DISCUSSION PAPER SERIES

IZA

IZA DP No. 7575

Testosterone and the Gender Wage Gap

Anne C. Gielen
Jessica Holmes
Caitlin Myers

August 2013

Forschungsinstitut
zur Zukunft der Arbeit
Institute for the Study
of Labor

Testosterone and the Gender Wage Gap

Anne C. Gielen
Erasmus University Rotterdam
and IZA

Jessica Holmes
Middlebury College

Caitlin Myers
Middlebury College
and IZA

Discussion Paper No. 7575
August 2013

IZA

P.O. Box 7240
53072 Bonn
Germany

Phone: +49-228-3894-0
Fax: +49-228-3894-180
E-mail: iza@iza.org

IZA Discussion Paper No. 7575
August 2013

ABSTRACT

Testosterone and the Gender Wage Gap*

Testosterone, which induces sexual differentiation of the male fetus, is believed to transfer from males to their littermates in placental mammals. Among humans, individuals with a male twin have been found to exhibit greater masculinization of sexually dimorphic attributes relative to those with a female twin. We therefore regard twinning as a plausible natural experiment to test the link between prenatal exposure to testosterone and labor market earnings. For men, the results suggest positive returns to testosterone exposure. For women, however, the results indicate that prenatal testosterone does not generate higher earnings and may even be associated with modest declines.

JEL Classification: J16, J31

Keywords: gender wage gap, twins, testosterone

Corresponding author:

Anne C. Gielen
Erasmus School of Economics
Erasmus University Rotterdam
PO Box 1738
3000 DR Rotterdam
The Netherlands
E-mail: Gielen@ese.eur.nl

* We gratefully acknowledge the helpful comments of Dan Hamermesh, Jeremy Ward, and seminar participants at the Swedish Institute for Social Research, Middlebury College, and 2013 annual meetings of the Society of Labor Economists. We also thank Middlebury College and Deutsche Forschungsgemeinschaft (DFG reference number GZ: GI 888/1-1 and AOBJ: 596610) for financial support.

There is reasonably strong evidence of taste differences between little girls and little boys that are not easy to attribute to socialization.

-- Lawrence Summers

Remarks at NBER Conference on Diversifying the Science and Engineering Workforce, January 14, 2005

I. Introduction

Gender gaps in labor market outcomes have occupied the attention of policymakers and academics for decades. Until recently, empirical analyses of the gender wage gap have focused largely on two broad and inter-related explanations: gender differences in human capital accumulation, and labor market discrimination against women (Altonji and Blank, 1999; Blau, 2012). Beginning roughly a decade ago, researchers began paying increasing attention to a third factor that may also contribute to the wage gap: gender differences in preferences and psychological attributes (Bertrand, 2010).

Evidence from laboratory and field experiments suggests that relative to men, women tend to be less aggressive (Maccoby and Jacklin, 1974; Bettencourt and Miller, 1996), more risk averse (Eckel and Grossman, 2008; Croson and Gneezy, 2009), and less attracted to and effective in competitive environments (Gneezy et al., 2003; Gneezy and Rustichini, 2004; Nierderle and Vesterlund, 2007; Flory et al., 2010; Buser et al., 2012; Ors, 2012). Whether these observed differences arise from nature or nurture—that is, whether they are explained by biology or socialization—remains controversial. Whether they influence real world economic outcomes like labor market earnings, moreover, remains largely untested due to the difficulty of obtaining appropriate data and devising a plausible research design to identify causal effects.

In this paper, we propose an innovative strategy for identifying a biological contribution to the gender wage gap. To the extent that biology plays a role in observed gender differences in labor market outcomes, one likely and frequently-discussed mechanism is prenatal exposure to testosterone, the principle androgen responsible for the physical sexual differentiation of the male fetus and one that also has been linked to sexually dimorphic psychological attributes including risk-preferences and levels of inhibition. To our knowledge, data do not exist that allow one to link a direct measure of prenatal testosterone exposure to labor market outcomes as an adult. However, we argue that opposite-sex twinning offers an observable and plausibly exogenous proxy. Studies of human twins suggest that, as with litter-bearing mammals, testosterone transfers in significant concentrations from a male twin to his female uterus mate, and females from opposite-sex pairs have been found to exhibit masculinized cognitive, behavioral and physiological attributes (Boklage, 1985; Cohen-Bendahan et al, 2004; Miller, 1994; Resnick et al, 1993; Vuoksimaa et al, 2010a; Vuoksimaa et al., 2010b). Though it has received comparably less attention, there is limited evidence of testosterone transfer between same-sex male twins as well (Galsworthy et al., 2000; van Hulle et al., 2004; Ho et al., 2005; Culbert et al., 2008; Peper et al., 2009, Cronqvist et al., 2013). We argue that twinning therefore presents a plausible natural experiment to measure the effect of heightened prenatal exposure to testosterone on labor market outcomes. We use administrative data from Statistics Netherlands that allow us to observe nearly eighty thousand twins born between 1959 and 1979. We then estimate the relationship between having a male twin and imputed hourly wages observed for men and women in administrative records in the year 2009.

If prenatal exposure to testosterone wires the brain in gendered ways, and if more masculine wiring plays a critical role in determining labor market outcomes, we should observe higher wages for individuals with a male twin than for those with a female twin. Moreover, this difference should be larger than any observed difference in earnings between opposite and same-sex singleton closely-spaced siblings, who are included in the sample to control for potential socialization effects. For males the results indicate that same-sex twins earn more than opposite-sex male twins, while there is little evidence of a comparable difference among singletons according to the gender of their sibling. The double difference estimate comparing these two effects suggests that same sex twinning leads to a 1.7 percent wage premium for males. The results fail to provide evidence of a similar premium for females with a male twin, and suggest that they may even suffer a modest wage penalty, though the estimates are imprecise.

II. Gender wage gaps and prenatal testosterone

Though gender gaps in wages narrowed over the last fifty years, substantial disparities persist. Across OECD countries, women earn on average 17 percent less than men, with the differential varying from less than 10 percent for Belgium to over 30 percent for Korea (OECD, 2008). The Netherlands, the setting for this study, has a gender wage gap of about 18 percent, similar both to the United States and the OECD average (OECD, 2008).

Numerous studies that rely on the human capital approach developed by Becker (1965) and Mincer (1974) have concluded that gender gaps in pay can in part be explained by differences in educational attainment, work experience, part-time status, occupational choice and household responsibilities (e.g., Mincer and Polacheck, 1974; Corcoran and Duncan, 1979; Polacheck, 1981; O'Neill, 2003; Blau and Kahn, 2006; Manning and Swaffield, 2008). The residual portion of the gap that cannot be explained by observable differences in human capital is often viewed as indirect evidence of labor market discrimination, though it may also reflect unobserved differences in human capital. Moreover, labor market discrimination may itself also influence choices about human capital attainment.

A meta-analysis by Weichselbaumer and Winter-Ebmer (2005) of more than 260 published studies in over 60 countries finds that between 1963 and 1997, the gender wage gap declined by an average rate of 1.2 percentage points annually. Most of the decline can be attributed to an increase in human capital among women; the unexplained residual remains roughly constant over the period of study. Focusing on the United States, Blau and Kahn (2006) report that the gender wage gap declined by an average of 1.6 percentage points annually between 1979 and 1989, but that the narrowing of the gap slowed in the 1990s to an average of 0.8 percentage points per year. The decelerated convergence in the 1990s is almost fully due to a slower narrowing of the unexplained residual, with the unexplained wage gap remaining stagnant at roughly nine percent during the nineties (Blau and Kahn, 2006; 2007). The relative stability of the unexplained portion of the gender wage gap may reflect persistent labor market discrimination, but it is also possible that it is explained by other omitted factors such as underlying time-invariant gender differences in personality, motivation and job preferences.

More recently, a better understanding of gender differences in personality and richer data sets have allowed researchers to incorporate measures of non-cognitive skills such as motivation, confidence, assertiveness and self-esteem as well as preferences for work/life balance into the wage equation. For example, using a survey of GMAT registrants, Grove, Hussey and Jetter (2011) find that gender differences in career tastes and non-cognitive attributes like assertiveness, confidence, leadership and sociability may explain an additional 25 percent of the wage gap. Similarly, studies by Mueller and Plug (2006) and Fortin (2008) find that gender differences in personality and work preferences as measured in psychological inventories help to explain gender differences in earnings. In this paper, we take the additional step of identifying a possible biological mechanism generating gender differences in personality and preferences and testing its effects on earnings for men and women.

The potential role of prenatal testosterone

Gonadal hormones play a key role in sexual differentiation of human fetuses (see, e.g., Baron-Cohen et al., 2004, upon which this description is based). Until the sixth week of gestation human fetuses are undifferentiated in terms of physical structure. At week six, the Y chromosome in male fetuses initiates testicular development, and at week eight the testes begin producing testosterone, which is the primary androgen responsible for male sexual differentiation. Between weeks 10 and 20 of fetal development, testosterone secretion remains high in the male fetus.[1] By contrast, the female fetus begins to develop ovaries around week seven, but these ovaries produce only low levels of estrogens. Instead, estrogens are primarily produced by the maternal placenta, and are present in similar levels for both males and female fetuses. As

[1] A second peak in testosterone production occurs during male adolescence.

a result, it is the production of testosterone that determines sexual phenotype. If testosterone is produced and the appropriate receptors are present and functioning, the male phenotype develops; if sufficient testosterone is not available, or if the receptors are not present or functioning, the female phenotype develops.

In addition to the role that testosterone plays in the development of sexually dimorphic physical characteristics, "brain organization theory" (a descriptor introduced by Jordan-Young, 2010) posits that prenatal exposure to testosterone permanently wires the brain with masculine or feminine patterns of preference, personality, and temperament. Mothers with high serum levels of testosterone while pregnant have been found to have offspring who display more typically masculine play and social behavior (Hines et al., 2002; Baron-Cohen et al., 2004; Chapman et al., 2006) and greater spatial abilities (Baron-Cohen et al., 2004). Researchers have also associated a lower second-to-fourth digit ratio (2D:4D), a common marker for greater prenatal exposure to testosterone, with increased aggression (Hampson et al., 2007), greater financial risk-taking in the laboratory (Dreber and Hoffman, 2007; Dreber and Hoffman, 2010; Garbarino et al., 2011), greater profitability in financial trades and longer careers in finance (Coates et al., 2009) and more managerial and entrepreneurial success (Guiso and Rustichini, 2010). Lombardo et al. (2012) find that fetal testosterone (measured in amniotic fluid) may influence the brain's reward system among adolescents, leading to greater responses to positive versus negative cues. In adult males, high circulating levels of testosterone have been associated with increased aggression and competitiveness (Carre and McCormick, 2008), greater risk-taking (Coates and Herbert, 2008), heightened status and dominance-seeking (Mazur and Booth, 1998; Burnham, 2007), a propensity to reject challenging offers in the ultimatum game (van den Burgh and Dewitte, 2006; Burnham, 2007) and a tendency towards entrepreneurship (White et al, 2006)

Due to the difficulty of measuring or manipulating human prenatal exposure to testosterone, a growing literature uses opposite-sex twinning as a readily-observable and plausibly random shock to prenatal testosterone exposure. There is substantial evidence among litter-bearing mammals that testosterone transfers from male fetuses to their littermates. Females who develop adjacent to males have been found to exhibit more masculine physiology and behaviors than those who do not (vom Saal, 1989; Breedlove, 1994; Ryan and Vandenbergh, 2002), and, male rodents who occupy intrauterine positions between two other males exhibit more masculinized sexual behavior than males who develop between two females (e.g., Clark, Tucker and Galef, 1998). This phenomenon likely applies to human opposite-sex twins as well. Testosterone is believed to transfer from a male fetus to his twin via the feto-fetal route (diffusing across amniotic membranes) and/or via the maternal-fetal route (crossing the placenta from the male fetus to the maternal circulatory system and then from the maternal circulatory system to a twin fetus) (Boklage, 1985; Baron-Cohen, 2004).

