Research Note

The Polygenic Risk Score of Subjective Well-Being, Self-Employment, and Earnings Among Older Individuals

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Abstract

We investigate whether the polygenic risk score (PRS) of subjective well-being (SWB), a weighted combination of multiple genetic variants which captures an individual's time-invariant genetic predisposition to SWB, influences the choice of self-employment and whether it explains differences in earnings between older self-employed and employed workers. In a sample of 4,571 individuals (50 to 65 years old) representing 14,937 individual-year observations from the Health and Retirement Study, we find that the PRS of SWB is positively associated with self-employment and earnings. However, contrary to our expectations, the positive association with earnings is not significantly different between self-employed and employed individuals.

Keywords

earnings, occupational choice, self-employment, subjective well-being, polygenic risk score

Genes appear to influence self-employment and self-employment income (Kuechle, 2019; Nofal et al., 2017; Shane & Nicolaou, 2013). However, the impact of individual genetic variants on the choice of self-employment seems to be very small (van der Loos et al., 2013). In this study, we analyze whether a combination of genetic variants influencing subjective well-being could also be helpful in explaining the choice of and income from self-employment because well-being is inherently connected with occupational choice (Backman, 2004; Brown & Lent, 2016). Subjective well-being (SWB), that is, how we feel about our lives (Diener et al., 1999), has important implications across a wide variety of life domains (e.g., Ryff, 2018). Entrepreneurship scholars increasingly focus on SWB (see Stephan (2018) for a recent review), because SWB may

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be particularly important in the work environment of the self-employed which is characterized by the presence of positive (Wiklund et al., 2019) as well as negative (Fritsch et al., 2019) experiences. As such, the vagaries of self-employment experiences could influence the self-reporting of SWB. Such self-reported measures are widely used in extant self-employment and well-being studies.

The present study represents the first attempt at examining how an individual's genetic predisposition to SWB, as measured by a polygenic risk score (PRS), is related to self-employment and earnings from self-employment.[1] The polygenic risk score of SWB is a weighted combination of multiple genetic variants that are associated with SWB. As such, it is a time-invariant measure established during conception that is related but distinct from the perceptual self-reporting of contemporaneous well-being. In this study, we ask the following two research questions: *Is the genetic predisposition to subjective well-being associated with self-employment?* and *is the relationship between the genetic predisposition to subjective well-being and income stronger in self-employment than in wage work?* For the empirical analysis of these questions, we draw on a longitudinal sample of 4,571 individuals between the ages of 50–65 years from the US Health and Retirement Study (HRS) for whom the PRS of SWB has become recently available.

In addressing these two research questions, we make the following contributions to the literature. First, our analysis of how an individual's genetic predisposition to SWB is related to entry into self-employment and self-employment performance supplements prior studies finding positive associations between well-being and performance (Ayala & Manzano, 2014; Gorgievski et al., 2014; Örtqvist et al., 2007) as well as the limited but steadily increasing number of studies examining how biological and genetic factors are related to self-employment and the entrepreneurial process (Nicolaou & Shane, 2014; Nicolaou et al., 2019; Nofal et al., 2018; van der Loos et al., 2013). By leveraging recent work from the field of molecular and behavioral genetics regarding how complex combinations of genetic markers can be used to predict specific outcomes (Dudbridge, 2013), we are the first to examine how someone's genetic predisposition to SWB is related to entrepreneurial performance. Our results provide initial evidence supporting the role of the genetic predisposition of SWB in predicting the likelihood of self-employment and earnings from self-employment, and as such are informative for the until now unsuccessful attempts to identify genetic variants which are associated with self-employment and entrepreneurship (Nicolaou et al., 2011; van der Loos et al., 2011).

Second, we establish a relevant baseline by considering the relationship between the genetic predisposition to SWB in self-employment and regular employment simultaneously. As opposed to prior studies (Korpi, 1997; Larson, 1978), we can, therefore, tease out if any observed relationships are unique to self-employment or similar between these two types of employment. In doing so, we rely on the time-invariant genetic predisposition to SWB as well as performance measures which were subjected to intensive checks to ensure their reliability, because those with a brighter outlook on life, in general, may also view their own performance more favorably (Luthans et al., 2007).

