Does Money Buy Happiness?
Evidence from Twins in Urban China*

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Abstract

This paper estimates the effect of income on individual self-reported happiness using unique Chinese twins data. To control for omitted genetic factors and family background, we use a within-monozygotic-twin-pair fixed-effects model. The instrumental variable fixed-effects method is used to correct measurement error bias. The results are robust after we address concerns about potential biases of within-monozygotic-twin-pair estimates, use various measures of income and wealth, consider the potential cross effect of twin sibling's income, and address the concern reverse causality. This paper adds to the literature on the effect of income on happiness, and to the best of our knowledge, it is the first such study which draws on twins data to correct both omitted variable bias and measurement error bias.

JEL Classifications: D1, D6, I1, I3, J3

Keywords: Income; Happiness; Twins; Fixed Effects; Instrumental Variables

1. Introduction

One of the fundamental issues in economics is whether money makes people happy. This paper presents new evidence on the relationship between self-reported happiness and income using unique twins data from China and addresses two key empirical challenges: omitted variable bias and measurement error bias.

The relationship between happiness or subjective well-being (SWB)[1] and socioeconomic status (SES), especially income, has been a focus of attention in "happiness economics" (Easterlin, 1974, 1995, 2001; Deaton, 2008; Layard, Mayraz & Nickell, 2008; Stevenson & Wolfers, 2008). But there remains no consensus. Easterlin (1974, 1995, 2001) reports that income and self-reported happiness are positively correlated across individuals within a country, but average happiness within countries does not seem to rise with economic growth over time. On the contrary, Stevensen and Wolfers (2008) use more data and find that cross-country and time-series relationships between subjective well-being and income are similar to the within-country relationship, indicating the clear role of absolute income and a lesser role of relative income in determining happiness.

Life satisfaction in transition economies and its relationship with economic growth attract attentions from economists, too. Easterlin (2009) studies the 1990s transition from socialism to capitalism in Eastern Europe and finds that life satisfaction followed the collapse and recovery of GDP, but failed to recover commensurately. Contrary to the story of Eastern Europe, China has experienced remarkable and smoother economic growth for the past three decades. However, several studies report that the Chinese's happiness or life satisfaction does not seem to increase (Burkholder, 2005; Brockmann et al., 2009; Crabtree & Wu, 2011; Knight & Gunatilaka, 2011; Easterlin et al., 2012), which may indicate that income is not the only factor determining SWB, and relative income (Easterlin, 1974, 1995,2001; Knight, Song & Gunatilaka, 2009 and Knight & Gunatilaka, 2011 for China's context) or income expectations (Frijters, Liu & Meng, 2008) may also matter. However, accompaning this puzzling pattern, for a given point of time those richer do feel happier (or more satisfied with life) than the poor, as acknowledged by Crabtree and Wu (2011) and Easterlin et al (2012). Consistent with the latter perspective, this study focuses on the cross-section aspect instead of time series evidence, but takes a further step to examine the casual effect of (absolute) income[2] on happiness.

[1] Happiness is different from other related measures of SWB (e.g., life satisfaction, mental well-being), although "happiness economics" refers to the broader literature on SWB. In this paper we focus on happiness, but also discuss studies on other SWB measures.

[2] In our data, we know respondents' city in residence but not their communities or other potential reference groups, so we can only compare respondents' incomes with those in the same city, thus

There are limitations in the literature on the effect of income on happiness. First, studies on the impact of income on happiness generally do not control for endowments that are correlated with income, thus likely confounding income effects with the effects of personality, ability, and family background (both genetic and cultural), and making the estimate biased even after controlling for the effects of observed demographic variables. Psychologists point that over time, the same individual tends to be high (or low) on the happiness scale, indicating that personality or genetic differences are the major source of variations in happiness and subjective well-being. For example, Diener and Lucas (1999) summarize that personality is the strongest and most dependable factor underlying differences in happiness among individuals.[3] Several psychological studies use twins data and estimate a dominant impact of genes on subjective well-being (Tellegen et al., 1988; Lykken & Tellegen, 1996; Nye et al., 2006; Keyes et al., 2010).[4] De Neve et al (2010) estimate that 33% of the variation in happiness is explained by genes and show evidences that a specific gene is associated with happiness. Second, measurement error in income is often severe, which attenuates the estimated effect of income on happiness. Third, causality may run from happiness to income, rather than the other way around. Therefore, ascertaining how much of the empirical association between income and happiness is due to the causal effect of income is difficult.

Given these challenges, a careful methodology is needed to examine whether economic circumstances have a causal effect on subjective well-being. The most compelling studies to date employ plausibly exogenous lotteries (Gardner & Oswald 2001, 2007; Lindahl, 2005; Apouey & Clarkm, 2010) or institutional changes (Frijters, Haisken-Denew, & Shields, 2004; Frijters et al., 2006). These studies find a positive causal effect of income. Still, these studies have their limitations. The use of lottery winners has several shortcomings, including the

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limiting our ability to evaluate the potential effect of relative income.

[3] Notably, neuroticism and extraversion go a long way in accounting for differences in levels of happiness (Hayes & Joseph, 2003).

[4] Tellegen et al. (1988) compare levels of subjective well-being for MZ and DZ (dizygotic) twins raised together and raised apart. Their study shows that 40% of the variance in positive emotionality and 55% of the variance in negative emotionality are attributable to genes, whereas shared familial circumstances account for only 22 and 2% of the observed variance, respectively. Especially, identical twins experience similar amounts of pleasant and unpleasant effects because they have exactly the same sequence of genes. Lykken and Tellegen (1996) report that between 44% and 52% of the variance in subjective wellbeing is due to genetic variation. None of the environmental variables such as education, socio-economic status, income, marriage, or religiosity could account for more than 3% of the variance. According to a subsample of the twins for which time series data were available, Lykken and Tellegen estimate that “the heritability of the stable component of subjective well-being approaches 80%.” Nes et al. (2006) study a sample of Norwegian twins and find that for both males and females, long-term stability of well-being is mainly attributable to stable additive genetic factors: additive genetic effects explain approximately 80% of the cross-time correlation.

potential direct effect of lottery winning on happiness (for the effect of mood on reported well-being, see Schwarz & Clore, 1983), small effective samples, and small income shocks. As for the fixed-effects panel data model used in conjunction with institutional changes, it cannot control for time-varying omitted variables. Powdthavee (2009) tries to solve the endogeneity problem by instrumenting for income and allowing for unobserved heterogeneity. However, his instrumental variables -- the proportions of those who either showed the interviewer their pay slip and those who have pay slip but did not show them -- are not well motivated.

In this paper, we use a cross-sectional twins dataset from urban China to examine the relationship between self-reported happiness and income. To control for the effect of omitted variables, we employ a fixed-effects (FE) model within monozygotic (MZ) twin pairs. We also use sibling-reported information as an instrumental variable, and employ instrumental variable fixed-effects (IVFE) model to correct measurement error bias magnified by the fixed-effects model. The within-MZ FE estimation and two IVFE estimations show that one standard deviation increase in logarithmic income leads to an increase of about 9%, 16% and 34% of standard deviation of happiness, respectively. Comparisons among OLS, with-MZ FE, and IVFE estimates show the existence of both omitted variables and measurement errors.

The results are also robust after we address concerns about potential biases of within-MZ-twin-pair estimates, use various measures of income and wealth, and consider the potential cross effect of twin sibling’s income. To address the potential for reverse causality, we instrument individual income with industry average income and industry wage growth. For the latter instrument, we examine a subsample of older workers for whom concerns about endogenous sorting into industries is likely less significant. The results based on both instruments support that the direction of causality runs from income to happiness.

This paper adds to the literature which empirically tests the effect of income on happiness, and to the best of our knowledge, it is the first such study which draws on twins data to correct both omitted variable bias and measurement error bias.

The rest of this paper is organized as follows. Section 2 outlines econometric specifications. Section 3 describes the data and variables. Sections 4 and 5 report the main results and the robustness checks, respectively. Section 6 concludes this paper.

2. Empirical Strategies

Our study begins with conventional cross-sectional estimates:

$$h_{1i} = X_i\alpha + \beta Y_{1i} + Z_{1i}\gamma + \mu_i + \varepsilon_{1i} \tag{1}$$

$$h_{2i} = X_i\alpha + \beta Y_{2i} + Z_{2i}\gamma + \mu_i + \varepsilon_{2i} \tag{2}$$

where h_{ji} $(j = 1, 2)$ is the self-reported happiness of the first and second twin in the pair; X_i is the set of observed variables that vary by family, but not across twins, which includes age, gender, and city dummies; Y_{ji} $(j = 1, 2)$ is the income of twin j in family i; Z_{ji} $(j = 1,2)$ is the set of variables that may vary across the twins (i.e., educational level, marital status, employment status, and self-reported health); μ_i represents a set of unobservable familial variables that also affect happiness (i.e., innate ability, common part of personality, and family background); and ε_{ji} $(j = 1,2)$ is an individual-level disturbance, representing other forces that affect happiness but are not explicitly measured.