Studies of human twins demonstrate that females from opposite-sex pairs exhibit masculinized sexually dimorphic physiological traits including cranio-facial phenotype (Boklage, 1985), brain structure (Cohen-Bendahan et al., 2004) and auditory systems (McFadden, 1993) as well as higher birth weight (Glinianaia et al., 1998), greater visual acuity (Miller, 1994), a greater propensity for right-handedness (Vuoksimaa, 2010a), larger tooth size (Dempsey et al., 1999), and greater brain volume (Peper et al., 2009). Females with a twin brother have been found to have a lower 2D:4D ratio in two studies (van Anders et al., 2006; Voracek and Dressler, 2007), but not in a third (Medland et al., 2008).

Females from opposite-sex twin pairs also have been found to exhibit more masculine cognitive and behavioral attributes. For example, relative to females from same-sex twin pairs, female opposite-sex twins have been found to have improved spatial abilities (Vuoksimaa et al., 2010b; Heil et al., 2011) and less expressive vocabulary (Galsworthy et al., 2000; Van Hulle et al., 2004). They also have been found to exhibit greater levels of aggression (Cohen-Bendahan et al., 2005), rule-breaking (Loehlin and Martin, 2000) and sensation-seeking (Resnick et al., 1993; Slutske et al., 2011). These differences generally are attributed to the increased prenatal exposure to testosterone experienced by female opposite-sex twins.

Male same-sex twins presumably also have greater prenatal testosterone exposure than male opposite-sex twins due to the presence of a male uterus-mate, but this possibility has received comparably little attention in the empirical literature. Among the studies comparing male same and opposite-sex human twins, same-sex males have been found to exhibit masculinization of brain volume (Peper et al., 2009), autistic symptomatology (Ho et al., 2005), eating behaviors (Culbert et al., 2008), and vocabulary (Galsworthy et al., 2000; van Hulle et al., 2004).

To our knowledge, only one other study has attempted to examine the effect of having a male twin on economic outcomes outside the laboratory. Cronqvist et al. (2013) exploit a large sample of dizygotic Swedish twins for whom they can observe financial decisions. They find both male and females with a male twin invest more in risky financial assets than those with a female twin, while there is no observable effect of having an older male sibling.

III. Research Design

We treat twinning as a natural experiment in which an individual with a male twin is expected to have greater prenatal exposure to testosterone than an individual with a female twin. The identification of a causal effect of prenatal testosterone exposure on labor market outcomes rests on three assumptions: (1) that testosterone transfers from a male fetus to his twin, (2) that the sex of twin pairs is randomly assigned, and (3) that the sex of a twin sibling does not influence labor market outcomes via any mechanism other than testosterone transfer.

The first assumption, that testosterone transfers from a male twin to his uterus-mate, is well-supported by the empirical literature described in the previous section. We do not make the much stronger assumption that the transfer of testosterone actually has an effect on cognition or behavior as an adult. Though we have cited numerous studies in the previous section suggesting that this may be the case, some studies examining differences in same and opposite-sex male and female twins have found evidence of effects for one sex and not the other (e.g., McFadden, 1993; Resnick et al., 1993; Dempsey et al., 1999; Ho et al., 2005), leading Jordan-Young (2010) and Tapp et al. (2011) to conclude that the evidence that testosterone transfer in human twins masculinizes cognition and behavior is incomplete. This paper, therefore, can be seen as an additional (and novel) contribution to the literature on the effects of prenatal testosterone exposure on later life outcomes.

The second assumption is that the sex of a twin sibling is randomly assigned. Twins are either monozygotic—formed when a single zygote splits— or dizygotic—formed when two separate eggs are fertilized by two separate sperm.

The sex ratio of twins at birth varies from that for singletons only slightly (Fellman and Eriksson, 2010).[2] Among monozygotic twins, it has been found to be weighted toward females, which James (2010) hypothesizes may be associated with an anomaly in X-inactivation that causes XX zygotes to be slightly more likely to divide than XY zygotes.[3] While this means that a monozygotic twin is slightly more likely to have a sister (and be female herself) than a singleton, we have not found evidence in the literature to suggest that the process of monozygotic twinning is itself influenced by prenatal androgen levels.

For dizygotic twins, it is commonly assumed that the probabilities of males and females are independent and roughly equal. In fact, this assumption underlies Weinberg's differential method, which is commonly used to estimate the number of dizygotic twins in a population as twice the number of opposite sex twins. The use of this method as a rule-of-thumb is supported by Vlietnick et al. (1988) and Fellman and Eriksson (2006), who observe that it holds empirically. However, the underlying assumption that the probabilities of male and female births are independent and roughly equal may not to be correct, either for singletons or dizygotic twins.

The conventional belief about human sex ratios is that there are an equal number of X and Y sperm and each has an equal chance of fertilizing an egg, so that a human fetus has an equal probability of being male or female. A large number of studies have examined the human sex ratio and found that, in fact, it is slightly weighted towards males and is influenced, if only slightly, by a large

[2] Using data from Swedish birth registries for 1869-1967, Fellman and Eriksson (2010) report that the sex ratio (males per 100 females) at birth was 105.97 for singletons and 103.43 for twins.

[3] Using summary statistics reported in James (2010), the sex ratio (males per 100 females) for non-conjoined monozygotic twins was 94.2.

number of factors including race, season, and birth order (James, 1987; Jacobsen et al., 1999). James (2008; 2010) suggests that high levels of maternal testosterone and/or estrogen may lead to an increased probability of both male offspring and dizygotic twinning, and that, as a result, dizygotic twins tend to have a slightly elevated sex ratio compared to singletons. If true, this suggests that male fetuses may be exposed to higher maternal testosterone and/or estrogen levels than females. The testosterone effect does not pose a major obstacle to this paper's identification strategy as it simply provides another reason to expect that individuals with a male twin have greater testosterone exposure. However, James' hypothesis also suggests that individuals with a male twin could have greater exposure to maternal estrogen as well. To our knowledge, there has been little additional research on this hypothesis, and it has not been considered in the current literature on opposite-sex twinning. The use of a control sample of closely-spaced singletons, which we describe subsequently, helps to ameliorate this issue in so far as the sexes of singleton and twin pairs are influenced similarly by parental hormone concentrations.

The third assumption is that the sex of a twin sibling does not influence labor market outcomes in any way other than prenatal exposure to testosterone. A potential violation of this assumption that particularly concerns us is that socialization may vary with the gender of a sibling through sibling and/or parent interactions. To account for this possibility, we include a control group of "closely-spaced singletons" who are not twins but have a sibling born within 12 months of their birthdates. If we observed similar differentials for this group as for twins, we would conclude that they are likely the effect of socialization rather than biology. To the extent that any effects of sibling sex observed for twins are not mirrored in the closely-spaced singletons sample, we assume that they result from differences in prenatal testosterone exposure.

In using closely-spaced singletons as a control, we are making two additional assumptions: (1) that the sexes of singleton siblings are not correlated with prenatal androgens, and (2) that any gendered socialization effects are similar for twins and closely-spaced singletons. With regards to the first assumption, the discussion above pertaining to sex ratios suggests that it is reasonable to treat singleton sex ratios as exogenous to in-utero androgen exposure. One potential complication is presented by Maccoby et al. (1979), who provide evidence that testosterone levels are lower in babies born within four years of an older sibling's birth. Though we are not aware of additional studies evaluating this possibility, if true, then the second-born in the closely-spaced sibling pairs may experience reductions in prenatal testosterone. However, in the analysis section we demonstrate that the results are robust to using only first-born closely-spaced singletons. We regard the second assumption-- that any effects of sibling gender are similar for twins and closely-spaced singletons—as a stronger one. We discuss and explore this assumption further in a series of robustness checks in the results section, concluding that differential socialization between the twins and closely-spaced singletons does not appear to be an issue.

On a related note, because we cannot identify zygocity, we also must assume that any socialization effects are similar for monozygotic and dizygotic twins. This relates to a fundamental component of most twin studies, the reliance on the equal environments assumption (EEA); that is, that there are no systematic differences in the environments in which monozygotic and dizygotic twins are raised. EEA requires that monozygotic and dizygotic twins either experience similar postnatal environments, or if differences exist, those differences are irrelevant to the outcome/trait studied. In our case, we must assume that there are no environmental differences between monozygotic and dizygotic twins that affect labor market outcomes as adults.

While it is widely recognized that monozygotic and dizygotic twins may be socialized differently as children (e.g., monozygotic twins tend to have more similar social environments and co-identify more strongly than dizygotic twins), many behavior geneticists find support for EEA among various traits and outcomes (e.g., Ericsson et al, 2006; Hettema et al, 1995; Kendler et al., 1994; Loehlin and Nichols, 1976; Matheny et al, 1976; Scarr and Carter-Saltzman, 1979). Perhaps most relevant to this analysis is the Netherlands study by Derks et al. (2006) which shows no detectable difference in aggression or spatial ability between monozygotic and dizygotic twins.

IV. Data

Twin studies are commonly employed by researchers seeking to identify the relative importance of genetic and environmental influences. Many of these studies utilize data from one of several well-known twin registries such as the Swedish Twins Registry and Minnesota Twins Registry. Existing registries, however, are inappropriate for our purposes because they collect information only from monozygotic twins—who by definition cannot be opposite sex—or contain dizygotic twins but do not contain measures of earnings, or have very small sample sizes. Moreover, twin registries do not include closely-spaced singletons in their scope. Instead of using a twin registry, we compile data from several large databases from the Netherlands that allow us to identify a large sample of twins and closely-spaced singletons and link them with economic outcomes.

