Competitiveness Differences between High Hormone Subjects and Low Hormone Subjects

	(1)	(2)	(3)	(4)	(5)	(6)
Competitiveness						
High progesterone	-0.333***	-0.382***	-0.350***			
	(0.104)	(0.101)	(0.100)			
High oestrogen				-0.287***	-0.332***	-0.295***
				(0.101)	(0.099)	(0.099)
Contraceptive taker	0.018	0.100	0.135	-0.084	-0.007	0.036
	(0.104)	(0.099)	(0.091)	(0.096)	(0.097)	(0.091)
Risk aversion			0.087**			0.088**
			(0.036)			(0.036)
Performance			0.002			0.005
			(0.011)			(0.012)
Confidence			0.195**			0.182*
			(0.093)			(0.096)
Demographic Controls	no	yes	yes	no	yes	yes
Observations	107	107	107	107	107	107
R-squared	0.107	0.230	0.299	0.092	0.218	0.285

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; demographic controls consist of age, nationality, and study background; risk aversion is measured by the Eckel-Grossman scale, performance by the average performance of subjects in rounds one and two, and confidence by the belief to have been amongst the top two in one's group.

inclusion of phase 3 subjects in the high oestrogen group.[13]

So far, our results do not enable us to distinguish whether the fluctuations in competitiveness correlate more strongly with oestrogen levels or progesterone levels. Table 2.4 shows the results for linear probability models regressing tournament entry on daily expected oestrogen and progesterone levels and day-to-day changes for the sample of subjects experiencing a natural cycle. Columns (1) to (3) show that progesterone levels have a significant and negative impact while oestrogen levels are never significant. From Columns (4) to (6) we can see that day-to-day changes in progesterone levels are highly significant and negatively correlated with tournament entry while changes in oe-

[13]It is interesting to note that we find no impact of the menstrual cycle and contraceptives on the difference in arithmetic scores between round one (piece-rate) and round two (tournament) which, apart from learning effects, also incorporates the reaction of performance to the increase in the competitiveness of the compensation scheme. This is consistent with the finding of Niederle and Vesterlund (2007) that there is no gender gap in score improvement between rounds one and two.

strogen levels are marginally significant and negative as well. This means that competitiveness is lower when hormone levels are increasing and vice versa which explains the low levels of competitiveness during the luteal phase when progesterone is rising steeply and the high levels during the premenstrual phase when it decreases rapidly. This result is consistent with recent findings in endocrinology suggesting that changes in hormone concentrations might matter as much or more than levels in triggering hormone-induced processes.[14] The regression in Column (7) includes both levels and changes and confirms that competitiveness moves in step with progesterone (Wald test for joint significance of levels and changes: $p<<0.01$) rather than oestrogen ($p=0.28$).[15]

These results fit well with the wide variety of behavioural fluctuations over the menstrual cycle and the behavioural effects of progesterone documented in the medical literature.[16] They are also consistent with an evolutionary explanation according to which competitiveness is less desirable during the infertile phase of the menstrual cycle and during pregnancy (when hormone levels are high) than during the fertile phase (when competition for genetically well-endowed males is most important and hormone levels are low). The rush in progesterone occurring during the luteal phase signals the end of the fertile part of the menstrual cycle during which women are more likely to engage in extra-pair copulations (Bellis and Baker, 1990) and are more attracted to testosterone-related masculine facial features (Penton-Voak and Perrett, 2000). Jones et al. (2005) similarly show that women's commitment to their romantic relationship and attraction to femininity in male faces are positively and significantly correlated with progesterone levels.

Our findings are seemingly at odds with Wozniak et al. (2010) who report that women are more competitive during high hormone phases. But their design is very different as their subjects can choose between three options, adding a group scheme in which proceeds are shared equally. They find that participation in the group scheme is higher when hormones are low whereas tournament entry is higher during the high hormone phase. Piece-rate participation is actually slightly, if insignificantly, higher during the high phase too, which is in accordance with our results. It is impossible to know whether the subjects choosing the group scheme would have chosen the piece-rate or the tournament in our design and it is therefore difficult, if not impossible, to compare results. It is also unclear whether the group scheme is uncompetitive as subjects may feel compelled to live up to the expectations of the other group members or feel competitive pressure to perform better than them. Furthermore, entry into the group scheme might depend on factors such as altruism or a wish

[14] Kol and Homburg (2008), for example, propose that "changes in hormone concentrations carry significant biological messages, much more than a given level at a given time point".