The ordinary least squares (OLS) estimate of income effect in Eqs. (1) and (2), β , is generally biased. The bias arises because normally, we do not have a perfect measure of μ_i, which is very likely to be correlated with Y_{ji}.

3.1 The MZ Twins Strategy

A within-MZ-twin-pair fixed-effects estimator for twins is based on the first difference between Eqs. (1) and (2):

$$h_{2i} - h_{1i} = \beta(Y_{2i} - Y_{1i}) + (Z_{2i} - Z_{1i})\gamma + (\varepsilon_{2i} - \varepsilon_{1i}) \tag{3}$$

The first difference removes both observable and unobservable family effects, or X_i and μ_i. As μ_i has been removed, we can apply the OLS method to Eq. (3) without worrying about bias being caused by the omitted genetic and family background variables. We do this by taking advantage of the fact that MZ twins have the same genetic endowments at birth and have similar abilities, personalities, and family backgrounds. Twins are more alike than a randomly selected pair of individuals on a variety of socioeconomic measures. The similarities arise from many sources: common heredity, both physical and cultural; similar access to financial resources; exposure to similar influences of friends, neighbors, schools, and other aspects of their particular community; the likelihood, even in adulthood, of closer location in space and hence exposure to similar regional price differentials and common business-cycle effects; and many more. Some of these effects are measurable, but many are not or are only imperfectly so. For more details on the methodology of twins data, see Gorseline (1932), Behrman and Taubman (1976), Griliches (1979), Behrman et al. (1980), Ashenfelter and Krueger (1994), Miller, Mulvey and Martin (1995), Ashenfelter and Rouse (1998), Behrman and Rosenzweig (1999), and Bonjour et al. (2003).

The within-MZ-twin-pair strategy has two further advantages for happiness studies. First, the similarity in feelings about the sources of happiness is higher between MZ twins than between random respondents, which makes the interpersonal comparison more credible. Second, relative income may affect happiness (Clark & Oswald, 1996; Ferrer-i-Carbonell, 2005; Luttmer, 2005; Rayo & Becker, 2007; Clark, Frijters, & Shields, 2008), and the reference group of MZ twins is supposed to be more similar than that of random respondents. Hence, the first difference between MZ twins can eliminate most of the bias caused by relative income.[5]

3.2 Measurement Error Bias

Another concern is the measurement error problem. Classical errors in the measurement of income lead to a downward bias in the OLS estimate of the effect of income on happiness, and the fixed-effects estimator magnifies the measurement error bias. The measurement error of income is generally more serious (Bound & Krueger, 1991) than that of education, which is small (Ashenfelter & Krueger, 1994; Huang et al., 2009; Li, Liu & Zhang, 2012).

A straightforward and consistent estimator for Eq. (3) can be obtained by the method of instrumental variables using an independent measure of the income variable as instrument. We follow Ashenfelter and Krueger's (1994) innovation and ask each individual both his or her own and his or her sibling's incomes. The survey used is designed to provide complete information about different measures of income levels. If self-reported income is measured with error, the co-twin-reported income provides a potential instrument because the report of the other twin should be correlated with the self-reported income level but not directly correlated with happiness. Assuming Y_j^k as twin k's report on twin j's income implies that there are two different ways to use the auxiliary income information as an instrumental variable. There are four different ways to estimate the income difference ΔY:

$$\Delta Y' = Y_1^1 - Y_2^2 \tag{4}$$

$$\Delta Y'' = Y_1^2 - Y_2^1 \tag{5}$$

$$\Delta Y^* = Y_1^1 - Y_2^1 \tag{6}$$

$$\Delta Y^{**} = Y_1^2 - Y_2^2 \tag{7}$$

A straightforward and consistent estimator for Eq. (3), under the classical assumption that measurement error terms in $Y_1^1 - Y_2^2$ and $Y_1^2 - Y_2^1$ are uncorrelated, may be obtained using instrumental variables. We use $\Delta Y''$ as an instrument of $\Delta Y'$ in the following estimation equation:

$$\Delta h_i = \beta \Delta Y'_i + \Delta Z_i \gamma + \Delta \varepsilon_i \tag{8}$$

The instrumental variable fixed-effects (IVFE) method is valid when the error term in

[5] The MZ twin possibly uses his or her twin sibling's income as a reference point. We will discuss this possibility in detail in Section 5.3.

the differenced independent variable is uncorrelated with that in the differenced instrument. The above IV estimation of Eq. (8) is consistent even in the presence of common family-specific measurement errors because the family effect is eliminated through differencing. We call this instrumental variable model IVFE-1.

However, IVFE-1 estimates may still be biased if the measurement error terms in $Y_1^1 - Y_2^2$ and $Y_1^2 - Y_2^1$ are correlated. This occurs if there is an individual-specific component of the measurement error in reporting income. Typically, for example, a twin may over-report his or her own income, as well as the income of his or her twin brother or sister. To eliminate the individual-specific component of the measurement error in the estimation, the use of $Y_1^1 - Y_2^1$ as the regressor in Eq. (3) and $Y_1^2 - Y_2^2$ as the IV is sufficient (Ashenfelter & Krueger, 1994). We call this estimator IVFE-2.

3. Data

We used data derived from the Chinese Twins Survey, which was carried out by the Urban Survey Unit of the National Bureau of Statistics in June and July 2002 in five cities in China. The survey was funded by the Research Grants Council of Hong Kong. Based on twins questionnaires from the US and elsewhere, the survey covered a wide range of socioeconomic information. The questionnaire was designed by two authors of this article in close consultation with Mark Rosenzweig and Chinese experts at the National Bureau of Statistics. Same-sex adult twins aged between 18 and 65 years were identified by the local Bureau of Statistics through various channels, including colleagues, friends, relatives, newspaper advertisements, neighborhood notices, neighborhood management committees, and household records in the public security bureau. Overall, these channels permitted a roughly equal probability of contacting all twins in these cities, so the twins sample that was obtained is approximately representative. The questionnaires were completed through household face-to-face personal interviews. The survey was conducted with considerable care, and several site checks were made by Junsen Zhang and experts from the National Bureau of Statistics. After discussions with Mark Rosenzweig and other experts, data input was closely supervised and monitored by Junsen Zhang himself in July and August 2002.

This is the first socioeconomic twins dataset in China, and perhaps the first in Asia. The dataset includes rich information on the socioeconomic situation of respondents in the five cities of Chengdu, Chongqing, Harbin, Hefei, and Wuhan. All together, there are 4683 observations, 3012 of which are from twins households. There are completed questionnaires from 3002 individuals, 2996 of which are twin individuals aged 17 to 62, and 6 triplets who are not included in our estimations. For the sample of twins, care was taken to distinguish between identical (monozygotic or MZ) and non-identical (fraternal or DZ) twins based on standard questions used in prior twins surveys. We consider a pair of twins to be identical if *both* twins responded that they have identical hair color, looks, and gender. Completed questionnaires were collected from 919 pairs of MZ twins (1838 individuals) and 576 pairs of DZ twins (1152 individuals). For 824 of these MZ twins pairs (1648 individuals), complete information on both twins in the pair was obtained. Each twin was also asked some questions (e.g., income, education) about his or her twin brother or sister.

For comparison, non-twin households in the five cities were taken from regular households on which the Urban Survey Unit conducts regular monthly surveys. The Urban Survey Unit started regular monthly surveys in the 1980s. Their initial samples were random and representative, and although they have made every effort to maintain good sampling characteristics, their samples have become less representative over time. In particular, given the increasingly high refusal rate of young people, the samples have gradually become biased toward the over sampling of old people. The survey of non-twin households was conducted at the same time as the twins survey using a similar questionnaire.

In the survey, the following question was asked: Do you have such emotions (happy, etc.)? As for the item “happy” (*kuaile* in Chinese), the possible 4-scale answers were “often feel happy,” “sometimes feel happy,” “seldom feel happy,” and “never feel happy.” The wording of this question makes it closer to those measures of emotional well-being[6] rather than life evaluation or life satisfaction (Kahneman & Deaton, 2010). It is also worth noting that the wording in our survey stresses the frequency of the feeling of happiness rather than its intensity which is used in the General Social Survey (Kahneman et al., 2006).[7] As for the number of scales in the potential answers, it is smaller than the 11-scale Cantril Self-Anchoring Scale of life evaluation[8] used by the Gallup Organization in the Gallup-Healthways Well-Being Index (Kahneman & Deaton, 2010), the 11-scale measure of life satisfaction used in German Socio-Economic Panel (Frijters, Haisken-Denew, & Shields, 2004),[9] and the 36-scale General Health Questionnaire Score of mental well-being (Gardner

[6] “The frequency and intensity of experiences of joy, stress, sadness, anger, and affection that make one’s life pleasant or unpleasant” (Kahneman & Deaton, 2010).