Identifying Dutch twins

Statistics Netherlands (*Centraal Bureau voor de Statistiek*) maintains administrative data on households, persons, and jobs covering all registered inhabitants of the Netherlands.[4] Individuals appearing in various data sets can be matched by a Random Identification Number (RIN), a coded Dutch equivalent of the U.S. Social Security number. To compile data on twins and labor market outcomes, we begin with the 1995-2010 Municipal Population Parent-Child Dataset (*Gemeentelijke BasisAdministratie Ouder-Kind* or GBA-OK), which is based on data from municipal registries. This dataset links individuals to any living parent appearing in one of the municipal records in the Netherlands (in the same or a different household as the child) at any point between 1995 and 2010. The GBA-OK file contains 14,602,884 individuals who could be linked to at least one living parent between 1995 and 2010.[5] Beginning with this file, we first drop individuals whose RIN number is coded as missing by Statistics Netherlands (n=62,123). Next, we match individuals to any siblings based on the RIN number of the mother, dropping individuals whose mother cannot be identified (n=1,167,317) or who are coded as having more than 15 siblings via either parent (n=8,751).

[4] These data can be accessed via a remote-access computer after a confidentiality statement has been signed.

[5] The total Dutch population in 2010 was approximately 16,574, 989 (Statistics Netherlands, 2012). Of this number, 9 percent were first generation immigrants, many (but not all) of whom would not have identifiable parents living in the Netherlands (Statistics Netherlands, 2012). Combined with the fact that other individuals lost parents to emigration or death prior to 1995, it seems reasonable that the sample size is about 88 percent of the total population.

We obtain demographic characteristics for the individuals in this dataset by matching to the Municipal Population dataset (*Gemeentelijke BasisAdministratie* or GBA), which contains information on all residents of the Netherlands recorded in municipal registry updates. This database includes information on each person's month and year of birth, marital status, number of children, race, and place of residence, and the identification numbers of other household members. We drop individuals with a missing birthdate or nativity (n=2,144). Using the month and year of each sibling's birth, we then identify twins as siblings sharing the same month and year of birth and closely-spaced singletons as singletons with a sibling born within 12 months of their own birthdate. Finally, we keep only individuals born between 1959 and 1979 (inclusive), who were aged 30-50 in 2009. This results in the deletion of 8,923,928 observations, leaving us with a sample of 4,438,621 individuals aged 30-50 in 2009. [6]

Table 1 describes the frequency of different family structures. Of the 4.4 million individuals in the sample, 86,822 (2.0 percent) are twins. This is consistent with the incidence of twinning in the Netherlands, where 2.2 percent (101,262) of babies born between 1959 and 1979 were twins.[7] We drop higher-order multiples, only children, and singletons with a sibling born more than 12 months before or after. The remaining sample is composed of twins and singletons born within 12 months of another sibling, who we refer to as "closely-spaced singletons," or "CSS" in the tables.

[6] We selected this age range because we were seeking a sample of working-age individuals who are likely to have completed their education and who also are young enough that we can identify at least one living parent. In addition, the 1979 cohort cut-off avoids the inclusion of twins born after the diffusion of assisted reproductive technologies. The results are not sensitive to expanding the age range to 22 to 65.

[7] Authors' calculation based on natality figures by type of confinement available at Statistics Netherlands (2012).

A twin or closely-spaced singleton is referred to as "same sex" if his or her sibling is of the same sex, and "opposite sex" if the reverse is true. A small fraction (3.4 percent) of twins and closely-spaced singletons have one or more additional siblings born within a year of their birth, meaning that there are three or more closely-spaced children in the family. For example, an individual could be identified as being a closely-spaced singleton based on having a sibling born 11 months later, but might also have a sibling born 11 months before. To avoid the complications inherent in classifying these individuals as "same" or "opposite-sex" siblings, we drop them from the sample.

The first column of Table 2 presents the frequency of same and opposite-sex sibling pairs in the remaining sample. Of the closely-spaced siblings, 50.1 percent are same-sex pairs, and 49.9 percent are opposite-sex pairs, which is as expected given that the sex ratio in the Netherlands for individuals aged 30 to 50 is approximately unity.[8] Of the twins, 68.3 percent are same sex pairs while 31.7 percent are opposite-sex pairs. This is again roughly the expected ratio. Natality records indicate that in the years these cohorts were born, 68.3 percent of twins born in the Netherlands were same-sex (34.8 percent boy-boy and 33.6 percent girl-girl) while 31.7 percent were opposite-sex.[9] Using Weinberg's differential method (which we discussed in the previous section), this suggests that 63.3 percent of the sample is dizygotic while 36.7 is monozygotic, though we do not have information on genetic testing that would allow us to identify zygocity for the same-sex twins. As mentioned earlier, this could present a potential

[8] Using population counts by sex and age in 2009 available online at Statistics Netherlands, the male/female sex ratio for individuals aged 30-50 was 1.01.

[9] Authors' calculation based on natality figures by type of confinement available at Statistics Netherlands (2012).

empirical issue if the socialization of MZ twins is different than DZ twins in ways related to labor market outcomes, but no such evidence exists.

Employment data

Statistics Netherlands also provided us with administrative data on all individuals in the Netherlands who are employed by firms. These data are based on the 2009 tax and social insurance records (*Loonaangifte*).[10] This dataset provides information on annual earnings and annual hours worked, type of contract, firm size, and industry sector.[11] Of the 229,860 individuals in the sample, 168,581 are observed in these employment records. The remaining individuals either are not employed (unemployed or out of the labor force) or are self-employed. For the 168,581 individuals employed by firms, we impute an hourly wage as total annual earnings divided by total annual hours.[12] We drop 2,997 individuals who have imputed hourly wages that are less than the minimum wage in the Netherlands in 2009 leaving 165,584 individuals with observable labor market outcomes. The distribution of twins and closely-spaced siblings in this sample, which is the one used in the analysis in the next section, is summarized in the right-hand panel of Table 2. We observe earnings for 72 percent of the sample present in the GBA, which is similar to the fraction of the

[10] We also have access to employment data for 2006. The results are substantially the same using these data.

[11] Two variables describe the type of contract an employee works under. The first is an indicator for the contract is "permanent," which means that it has no fixed end date. The second variable is "part-time," which means that the worker works fewer hours than the full time week as determined by that firm's collective wage agreement. In the Netherlands, full-time status is commonly defined in these agreements as either 36 or 40 hours per week. Firm size is coded as a categorical variable with five categories: 0-9 employees, 10-49 employees, 50-99 employees, 100-499 employees and 500 or more employees. Industry is coded at a categorical variable with five categories: agriculture, forestry and fishing; manufacturing; commercial services, which include transportation services, restaurants, banks, and insurance companies; services provided to firms only; and all other services.

[12] We exclude overtime pay and overtime hours when imputing the hourly wage. The results are not sensitive to including them.

Dutch population aged 30-50 that Statistics Netherlands reports is employed by firms.[13]

Descriptive statistics

Table 3 summarizes the demographic and employment characteristics of the samples of males and females used in the analysis. Age, marital status, presence of household children, part-time status, and type of contract are similar for the twins and closely-spaced singletons of each gender. However, closely-spaced singletons are considerably less likely to be citizens of the Netherlands than members of the twins sample. If socialization effects are different for children who immigrated or were born to immigrants, then this could raise concerns about the use of closely-spaced siblings as a control. We consider this issue further in the following section, and demonstrate that the results are robust to restricting the sample to Dutch citizens.

V. Results

To identify and measure the effect of having a male twin, we estimate the following specification separately for men and women in a sample composed of twins and closely-spaced singletons:

$$(1)\ y_i = \alpha_0 + \alpha_1 twin_i + \alpha_2 OS_i + \lambda(twin_i \times OS_i) + \boldsymbol{Z_i \delta} + \varepsilon_i.$$

[13] Authors' calculation based on figures available at Statistics Netherlands (2012) indicate that 74 percent of residents of that country aged 30-50 were employed by firms in 2009.

The dependent variable in most models is the log imputed hourly wage of person *i*, where the imputation is based on the ratio of annual earnings to annual hours worked. We also present results using log annual earnings as the outcome. On the right-hand-side, $twin_i$ indicates that the individual is a twin, OS_i indicates that the individual is from an opposite-sex sibling pair, and ($OS_i \times Twin_i$) is an interaction between these two indicator variables. This is a standard differences-in-differences model in which the average difference in the wages of opposite and same-sex twins, estimated separately for men and women, is $\mathrm{D}_{twins} = \propto_2 + \lambda$, and the average difference in the wages of opposite and same-sex closely-spaced singletons is $\mathrm{D}_{CSS} = \propto_2$. The double difference is $\mathrm{DD} = \lambda$, the differences in average wages for opposite and same-sex twins relative to that for closely-spaced singletons.

The vector $\boldsymbol{Z}_i$ contains control variables that vary across regression models. We estimate the model without any controls, with controls for age and its square, and with additional controls for marital status, the presence of children at home, nativity, part-time status, type of contract (permanent versus fixed-term), firm size, and industry sector fixed effects.[14] A potential concern is that any variables in this last set of controls may themselves be influenced by prenatal testosterone exposure, and hence represent what Angrist and Pischke (2009) dub "bad controls." However, the results of interest prove to be similar whether these variables are included or excluded.[15]

[14] Unfortunately, the data do not contain information on occupation or educational attainment. Any observed relationship between twinning and wages could be partially explained by the influence of prenatal testosterone on these two outcomes, but we will be unable to investigate this possibility.

[15] We also estimated double difference linear probability models predicting each of the outcomes in the set of the controls as a function of being a twin, having an opposite sex sibling, and their interactions. These outcomes do not appear to be strongly correlated with opposite-sex twinning. These results are available upon request.

Panel A of Table 4 presents the estimated coefficients and single and double differences based on the sample of female twins and closely-spaced singletons. The standard errors are clustered at the sibling-pair level. The coefficients in Column 1 indicate that opposite-sex female twins earn 1.2 percent less (p=0.006) than same-sex female twins. However, the point estimates indicate that opposite-sex female singletons also earn 0.4 percent less (p=0.202) than same-sex female singletons, suggesting that some of the estimated difference for twins may be explained by socialization effects. The estimated double difference effect of opposite sex twinning is a statistically insignificant 0.8 percent wage reduction (p=0.159). The results in Model 2, which includes controls for age and its square, are similar. Female opposite-sex twins are estimated to earn 1.3 percent less than same-sex twins (p=0.005), but female opposite-sex closely-spaced singletons also earn less than same-sex singletons (difference=-0.004, p=0.201), The double difference estimate is a 0.8 percent wage reduction (p=0.141). This double difference estimate also is similar when we add the full set of additional controls (Column 3) and if the outcome is log annual earnings rather than the log imputed hourly wage (Columns 4-6). The results, therefore, do not support the hypothesis that prenatal testosterone exposure increases labor market earnings for women, and in fact suggest that it may even lead to slight decreases, though the estimates are imprecise.