[15] The results are robust to excluding premenstrual phase subjects. Given that premenstrual symptoms are hormone-driven, the under-representation of these subjects may cause bias. However, our main results carry through and our findings are therefore not an artifact of selective attrition of subjects in the fifth phase.

[16] de Wit et al. (2001), for example, find that exogenous administration of progesterone leads to feelings of sluggishness and a decrease in vigor.

Table 2.4: Natural Hormone Fluctuations and Competitiveness

Competitiveness	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Oestrogen (level)	0.004	0.005	0.004				0.003
	(0.009)	(0.009)	(0.010)				(0.008)
Progesterone (level)	-0.009*	-0.011***	-0.011**				-0.008**
	(0.005)	(0.004)	(0.005)				(0.004)
Oestrogen (change)				-0.015	-0.018*	-0.018*	-0.017
				(0.010)	(0.010)	(0.010)	(0.011)
Progesterone (change)				-0.034***	-0.042***	-0.042***	-0.036***
				(0.012)	(0.008)	(0.008)	(0.008)
Risk aversion			0.037			0.025	
			(0.059)			(0.053)	
Performance			0.005			0.016	
			(0.017)			(0.016)	
Confidence			0.039			-0.0570	
			(0.194)			(0.182)	
Demographic controls	no	yes	yes	no	yes	yes	yes
Observations	54	54	54	54	54	54	54
R-squared	0.054	0.209	0.220	0.111	0.283	0.303	0.319

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; demographic controls consist of age, nationality, and study background; risk aversion is measured by the Eckel-Grossman scale, performance by the average performance of subjects in rounds one and two, and confidence by the belief to have been amongst the top two in one's group.

to freeride which are unrelated to competitiveness and which may themselves be correlated with hormones. A further important design difference is that Wozniak et al. (2010) use a mixed gender sample. The remaining two experimental economics studies on the menstrual cycle look at bidding in first price auctions. Chen et al. (2009) find that contraceptive takers bid higher during and immediately after the pill break while there is no significant variation in bidding over the natural cycle. Pearson and Schipper (2011b) find that bidding is higher during the pre-menstrual and menstrual phases. Although both papers devote substantial space to discussing the differences in their results, it is worth pointing out that both find bidding to be higher during phases when hormone levels are low and which according to our results coincide with increased competitiveness.

2.6 Possible pathways

Our results show that the menstrual cycle and hormonal contraceptives have a significant impact on competitiveness. We will now investigate whether this effect is mediated by an impact on one of several possible determinants of competitiveness. We consider three possible pathways: via an impact on risk aversion, via an impact on mathematical abilities, and via an impact on overconfidence. None of these hypotheses hold up to the data.

2.6.1 Risk aversion

Datta Gupta et al. (2011) show that risk attitudes help determine women's competitiveness and there is a host of studies, including Eckel and Grossman (2002) and Powell and Ansic (1997), showing that women are more risk averse than men.[17] The regressions in Columns (3) and (6) of Table 2.3 show that an increase of one (on a five-point scale) in our risk taking indicator leads to an increase in the likelihood of competing of around nine percentage points. But neither the menstrual cycle phases nor hormonal contraceptives have a significant impact on risk aversion (ANCOVA with demographic controls; p=0.88 and p=0.18 respectively). However, pill takers are around one half of a standard deviation more risk averse during the intake phase and a doubling of the sample to n=106 would be enough to yield significance at the 5%-level. Future research on the effects of hormonal contraceptives on risk aversion seems therefore warranted. Chavanne and Gallup Jr (1998) and Bröder and Hohmann (2003) both study the impact of the menstrual cycle on risky behaviour and find a mid-cycle decrease. But these papers specifically look at behaviours which increase the risk of falling victim to rape and not at general risk attitudes. Also, risk aversion

[17] See Croson and Gneezy (2009) for a full survey of studies investigating gender differences in risk attitudes. The vast majority of surveyed papers find either that women are more risk averse than men or find no significant difference.

theoretically leads to higher bidding in first-price auctions and the findings of Chen et al. (2009) and Pearson and Schipper (2011b) are thus consistent with a negative impact of hormones on risk aversion. But these papers do not investigate directly whether the impact of the cycle on bidding is mediated via an impact on risk attitudes.