Finally, we show how a combination of genetic variants (i.e., a polygenic risk score) provides an additional mode of studying the role of genes in self-employment. Earlier studies on this topic have mainly drawn on twin samples (Nicolaou & Shane, 2014; Shane & Nicolaou, 2013, Shane & Nicolaou, 2015) or have analyzed individual genetic variants (Nicolaou & Shane, 2011; van der Loos et al., 2011, 2013). Despite the growing popularity of using PRSs in social science research, we find that the PRS of SWB does not contribute to significantly explaining differences in earnings between wage employment and self-employment. However, with small effects, it is associated with self-employment. We caution that the low explanatory power of the PRS of SWB in the current study, which is consistent with findings in other PRS studies (Duncan et al., 2019), may increase the odds of our results for self-employment being a false positive and the results for income being a false negative. Though we conduct a variety of robustness checks to lower these concerns, we are reticent to infer the strong effects of the PRS of SWB on entrepreneurial outcomes. As such, our study can be considered as a benchmark for determining the added value of PRSs for self-employment and entrepreneurship studies.

Theory and Hypotheses

For decades, psychologists have been interested in the relationship between well-being on the one hand and occupational choice and work performance on the other. Across a variety of theories, the industrial-organizational psychology literature identifies a number of mechanisms responsible for these relationships (e.g., Iaffaldano & Muchinsky, 1985; Tett & Meyer, 1993). Our study is distinct from this prior research because we focus on more distal processes (the genetic predisposition to SWB). As such, our research builds on overall insights of this literature but does not constitute a test of any previously identified mechanism.

The Genetic Predisposition to Subjective Well-Being

There is a variety of methods that have been employed to measure the well-being construct, ranging from single-item measures (Andrews & Withey, 2012; Kammann & Flett, 1983) to multi-item scales (Diener et al., 1985; Yardley & Rice, 1991). Although a substantial amount of the literature has been based upon multi-item measures (Allen et al., 2000; McKee-Ryan et al., 2005), research from the field of economics provides support for the validity of single-item measures (Nikolaev & Burns, 2014; Tella et al., 2001, 2003). In addition, evidence from the field of medicine suggests that there are various biological and physiological factors that could also be used as measures of individual happiness and well-being (Steptoe et al., 2005).

In this study, we draw on such a biological measure namely the genetic predisposition to SWB. Heritability studies have shown that genes have a profound impact on self-employment (Nicolaou et al., 2008; Quaye et al., 2012; van der Loos et al., 2010), but associations between specific genetic variants and self-employment have been proven difficult to detect because of the small effect size of *single* genetic variants (van der Loos et al., 2013). Based on the inherent connection between work and well-being (Li et al., 2016), here we examine the association between SWB and self-employment by employing a PRS which captures the genetic predisposition to SWB and which is based on *multiple* genetic variants.

Substantial research has been done in an effort to identify single-gene influences underlying complex biochemical processes and traits (Karp et al., 2000; Schadt et al., 2005). In so-called genome-wide association studies (GWASs), relationships are being analyzed between individual genetic variants and traits. Results obtained with GWAS "have proven highly replicable, both within and between populations" (Visscher et al., 2017: page 7–8). In 2016, the first three robust associations between individual genetic variants and SWB were identified (Okbay et al., 2016). The explanatory power of the genetic variant with the largest R^2 (variance explained) is only 0.01%. These tiny effect sizes are comparable to genetic effects found for other complex traits (Visscher et al., 2017). Therefore, there has been a surge in interest regarding how variations in complex groups of genetic markers can help to predict specific traits and diseases (Dudbridge, 2013). One such approach is the construction of so-called polygenic risk scores (PRSs). To construct a PRS, all genetic variants in a sample are summed up in a weighted fashion in which each weight is proportional to the strength of the association estimated in the GWAS (The International Schizophrenia Consortium, 2009). Not surprisingly, the resulting PRS has larger explanatory power than an individual genetic variant. For example, Okbay et al. (2016) find that their PRS of SWB explains 0.9% of the variance in SWB. Similar levels of explained variance are found in other recent studies leveraging PRSs to predict later life socioeconomic outcomes (Barth, Papageorge, Thom, 2020; Belsky et al., 2018, 2019; Karlsson Linnér et al., 2019; Rimfeld et al., 2018).