Panel B of Table 4 presents the results of the analysis for males. The results in Column 1 indicate that male opposite-sex twins earn 0.7 percent less than male same-sex twins (p=0.178), while male opposite-sex closely-spaced singletons earn 0.2 percent more than male same-sex closely-spaced singletons (p=0.553). The double difference estimate of the effect of opposite-sex twinning for males is a 0.9 percent wage reduction (p=0.178). These point estimates are larger in magnitude and achieve statistical significance when the additional control variables are added in Columns 2 and 3. Once age is added as a control, the results indicate that male opposite-sex twins earn 1.7 percent less than male same-sex twins (p=0.012) relative to the differential for singletons, consistent with the hypothesis that male same-sex twins are exposed to relatively high prenatal testosterone levels and that this enhances their earnings later in life. Similar findings are observed when using log annual earnings as an outcome. The results in Column 5, for instance, indicate that for males, opposite-sex twinning is associated with a 2.7 percent reduction in annual earnings (p=0.005).

Robustness to alternative control groups

One concern about the use of closely-spaced singletons as a control group is that socialization effects for these individuals may be unobservably different than those in the experimental group of twins. For instance, the closely-spaced siblings may be from families with different religious backgrounds or from families in which completed maternal fertility is higher than that for the twins. If these unobserved characteristics lead to differential parental investments in children regardless of the gender composition of sibling pairs, this does not pose a threat to the identification strategy. However, if socialization effects in families with closely-spaced siblings vary differentially from those in families with twins according to the genders of the sibling pairs, then the double difference estimator will be biased. To address this concern, we first note that the estimates suggest that there is little if any effect of sibling gender for closely-spaced singletons; it is primarily the difference in outcomes for twins that drive the results.

As a second check of the appropriateness of the use of closely-spaced siblings as a control, Table 5 presents results of models using alternative sub-groups of the original sample. In the first column, we repeat the results for the full sample. In Column 2, we re-estimate this specification using only citizens of the Netherlands because, as noted previously, the closely-spaced singletons are less likely to be Dutch citizens than the twins. Both the single difference estimates for closely-spaced siblings and the double difference coefficients of interest are similar to the original estimates, suggesting that non-citizens do not exhibit different gendered socialization effects or parental investment effects than citizens.

In Column 3, we address a second way in which families with closely-spaced siblings may differ than those with twins: they may have a larger number of children overall. Again, for this to threaten the identification strategy, it has to be the case that gendered socialization effects are different in large families than in small ones. In this model, we limit the sample to individuals from families in which completed maternal fertility was exactly two children so that both the twins and closely-spaced singletons come from families of identical size (based on maternal fertility). The double-difference estimate of the effect of opposite-sex twinning increases to a 2.5 percent (p=0.096) reduction in wage for males and decreases to a 0.4 percent reduction in wage for females (p=0.775). However, both results are driven in part by changes in the difference estimate for twins rather than for the closely-spaced singletons, and the estimates are imprecise. Overall, the results continue to support the conclusion that males with a male twin receive a wage premium, while there is weaker evidence of a wage penalty for females with a male twin.

The model presented in Column 4 addresses a concern related to possible effects of birth order on testosterone exposure. As noted previously, Maccoby et al. (1979) find that testosterone levels decline in subsequent closely-spaced births. We therefore limit the sample to twins and closely-spaced siblings who are first-parity births. The point estimates using this sample of "first-borns" are similar to those in the primary specifications. The estimated wage decline for females with a male twin is 0.7 percent (p=0.370) while the estimated wage gain for males with a male twin is 1.2 percent (p=0.143).

Alternative bandwidths defining "Closely Spaced"

Assuming that closely-spaced siblings can be used an appropriate control for socialization effects, the choice of a 12 month bandwidth to define them is admittedly somewhat arbitrary. We chose a twelve-month bandwidth because it was quite narrow, and these singletons seemed likely to have the most twin-like socialization effects via shared activities in the home and at school. On the other hand, this group of singletons is quite small and the estimates are less precise as a result. Table 6 presents estimates from a series of models exploring the robustness of the results to a series of alternative bandwidths defining "closely-spaced": 12 months, 18 months, 24 months, and 36 months. For males, the results are highly robust to the use of each alternative control group (Columns 1-4). The estimated difference in earnings for opposite versus same sex twins ranges from 1.3 percent to 1.4 percent across the specifications, while the estimated difference for singletons ranges from less than 0.1 percent to 0.4 percent. For females, the double difference estimator is slightly larger in magnitude and achieves statistical significance when using any of the bandwidths that are greater than 12 months. This is driven by two factors: the estimated difference for twins increases slightly, and the larger sample also increases the precision of the estimates. This suggests that the results for females presented in the remainder of the paper may be conservative.

In the final column of Table 6, we present the results of a model that allow us to explore how socialization varies among singleton siblings according to their gender composition, birth order, spacing, and interactions of all three factors. We estimate the following model:

$$(2)\ \log(wage_i) = \propto_0 + \propto_1 twin_i + \propto_2 OS_i + \lambda(twin_i \times OS_i) + \gamma_1 older_i + \gamma_2|agedif_i| + \gamma_3(OS_i \times older_i) + \gamma_4(OS_i \times |agedif_i|) + \gamma_5(older_i \times |agedif_i|) + \gamma_6(OS_i \times older_i \times |agedif_i|) + \boldsymbol{Z_i\delta} + \varepsilon_i\ .$$

The two new variables in this model are *older,* which indicates that a sibling is the older of the two in the pair, and |*agedif*|, which is the absolute value of the age difference between siblings. Both of these variables are equal to zero for twins. The model includes the complete set of possible interactions between *older*, |*agedif*|, and *OS* that allow for the possibility that among singletons, socialization effects vary with gender composition, birth order, and spacing, and that the effect of each varies with the other variables. The results of these models are presented in Column 5 of Table 6. They suggest that the older member of singleton sibling pairs tends to earn more than the younger, and that this effect diminishes with the spacing of the siblings.

Our particular interest is the correlation between having an opposite-sex sibling and wages, and testing for whether this varies with the spacing between siblings. For singletons, the estimated effect of being a member of an opposite-sex pair is

(3) $\frac{\Delta\hat{Y}}{\Delta OS} = \widehat{\propto_2}\ OS + \hat{\gamma}_3 older + \hat{\gamma}_4 |agedif| + \hat{\gamma}_6 (older \times |agedif|)$.

For females, $\hat{\gamma}_3, \hat{\gamma}_4,$ and $\hat{\gamma}_6$ are small in magnitude and lack statistical significance, suggesting that any socialization effects arising from sibling gender do not vary with birth order or spacing. This also is true for males with the exception of the coefficient on *OSxolder*, which suggests that younger sisters are associated with small wage reductions for their brothers while older ones are not. The size of the differential is not large, however. For example, having a sister who is 18 months older is predicted to increase wages by 0.2 percent (p=0.031) while having a sister who is 18 months younger is predicted to decrease wages by 0.3 percent (p=0.018). On the whole, therefore, we regard these results as further supporting the use of the closely-spaced siblings as a control.

Quantile Regressions

It is possible that preferences and personality traits may be rewarded differently in high and low-wage occupations. To allow for this, we estimate quantile regressions estimating the effect of prenatal testosterone exposures on the 10th, 25th, 50th, 75th, and 90th percentiles of imputed hourly wages. These results are presented in Table 7. The double difference point estimates for females suggest that opposite-sex twinning is associated with an approximately one percent reduction in the 10th, 25th, 75th, and 90th percentiles of wages. These are similar to the estimated effect on mean wages in the OLS model, and, like the previous results also lack statistical significance. The results for the 50th percentile models are smaller, but also imprecisely estimated. The estimated coefficients for males also are similar both to each other as well as to the OLS coefficients presented in previous tables, suggesting approximately a two percent reduction in wages resulting from opposite-sex twinning. As a whole, these results do not provide evidence that the effects of prenatal exposure to testosterone vary over the wage distribution.

VI. Discussion

The results of an analysis using a large sample of twins and closely-spaced singletons fail to provide evidence that opposite-sex twinning is associated with higher labor market earnings for women. One explanation for this finding is that females with a male twin either are not exposed to higher levels of prenatal testosterone or such exposure is unrelated to the development of sexually dimorphic physical or behavioral characteristics. Another explanation—and one that is consistent both with previous evidence supporting the testosterone transfer hypothesis and with the marginally statistically significant evidence across multiple models of an approximate one percent wage reduction for female opposite-sex twins—is that female opposite sex twins absorb more testosterone in utero and exhibit more masculine preferences and behaviors, but that such masculine traits are not rewarded in the labor markets and may even be penalized. When one considers the results for male twins, the statistically significant and robust wage premiums for same-sex twins also support the testosterone transfer hypothesis, but for men the resulting increase in prenatal testosterone is associated with a one to two percent wage premium.

The finding that increased prenatal exposure to testosterone via a male twin does not result in higher earnings for women but does confer some advantage for men is consistent with anecdotal claims that men and women are evaluated under different standards in the workplace. In the popular press, essays and articles, ambitious women are described as wearing "a scarlet A" (Bennetts, 2010) or battling "the bitch in the boardroom" stereotype (Dishman, 2012). As one female CEO explains it, "Assertive or competitive qualities are usually associated with men, and are thought to be essential for successful leaders. But for women, they can be a landmine" (Diana Middleton, global CEO of Performics quoted in Dishman, 2012).

In laboratory experiments, women whose behavior is more agentic (ambitious, competitive, dominant, aggressive, assertive) have been found to experience a "backlash" effect in which they are perceived as more competent, but viewed as socially deficient and penalized in hiring and promotion decisions (Eagly and Karau, 2002; Heilman et al, 2004; Rudman and Glick, 2001; Rudman and Fairchild, 2004; Bowles et al., 2001; Phelan et al., 2008; O'Neill and O'Reilly, 2011). In contrast, more agentic men in these studies were viewed as more socially skilled, competent, hirable and promotable.

In examining the relationship between personality traits measured as a child and later labor market outcomes, Groves (2005) finds that for women a one standard deviation increase in aggression is associated with an 8 percent decrease in wages as an adult, while earlier results of the study reported in Bowles et al. (2001) suggest that aggressive men are rewarded in high-status jobs but penalized in lower status ones. Both Judge, Livingston and Hurst (2012) and Mueller and Plug (2006) report that men who are more assertive and/or antagonistic (a "masculine" trait) earn significantly higher wages than men who are more agreeable (a "feminine" trait). The associated wage effect for women was largely non-existent in both studies.

Thus the combination of anecdotal claims of a "double standard" and laboratory and survey-based evidence on personality and labor market outcomes suggest that it is plausible that prenatal exposure to testosterone confers a comparative advantage on men whose associated masculine behaviors are expected, while providing little to no benefit to women whose associated masculine behaviors are not rewarded and possibly penalized in hiring, wage or promotion decisions.

VII. Conclusion

This paper provides a link between two relatively new literatures, one using opposite-sex twinning to estimate the effects of prenatal testosterone on adult personality and preferences, and a second asking whether personality and preferences may help to explain gender differences in labor market outcomes. By identifying a novel data set for identifying labor market outcomes for a large number of twins, we have been able to estimate whether having a male uterus-mate and the associated additional testosterone exposure is linked to improved labor market outcomes later in life.