2.6.2 Mathematical ability

Average performance is 9.6 correct answers in round one and 11.5 in round two ($p<0.01$; one-sided t-test). We observe a further significant increase from the second to the third round even for those subjects choosing the piece rate ($p<0.01$), and it seems therefore more likely that the performance increase is due to learning effects than to a competition effect. The psychological literature has found some cognitive functions to vary over the menstrual cycle (Hampson and Kimura, 1992) and one could thus imagine that the same is true for the ability to solve sums. Diminished mathematical ability could obviously have a negative impact on subjects' readiness to compete. But a one-way ANCOVA model with demographic controls indicates that average mathematical performance shows no significant variation across the menstrual cycle phases ($p=0.75$) or between the pill-break and the pill-intake phase (p=0.21).[18] Moreover, absolute performance in rounds one and two, which is all the information subjects have at the moment of making their decision, has no impact on competitiveness. The regressions in Columns (3) and (6) of Table 2.3 show that the effect of the mean score from rounds one and two on the likelihood of competing in round three is both insignificant and negligibly small.[19]

2.6.3 Overconfidence

Niederle and Vesterlund (2007) find that confidence plays a significant but limited role in explaining whether an individual chooses to compete and that men are significantly more overconfident than women. Subjects are clearly overconfident: 67 percent believe to be amongst the top half of their group in round two and 41 percent of subjects overestimate their rank while only 21 percent underestimate it. We find some weak evidence that (over)confidence increases tournament entry. Subjects who overestimate their performance are 13 percent more likely to compete (one-sided

[18] Pill-takers do perform half a standard deviation worse during the pill intake phase though. A doubling of the sample is enough to yield significance at the 5%-level and an impact of hormonal contraceptives on performance can therefore not be rejected with confidence. We can still exclude an impact of contraceptives on maths scores as a possible pathway as performance has no effect on the likelihood of entering the tournament.

[19] Regressions without additional controls or with other measures of performance yield the same result. Scores from round two only and group ranks in rounds one and two are not significant in any specification when used to replace average performance. The same is true for dummies indicating an individual was the best or amongst the two best of her group.

t-test; p=0.10), but subjects who believe to be first – and who should therefore want to compete – are no more likely to enter the tournament than the rest (p=0.24). Subjects who believe to be amongst the two best in their group, however, are 16 percent more likely to compete (p=0.06). But conditional on performance neither the menstrual cycle phases (ANCOVA with controls; p=0.89) nor contraceptive intake (p=0.82) significantly affect the belief of subjects to be amongst the two best in their group.[20]

2.7 Conclusions

The labour market decisions of men and women are strikingly different, especially when it comes to the competitiveness of the chosen work environment. Simply put, men seem to actively seek competition while women tend to avoid it – a fact that is corroborated by several controlled experiments in the lab. Next to other explanations such as gender discrimination and conflicts between work and family life, this difference is likely one of the causes of the low number of women in top positions and the gender gap in wages.[21] It is therefore an important question whether these differences are purely a consequence of upbringing and education or whether biological differences between women and men play a role as well. Which policies we should adopt if we wish to tackle the gender imbalances in the labour market crucially depends on whether nature or nurture is at play.

Our results indicate that next to the cultural factors identified by Gneezy et al. (2009) amongst others, biological factors play a role in explaining gender differences in competitiveness. Multiplying the estimated coefficients for menstrual cycle phases two to five with their average duration, we find that women are 10.5 percentage points less likely to enter the tournament compared to a fictitious situation in which sex hormones are always at the low levels observed during the menstrual phase. And our regressions using daily expected hormone levels and changes indicate that the probability of entering the tournament is approximately fifty percent lower around day twenty of the menstrual cycle than during the menstrual phase. These back-of-the-envelope calculations indicate that the effect of hormones can account for a substantial part of the gender gap in competitiveness estimated by Niederle and Vesterlund (2007).

An interesting direction for future research could be to directly measure hormones by taking blood

[20] Using the belief of being first in one's group or overestimation of rank as an indicator does not affect results. Omitting the control for round two performance does not change results either.

[21] Using a dataset containing information on the five highest paid executives in large US corporations for the years 1992-97, Bertrand and Hallock (2001) find that the representation of women reaches a mere 2.5 percent. Also, the gender wage gap is increasing across the wages distribution Arulampalam et al. (2007) and is thus highest for those positions where competition is especially fierce.

or urine samples or to conduct a placebo-controlled trial. The literature on the effects of hormones on economic decision making has strongly focused on testosterone and to a lesser extent on oxytocin, cortisol and oestrogen. Our results suggest the possibility that progesterone could play an equally important role in explaining individual differences in competitiveness and possibly other areas of economic decision making as well. Further research into the exact mechanisms underlying the effects of hormones on competitiveness also seems warranted. This includes the open question of whether it is the preferences of individuals or rather their perceptions of competitive situations which are influenced by hormones.