The use of a PRS of SWB in our study provides a number of key advantages. PRSs constitute a time-invariant measure that does not vary because of external environmental factors or individual experiences and the plausibility of reverse causality is low when using a PRS to explain some outcome. Specifically, because the genetic code is established prior to birth, the PRS of SWB represents a time-invariant predisposition to SWB that is established prior to any work experiences or life events. As such, this allows us to make stronger inferences regarding the direction of the relationship between genetic predisposition to SWB and self-employment.

The Genetic Predisposition to Subjective Well-Being and Self-Employment

Well-being is associated with job turnover and turnover intentions, with the vast amount of the evidence suggesting that people with a more positive outlook on life and work are less likely to change jobs (see e.g., Zimmerman (2008) for meta-analytic evidence). By definition, those with higher well-being tend to view their world more positively. Because they pay greater attention to positive cues and are less sensitive to negative ones, on average they experience greater job-person fit regardless of their occupation. They are also more likely to interpret and experience various workplace events in a positive way, which leads them to become more committed to their careers and workplaces, making them more prone to stay rather than seeking alternative employment (Weiss and Cropanzano (1996)).

Predisposition to SWB is associated with elements of self-employment -- curiosity (Jovanovic & Brdaric, 2012), creativity (Amabile et al., 2005), risk-taking () internal locus of control (Kulshrestha & Sen, 2006) and autonomy (Sheldon et al., 2005). All these characteristics are of central importance for entrepreneurship (Miner, 2000). Thus, people with a higher genetic predisposition to SWB could experience a particularly high job-person fit in self-employment. Also, self-employment allows for greater levels of autonomy and control, as well as high alignment between individual/occupational values and beliefs, which resonates with aspects of life sought out by people predisposed towards higher SWB. Additionally, predisposition to SWB could be linked to positive affect, which could broaden the thought repertoires that individuals could retrieve for work (Fredrickson & Branigan, 2005) which can increase creativity and innovativeness (Amabile et al., 2005).

Indeed, this link between SWB and specific characteristics of entrepreneurship could help shed light on previous evidence regarding the association between genes and entrepreneurship. Whereas prior research has provided evidence that genes influence a range of operationalizations of entrepreneurship (Nicolaou & Shane, 2009, 2011; Nicolaou et al., 2008), not much is known about the mechanisms explaining these associations. As such, it is possible that the analysis of the genetic predisposition to SWB could shed light on how genes influence self-employment. Taken together, the above suggests that those predisposed towards higher SWB will be more attracted to self-employment, and more likely to remain in self-employment once having made this career choice. Based on this reasoning, we propose the following:

> ***Hypothesis 1:*** *The genetic predisposition to subjective well-being is positively related to the likelihood of engagement in self-employment (versus wage work).*

Genetic Predisposition to Subjective Well-Being and Earnings

In addition to the positive association that the PRS of SWB can have with the likelihood that individuals engage in self-employment, it is also possible that it is positively related to individual earnings. Well-being positively influences a number of life aspects, including providing benefits on work performance within organizational settings (De Neve et al., 2013). For instance, workers with higher levels of SWB have been shown to be more curious and creative (Ashby et al., 2002), and experimental evidence indicates that individuals who are placed in a positive mood have greater levels of creativity and cognitive flexibility (Baas et al., 2008). Building upon this perspective, we postulate that the PRS of SWB will have an important relationship with earnings.