[7] The question is “Taken all together, how would you say things are these days—would you say that you are very happy, pretty happy, or not too happy?’’

[8] The question is “Please imagine a ladder with steps numbered from 0 at the bottom to 10 at the top. The top of the ladder represents the best possible life for you, and the bottom of the ladder represents the worst possible life for you. On which step of the ladder would you say you personally feel you stand at this time?”

[9] The question is “How satisfied are you at present with your life, all things considered?” The

& Oswald 2007; Apouey & Clarkm, 2010), but larger than the 3-scale measure used in the General Social Survey mentioned above (Kahneman et al., 2006). There has been a concern on the measurement credibility of self-reported subjective well-being in the literature. Fortunately, extensive studies by Easterlin (1974, 2001), Diener (1984), Veenhoven (1993), and Kahneman and Krueger (2006) give the general conclusion that subjective indicators, although imperfect, do reflect interviewees' substantive feelings of well-being, and that the similarity among people in feelings about the sources of happiness gives credence to interpersonal comparison.[10]

Table 1 shows the distribution of self-reported happiness by five income brackets. It clearly shows that those in higher income brackets are generally more likely to report "often feel happy" and less likely to report "never feel happy" or other responses. This gives us a first impression that happiness does positively relate to income at a given time in China, as acknowledged by Crabtree and Wu (2011) and Easterlin et al (2012). Thus the main purpose of this paper is to examine whether this result holds when we conduct various econometrics analyses to explore the potential causality of income on happiness. A majority of responses were "often feel happy" (1657 cases, or 58.28%) or "sometimes feel happy" (916 cases, or 32.22%). There were few respondents in our data who answered "never feel happy" (52 cases, or 1.83%), so we combine the lowest two categories of the happiness responses and set the value of self-reported happiness as 3 if the answer was "often feel happy," 2 if "sometimes feel happy," and 1 if "seldom feel happy" or "never feel happy." However, coding happiness

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responses run from 0 (completely dissatisfied) to 10 (completely satisfied).

[10] First, respondents have little trouble answering questions about their subjective well-being. In the 1998 American General Social Survey, for example, less than 1% of the respondents refused to provide an answer or answered "do not know" for the happiness question; however, 17% of the respondents refused to provide their earnings (Kahneman & Krueger, 2006). Second, the validity of subjective well-being can be assessed by correlations documented between its measures and other characteristics of individuals, and various situations under which individuals are placed, such as objective physiological and medical criteria (Diener & Suh, 1999; Frey & Stutzer, 2002; Layard, 2005), changes in circumstances (e.g., weather and mood, see Schwarz & Clore, 1983), demographic factors (e.g., age, gender, marriage status, etc.), education (Oreopoulos, 2007), the labor market (Alesina, Glaeser & Sacerdote, 2005), unemployment and inflation (Di Tella, MacCulloch & Oswald, 2001), income (see the introduction section), institutional conditions (Frey & Stutzer, 2000; Veenhoven, 2000; Radcliff, 2001), and environmental factors (Rehdanz & Maddison, 2005; Becchetti et al., 2007). Third, significant correlations among repeated measures of life satisfaction suggest that the data may be reliable enough for many purposes (Lucas, Diener & Suh, 1996). Fourth, measures of satisfaction can predict future outcomes. For example, job satisfaction is a strong predictor of workers' subsequent turnover (Freeman, 1978). Fifth, although circumstances (Schwarz & Clore, 1983) and duration (Lucas, Diener & Suh, 1996; Kahneman & Krueger, 2006) cause fluctuations in people's answers from day to day, the idiosyncratic effects of recent, irrelevant events are likely to average out in representative population samples. As long as the idiosyncratic effects are uncorrelated with the variable that we are interested in, they will not cause any bias in the regression analyses.

as four valued does not change our qualitative results.[11]

The descriptive statistics are reported in Table 2. To compare the twins sample with other available samples, we also provide the basic statistics for a large-scale survey conducted by the National Bureau of Statistics as a benchmark.[12] Column 1 reports the means of all the variables for twins. Of these twins, 58% were males, and 69% were married. On the average, they were 36.4 years old, with 11.3 years of schooling, and with monthly incomes of 846 yuan (about USD 102 in 2002). Income included all wage and non-wage earnings. The average value of happiness was 2.49 (between "sometimes feel happy" and "often feel happy").[13] Fourteen percent of the twins were unemployed (the variable "unemployed" was defined as 1 if the individual was unemployed, 0 if working, being a student, retired, or doing housework). Health was a self-reported five-point scale variable with a higher value indicating better health conditions (1="very poor," 2="poor," 3="fair," 4="good" and 5="very good"), and the mean was 3.71 (between "fair" and "good"). Column 2 reports the summary statistics for MZ twins, with both twins having complete information (which were very similar with those of all twins). The individuals in the twins sample were younger and were earning less than those in the National Bureau of Statistics sample.[14] Finally, individuals in the non-twins sample (Column 3) were older than those in the National Bureau of Statistics sample and in the twins sample.

4. Main Results

4.1 OLS Regressions Using the Whole Twins Sample

In the first three columns of Table 3, we report the results of the OLS regressions using all twins, including MZ twins and DZ twins. The main independent variable of interest is the logarithm of monthly income,[15] and the standard errors reported in parentheses are robust to heteroscedasticity and clustering at the family level. In Column 1, we show a simple regression with income, age, age squared, gender, birth weight, history of disease symptom

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[11] Results are available upon request.

[12] The National Bureau of Statistics has been conducting an annual survey of urban households from 226 cities (counties) in China since 1986. It is the best large-scale survey of this kind. However, the NBS only allows us to use its data from six provinces, including Beijing, Liaoning, Sichuan, Shaanxi, Zhejiang, and Guangdong.

[13] 9.5% of respondents report "seldom feel happy" or "never feel happy" (with the value of happiness 1), 32.2% "sometimes feel happy" (with value 2) and the remaining 58.3% "often feel happy" (with value 3).

[14] Only one of our cities is in the NBS sample. The six provinces in the NBS sample include the three richest provinces in China, namely, Beijing, Zhejiang, and Guangdong, and so have larger average earnings than our sample.

[15] There are about 6% of people in our data with zero income, and the lowest non-zero income in our data is RMB 30. Hence, we use log (income+1) in all regressions.

occurrence before adulthood, and city dummies[16] as independent variables. Here history of disease symptom occurrence before adulthood is a dummy variable, with 1 indicating symptom occurrence of any of nine major diseases.[17] We control for birth weight and early disease history for two reasons. First, they are plausibly exogenous. Second, they may affect both income and happiness through various channels. The coefficient on logarithmic income is 0.043, which is highly precisely estimated with a standard error of 0.008.[18] An increase of one standard deviation (1.74) in logarithmic income leads to about 0.075 increase in the happiness value, which is about 11% of the standard deviation (0.66) of happiness.[19] Put in another way, doubling the income (associated with a 0.69 increase in logarithmic income) on average increases the happiness value by 0.03, or about 4.5% of the standard deviation of happiness. So the income effect is modest given the 3-scale measure; but given the small standard deviation of happiness in our data, the share of the impact from income among all covariates is not small. The negative coefficient on age and the positive coefficient on age squared are both insignificant. Females, on the average, report a happiness value 0.12 higher than males, and the estimation is very precise. Neither birth weight nor early disease history has a significant effect on happiness. In unreported specifications, we drop out controls of birth weight and early disease history, and find almost identical results to those in Column 1.[20]

When we add other control variables in the second column, including education, marital status and health, the estimated coefficient on income decreases by 28% to 0.031, but remains positive and highly significant. The negative coefficient on age and the positive coefficient on age squared become both significant. Happiness is higher among young people, declines at middle age (reaches the lowest at ages 40–50), and increases again at an older age, consistent with other studies showing that people with teenagers at home have the lowest level of life satisfaction and that satisfaction improves thereafter (Kahneman & Krueger, 2006). Females are happier, which reveals the gender difference in subjective well-being (Nolen-Hoeksema & Rusting, 1999). Education has a positive and large effect on happiness, consistent with Oreopoulos (2007) who -- using features of compulsory schooling laws as an instrumental variable for schooling -- finds that years of schooling have a causal effect on happiness.