For men, we find that having a male twin is associated with increased earnings. For women, however, we find that having a male twin is not associated with increased—and may even be associated with decreased—earnings. To the extent that opposite-sex twinning continues to be regarded as a reliable proxy for prenatal testosterone exposure, these results suggest that the gender earnings differential may be in part explained by an earnings premium that men receive for characteristics associated with prenatal testosterone exposure. The results do not suggest, however, that women would receive similar premiums for behaving in a more typically masculine fashion.

References

Altonji, Joseph and Rebecca Blank. 1999. "Race and gender in the labor market," in *Handbook of Labor Economics*. Vol. 3C, O. Ashenfelter and D. Card, Eds. New York, Elsevier: 3143-3259.

Angrist, Joseph and J Jörn-Steffen Pischke. 2009. Mostly Harmless Econometrics: An Empiricist's Companion. Princeton, NJ: Princeton University Press.

Baron-Cohen, Simon, Svetlana Lutchmaya and Rebecca Knickmeyer. 2004. *Prenatal testosterone in mind: Amniotic fluid studies*. Boston: MIT Press.

Becker, Gary. 1965. "A Theory of the Allocation of Time," *Economic Journal* 75 (299): 493-517.

Bennetts, Leslie. 2010. "The Scarlett A." *Elle* December 16, 2010.

Bertrand, Marianne. 2010. "New Perspectives on Gender" in Orley Ashenfelter and David Card, eds., Handbook of Labor Economics, Vol. 4b, Elsevier: 1545-92.

Bettencourt, Anne and Norman Miller. 1996. "Gender differences in aggression as a function of provocation: A meta-analysis." *Psychological Bulletin* 119(3): 422-477.

Blau, Francine. 2012. *Gender Inequality and Wages*. Anne C. Gielen and Klaus F. Zimmerman, eds. Oxford: Oxford University Press.

Blau, Francine and Lawrence Kahn. 2006. "The U.S. Gender Pay Gap in the 1990s: Slowing Convergence." *Industrial and Labor Relations Review*, 60(1): 45-66.

Blau, Francine and Lawrence Kahn. 2007. "The Gender Pay Gap." *The Economist's Voice*, 4(4).

Boklage, Charles. 1985. "Interactions between opposite-sex dizygotic fetuses and the assumptions of Weinberg Difference Method Epidemiology." *American Journal of Human Genetics,* 37(3): 591-605.

Bowles, Hannah Riley, Linda Babcock, and Lei Lai. 2007. "Social incentives for gender differences in the propensity to initiate negotiations." *Organizational Behavior and Human Decision Processes,* 103(1): 84-103.

Bowles Samuel, Herbert Gintis, Melissa Osborne. 2001. "Incentive-enhancing preferences: Personality behavior and earnings." *American Economic Review Papers and Proceedings*, 91(2): 155 – 158.

Breedlove, S. Marc. 1994. "Sexual differentiation of the human nervous system." *Annual Review of Psychology*, 45: 389-418.

Burnham, Terence. 2007. "High testosterone men reject low ultimatum game offers." *Proceedings of the Royal Society B,* 274(1623): 2327-2330.

Buser, Thomas, Muriel Niederle and Hessel Oosterbeek. 2012. "Gender Competitiveness and Career Choices." Working paper.

Carre, Justin and Cheryl McCormick. 2008. "Aggressive behavior and change in salivary testosterone concentrations predict willingness to engage in a competitive task." *Hormones and behavior,* 54(3): 403-409.

Chapman, Emma, Simon Baron-Cohen, Bonnie Auyeung, Rebecca Knickmeyer, Kevin Taylor, and Gerald Hackett. 2006. "Fetal testosterone and empathy: Evidence from the empathy quotient (EQ) and the `Reading of the mind in the eyes' test." *Social Neuroscience*, 1(2): 135-148.

Clark, Mertice M, Leanne Tucker and Bennett Galef. 1992. "Stud males and dud males: intrauterine position effects on the reproductive success of male gerbils." *Animal Behavior*. 43: 215-221.

Coates, J.M. and J. Herbert. 2008. "Endogenous steroids and financial risk-taking on a London trading floor," *Proceedings of the National Academy of Sciences,* 104(16): 6167-6172.

Coates, John, Mark Gurnell and Aldo Rustichini. 2009. "Second to fourth digit ratio predicts success among high frequency financial traders." *Proceedings of the National Academy of Sciences,* 106(2): 623-628.

Cohen-Bendahan, Celina, Jan Buitelaar, Stephanie van Goozen and Peggy

Cohen-Kettenis. 2004. "Prenatal exposure to testosterone and functional cerebral lateralization: A study in same-sex and opposite-sex twin girls." *Psychoneuroendocrinology,* 29(7): 911-916.

Cohen-Bendahan, Celina, Jan Buitelaar, Stephanie van Goozen, Jacob Orlebeke and Peggy Cohen-Kettenis. 2005. "Is there an effect of prenatal exposure to testosterone on aggression and other behavioral traits? A study comparing same-sex and opposite-sex twin girls." *Hormones and Behavior*, 47(2): 230-237.

Corcoran, Mary and Greg Duncan. 1979. "Work history, labor force attachment, and earnings differences between the races and sexes." *The Journal of Human Resources*, 14(1): 3-20.

Heilman, Madeline E., Aaron S. Wallen, Daniella Fuchs, and Melinda M. Tamkins. 2004. "Penalties for success: Reactions to women who succeed at male gender-typed tasks." *Journal of Applied Psychology*. 89(3): 416-427.

Cronqvist, Henrik, Alessandro Previtero, Stephan Siegel, and Roderick White. 2013. "Prenatal exposure to testosterone reduces the gender gap in financial risk taking" Working paper.

Croson, Rachel and Uri Gneezy. 2009. "Gender differences in preferences" *Journal of Economic Literature*, 47(2): 448-474.

Culbert, Kristen, S. Marc Breedlove, Alexandra Burt and Kelly Klump. 2008. "Prenatal hormone exposure and risk for eating disorders: A comparison of opposite-sex and same-sex twins." *The Archives of General Psychiatry*, 65(3): 329-336.

Dempsey, Paula, Grant Townshend and Lindsay Richards. 1999. "Increased tooth crown size in females with twin brothers: Evidence for hormonal diffusion between twins in utero," *American Journal of Human Biology,* 11(5): 577-586.

Derks, Eske, Conor Dolan and Dorret Boomsma. 2006. "A test of the equal environment assumption (EEA) in multivariate twin studies" *Twin Research and Human Genetics*, 9(3):403-411.

Dishman, Lydia. 2012. "The `Bitch in the boardroom' stereotype: Women speak out about success and likeability." *Fast Company*, April 19, 2012.

Dreber, Anna and Moshe Hoffman. 2007. "Portfolio selection in utero." Unpublished paper.

Dreber, Anna and Moshe Hoffman. 2010. "Biological basis of sex differences in risk aversion and competitiveness." Unpublished paper.

Eagly, Alice and Steven J Karau. 2002. "Role congruity theory of prejudice toward female leaders " *Psychological Review*, 109(3): 573-598.

Eckel, Catherine and Philip Grossman. 2008. "Men, women and risk aversion: Experimental evidence" in Charles Plott and Vernon Smith, eds., Handbook of Experimental Economics, Vol. 1, Elsevier: 1061-1073.

Eriksson, Marit, Finn Rasmussen and Per Tynelius. 2006. "Genetic factors in physical activity and the equal environment assumption—the Swedish young male twins study." *Behavior Genetics*, 36:238-47.

Fellman, Johan and Aldur Eriksson, 2010. "Secondary sex ratio in multiple births." *Twin Research and Human Genetics*, 13(1): 101-108.

Fellman, Johan and Aldur Eriksson. 2006. "Weinberg's differential rule reconsidered." *Human Biology*, 78(3): 253-272.

Flory, Jeffrey, Andreas Leibbrandt and John A List. 2010. "Do competitive workplaces deter female workers? A large-scale field experiment on gender differences in job-entry decisions." NBER Working paper #16546.

Fortin, Nicole M. 2008. "The Gender Wage Gap among Young Adults in the United States: The Importance of Money versus People." *Journal of Human Resources* 43(4): 884-918.

Galsworthy, Michael, Ginette Dionne, Philip Dale, and Robert Plomin. 2000. "Sex differences in early verbal and non-verbal cognitive development." *Developmental Science*, 3(2): 206-215.

Garbarino, Ellen, Robert Slonim and Justin Sydnor. 2011. "Digit ratios (2D:4D) as predictors of risky decision making for both sexes." *Journal of Risk and Uncertainty,* 42(1): 1-26.

Glinianaia, Svetlana, Per Magnus, Jennifer Harris and Kristian Tambs. 1998. "Is there a consequence for fetal growth of having an unlike-sexed cohabitant in utero?" *International Journal of Epidemiology,* 27(4): 657-659.

Gneezy, Uri, Muriel Niederle and Aldo Rustichini. 2003. "Performance in competitive environments: Gender differences" *The Quarterly Journal of Economics,* 118(3): 1049-1074.

Gneezy, Uri and Aldo Rustichini. 2004. "Gender and competition at a young age" *American Economic Review, Papers and Proceedings,* 94(2): 377-381.

Grove, Wayne, Andrew Hussey and Michael Jetter. 2011. "The Gender Pay Gap Beyond Human Capital: Heterogeneity in Non-cognitive Skills and in Labor Market Tastes," *Journal of Human Resources*. 46(4): 827-874.

Groves, Melissa Osborne. 2005. "How important is your personality? Labor market returns to personality for women in the US and UK." *Journal of Economic Psychology*, 26(6): 827-841.

Guiso, Luigi and Aldo Rustichini. 2010. "Understanding the size and profitability of firms: The role of a biological factor." CEPR Discussion Paper No. DP 8205.

Hampson, Elizabeth, Connie Ellis and Christine Tenk. 2007. "On the relation between 2D:4D and sex-dimorphic personality traits." *Archives of sexual behavior,* 37(1): 133-144.

Heil, Martin, Kavsek, Michael, Rolke, Bettina, Beste, Christian; Jansen, Petra. 2011. "Mental rotation in female fraternal twins: Evidence for intra-uterine hormone transfer?" *Biological Psychology* 86(1): 90-93

Hettema, John, Michael Neale, and Kenneth Kendler. 1995. "Physical similarity and the equal environments assumption in twin studies of psychiatric disorders." *Behavior Genetics*, 25:327-335.

Hines, Melissa, Susan Golombok, John Rust, Katie Johnston, and Jean Golding.

2002. “Testosterone during pregnancy and gender role behavior of preschool children: A longitudinal population study.” *Child Development*, 73(6): 1678-1687.

Ho, Alexander, Richard Todd, and John Constantino. 2005. “Brief report: Autistic traints in twins vs. non-twins—a preliminary study.” *Journal of Autism and Developmental Disorders*, 35: 129-133.