A predisposition towards SWB could be positively related to a range of work aspects that can influence earnings, and related outcomes such as productivity, lower absenteeism, collaboration, and peer-rated performance (De Neve et al., 2013). Indeed, prior evidence has indicated that well-being is positively related to job performance (Wright & Cropanzano, 2000) and that happiness often promotes overall career productivity (Robertson & Cooper, 2011) and success (Boehm & Lyubomirsky, 2008). Additionally, well-being has been linked to several important business outcomes (Harter et al., 2003), and can also serve to moderate other relationships that enhance job performance (Wright et al., 2007). Finally, a lack of well-being positively predicts job turnover (Wright & Bonett, 2007), further substantiating the potential relationship between well-being and work performance.

It has been shown that individuals with higher levels of well-being can access a greater level of cognitive and affective resources (Hobfoll, 2001), which could further enhance performance, thereby increasing earnings. Additionally, well-being has also been linked to a reduction in the likelihood that individuals will experience burnout as a result of work (Wright & Hobfoll, 2004), which could also prove beneficial to performance and earnings. Furthermore, well-being can also serve to positively moderate the relationship between job satisfaction and job performance (Wright et al., 2007), thereby enhancing earnings. Also, meta-analytical evidence suggests that job satisfaction is positively related to earnings (Judge et al., 2010). Well-being is a prominent factor in determining the number of life aspects, including individual income (De Neve et al., 2013). Based on this reasoning, we propose the following.

Hypothesis 2: *The genetic predisposition to SWB is positively related to earnings (for both employed and self-employed individuals).*

The Moderating Effect of Self-Employment

Although the PRS of SWB is expected to have a positive relationship with individual earnings in general, it is likely to be of particular importance for those who are self-employed. Because factors such as innovation are so important for success in entrepreneurial endeavors (Baron & Tang, 2011), it is possible that well-being could be a particularly valuable resource for individuals who are self-employed. Moreover, considering the higher levels of failure inherent in entrepreneurship (Shepherd, 2009), the ability to persist in the face of adversity that can result from higher levels of well-being might play a critical role in the ultimate success of individuals who are self-employed.

In regards to the association that the genetic predisposition to SWB can have with regards to self-employed individuals versus those in wage-earning positions, it is likely that individuals who are self-employed will experience even greater benefits from a performance perspective as a result of a higher predisposition to SWB. Predisposition to SWB is especially beneficial given that self-employed individuals experience higher levels of well-being than individuals employed in wage-earning occupations (Andersson, 2008) and that indeed they are often more satisfied with their jobs (Blanchflower, 2004). Furthermore, increased well-being among individuals who pursue entrepreneurial endeavors has been shown to be particularly beneficial to new venture performance (Hmieleski & Baron, 2009). Additionally, SWB could be a crucial form of individual human capital that is uniquely valuable in terms of potential success within the context of self-employment (Hmieleski & Carr, 2007; Markman & Baron, 2003). Endowed with such a predisposition, the self-employed could realize higher performance gains in terms of higher human capital and improved performance. Taken together, this suggests that while the genetic predisposition to SWB could be beneficial in general as it relates to work performance (Hypothesis 2), it is likely that it will have a greater influence on performance (i.e., earnings) for self-employed individuals than for wage-earning individuals. Based on this reasoning, we propose the following.

> ***Hypothesis 3:*** *Self-employment moderates the positive relationship between genetic predisposition to SWB and earnings, such that the relationship is more positive for the self-employed.*

Data and Methods

Sample

For our empirical analyses, we draw on data from the US Health and Retirement Study (HRS). The HRS is a representative panel of Americans over 50 and their spouses and is supported by the National Institute on Aging and the Social Security Administration. The target population in the first wave of HRS in 1992 were community-dwelling, noninstitutionalized adults in the contiguous United States and born between 1931 and 1941 drawn at the household financial unit level using a multistage, national area clustered probability sampling (Fisher & Ryan, 2018; Sonnega et al., 2014). A total of 43,478 individuals were interviewed biennially between 1992 and 2016 (Fisher & Ryan, 2018; Sonnega et al., 2014). Periodically, new cohorts of individuals were added. The HRS is geared toward assessing job status and health in the later years of participants' lives. The study also collects a variety of data on income, assets, work, retirement planning, health, and cognitive functioning. For additional details on the data collection steps over time, we refer to Sonnega et al. (2014).