[16] In our sample of twins in five cities, all twins live in the same city as their twin siblings. Thus we control city dummies in both OLS and within-MZ-twin fixed-effects estimates.

[17] They are migraine, pollen allergy, frequent skin rash, acoustic trauma, hypertension, neurasthenia, problems caused by drinking, cardiac problems, and dysfunction of neck, back, arms or legs.

[18] Due to the limitation of our 3-scale measure of happiness, we cannot persuasively test the potential nonlinearity of the effect of (logarithmic) income on happiness (e.g., decreasing marginal effect of income).

[19]

[20] Available upon request.

However, the OLS estimate in this study can be biased because the positive effect may be caused by other omitted factors, such as ability and family background. Consistent with most studies (e.g., Kohler, Behrman & Skytthe, 2005), marital status has a large effect: married people are happier than those divorced, widowed, or never married. However, we cannot interpret this as a causal effect and conclude that marriage is much more important than income because marriage itself is an endogenous choice that may be decided by income (and other factors). The coefficient on self-reported health, 0.11, is positive and highly significant, with an increase by one standard deviation (0.81) of health associated with an increase of happiness by 14% of the standard deviation. The dependent variable, happiness, is discrete; hence, we also conduct ordered probit estimation; the results are qualitatively similar (see Table A3 in Appendix). Thus we treat the happiness variable as continuous hereafter.

Column 2 shows that income affects happiness, even conditional on education attainment, marital status and health, etc. Specifically, it is worth noting that after we control for education, the income variable should capture the effect of those plausibly random shocks of income, i.e., after taking out those standard factors of earnings in the Mincer equation (Mincer, 1974).[21]

Non-pecuniary elements of employment, such as amenities, may be both correlated with income and happiness. Specifically, the theory of equalizing differences (e.g., Rosen, 1986) predicts that the earnings and amenities of jobs may be substitutes faced by the same worker and negatively correlated. Thus a job with higher income may have lower amenities, such as higher working hours. If this is true, then omitting such job features may underestimate the effect of income on happiness. To estimate the real effect of income on happiness, we need to control for these factors. Although we do not have full information about all these aspects, self-reported working hours is included in the survey. In the third column, we add a dummy indicating whether one works overtime (more than 40 hours a week). The coefficient on income increases slightly from 0.031 to 0.032. Working overtime is negatively associated with happiness, although the estimate is imprecise. This result is consistent with what we expect: working over time is positively correlated with income while negatively correlated with happiness, thus omitting this variable leads to a downward bias on the estimate of the effect of income on happiness, although this bias turns out to be small.

[21] In our data, tenure (defined as the number of years in full-time work since the age of 16) does not significantly affect income (see Li, Liu & Zhang, 2012). In addition, whether controlling for tenure does not change the coefficient on income. Thus in order to have more observations, we do not control for experience in reported specifications.

4.2 OLS Regressions Using the MZ Twins Sample

In this subsection, we repeat the same OLS regressions using the MZ twins sample. Comparing the OLS results from the MZ twins sample with those from the whole sample provides a means of checking the robustness of the estimated coefficients using different samples. We only use the MZ twins sample, so the sample size is reduced to 1648 observations (or 824 pairs of twins).

The regression results reported in the fifth to eighth columns of Table 2 suggest that the effect of income is larger for our MZ twins sample. The coefficient on income is 0.052 in the simple regression in Column 4. It becomes 0.039 and 0.041 in Columns 5 and 6, respectively, when other control variables are included. The estimated coefficients of most of the other variables are very similar for both samples, except that the coefficient on marriage becomes smaller.

To summarize, the OLS estimate of the effect of income is positive and significant even after controlling for many covariates. However, we still do not know how much of this effect is the true effect of income and how much is due to the effects of unobserved genetic factors or family background. In the next section, we use within-MZ-twin estimations to correct the omitted variable bias.

4.3 Within-MZ-Twin Fixed-Effects Estimation

Before we run the within-MZ-twin fixed-effects estimation, we check the distribution of happiness levels and income brackets of the 824 pairs of MZ twins in Tables A1 and A2 in the Appendix. There are 303 or 429 pairs in which the two twins have different values of happiness or belong to different income brackets, respectively; these account for 37% or 52% of all the 824 pairs.[22] These show that there is really enough variation in happiness or income between the MZ twins in the same family.

In Columns 7 to 9 of Table 3, we report the results of the within-MZ-twin fixed-effects estimation using Eq. (3). Given that MZ twins are of the same age and gender, these variables are dropped when calculating the first difference. In our sample, all twins live in the same city as their twin siblings, so the city dummies are also dropped after first difference.

The coefficients on income are about 0.033 for Columns 7 to 9, i.e., an increase of one standard deviation (1.74) in logarithmic income leads to about 0.057 increase in the happiness value, which is about 9% of the standard deviation (0.66) of happiness.

[22] In 64% of 824 twin pairs, the difference in logarithmic income is larger than 0.2 (i.e., one twin earns at least 22% more than his/her sibling).

The within-twin estimation shows that part of the effect of income, which is obtained by the OLS estimation, is the result of the effects of unobserved innate ability, personality, or family background. Note that the within-twin estimate of the effect of income is about two thirds to fourth fifths of the OLS estimate. This suggests that one fifth to one third of the OLS estimate of the return is actually due to unobserved innate ability, personality, or family effect. However, these estimates may be biased by measurement error, which we will address shortly.

Interestingly, the effect of education in OLS disappears in fixed-effects estimations, implying that education per se does not affect happiness. One might suspect that this only shows that education affects happiness completely through its effect on income, since in these specifications both education and income are put on the right hand side. To answer this concern, in unreported specifications, we do not control for income, but still find no effect of education, which shows that education really has no impact on happiness. This may be due to the high correlation between education and ability, which is verified by Li, Liu, and Zhang (2012). The formal educational system in China is very selective, and those with more schooling years are likely to be more able. Individuals with higher abilities are more likely to be happier because they have relative advantages at school, workplace, and so on. The high correlation between happiness and education shown in OLS may in fact reveal the high correlation between happiness and unobserved ability. Thus, education per se, on average, does not help improve individual happiness in China.[23] Further explorations will help provide a more complete answer.

4.4 Measurement Error

When there is a severe measurement error, the within-MZ-twin-pair fixed-effects estimation may exacerbate the measurement error bias. To correct this potential bias, we use an IVFE model. Following Ashenfelter and Krueger (1994), we ask each twin to report his or her twin sibling's income. In this study, the income cross-reported by a sibling is defined as the total annual income cross-reported by the sibling divided by 12.

We write Y_1^1 for the self-reported income of the first twin, Y_1^2 for the sibling-reported income of the first twin, Y_2^2 for the self-reported income of the second twin, and Y_2^1 for the sibling-reported income of the second twin (that is, Y_n^m, n, m=1,2 refers to the income of the nth twin as reported by the mth twin). The correlations between self and co-twin reports on the income of the same twin, or $\mathrm{Cor}\left(Y_1^1, Y_1^2\right)$ and $\mathrm{Cor}\left(Y_2^1, Y_2^2\right)$, are 0.614 and 0.582,

[23] A similar conclusion is reached outside China by Michalos (2007).

respectively, in our sample, which are much smaller than the correlations between self and co-twin reports on the education of the same twin in Ashenfelter and Krueger (1994), Huang et al. (2009), and Li, Liu, and Zhang (2012). This implies that the measurement error of income is much larger than that of education, making measurement error bias in estimate of income effect a bigger concern. However, $\mathrm{Cor}\left(Y_1^1, Y_1^2\right)$ and $\mathrm{Cor}\left(Y_2^1, Y_2^2\right)$ are high enough that the co-twin-reported level of income is a good instrumental variable for the self-reported level of income in our sample.

The IVFE-1 estimates reported in the first three columns of Table 4 show that measurement error has biased the fixed-effects estimates in Columns 7 to 9 of Table 2 downward, as in other studies in the literature. If we choose the specification with controls of education, marital status, health and working overtime (Column 3), the IVFE-1 estimate of the income effect almost doubles (from 0.033 with the fixed-effects model to 0.062 with the IVFE-1 model). This result suggests that a fraction of the variability in the reported differences in income is due to measurement error. Since we find the estimates with and without controls of birth weight and early disease are almost identical, we drop out these two controls in Table 4.

The IVFE-2 estimates reported in Columns 4 to 6 are even larger. Under IVFE-2, the coefficient on logarithmic income is 0.131 (Column 6), about four times the fixed-effects estimate.

To summarize, IVFE-1 and IVFE-2 estimates are much larger than fixed-effects estimates, which implies a measurement error bias in both OLS and fixed-effects models. According to IVFE-1 (IVFE-2) estimates, an increase of one standard deviation (1.74) in logarithmic income leads to about 0.11 (0.21) increase in the happiness value, which is about 16% (34%) of the standard deviation (0.66) of happiness.