Jacobsen, R., H. Møller, and A. Mouritsen. 1999. “Natural variation in the human sex ratio.” *Human reproduction*, 14(12): 3120-3125.

James, William. 1987. “The human sex ratio, Part 1: A review of the literature.” *Human Biology*, 59(5): 721-752.

James, William. 2008. “Evidence that mammalian sex ratios at birth are partially controlled by parental hormone levels around the time of conception.” *Journal of Endocrinology*, 198: 3-15.

James, William. 2010. “The sex ratios of monozygotic and dizygotic twins.” *Twin research and human genetics*, 13(4): 381-382.

Jordan-Young, Rebecca. 2010. *Brain Storm: The Flaws in the Science of Sex Differences*. Cambridge: Harvard University Press.

Judge, Timothy, Beth Livingston and Charlice Hurst. 2012. “Do nice guys -- and gals -- really finish last? The joint effects of sex and agreeableness on income.” *Journal of Personality and Social Psychology*, 102(2): 390-407.

Kendler, Kenneth, Michael Neale, Ronald Kessler, Andrew Heath and Lindon Eaves. 1994. “Parental treatment and the equal environment assumption in twin studies of psychiatric illness. “ *Psychological Medicine*, 24(3):579-90.

Loehlin, John and Nicholas Martin. 2000. “Dimensions of psychological masculinity-femininity in adult twins from opposite-sex and same-sex pairs.” *Behavior Genetics*. 30(1):19-28.

Loehlin, John and Robert Nichols. 1976. Heredity, environment and personality: a study of 850 sets of twins. Austin: University of Texas Press.

Lombardo Michael, Ashwin Emma, Auyeung Bonnie, Chakrabarti Bhismadev, Lai Meng-Chuan, Taylor Kevin, Hackett Gerald, Bullmore Edward T, Baron-Cohen Simon. 2012. "Fetal programming effects of testosterone on the reward system and behavioral approach tendencies in humans." *Biological Psychiatry* 72(10): 839-47

Maccoby, Eleanor, Charles Doering, Carol Nagy Jacklin and Helena Kraemer. 1979. "Concetrations of sex hormones in umbilical-cord blood: Their relation to sex and birth order in infants." *Child Development*, 50(3): 632-642.

Maccoby, Eleanor and Carol Jacklin. 1974. *The Psychology of sex differences*. Stanford: Stanford University.

Manning, Alan and Joanna Swaffield. 2008. "The Gender gap in early-career wage growth." *The Economic Journal*, 118(530): 983-1024.

Mathany, Adam, Ronald Wilson and Anne Dolan. 1976. "Relations between twins' similarity of appearance and beahvioral similarity: testing an assumption." *Behavior Genetics*, 6: 343-351.

Mazur, Allan and Alan Booth. 1998. "Testosterone and dominance in men," *Behavioral and brain sciences,* 21(3): 353-397.

McFadden, Dennis. 1993. "A masculinizing effect on the auditory systems of human females having male co-twins," *Proceedings of the National Academy of Sciences,* 90(24): 11900-11904.

Medland, Sarah, John Loehlin and Nicholas Martin. 2008. "No effects of prenatal hormone transfer on digit ratio in a large sample of same and opposite-sex dizygotic twins," *Personality and Individual Differences,* 44(5): 1225-1234.

Miller, Edward. 1994 "Prenatal sex hormone transfer: a reason to study opposite-sex twins," *Personality and Individual Differences,* 17(4): 511-529.

Mincer, Jacob. 1974. Schooling, Experience, and Earnings. New York: Columbia University Press for the National Bureau of Economic Research.

Mincer, Jacob and Solomon Polachek. 1974. "Family investment in human capital: Earnings of women." *Journal of Political Economy*, 82(2): S76-S108.

Mueller, Gerrit and Erik Plug. 2006. “Estimating the Effect of Personality on Male and Female Earnings” *Industrial and Labor Relations Review*., 60(1): 3-22.

Niederle, Muriel and Lise Vesterlund. 2007. “Do women shy away from competition? Do men compete too much?” *Quarterly Journal of Economics*, 122(3): 1067-1101.

O'Neill, June. 2003. "The gender gap in wages circa 2000." *The American Economic Review*. 93(2): 309-314.

O’Neill, Olivia and Charles O’Reilly. 2011. “Reducing the backlash effect: Self-monitoring and women’s promotions.” *Journal of Occupational and Organizational Psychology*, 84(4): 825-832.

Organization for Economic Development and Cooperation (OECD) Employment Outlook. 2008. “The price of prejudice: Labour market discrimination on the grounds of gender and ethnicity.” Chapter 3 in *OECD Employment Outlook, 2008*.

Ors, Evren, Frederic Palomino and Eloic Peyrache. 2012. “Performance gender-gap: does competition matter?” Working paper.

Peper, Jiska, Rachel Brouwer, G. Caroline van Baal, Hugo Schnack, Marieke van Leeuwen, Dorret Boomsma, René Kahn and Hilleke Pol. 2009. “Does having a twin brother make for a bigger brain?” *European Journal of Endocrinology*, 160(5): 739-46.

Phelan, Julie, Corinne Moss-Racusin and Laurie Rudman. 2008. “Competent yet out in the cold: Shifting criteria for hiring reflect backlash toward agentic women.” *Psychology of Women Quarterly,* 32(4): 406-413.

Polachek, Solomon. 1981. "Occupational self-selection: A Human capital approach to sex differences in occupational structure." *The Review of Economics and Statistics* 63(1): 60-69.

Resnick, Susan, Irving Gottesman and Matthew McGue. 1993. “Sensation seeking in opposite-sex twins: An effect of prenatal hormones?" *Behavior Genetics*, 23(4): 323-329.

Rudman, Laurie and Kimberly Fairchild. 2004. "Reactions to counterstereotypic behavior: The role of backlash in cultural stereotype maintenance." *Journal of Personality and Social Psychology*, 87(2), 157-176.

Rudman, Laurie and Peter Glick. 2001. "Prescriptive gender stereotypes and backlash toward agentic women." *Journal of Social Issues*, 57(4): 743-762.

Ryan, Bryce and John Vandenbergh. 2002. "Intrauterine position effects." *Neuroscience and biobehavioral reviews,* 26(6): 665-678.

Scarr Sandra and Louise Carter-Saltzman. 1979. "Twin method: Defense of a critical assumption." *Behavior Genetics*, 9: 527-542.

Slutske, Wendy, Bascom, Elise, Meier, Madeline, Medland, Sarah, and Martin, Nicholas. 2011. "Sensation Seeking in Females from Opposite- Versus Same-Sex Twin Pairs: Hormone Transfer or Sibling Imitation?" *Behavior Genetics* 41(4): 533–542.

Statistics Netherlands. 2012. *Statline Database*. Accessed online June 28, 2012.

Tapp, Aimee, Murray Mayberry, and Andrew Whitehouse. 2011. "Evaluating the twin testosterone transfer hypothesis: A review of the empirical evidence." *Hormones and Behavior*, 60(5): 713-722.

van Anders, Sari, Philip Vernon and Christopher Wilbur. 2006. "Finger-length ratios show evidence of prenatal hormone-transfer between opposite sex twins." *Hormones and Behavior,* 49(2): 315-319.

van den Bergh, Bram and Siegfried Dewitte. 2006. "Digit ratio (2D:4D) moderates the impact of sexual cues on men's decisions in ultimatum games." *Proceedings of the Royal Society*, 273(1597): 2091-2095.

van Hulle, Carol, H.H. Goldsmith, and Kathryn Lemery. 2004. "Genetic, environmental, and gender effects on individual differences in toddler expressive language." *Journal of Speech, Language, and Hearing Research*, 47: 904-9012.

Vlietinck, R., C. Derom, R. Derom, H. van den Berghe, M. Thiery. 1988. “The validity of Weinberg’s rule in the East Flanders Prospective Twin Survey (EFPTS).” *Acta Genetiicae medica et gemellologiae*, 37(2): 137-141.

vom Saal, F. 1989. "Sexual differences in litter-bearing mammals: Influence of sex of adjacent fetuses in utero." *Journal of Animal Science,* 67(7): 1824-1840.

Voracek Martin and Stefan Dressler. 2007. "Digit ratio (2D:4D) in twins: Heritability estimates and evidence for a masculinized trait expression from opposite-sex twin pairs." *Psychological Reports,* 100(1): 115-126.

Vuoksimaa, Eero, C.J. Peter Eriksson, Lea Pulkkinen, Richard J Rose, Jaakko Kaprio. 2010a. “Decreased prevalence of left-handedness among females with male co-twins: Evidence suggesting prenatal testosterone transfer in humans? *Psychoneuroendocrinology*. 35(1): 1462-1472.

Vuoksimaa, Eero, Jaakko Kaprio, William Kremen, Laura Hokkanen, Richard Viken, Annamari Tuulio-Henriksson and Richard Rose. 2010b. "Having a male co-twin masculinizes mental rotation performance in females." *Psychological Science,* 21(8): 1069-1071.

Weichselbaumer, Doris and Rudolf Winter-Ebmer. 2005. “A meta-analysis of the international gender wage gap.” *Journal of Economic Surveys*, 19(3): 479-511.

White, Roderick, Stewart Thornhill and Elizabeth Hampson. 2006. “Entrepreneurs and evolutionary biology: The relationship between testosterone and new venture creation.” *Organizational Behavior and Human Decision Processes*, 100(1): 21-34.

Table 1: Frequencies of family types in 2009 GBA

Family type	Frequency	Percent
Only child	280,771	6.33
Singleton, closest sibling>12 months	3,918,793	88.29
Singleton, closest sibling<12 months	151,011	3.40
Twin	86,822	1.96
Higher order multiple	1,224	0.03
Total	4,438,621	100.00

*Sample is individuals in 2009 Dutch GBA who were born from 1959-1979 and have an identifiable mother and birthdate.

Table 2: Twins and closely-spaced siblings

	Observed in GBA		Observed in employment data	
	Frequency	Percent	Frequency	Percent
Females				
OS twin	13,303	5.79	9,479	5.72
SS twin	29,380	12.78	20,817	12.57
OS closely-spaced singleton	36,389	15.83	24,622	14.87
SS closely-spaced singleton	34,888	15.18	23,913	14.44
Males				
OS twin	13,303	5.79	10,318	6.23
SS twin	27,932	12.15	21,490	12.98
OS closely-spaced singleton	36,487	15.87	26,837	16.21
SS closely-spaced singleton	38,178	16.61	28,108	16.98
Total	229,860	100.00	165,584	100.00

*The first panel presents the frequency distribution of the final GBA sample, which include all individuals born from 1959-1979 who can be identified as a twin or closely-spaced singleton and who do not have more than one sibling born within 12 months. The second panel reports the frequency distribution of the members of the first sample who also are observable in the employment database. The majority of the individuals who are not present in the second panel are out of the labor force, unemployed, or self-employed.