Despite the plausible limitations of the HRS focus on individuals over 50 years of age and their spouses, the sample offers several advantages. First, the HRS collected genetic data from their participants and hence provides a fairly unique opportunity to analyze the PRS of SWB in a longitudinal sample that enables controlling for a variety of individual confounds. Second, by restricting the sample to individuals between 50 and 65 years old, we focus on an increasingly important part of the working-age population in the US. According to a 2017 report from the Bureau of Labor Statistics, starting in the 1990s, "older workers began to increase their share of the labor force, while workers in younger age groups started to have declined in their labor force shares" and "workers in older age groups have higher rates of self-employment than do workers in younger groups" (Toossi & Torpey, 2017). As such, our sample represents an age segment that actively participates in the labor force and in self-employment.

In 2006, the HRS started to collect blood and saliva samples, which eventually resulted in the release of genetic information from consented respondents in 2012 (Health and Retirement Study, 2012). Following the recommendations of the genotyping center, we restrict the analysis sample first to individuals from European-ancestry (Health and Retirement Study, 2012). We further only include individuals between 50 and 65 years of age, those who reported being not retired, engaged in work, and having earnings unequal to zero. We impose these restrictions to ensure that we focus on individuals active in the labor market and that our results are not influenced by preferences to continue work after the retirement age of 65 + in the US. Based on subsequent pairwise deletion for all the variables in the analysis, the final sample includes 4,571 individuals representing 14,937 individual-year observations. In the sample 706 individuals were self-employed (1,209 individual-year observations) and 4,130 individuals were wage earners (13,728 individual-year observations). The sum of the number of self-employed individuals and wage employed individuals is larger than the number of individuals in the full sample because some individuals have been switching between self-employment and wage employment during the period of observation.

Measures

Dependent Variables

For testing Hypothesis 1, the dependent variable in our analysis is the self-employment status of an individual. In HRS the participants were asked, "whether self-employed" (0 = not-self-employed; 1 = self-employed). Self-employed individuals are coded as 1, and those who are working for a wage are coded as 0. For testing Hypothesis 2 and 3, our dependent variable is total earnings in dollars. The individual earning is the sum of total income from wages, salary, income, incentive pay, income from professional practice and trade and from the second job or military reserve earnings. The measure of earnings is reliable and derived through checks and balances during the data collection process (Moon & Juster, 1995). The respondents were interviewed biennially and in case of a major shift in reported income from the previous wave additional questions were asked to the respondent. Research matching the self-reported income in the HRS with the W-2s (i.e., annual income statement for tax filing purposes) found that that "broadly speaking, the empirical findings are qualitatively consistent with the findings of previous studies [matching reported income with income in archival sources] and mean measurement error … is somewhat larger than what has been found in the CPS, PSID, and SIPP, but is still modest, averaging 0.059 log points, approximately 5.9 percent, or $1,500" (Bricker & Engelhardt, 2008, p. 40). We log-transform this variable, because of its skewness.

Predictor Variable

Our main predictor is the PRS of SWB (additional details about its construction are provided in the Appendix). In the HRS, approximately 700,000 genetic variants (so-called single nucleotide polymorphisms "SNPs") have been used to construct the PRS (Ware et al., 2018). The weights used in the construction of the PGS used in the present study results from the study by Turley et al. (2018) who amended the earlier mentioned GWAS of SWB conducted by Okbay et al. (2016).[2] The PRS follows a normal distribution in the population (Ware et al., 2018). We standardized the PRS to have a mean of 0 and a standard deviation of 1 in the analysis sample in order to be able to interpret the effects in terms of changes resulting from a one standard deviation change in the PRS.

Control Variables

It is standard in genetic studies to include these components to control for subtle population stratification in the sample (Rietveld et al., 2014).[3] Therefore, in addition to the PRS of SWB, we include 10 principal components of a genetic relationship matrix (Turley et al., 2018). Furthermore, we control for sex (=2 for female and =1 for male). Age (in years) is included to control age-related factors driving self-employment or earnings. To control for endowment effects, we included a lagged log of household assets. We also control for self-reported health (1-poor to 5-excellent). To control for human capital, we include educational categories (1-less than high school; 2-GED; 3-high-school graduate; 4-some college; 5-college and above). Partner status is coded for as 1 if living together with a partner, and 0 if not. We also include wave dummies.