5. Robustness Check

5.1 Potential Biases of Within-MZ-Twin-Pair Estimates

Bound and Solon (1999) examine the implications of the endogenous determination of which twin receives more formal education, and they conclude that twins-based estimation is vulnerable to the same sort of bias affecting conventional cross-sectional estimation. The resultant major concern over the within-twins estimate is whether it is less biased than the OLS estimate and is therefore a better estimate (Bound & Solon, 1999; Neumark, 1999). From this work, we can argue that although within-twins differencing removes variations in genes and family background, that is, it removes μ_i from Eq. (3), this difference may still reflect ability and personality bias because ability and personality consist of more than just genes (see, e.g., Sandewall et al., 2009) . In other words, within-twins estimation may not completely eliminate the bias of conventional cross-sectional estimation because the within-twins difference in ability and personality may remain in Eq. (3), which may be correlated with $Y_{2i} - Y_{1i}$. Other factors, such as luck in labor or marriage market, and non-pecuniary features of employment, may also be correlated with both income and happiness. If the endogenous share of variation in income comprises as large a proportion of the remaining within-twins variation as it does of the cross-sectional variation, then within-twins estimation is subject to as large an endogeneity bias as cross-sectional estimation.

Although within-twins fixed-effects estimation cannot completely eliminate the bias of the OLS estimator, it may tighten the upper bound (relative to the OLS estimation) on the effect of income when there is no measurement error in income; if this is true, IVFE estimation will tighten the upper bound when the measurement error is severe.

At length, Ashenfelter and Rouse (1998), Bound and Solon (1999), Neumark (1999), and Isacsson (2007) debate on the bias in OLS and within-twins estimations. Note that the bias in the OLS estimator depends on the fraction of variance in income accounted for by variance in unobserved ability, personality, and other factors that may also affect income, that is, $\mathrm{Cov}(Y_i, \mu_i + \varepsilon_i) / \mathrm{Var}(Y_i)$. Similarly, the bias of the fixed-effects estimator depends on the fraction of within-twins variance in income accounted for by within-twins variance in unobserved ability, personality, and other factors also affecting income, that is, $\mathrm{Cov}(\Delta Y_i, \Delta\mu_i + \Delta\varepsilon_i) / \mathrm{Var}(\Delta Y_i)$. If we are confident that income and happiness error terms are positively correlated both in the cross-sectional and within-twins regressions, and if the endogenous share of variation within a family is smaller than that between families, then the fixed-effects estimator is less biased than the OLS estimator. Hence, even if there is an ability or personality bias in the within-twins regressions, the fixed-effects estimator can still be regarded as an upper bound on the effect of income (if income, ability, and personality are positively correlated). In this case, we can credit the within-twins estimates with having tightened the upper bound on the effect of income.

To examine whether the within-twin-pair estimate is less biased than the cross-sectional estimate, we follow Ashenfelter and Rouse (1998) and conduct a correlation analysis. In Table 5a, we use the correlations of average family education over each twin pair with the average family characteristics that may be correlated with ability, personality, and family background (for example, employment status, marital status, spousal education, health, and job tenure) to indicate the expected ability (or personality, family background) bias in a cross-sectional OLS regression. We then use the correlations of the within-twin-pair differences in education with the within-twin-pair differences in these characteristics to indicate the expected ability bias in a within-twin-pair regression. If the correlations in the cross-sectional case are larger than those in the within-twin-pair case, then the ability bias in the cross-sectional regressions is likely to be larger than the bias in the within-twin-pair regressions. In Table 5b, we do a similar correlation analysis, but the main interest variable is income.

The correlation tests reported in Tables 5a and 5b suggest that the within-twin-pair estimation of the effect of income on happiness may indeed be less affected by omitted variables than the cross-sectional OLS estimation. Note that the between-family correlations are all larger in magnitude than the within-twin-pair correlations. For example, the correlation between average family education and average spousal education is as large as 0.64 (Column 1, Row 4 of Table 5a), suggesting that twins in families with high average levels of education marry highly educated spouses. This is consistent with the assumption that spousal education reflects an individual’s ability, personality, and family background. The correlation between the within-twin-pair difference in education and that in spousal education is about a quarter of the between-family correlation. Similarly, in Table 5b, the correlation between average family income and average spousal education is 0.21 (Column 1, Row 5), whereas the correlation between the within-twin-pair difference in income and that in spousal education is about one third of the between-family correlation. This suggests that to the extent that spousal education measures ability, personality, and family background, the within-twin-pair difference in income and education is less affected by these biases than average family income and education. The correlations of income and education with some other variables provide similar evidence that within-twin-pair estimation is subject to a smaller omitted variable bias. Of course, these characteristics are only an incomplete set of ability and personality measures, but the evidence is suggestive.

5.2 Reverse Causality?

The foregoing analysis does not exclude the potential possibility of reverse causality: happier people might be earning more, but people earning more are not necessarily happier. Diener et al. (2002) show that happier college students later earn more in their careers. However, their study cannot exclude the possibility that other factors lead to both happiness and higher earnings, so the causality from happiness to income is not established. Oswald, Proto, and

Sgroi (2009) confirm the causality from happiness to productivity in a laboratory setting. However, whether and to what degree their results are applicable in the real world remain unclear. On the contrary, the causality from income to happiness is better established by Gardner and Oswald (2001, 2007).

To answer the reverse causality concern, we use industry average income and industry-age average income computed from our sample as instrumental variables of own income in Columns 1 and 2 of Table 6, respectively.[24] We have 16 categories of industry in our survey[25] and define four age groups (below 25, 26-35, 36-45, and above 45). Although imperfect, these are plausible instrumental variables for two reasons. First, they are aggregate measures that are correlated with individual income but are beyond individual influences as long as the industry is large enough and supposing that they do not directly affect own happiness.[26] Second, at least part of the variation in industry wage differentials is due to rents rather than employee characteristics (Katz & Summers, 1989, among others), and part of the pattern of industry affiliations is random. In the context of China, Chen, Lu, and Wan (2009) find that inter-industry wage differentials increasingly contribute to income inequality in urban China through 1988, 1995, and 2002, mainly due to rapid income growths in monopolistic industries. This kind of IV strategy can be found in Luttmer (2005), where industry-occupation predicted earning is used as an IV of household income to identify its effect on happiness.[27] We follow previous regressions and control for self-reported health status and a dummy indicating whether working overtime.[28]

According to Columns 1 and 2, the coefficients of income are 0.083 and 0.060, respectively, and both are highly significant. In unreported regressions, we use industry-occupation-age average income as IV,[29] and we also try median income instead of

[24] The average is calculated using all observed income in each cell except own income. We drop cells that include fewer than 10 observations and use the logarithm of the average income as IV.

[25] To make full use of the sample, we define "not working" as a further category, thus having a total of 17 categories.

[26] Arguably, these industry-level median (average) incomes serve as reference points, which directly affect own happiness. Although we admit that they might not be perfect IVs, we argue that a reference group is more likely to be beyond industry. One is more likely to compare his or her own income with those in his or her city or community working in all industries, and to perceive the median (average) income of people in a similar position within his or her industry as the key factor deciding his or her earning potential.

[27] In a less related study (DiPasquale & Glaeser, 1999), the average home ownership rate within an income quartile, race, and state cell is used as an IV of individual home ownership to identify its effect on citizenship.

[28] Health and overtime status are both endogenous. We do run regressions without controlling them, and the results are similar.

[29] The advantage of this IV is that it accounts for the large wage differentials across occupations even within the same industry. However, occupation is an even more endogenous variable than industry.

average income. The results are similar.

Even if industry wage differentials entirely reflect rents, there is another potential problem: the sorting of individuals into these industries. To deal with this problem, in Column 3, we use the average annual wage growth rate of the industry over the past five years as an IV, thus restricting the sample to those aged beyond 25.[30] Given the highly dynamic nature of the Chinese economy, industrial differences in wage growth rates over a relatively long period are more exogenous and less predictable than current industry wage differentials. These growth rates are calculated using data on industry average wage from 1996 to 2001 in China Statistical Yearbook 2002, which uses the same 16 categories of industry. The coefficient on income is positively significant and is much larger (0.421) than the other two IV estimates. We also report the weak IV tests of the first stage in the lower panel of Table 4, including Shea's partial R-squared, and a weak IV test suggested by Stock and Yogo (2005). These tests show that the first two IVs are strong, whereas the third one is relatively weak. Hence, the first two coefficient estimates (0.083 and 0.060) are more reliable, whereas the coefficient (0.421) in Column 3 should be treated with caution. But it further suggests that income may have a positive causal effect on happiness.