Table 3: Summary Statistics for sample used in analysis

Panel A: Female twins and closely-spaced singletons

variable	description	**OS Twin** *(n=9,479)*	**SS Twin** *(n=20,817)*	**OS Singleton** *(n=24,622)*	**SS Singleton** *(n=23,913)*	**All Females** *(n=78,831)*
log(wage)	log imputed hourly wage	2.718	2.730	2.720	2.725	2.724
log(earnings)	log imputed annual earnings	9.708	9.735	9.670	9.688	9.698
age	mean age	40.482	39.872	41.812	41.879	41.293
married	I(married)	0.766	0.767	0.773	0.776	0.775
child 0-4	I(children under age 5 living at home)	0.184	0.204	0.142	0.145	0.175
child 5-17	I(children age 5-17 living at home)	0.500	0.494	0.568	0.566	0.504
non-citizen	I(not a citizen of the Netherlands)	0.114	0.115	0.180	0.186	0.156
part-time	I(part-time worker)**	0.753	0.752	0.770	0.768	0.763
permanent	I(permanent contract)	0.941	0.942	0.936	0.930	0.946

Panel B: Male twins and closely-spaced singletons

		OS Twin *(n=10,318)*	**SS Twin** *(n=21,490)*	**OS Singleton** *(n=26,837)*	**SS Singleton** *(n=28,108)*	**All males** *(n=86,753)*
lwage	log imputed hourly wage	2.904	2.911	2.907	2.904	2.907
log(earnings)	log imputed annual earnings	10.356	10.371	10.340	10.339	10.349
age	mean age	40.733	40.251	41.930	42.059	41.413
married	I(married)	0.770	0.761	0.784	0.789	0.778
child 0-4	I(children under age 5 living at home)	0.188	0.203	0.176	0.176	0.184
child 5-17	I(children age 5-17 living at home)	0.424	0.425	0.491	0.504	0.471
non-citizen	I(not a citizen of the Netherlands)	0.112	0.105	0.180	0.187	0.156
part-time	I(part-time worker)**	0.182	0.173	0.190	0.188	0.184
permanent	I(permanent contract)	0.960	0.963	0.951	0.952	0.956

*The sample is limited to individuals who were born between 1959 and 1979 who have exactly one sibling born within 12 months of their date of birth and who are observed in the employment data described in the text.

**Part-time status is determined by Statistics Netherlands, which defines it as working fewer hours than the full time work week determined in a firm's collective wage agreement. For most workers, part-time status is coded as 1 if a worker works fewer than 36 or 40 hours per week.

Table 4: Wage regressions

Panel A: Female twins and closely-spaced singletons

	dep. variable: log(imputed hourly wage)									*dep. variable: log(annual earnings)*								
	(1) Full sample n=78,831			(2) Full sample n=78,831			(3) Full sample n=78,831			(4) Full sample n=78,831			(5) Full sample n=78,831			(6) Full sample n=78,831		
	coef.		*s.e.*	*coef.*		*s.e.*	*coef.*		*s.e.*	*coef.*		*s.e.*	*coef.*		*s.e.*	*coef.*		*s.e.*
twin	0.005		(0.004)	0.008	**	(0.004)	0.001		(0.003)	0.047	***	(0.008)	0.035	***	(0.008)	0.016	**	(0.007)
OS	-0.004		(0.003)	-0.004		(0.003)	-0.003		(0.003)	-0.018	**	(0.008)	-0.018	**	(0.008)	-0.018	***	(0.007)
twin*OS	-0.008		(0.006)	-0.008		(0.006)	-0.008		(0.005)	-0.009		(0.013)	-0.007		(0.013)	-0.005		(0.011)
age	.		.	0.031	***	(0.003)	0.058	***	(0.003)	.		.	-0.071	***	(0.008)	0.068	***	(0.007)
age^2	.		.	0.000	***	(0.000)	-0.001	***	(0.000)	.		.	0.001	***	(0.000)	-0.001	***	(0.000)
married	.		.	.		.	0.026	***	(0.003)	.		.	.		.	-0.025	***	(0.007)
child 0-4	.		.	.		.	0.103	***	(0.004)	.		.	.		.	0.049	***	(0.008)
child 5-17	.		.	.		.	-0.002		(0.003)	.		.	.		.	-0.159	***	(0.006)
non-citizen	.		.	.		.	-0.053	***	(0.003)	.		.	.		.	-0.036	***	(0.008)
part-time	.		.	.		.	-0.144	***	(0.003)	.		.	.		.	-0.657	***	(0.006)
permanent	.		.	.		.	0.127	***	(0.004)	.		.	.		.	0.770	***	(0.018)
D_{twins}	-0.012	***	(0.004)	-0.013	***	(0.004)	-0.011	***	(0.004)	-0.027	***	(0.010)	-0.025	**	(0.010)	-0.023	***	(0.009)
D_{CSS}	-0.004		(0.003)	-0.004		(0.003)	-0.003		(0.003)	-0.018	**	(0.008)	-0.018	**	(0.008)	-0.018	***	(0.007)
DD	-0.008		(0.006)	-0.008		(0.006)	-0.008		(0.005)	-0.009		(0.013)	-0.007		(0.013)	-0.005		(0.011)

continued…..

Table 4: Wage regressions, continued

Panel B: Male twins and closely-spaced singletons

	dep. variable: log(imputed hourly wage)									*dep. variable: log(annual earnings)*								
	(1)			(2)			(3)			(4)			(5)			(6)		
	Full sample n=86,753			Full sample n=86,753			Full sample n=86,753			Full sample n=86,753			Full sample n=86,753			Full sample n=86,753		
	coef.		*s.e.*	*coef.*		*s.e.*	*coef.*		*s.e.*	*coef.*		*s.e.*	*coef.*		*s.e.*	*coef.*		*s.e.*
twin	0.007		(0.004)	0.034	***	(0.004)	0.017	***	(0.004)	0.033	***	(0.007)	0.068	***	(0.007)	0.028	***	(0.006)
OS	0.002		(0.004)	0.004		(0.004)	0.005		(0.003)	0.002		(0.006)	0.004		(0.006)	0.006		(0.005)
twin*OS	-0.009		(0.007)	-0.017	***	(0.006)	-0.011	*	(0.006)	-0.017		(0.010)	-0.027	***	(0.010)	-0.015	*	(0.009)
age	.		.	0.080	***	(0.004)	0.043	***	(0.003)	.		.	0.110	***	(0.006)	0.046	***	(0.005)
age^2	.		.	-0.001	***	(0.000)	0.000	***	(0.000)	.		.	-0.001	***	(0.000)	0.000	***	(0.000)
married	.		.	.		.	0.095	***	(0.004)	.		.	.		.	0.154	***	(0.006)
child 0-4	.		.	.		.	0.067	***	(0.004)	.		.	.		.	0.081	***	(0.005)
child 5-17	.		.	.		.	0.090	***	(0.003)	.		.	.		.	0.112	***	(0.005)
non-citizen	.		.	.		.	-0.104	***	(0.004)	.		.	.		.	-0.182	***	(0.007)
part-time	.		.	.		.	-0.078	***	(0.004)	.		.	.		.	-0.513	***	(0.007)
permanent	.		.	.		.	0.221	***	(0.006)	.		.	.		.	0.769	***	(0.020)
D_{twins}	-0.007		(0.005)	-0.013	**	(0.005)	-0.006		(0.005)	-0.015	**	(0.008)	-0.022	***	(0.008)	-0.008		(0.007)
D_{CSS}	0.002		(0.004)	0.004		(0.004)	0.005		(0.003)	0.002		(0.006)	0.004		(0.006)	0.006		(0.005)
DD	-0.009		(0.007)	-0.017	***	(0.006)	-0.011	*	(0.006)	-0.017		(0.010)	-0.027	***	(0.010)	-0.015	*	(0.009)

*The sample is limited to individuals who were born between 1959 and 1979 who are observed in the employment data described in the text and who have exactly one sibling born within 12 months of their birthdate. Additional controls in Model 3 include firm-size and industry fixed effects. Standard errors are clustered on sibling pairs. *p<0.10, **p<0.05, ***p<0.01

Table 5: Wage regressions for alternative subsamples

Panel A: Female twins and closely-spaced singletons

	dep. variable: log(imputed hourly wage)											
	(1) Full sample n=78,831			(2) Dutch citizens n=66,487			(3) Two-child families n=15,039			(4) First-borns n=44,146		
	coef.		*s.e.*	*coef.*		*s.e.*	*coef.*		*s.e.*	*coef.*		*s.e.*
twin	0.008	**	(0.004)	0.002		(0.004)	0.010		(0.009)	-0.014	***	(0.003)
OS	-0.004		(0.003)	-0.002		(0.004)	-0.006		(0.008)	-0.006		(0.003)
twin*OS	-0.008		(0.006)	-0.009		(0.006)	0.004		(0.013)	-0.007		(0.004)
age	0.031	***	(0.003)	0.028	***	(0.004)	0.045	***	(0.008)	0.036	***	(0.001)
age^2	0.000	***	(0.000)	0.000	***	(0.000)	-0.001	***	(0.000)	0.000	***	(0.000)
D_{twins}	-0.013	***	(0.004)	-0.011	**	(0.005)	-0.002		(0.010)	-0.012	**	(0.005)
D_{CSS}	-0.004		(0.003)	-0.002		(0.004)	-0.006		(0.008)	-0.006		(0.003)
DD	-0.008		(0.006)	-0.009		(0.006)	0.004		(0.013)	-0.007		(0.004)

continued....