Analysis

Because the polygenic SWB score is a time-invariant variable, we use a random-effects panel regression to model the relation between our predictor variables and the dependent variables. The self-employment status of the respondent is the dependent variable in the regression testing of the first hypothesis. For testing the second hypothesis, the dependent variable is the logarithm of individual yearly earnings. We report both results of regression specification with and without the control variables.

Results

Summary Statistics

Table 1(a) presents the sample descriptives for the full sample, and for the subsamples of self-employed and wage workers separately. In total, there are 14,937 individual-year observations from 4,571 unique respondents. About 8.1% of the sample (in terms of individual-year observations) is self-employed. Consistent with past works on lower earnings among self-employed individuals, those in self-employment have lower earnings than those in wage work. They are more often male, have no discernible differences in age, more frequently living with a partner, have higher education, and have no discernible differences in self-reported health. In Table 1(b), we present the bivariate correlations between the main variables in the full sample. Most importantly, the PRS of SWB is significantly correlated with self-employment ($r = .022$, $p < .01$) and earnings ($r = .043$, $p < .01$).

The Explanatory Power of the PRS of SWB

Before testing our hypotheses, we investigated the explanatory power of the PRS of SWB on contemporaneously self-reported SWB. We constructed the self-reported SWB measure by taking the sum of binary responses to four items of the CES-D depression scale: "Now think about the past week and the feelings you have experienced. Please tell me if each of the following was true for you much of the time during the past week": i) You were happy?, ii) You felt lonely? (reverse coded), iii) You enjoyed life?, iv) You felt sad? (reverse coded). Cronbach's α for these four items is 0.70. The correlation between PRS SWB and self-reported SWB was 0.035 ($p < .001$). A random effect panel regression with SWB as the dependent variable, the PRS of SWB as the independent variable, and the 10 principal components as control variables for possible population stratification, shows that the PRS of SWB explains 0.83% of the differences across individuals in SWB ($p < .001$). This figure is reasonably close to the 1.0% ($p < .001$) Turley et al. (2018) report based on a similar regression in the HRS although without imposing our sample restrictions. Hence, our PRS of SWB explains 10% to 20% of the heritability of SWB which is captured by SNPs (which is estimated to be between 5% and 10% by van der Loos et al., 2013). The relatively low explanatory power can increase if the GWAS for SWB which provides the weights for the PRS will increase in sample size (Dudbridge, 2013), but is also indicative of the transient assessment of self-reported SWB throughout the data collection waves. The self-reports may be prone to measurement errors and relatively sensitive to concurrent life conditions.

Table 1. Summary Statistics of the Analysis Sample.

Table 1(a): Descriptive Statistics Analysis Sample.