5.3 Other Indicators of Income and Wealth

To further address concerns over the measurement error of income, we also use wage[31] (including bonus and subsidies), family income (it was reported in range in the survey, so we use scale numbers from 1 to 9, with a larger value indicating a higher total family income: 1 indicates a total family income less than 5,000 *yuan*, whereas 9 indicates a total family income larger than 110,000 *yuan*), and home ownership (the best indicator of wealth in our survey, which is equal to 1 if owner occupied, 0 if otherwise) as alternative indicators of income and wealth (Table 7). We do not have sibling-reported measures of these variables; hence, we use the within-twin fixed-effects estimation as our model. We argue that there is less concern over the measurement error for these variables because the respondents are less likely to misreport wage, scale (instead of exact value) of family income, and home ownership, either intentionally or by mistake. If this is true, our fixed-effects model reveals the true effects of these variables on happiness. As shown in Table 7, these indicators have large significant and positive effects on happiness. If we select those regressions with full

[30] We use the cutoff age of 25 because the average age at the time of the first full-time job in our sample is 20. The results are similar when an alternative cutoff (tenure>=5) is used.

[31] The lowest non-zero wage in our data is RMB 50. We exclude those with zero wages, and use log (wage) in regressions.

controls as our specifications, holding other factors constant, an increase of one standard deviation (0.55) in logarithmic wage leads to a 0.090 increase (or an increase of 14% of the standard deviation) in happiness. If family income increases from the bottom scale (1) to the top (9), the happiness value, on average, increases by 0.576 (or 85% of the standard deviation). The value of happiness will increase by about 0.147 (or 22% of the standard deviation) if one owns his or her home. The significant effect of home ownership on happiness exactly reveals the strong preference for owner-occupied housing among Chinese societies.

5.4 Twin Sibling as Negative?

As discussed in Section 3.1, relative income may affect happiness, and the reference group of MZ twins within the same family is supposed to be more similar than that of random respondents. Hence, the first difference between MZ twins can eliminate most of the potential bias caused by relative income.[32] However, if the income of twin sibling *per se* serves as a reference point, then the situation becomes more complicated. Although we believe this concern is less likely to apply due to the strong family tie in Chinese society, below we try to address it as best as we can.

In Eqs. (1) and (2), and in the foregoing analysis, we assume that the income of twin sibling has no direct effect on own happiness. To relax this assumption, the equations can be written as follows:

$$h_{1i} = X_i\alpha + \beta Y_{1i} + \delta Y_{2i} + Z_{1i}\gamma + \mu_i + \varepsilon_{1i} \tag{9}$$

$$h_{2i} = X_i\alpha + \beta Y_{2i} + \delta Y_{1i} + Z_{2i}\gamma + \mu_i + \varepsilon_{2i} \tag{10}$$

The first difference equation will then be

$$h_{2i} - h_{1i} = (\beta - \delta)(Y_{2i} - Y_{1i}) + (Z_{2i} - Z_{1i})\gamma + (\varepsilon_{2i} - \varepsilon_{1i}) \tag{11}$$

If $\delta = 0$, then the estimation of β in Eq. (3) will be the same as that in Eq. (11). However, if $\delta < 0$, then the estimation of β in Eq. (3) is upward biased; if $\delta > 0$, then the estimation of β in Eq. (3) is downward biased. Intuitively, for example, if a sibling's income has a direct negative effect ($\delta < 0$) on own happiness, then the happiness difference between MZ twins is partially due to the effect of relative income between twins. However, Eq. (3) does not account for this, thus making the estimate of own income's effect upward biased. So if $\delta \neq 0$, the estimation of β in Eq. (3) using MZ twins sample may not be used for an external inference about the effect of income on happiness for a general population.

To estimate the true β which allows a valid external inference, as well as δ, we use

[32] We know which city the twins live, but have no information at the neighborhood or community level, so we cannot test the effect of relative income.

Eqs. (9) and (10), and employ the generalized least-squares (GLS) method to overcome the omitted variable bias, which can directly estimate both the bias and the income effect.[33] The correlation between the unobserved family effect and the observables is given as follows:

$$\mu_i = (Z_{1i} + Z_{2i})\xi + X_i\eta + \omega_i \tag{12}$$

where we assume that the correlations between the family effect μ_i and the characteristics of each twin $Z_{ji}(j=1,2)$ are the same, and that ω_i is uncorrelated with $Z_{ji}(j=1,2)$ and X_i. The vector of the coefficients ξ measures the selection effect related to the family effect and individual characteristics, including all covariates in Eqs. (9) and (10) other than the incomes of both twins. After controlling for education and other characteristics of both twins, if the incomes of both twins have little extra explanation power for the omitted family effect μ_i, then the effects of own income and twin sibling's income can be simultaneously identified through the following procedure.

The reduced forms of Eqs. (9), (10), and (12) are obtained by substituting Eq. (12) into Eqs. (9) and (10) and by collecting the terms as follows:

$$h_{1i} = X_i(\alpha+\eta) + \beta Y_{1i} + \delta Y_{2i} + Z_{1i}\gamma + (Z_{1i} + Z_{2i})\xi + \varepsilon'_{1i} \tag{13}$$

$$h_{2i} = X_i(\alpha+\eta) + \beta Y_{2i} + \delta Y_{1i} + Z_{2i}\gamma + (Z_{1i} + Z_{2i})\xi + \varepsilon'_{2i} \tag{14}$$

where $\varepsilon'_{ji} = \omega_i + \varepsilon_{ji}(j=1,2)$. Equations (13) and (14) are estimated using the GLS method, which is the best of the estimators that allow cross-equation restrictions on coefficients. The GLS model is estimated by stacking Eqs. (13) and (14) and by fitting them using the seemingly unrelated regressions (SUREG) model.

The GLS estimates are shown in Table 8a. δ is positive with a mean of 0.007 in Column 3 (although it is imprecisely estimated), implying that the within-MZ-twin fixed-effects estimate by Eq. (3) may be downward biased. The true β, which takes into account the cross effect of twin sibling's income, is 0.039 and is highly significant. It is also larger than 0.033 in the fixed-effects model. The results show that twin sibling's income may positively, rather than negatively, affect own happiness, although the estimation is not precise. So twin sibling's income may not serve as a reference point for own happiness.

This finding is consistent with prevalent income transfer among siblings in China. In our sample, about 46% of twin pairs have income transfers between twin siblings.

To further study transfers between twin siblings, we conduct further regressions (Table 8b). The results show that the twin with higher income does have a positive net transfer toward his or her twin sibling. The net transfer accounts for 30% of within-twin income difference, which is a large portion. In unreported specifications, we add the squared term of

[33] This method is a variant of the approach of Ashenfelter and Krueger (1994) for twins studies.

income difference, and we do not find a nonlinear relationship. The coefficients of income difference are identical to those in Table 8b, whereas the coefficients of the squared term are very close to zero and are insignificant. These results suggest that income support between twin siblings serves as an informal insurance channel of happiness.

6. Conclusions

To estimate the causal effect of income on happiness in China, we have used a new sample of identical Chinese twins and apply a within-twin-pair fixed-effects method to correct for omitted variable bias (innate ability, personality, and family background). We have also used sibling-reported information as an instrumental variable, and employed instrumental variable fixed-effects model to adjust the measurement error bias amplified by the fixed-effects model. The within-MZ FE estimation and two IVFE estimations show that one standard deviation increase in logarithmic income leads to an increase of about 9%, 16% and 34% of standard deviation of happiness, respectively. Put another way, a one-unit increase in logarithmic income improves happiness by 0.033, 0.062, or 0.131 points on a 3-point scale, depending on the specification. This effect is smaller than the estimate by Frijters, Haisken-Denew, and Shields, but larger than those in studies using lotteries.[34]

To address potential reverse causality between happiness and income, we use industry average income and industry wage growth as instrumental variables. These results suggest that the direction of causality does run from income to happiness. Our results are also robust after we address concerns of potential biases of within-MZ-twin-pair estimates, use various measures of income and wealth, and consider the potential cross effect of twin sibling's income.

By comparing different models, we find that aside from the omitted variable bias, measurement error bias is an important issue in estimating the effect of income on subjective well-being. Self-reported income is generally imprecise in household survey data, which also applies to urban China. Our results show that measurement improvement or econometrics

[34] Frijters, Haisken-Denew, and Shields find that around 35-40 percent of the increase in life satisfaction in East Germany from 1991 to 2001 was attributable to the large increase in real household incomes, and a one-unit increase in logarithmic income leads to an increase of around 0.5 in an 11-point-scale life satisfaction measure. Gardner and Oswald (2007) estimate that a medium-sized lottery win improves mental well-being by approximately 1.4 points on a 36-point scale after 2 years (A medium-sized lottery win is between £1,000 and £120,000 in their data; the standard deviation of mental distress is not reported.) Apouey and Clark (2010) estimate that one-unit increase in logarithmic lottery prize improves mental health by 0.025 points on a 12-point scale after 2 years (the average win reported is around £170 in real 2005 Pounds; the mean and standard deviation of the mental health measure are not reported.)

refinement to correct measurement error bias should be seriously considered by future studies on any kind of income effect.