Table 5: Wage regressions for alternative subsamples, continued

Panel B: Male twins and closely-spaced singletons

	dep. variable: log(imputed hourly wage)											
	(1) Full sample n=86,753			(2) Dutch citizens n=73,254			(3) Two-child families n=16,230			(4) First-borns n=47,536		
	coef.		*s.e.*	*coef.*		*s.e.*	*coef.*		*s.e.*	*coef.*		*s.e.*
twin	0.034	***	(0.004)	0.015	***	(0.005)	0.038	***	(0.010)	0.012	**	(0.006)
OS	0.004		(0.004)	0.000		(0.004)	0.005		(0.008)	-0.001		(0.006)
twin*OS	-0.017	***	(0.006)	-0.013	**	(0.007)	-0.025	*	(0.015)	-0.012		(0.008)
age	0.080	***	(0.004)	0.075	***	(0.004)	0.078	***	(0.009)	0.081	***	(0.005)
age^2	-0.001	***	(0.000)	-0.001	***	(0.000)	-0.001	***	(0.000)	-0.001	***	(0.000)
D_{twins}	-0.013	**	(0.005)	-0.013	**	(0.005)	-0.020		(0.013)	-0.013	**	(0.005)
D_{CSS}	0.004		(0.004)	0.000		(0.004)	0.005		(0.008)	-0.001		(0.006)
DD	-0.017	***	(0.006)	-0.013	**	(0.007)	-0.025	*	(0.015)	-0.012		(0.008)

*The sample is limited to individuals who were born between 1959 and 1979 who are observed in the employment data described in the text and who have exactly one sibling born within 12 months of their birthdate. Standard errors are clustered on sibling pairs. *p<0.10, **p<0.05, ***p<0.01

Table 6: Alternative bandwidths for the CSS Designation

Panel A: Female twins and closely-spaced singletons

<table>
<tr><td></td><td colspan="10">dep. variable: log(imputed hourly wage)</td></tr>
<tr><td></td><td colspan="2">(1)
12 months
n=78,831</td><td colspan="2">(2)
18 months
n=491,175</td><td colspan="2">(3)
24 months
n=924,719</td><td colspan="2">(4)
36 months
n=1,618,540</td><td colspan="2">(5)
36 months
n=1,618,540</td></tr>
<tr><td></td><td>coef.</td><td>s.e.</td><td>coef.</td><td>s.e.</td><td>coef.</td><td>s.e.</td><td>coef.</td><td>s.e.</td><td>coef.</td><td>s.e.</td></tr>
<tr><td>twin</td><td>0.008 **</td><td>(0.004)</td><td>-0.002</td><td>(0.003)</td><td>-0.013 ***</td><td>(0.003)</td><td>-0.021 ***</td><td>(0.003)</td><td>0.016 ***</td><td>(0.003)</td></tr>
<tr><td>OS</td><td>-0.004</td><td>(0.003)</td><td>-0.006 ***</td><td>(0.001)</td><td>-0.004 ***</td><td>(0.001)</td><td>-0.004 ***</td><td>(0.001)</td><td>-0.007 ***</td><td>(0.002)</td></tr>
<tr><td>twin*OS</td><td>-0.008</td><td>(0.006)</td><td>-0.010 **</td><td>(0.005)</td><td>-0.012 ***</td><td>(0.005)</td><td>-0.012 ***</td><td>(0.005)</td><td>-0.009 *</td><td>(0.005)</td></tr>
<tr><td>age</td><td>0.031 ***</td><td>(0.003)</td><td>0.046 ***</td><td>(0.000)</td><td>0.050 ***</td><td>(0.000)</td><td>0.054 ***</td><td>(0.000)</td><td>0.054 ***</td><td>(0.000)</td></tr>
<tr><td>age^2</td><td>0.000 ***</td><td>(0.000)</td><td>0.000 ***</td><td>(0.000)</td><td>-0.001 ***</td><td>(0.000)</td><td>-0.001 ***</td><td>(0.000)</td><td>-0.001 ***</td><td>(0.000)</td></tr>
<tr><td>older</td><td>.</td><td>.</td><td>.</td><td>.</td><td>.</td><td>.</td><td>.</td><td>.</td><td>0.045 ***</td><td>(0.003)</td></tr>
<tr><td>|agedif|</td><td>.</td><td>.</td><td>.</td><td>.</td><td>.</td><td>.</td><td>.</td><td>.</td><td>0.001 ***</td><td>(0.000)</td></tr>
<tr><td>OS*older</td><td>.</td><td>.</td><td>.</td><td>.</td><td>.</td><td>.</td><td>.</td><td>.</td><td>0.002</td><td>(0.004)</td></tr>
<tr><td>OS*|agedif|</td><td>.</td><td>.</td><td>.</td><td>.</td><td>.</td><td>.</td><td>.</td><td>.</td><td><|0.001|</td><td>(0.000)</td></tr>
<tr><td>older*|agedif|</td><td>.</td><td>.</td><td>.</td><td>.</td><td>.</td><td>.</td><td>.</td><td>.</td><td>-0.001 ***</td><td>(0.000)</td></tr>
<tr><td>OS*older*|agedif|</td><td>.</td><td>.</td><td>.</td><td>.</td><td>.</td><td>.</td><td>.</td><td>.</td><td><|0.001|</td><td>(0.000)</td></tr>
<tr><td>D_{twins}</td><td>-0.013 ***</td><td>(0.004)</td><td>-0.016 ***</td><td>(0.004)</td><td>-0.016 ***</td><td>(0.004)</td><td>-0.016 ***</td><td>(0.004)</td><td>-0.016 ***</td><td>(0.004)</td></tr>
<tr><td>D_{CSS}</td><td>-0.004</td><td>(0.003)</td><td>-0.006 ***</td><td>(0.001)</td><td>-0.004 ***</td><td>(0.001)</td><td>-0.004 ***</td><td>(0.001)</td><td>-0.007</td><td>(0.002)</td></tr>
<tr><td>DD</td><td>-0.008</td><td>(0.006)</td><td>-0.010 **</td><td>(0.005)</td><td>-0.012 ***</td><td>(0.005)</td><td>-0.012 ***</td><td>(0.005)</td><td>-0.009</td><td>(0.005)</td></tr>
</table>

continued....

Table 6: Alternative bandwidths, continued

Panel B: Male twins and closely-spaced singletons

	dep. variable: log(imputed hourly wage)									
	(1) 12 months n=78,831		(2) 18 months n=574,397		(3) 24 months n=1,075,620		(4) 36 months n=1,867,517		(4) 36 months n=1,867,517	
	coef.	*s.e.*	*coef.*	*s.e.*	*coef.*	*s.e.*	*coef.*	*s.e.*	*coef.*	*s.e.*
twin	0.034 ***	(0.004)	0.006 *	(0.003)	-0.004	(0.003)	-0.014 ***	(0.003)	0.044 ***	(0.004)
OS	0.004	(0.004)	<|0.001|	(0.001)	<|0.001|	(0.001)	<|0.001|	(0.001)	0.002	(0.003)
twin*OS	-0.017 ***	(0.006)	-0.014 ***	(0.005)	-0.014 ***	(0.005)	-0.015 ***	(0.005)	-0.017 ***	(0.006)
age	0.080 ***	(0.004)	0.073 ***	(0.000)	0.076 ***	(0.000)	0.078 ***	(0.000)	0.079 ***	(0.000)
age^2	-0.001 ***	(0.000)	-0.001 ***	(0.000)	-0.001 ***	(0.000)	-0.001 ***	(0.000)	-0.001 ***	(0.000)
older	.	.	.	.	.	.	.	.	0.065 ***	(0.003)
|agedif|	.	.	.	.	.	.	.	.	0.002 ***	(0.000)
OS*older	.	.	.	.	.	.	.	.	-0.010 **	(0.004)
OS*|agedif|	.	.	.	.	.	.	.	.	<|0.001|	(0.000)
older*|agedif|	.	.	.	.	.	.	.	.	-0.001 ***	(0.000)
OS*older*|agedif|	.	.	.	.	.	.	.	.	<|0.001|	(0.000)
D_{twins}	-0.013 **	(0.005)	-0.014 ***	(0.005)	-0.014 ***	(0.005)	-0.014 ***	(0.005)	-0.014 ***	(0.005)
D_{CSS}	0.004	(0.004)	<|0.001|	(0.001)	<|0.001|	(0.001)	<|0.001|	(0.001)	0.002	(0.003)
DD	-0.017 ***	(0.006)	-0.014 ***	(0.005)	-0.014 ***	(0.005)	-0.015 ***	(0.005)	-0.017 ***	(0.006)

*The sample is limited to individuals who were born between 1959 and 1979 who are observed in the employment data described in the text and who have exactly one sibling born within 12, 18, 24 or 36 months of their birthdate. Standard errors are clustered on sibling pairs. *p<0.10, **p<0.05, ***p<0.01

Table 7: Quantile Regressions

Panel A: Female twins and closely-spaced singletons

	(1) 10th percentile n=78,831			(2) 25th percentile n=78,831			(3) 50th percentile n=78,831			(4) 75th percentile n=78,831			(5) 90th percentile n=78,831		
variable	*coef.*		*s.e.*	*coef.*		*s.e.*	*coef.*		*s.e.*	*coef.*		*s.e.*	*coef.*		*s.e.*
twin	0.018	***	(0.003)	0.019	***	(0.004)	0.008	*	(0.004)	0.002		(0.004)	-0.004		(0.007)
OS	-0.005		(0.004)	-0.006		(0.004)	-0.007	*	(0.004)	-0.008	*	(0.004)	0.001		(0.007)
twin*OS	-0.009		(0.006)	-0.010		(0.007)	-0.002		(0.006)	-0.009		(0.007)	-0.015		(0.011)
age	-0.009	**	(0.004)	-0.007		(0.004)	0.019	***	(0.004)	0.058	***	(0.004)	0.090	***	(0.006)
age^2	0.000	**	(0.000)	0.000		(0.000)	0.000	***	(0.000)	-0.001	***	(0.000)	-0.001	***	(0.000)
D_{twins}	-0.014	***	(0.004)	-0.016	***	(0.006)	-0.009	*	(0.005)	-0.017	***	(0.005)	-0.015		(0.009)
D_{CSS}	-0.005		(0.004)	-0.006		(0.004)	-0.007	*	(0.004)	-0.008	*	(0.004)	0.001		(0.007)
DD	-0.009		(0.006)	-0.010		(0.007)	-0.002		(0.006)	-0.009		(0.007)	-0.015		(0.011)

continued....

Table 7: Quantile regressions, continued

Panel B: Male twins and closely-spaced singletons

	(1) 10th percentile n=86,753			(2) 25th percentile n=86,753			(3) 50th percentile n=86,753			(4) 75th percentile n=86,753			(5) 90th percentile n=86,753		
variable	*coef.*		*s.e.*	*coef.*		*s.e.*	*coef.*		*s.e.*	*coef.*		*s.e.*	*coef.*		*s.e.*
twin	0.048	***	(0.006)	0.049	***	(0.005)	0.037	***	(0.004)	0.034	***	(0.005)	0.020	***	(0.007)
OS	0.002		(0.004)	0.004		(0.004)	0.003		(0.004)	0.011	**	(0.005)	0.007		(0.007)
twin*OS	-0.018	**	(0.008)	-0.015	**	(0.007)	-0.016	**	(0.007)	-0.023	***	(0.008)	-0.020		(0.012)
age	0.036	***	(0.004)	0.054	***	(0.004)	0.068	***	(0.004)	0.107	***	(0.005)	0.147	***	(0.007)
age^2	0.000	***	(0.000)	-0.001	***	(0.000)	-0.001	***	(0.000)	-0.011	***	(0.000)	-0.002	***	(0.000)
D_{twins}	-0.015	**	(0.007)	-0.012	*	(0.006)	-0.013	**	(0.005)	-0.012	*	(0.006)	-0.012		(0.010)
D_{CSS}	0.002		(0.004)	0.004		(0.004)	0.003		(0.004)	0.011	**	(0.005)	0.007		(0.007)
DD	-0.018	**	(0.008)	-0.015	**	(0.007)	-0.016	**	(0.007)	-0.023	***	(0.008)	-0.020		(0.012)

*The sample is limited to individuals who were born between 1959 and 1979 who are observed in the employment data described in the text and who have exactly one sibling born within 12 months of their birthdate. The standard errors are estimated using bootstrap resampling with 2,500 replications. *p<0.10, **p<0.05, ***p<0.01