	Full sample $N_{individuals} = 4,571$ $N_{individual\text{-}year} = 14,937$				Self-employed individuals $N_{individuals} = 706$ $N_{individual\text{-}year} = 1,209$				Wage employed individuals $N_{individuals} = 4,130$ $N_{individual\text{-}year} = 13,728$			
	Mean	S.D.	Min.	Max.	Mean	S.D.	Min.	Max.	Mean	S.D.	Min.	Max.
Self-employment	0.081	0.273	0.000	1.000	1.000	0.000	1.000	1.000	0.000	0.000	0.000	0.000
Log(earnings)	10.284	1.005	2.197	14.170	9.831	1.555	2.398	13.710	10.324	0.931	2.197	14.170
Polygenic risk score of SWB	0.004	0.044	−0.164	0.159	0.007	0.042	−0.116	0.138	0.004	0.044	−0.164	0.159
Sex (1 = Male; 2 = Female)	1.577	0.494	1.000	2.000	1.439	0.497	1.000	2.000	1.590	0.492	1.000	2.000
Age (years)	58.173	3.814	50.000	65.000	58.582	3.786	50.000	65.000	58.137	3.815	50.000	65.000
Lagged household assets	11.938	1.528	0.000	18.323	12.685	1.552	5.303	17.312	11.873	1.509	0.000	18.323
Self-reported health	2.297	0.922	1.000	5.000	2.146	0.936	1.000	5.000	2.310	0.920	1.000	5.000
Education: Less than high school	0.067	0.251	0.000	1.000	0.063	0.253	0.000	1.000	0.068	0.252	0.000	1.000
Education: GED	0.042	0.200	0.000	1.000	0.034	0.181	0.000	1.000	0.042	0.201	0.000	1.000
Education: High-school graduate	0.324	0.468	0.000	1.000	0.249	0.433	0.000	1.000	0.330	0.470	0.000	1.000
Education: Some college	0.263	0.440	0.000	1.000	0.297	0.457	0.000	1.000	0.260	0.439	0.000	1.000
Education: College and above	0.305	0.460	0.000	1.000	0.357	0.479	0.000	1.000	0.300	0.458	0.000	1.000
Partner status (1 = Yes; 0 = No)	0.778	0.416	0.000	1.000	0.812	0.391	0.000	1.000	0.775	0.418	0.000	1.000

Notes. S.D. = Standard Deviation; Min. = Minimum; Max. = Maximum; Descriptive statistics for the wave dummies and the 10 principal components are not reported here but are available upon request from the authors.

Table 1(b): Bivariate correlations in the (full) analysis sample.

		1	2	3	4	5	6	7	8	9	10	11	12	13
1	Self-employment	1.000												
2	Log(earnings)	−0.134***	1.000											
3	Polygenic risk score of SWB	0.022***	0.043***	1.000										
4	Sex (1 = Male; 2 = Female)	−0.083***	−0.306***	−0.023***	1.000									
5	Age (years)	0.032***	−0.012	0.022***	−0.102***	1.000								
6	Lagged household assets	0.145***	0.190***	0.036***	−0.035***	0.077***	1.000							

(Continued)

Table 1. Continued

Table 1(b): Bivariate correlations in the (full) analysis sample.

7	Self-reported health	−0.049***	−0.110***	−0.077***	−0.026***	0.062***	−0.195***	1.000						
8	Education: Less than high school	−0.006	−0.134***	−0.009	−0.23***	0.030***	−0.177***	0.141***	1.000					
9	Education: GED	−0.011	−0.086***	−0.019***	−0.010	0.001	−0.121***	0.085***	−0.056***	1.000				
10	Education: High-school graduate	−0.047***	−0.186***	−0.034***	0.079***	−0.012	−0.116***	0.072***	−0.186***	−0.144***	1.000			
11	Education: Some college	0.023***	0.006	−0.003	0.052***	−0.025***	0.019***	−0.010	−0.161***	−0.124***	−0.413***	1.000		
12	Education: College and above	0.034***	0.293***	0.051***	−0.114***	0.019***	0.249***	−0.177***	−0.178***	−0.138***	−0.458***	−0.395***	1.000	
13	Partner status (1 = Yes; 0 = No)	0.024***	0.045***	0.030***	−0.157***	−0.085***	0.238***	−0.047***	0.000	−0.008	−0.018***	−0.004	0.025***	1.000

Notes. ***$p < .01$, **$p < .05$, *$p < .10$; Bivariate correlations for the wave dummies and the 10 principal components are not reported here but are available upon request from the authors.

Main Results

Hypothesis 1 proposed that the PRS of SWB is positively associated with the choice of self-employment. Both in the model without (Column 1) and with (Column 2) the control variables the coefficient for the PRS of SWB is positive and statistically significant. The inclusion of the control variables reduces the magnitude of the coefficient a little, but it remains sizeable and statistically significant. The full model (Column 2) indicates that at the sample mean, a one-tenth of standard deviation increase in the PRS of SWB is associated with 2.67 times higher odds of being self-employed (compared to being wage worker). Hence, we find support for the first hypothesis.