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Table 1: Distribution of Self-reported Happiness by Individual Monthly Income

	Percentage indicating happiness at individual monthly income (*yuan*) of					Observations
Response	**<200**	**200-400**	**400-800**	**800-1600**	**>1600**	
Often Feel Happy	47.99%	52.63%	56.14%	62.22%	70.45%	1,657
Sometimes Feel Happy	33.70%	35.60%	34.41%	30.70%	23.08%	916
Seldom Feel Happy	15.38%	8.98%	7.60%	5.54%	6.07%	218
Never Feel Happy	2.93%	2.79%	1.85%	1.54%	0.40%	52
Observations	273	323	1,026	974	247	Total: 2,843

Table 2: Descriptive Statistics of the Twins and Non-twins Samples

Variable	All Twins	MZ Twins (both twins have complete information)	Non-twins	NBS Sample
	(1)	(2)	(3)	(4)
Happiness	2.49	2.52	2.44	---
	(0.66)	(0.65)	(0.67)	---
Income(yuan)	846.10	856.67	947.60	1062.92
	(1039.80)	(1094.24)	(2564.66)	(840.09)
Unemployed	0.14	0.14	0.05	---
	(0.35)	(0.35)	(0.23)	---
Age	36.43	37.25	43.19	40.80
	(10.21)	(10.27)	(8.70)	(11.98)
Male	0.58	0.57	0.44	0.55
	(0.49)	(0.50)	(0.50)	(0.50)
Education	11.31	11.27	11.41	11.62
	(2.95)	(2.95)	(2.90)	(2.83)
Married	0.69	0.72	0.90	---
	(0.46)	(0.45)	(0.31)	---
Health	3.71	3.73	3.45	---
	(0.81)	(0.81)	(0.74)	---
Observations	2843	1648	1592	23288

Notes: Mean and standard deviation (in parentheses) are reported here. The first column includes all individuals from the twins sample for which we have complete information on the above variables. The second column only includes those MZ twin pairs for which we have complete information on both twins in a pair. The NBS sample comes from six provinces. Unemployed is defined as 1 if the individual was unemployed, 0 if working, being a student, retired, or doing housework. Education measures years of schooling. Married is defined as 1 if being married, and 0 otherwise. Health is a self-reported five-point scale variable with a higher value indicating better health conditions (1="very poor," 2="poor," 3="fair," 4="good" and 5="very good").

Table 3: OLS and Fixed-Effects Estimates of the Effect of Income for all Twins and MZ Twins (Dependent variable: Happiness)

Sample	All Twins			MZ Twins					
Model	OLS	OLS	OLS	OLS	OLS	OLS	FE	FE	FE
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Log(income)	0.043***	0.031***	0.032***	0.052***	0.039***	0.041***	0.033*	0.030*	0.033**
	(0.008)	(0.008)	(0.008)	(0.011)	(0.011)	(0.011)	(0.017)	(0.016)	(0.017)
Age/10	-0.106	-0.265**	-0.266**	-0.174	-0.313**	-0.318**			
	(0.105)	(0.115)	(0.115)	(0.135)	(0.149)	(0.149)			
$Age^2/100$	0.009	0.030**	0.030**	0.018	0.038*	0.038*			
	(0.014)	(0.015)	(0.015)	(0.018)	(0.019)	(0.019)			
Male	-0.115***	-0.113***	-0.113***	-0.118***	-0.117***	-0.115***			
	(0.029)	(0.029)	(0.029)	(0.036)	(0.036)	(0.036)			
Birth Weight	0.002	-0.007	-0.006	0.011	0.003	0.003	0.001	-0.001	-0.001
	(0.024)	(0.023)	(0.023)	(0.032)	(0.031)	(0.031)	(0.064)	(0.060)	(0.060)
Early Disease	0.040	0.079	0.078	0.064	0.105	0.102	-0.013	0.003	-0.006
	(0.049)	(0.049)	(0.049)	(0.066)	(0.067)	(0.067)	(0.095)	(0.097)	(0.096)
Education		0.020***	0.020***		0.020***	0.020***		0.003	0.003
		(0.005)	(0.005)		(0.006)	(0.006)		(0.014)	(0.014)
Married		0.163***	0.164***		0.136***	0.138***		0.123**	0.127**
		(0.037)	(0.037)		(0.049)	(0.049)		(0.060)	(0.060)
Health		0.113***	0.113***		0.113***	0.113***		0.107***	0.107***
		(0.017)	(0.017)		(0.022)	(0.022)		(0.031)	(0.031)
Working overtime			-0.013			-0.031			-0.053
			(0.028)			(0.036)			(0.049)
Twin pairs				824	824	824	824	824	824
Observations	2843	2843	2843	1648	1648	1648	824	824	824
R-squared	0.03	0.06	0.06	0.03	0.06	0.06	0.01	0.02	0.03

Notes: Standard errors in parentheses are robust to heteroscadesticity and for OLS clustering at the family level. * significant at 10%; ** significant at 5%; *** significant at 1%. OLS regressions include city dummies. Working overtime is a dummy indicating whether one works overtime (more than 40 hours a week). Early disease is a dummy indicating a disease symptom occurrence before adulthood. For FE specifications, each observation is the first difference between the twin pair.

Table 4: Instrumental Variable Fixed-Effects Estimates of the Effect of Income on Happiness (Dependent variable: Happiness)

	IVFE-1 ($\Delta Y''$ as IV)			IVFE-2 (ΔY^{**} as IV)		
	(1)	(2)	(3)	(4)	(5)	(6)
Log (income) ($\Delta Y'$)	0.064**	0.060**	0.062**			
	(0.028)	(0.027)	(0.028)			
Log (income) (ΔY^*)				0.122**	0.120**	0.131**
				(0.059)	(0.060)	(0.063)
Education		0.002	0.002		-0.004	-0.005
		(0.013)	(0.013)		(0.014)	(0.014)
Married		0.124**	0.128**		0.109*	0.113*
		(0.060)	(0.060)		(0.062)	(0.062)
Health		0.103***	0.103***		0.092***	0.091***
		(0.031)	(0.031)		(0.033)	(0.033)
Working overtime			-0.073			-0.082
			(0.052)			(0.053)
Twin pairs	824	824	824	824	824	824
Observations	824	824	824	824	824	824

Notes: $\Delta Y'$ is the difference between the self-reported income of twin 1 and the self-reported income of twin 2. $\Delta Y''$ is the difference between the income of twin 1 as reported by twin 2 and the income of twin 2 as reported by twin 1. ΔY^* (ΔY^{**}) is the difference between twin 1's (twin 2's) report of his or her own income and his or her report of the other twin's income. Standard errors in parentheses are robust to heteroscadesticity. * significant at 10%; ** significant at 5%; *** significant at 1%. Each observation is the first difference between the twin pair.

Table 5a: Between-Families and Within-MZ-Twin-Pair Correlations of Education with Other Variables

Between-family correlations		Within-MZ-twin-pair correlations	
	Education		ΔEducation
Unemployed	-0.1909***	ΔUnemployed	0.0035
	(<0.01)		(0.92)
Married	-0.1592***	ΔMarried	-0.0075
	(<0.01)		(0.83)
Health	0.1123***	ΔHealth	0.0667*
	(<0.01)		(0.06)
Spouse education	0.6354***	ΔSpouse education	0.1814***
	(<0.01)		(<0.01)
Tenure	-0.2653***	ΔTenure	-0.0327
	(<0.01)		(0.36)

Notes: the significance levels are in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. The between-family correlations are the correlations between average family education (average of the twins) and average family characteristics, and the within-MZ-twin-pair correlations are the correlations between the within-MZ-twin-pair differences in education and the within-twin-pair differences in other characteristics.

Table 5b: Between-Families and Within-MZ-Twin-Pair Correlations of Income with Other Variables

Between-family correlations		Within-MZ-twin-pair correlations	
	Income		ΔIncome
Education	0.2440***	ΔEducation	0.0405
	(<0.01)		(0.26)
Married	0.0110	ΔMarried	-0.0040
	(0.76)		(0.91)
Health	0.1168***	ΔHealth	0.0564
	(<0.01)		(0.11)
Spouse income	0.2953***	ΔSpouse income	0.0944*
	(<0.01)		(0.06)
Spouse education	0.2074***	ΔSpouse education	0.0686
	(<0.01)		(0.12)

Notes: the significance levels are in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. The between-family correlations are the correlations between average family income (average of the twins) and average family characteristics, and the within-MZ-twin-pair correlations are the correlations between the within-MZ-twin-pair differences in income and the within-MZ-twin-pair differences in other characteristics.

Table 6: IV Estimates of the Effect of Income on Happiness for all Twins (Dependent variable: Happiness)

	IV: industry average income	IV: industry-age average income	IV: growth rate of industry average wage over past five years (restricted to age>=25)
	(1)	(2)	(3)
Log(income)	0.083***	0.060***	0.421**
	(0.020)	(0.019)	(0.196)
Age/10	-0.288**	-0.288**	-0.408*
	(0.117)	(0.116)	(0.226)
$Age^2/100$	0.031**	0.031**	0.044
	(0.015)	(0.015)	(0.029)
Male	-0.119***	-0.115***	-0.131***
	(0.030)	(0.029)	(0.044)
Education	0.011**	0.014**	-0.014
	(0.006)	(0.006)	(0.018)
Married	0.169***	0.172***	0.138***
	(0.038)	(0.038)	(0.048)
Health	0.104***	0.108***	0.064**
	(0.018)	(0.018)	(0.029)
Working overtime	-0.052*	-0.032	-0.075
	(0.031)	(0.032)	(0.045)
Observations	2765	2765	1692
First-stage weak IV tests			
F-statistics	358.44	334.30	15.53
Critical value (10% maximal IV size)	16.38	16.38	16.38
Shea's Partial R-squared	0.17	0.18	0.01

Notes: Standard errors in parentheses are robust to heteroscadesticity and clustering at the family level. * significant at 10%; ** significant at 5%; *** significant at 1%. All regressions include city dummies. Industry average income and industry-age average income are computed from our sample. The growth rate of industry average wage over the past 5 years is calculated using the data of industry average wage from 1996 to 2001 in China Statistical Yearbook 2002. The first-stage weak IV tests follow Stock and Yogo (2005), and Shea's partial R-squared.

Table 7: Effects of Other Indicators of Income and Wealth on Happiness for MZ Twins (Dependent variable: Happiness)

	FE	FE	FE	FE	FE	FE	FE	FE	FE
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Log(Wage)	0.172***	0.161***	0.163***						
	(0.062)	(0.062)	(0.062)						
Family income				0.073***	0.070***	0.072***			
				(0.021)	(0.021)	(0.021)			
Home ownership							0.136**	0.147**	0.147**
							(0.065)	(0.065)	(0.065)
Education		0.007	0.007		-0.001	-0.001		0.003	0.003
		(0.015)	(0.015)		(0.013)	(0.013)		(0.013)	(0.013)
Married		-0.000	0.001		0.090	0.092		0.124**	0.126**
		(0.066)	(0.066)		(0.059)	(0.059)		(0.059)	(0.059)
Health		0.062*	0.061*		0.104***	0.104***		0.107***	0.107***
		(0.036)	(0.036)		(0.031)	(0.031)		(0.032)	(0.032)
Working overtime			-0.022			-0.041			-0.029
			(0.055)			(0.048)			(0.048)
Twin pairs	461	461	461	833	833	833	833	833	833
Observations	461	461	461	833	833	833	833	833	833
R-squared	0.02	0.03	0.03	0.01	0.03	0.03	0.01	0.02	0.02

Notes: Standard errors in parentheses are robust to heteroscadesticity. * significant at 10%; ** significant at 5%; *** significant at 1%. Wage includes bonus and subsidies. Family income is scaled from 1 to 9, with a larger value indicating a higher total family income: 1 indicates a total family income less than 5,000 *yuan*, whereas 9 indicates a total family income larger than 110,000 *yuan*. Home ownership equals 1 if owner occupied, 0 if otherwise. Each observation is the first difference between the twin pair.

Table 8a: Estimating the Effect of Own Income and Twin Sibling's Income on Happiness (Dependent variable: Happiness)

	GLS	GLS	GLS
	(1)	(2)	(3)
Log(income)	0.046***	0.037***	0.039***
	(0.009)	(0.009)	(0.010)
Log(twin sibling's income)	0.014	0.007	0.007
	(0.009)	(0.009)	(0.010)
Age/10	-0.161	-0.299*	-0.303*
	(0.132)	(0.155)	(0.155)
$Age^2/100$	0.017	0.036*	0.036*
	(0.017)	(0.019)	(0.019)
Male	-0.108***	-0.111***	-0.110***
	(0.038)	(0.037)	(0.038)
Education		0.003	0.003
		(0.013)	(0.013)
Sum of education		0.009	0.009
		(0.008)	(0.008)
Married		0.124**	0.128**
		(0.061)	(0.061)
Sum of married		0.006	0.005
		(0.046)	(0.046)
Health		0.108***	0.108***
		(0.033)	(0.033)
Sum of health		0.003	0.003
		(0.021)	(0.021)
Working overtime			-0.055
			(0.050)
Sum of working overtime			0.012
			(0.035)
Twin Pairs	824	824	824
Observations	1648	1648	1648

Notes: Standard errors in parentheses are robust to heteroscadesticity and clustering at the family level. * significant at 10%; ** significant at 5%; *** significant at 1%. All regressions include city dummies.

Table 8b: The effect of within-twin income difference on net transfer to twin sibling (Dependent variable: Net transfer to twin sibling)

	OLS	OLS
	(1)	(2)
Income difference	0.309*	0.304*
	(0.162)	(0.160)
Controls	NO	YES
Twin pairs	800	800
Observations	800	800
R-squared	0.03	0.04

Notes: Standard errors in parentheses are robust to heteroscadesticity. * significant at 10%; ** significant at 5%; *** significant at 1%. Control variables include within-twin differences in education, in marital status, in health status, and in the dummy indicating whether one is working overtime. Income difference is the numerical difference between own total income from last year and twin sibling's total income from last year. Net transfer to twin sibling is the numerical difference between the transfer to twin sibling last year and twin sibling's transfer last year.

Appendix

Table A1. Distribution of Happiness Levels of the MZ Twins Sample

(824 Pairs of MZ Twins)

Twin 1	Twin 2		
	Often Feel Happy	Sometimes Feel Happy	Seldom Feel Happy or Never Feel Happy
Often Feel Happy	**369**	96	29
Sometimes Feel Happy	110	**131**	17
Seldom Feel Happy or Never Feel Happy	24	27	**21**
Total	503	254	67

Table A2: Distribution of Income Brackets of the MZ Twins Sample

(824 Pairs of MZ Twins)

Twin 1	Twin 2				
	<200 *yuan*	200-400 *yuan*	400-800 *yuan*	800-1600 *yuan*	>1600 *yuan*
<200 *yuan*	**28**	14	26	16	2
200-400 *yuan*	10	**28**	33	14	0
400-800 *yuan*	23	31	**155**	64	6
800-1600 *yuan*	8	21	70	**164**	42
>1600 *yuan*	0	2	12	35	**20**
Total	69	96	296	293	70

Table A3. Ordered Probit Estimates of the Effect of Income for all Twins (Dependent variable: Happiness)

	(1)	(2)	(3)	(4)
Log(income)	0.074***	0.062***	0.053***	0.054***
	(0.013)	(0.013)	(0.013)	(0.013)
Age/10	-0.219	-0.208	-0.494**	-0.496**
	(0.190)	(0.191)	(0.209)	(0.209)
$Age^2/100$	0.020	0.022	0.056**	0.056**
	(0.026)	(0.026)	(0.027)	(0.027)
Male	-0.212***	-0.201***	-0.212***	-0.211***
	(0.054)	(0.055)	(0.055)	(0.055)
Birth Weight	0.008	0.008	-0.008	-0.007
	(0.043)	(0.043)	(0.043)	(0.043)
Early Disease	0.067	0.076	0.140	0.139
	(0.093)	(0.094)	(0.096)	(0.096)
Education		0.036***	0.038***	0.037***
		(0.009)	(0.009)	(0.009)
Married			0.292***	0.292***
			(0.066)	(0.067)
Health			0.210***	0.210***
			(0.033)	(0.033)
Working overtime				-0.022
				(0.053)
Observations	2,843	2,843	2,843	2,843

Notes: Standard errors in parentheses are robust to heteroscadesticity and clustered at the family level. * significant at 10%; ** significant at 5%; *** significant at 1%. All regressions include city dummies. Working overtime is a dummy indicating whether one works overtime (more than 40 hours a week). Early disease is a dummy indicating a disease symptom occurrence before adulthood.