Regarding the second hypothesis, we find a positive and significant coefficient for the PRS of SWB in the model explaining the logarithm of earnings both in the model without (Column 3) and with (Column 4) control variables. The inclusion of the control variables reduces the coefficient by around 40% but it remains statistically significant. Column 4 of Table 2, the regression results including the control variables, indicates that a one-tenth standard deviation increase in the PRS of SWB is related to an 8.09% increase in earnings for both the self-employed and wage employed workers. Hence, we find support for the second hypothesis. The inclusion of self-employment as the explanatory variable in the model (Column 5 and 6) does not change this conclusion. We note that self-employment itself is negatively associated with earnings, which correspond to earlier findings in the literature.

Hypothesis 3 proposed that self-employment moderates the positive relation between PRS of SWB and earnings, such that the relationship is more positive in self-employment. However, columns 7 and 8 of Table 2 indicate that the interaction term between the PRS of SWB and self-employment is not statistically significant. Hence, we do not find support for Hypothesis 3. We note that in the behavioral genetics literature, there is some discussion about the correct specification of an interaction term in Gene × Environment (G × E) studies. Keller (2014) proposed that models testing for interactions should also incorporate interactions of the genetic factors with environmental factors to be sure that the coefficients for G × E interaction are not biased. Following this proposal, our conclusion regarding Hypothesis 3 does not change.

Robustness Checks

The Age Composition of the Sample

Our sample excludes retirees, however, it does not rule out the effects of closeness to retirement benefits and continuation in the workforce affect our results. Therefore, we repeated our analyses, but restrict the sample to those aged between 50 and 60 (instead of 65). The estimates for Hypothesis 1 (Table 3, Column 1), and for Hypothesis 2 (Table 3, Column 2) are consistent with the main results, although the statistical inference is weaker. Hence, the marginal significance seems to be driven by the smaller sample rather than other effects. Again, we do not find evidence for Hypothesis 3. Overall, we conclude that our main results are not driven by retirement considerations.

The Effect of Self-Reported Subjective Well-Being

In the main analysis, we excluded the control for self-reported subjective well-being to lower amplification effects from the on-going effects of self-reported well-being. To assess if our findings are an artifact of this exclusion, we included self-reported SWB in the regressions. Models 4–6 in Table 3 indicate that the inclusion of SWB barely changes the estimated coefficients for the PRS of SWB, and hence that someone's genetic predisposition to SWB seems to impact behavior beyond contemporaneous SWB. Hence, our conclusions regarding the hypotheses do not change.

Table 2. Results of the Random Effects Panel Regression Explaining Self-Employment and the Logarithm of Earnings.

	Self-Employed		Logarithm of Earnings					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Polygenic risk score of SWB	4.859***	3.285**	0.959***	0.593**	1.051***	0.667**	0.987***	0.572**
	(1.259)	(1.542)	(0.329)	(0.286)	(0.323)	(0.278)	(0.326)	(0.275)
Self-employment					−0.471***	−0.548***	−0.475***	−0.554***
					(0.052)	(0.050)	(0.052)	(0.050)
Polygenic risk score of SWB × Self-employment							0.595	0.890
							(1.149)	(1.109)
Sex (1 = male; 2 = female)		−1.043***		−0.637***		−0.662***		−0.662***
		(0.138)		(0.025)		(0.025)		(0.025)
Age		0.024		−0.016***		−0.016***		−0.016***
		(0.019)		(0.002)		(0.002)		(0.002)
Log of household assets (lagged)		0.660***		0.018**		0.030***		0.030***
		(0.084)		(0.007)		(0.007)		(0.007)
Self-reported health		−0.087		−0.026***		−0.029***		−0.029***
		(0.077)		(0.009)		(0.009)		(0.009)
Education: Less than high school		*Reference*		*Reference*		*Reference*		*Reference*
Education: GED		−0.047		−0.009		−0.014		−0.014
		(0.418)		(0.075)		(0.072)		(0.072)
Education: High-school graduate		−0.473*		0.187***		0.177***		0.176***
		(0.284)		(0.047)		(0.047)		(0.047)
Education: Some college		0.008		0.378***		0.380***		0.379***
		(0.288)		(0.050)		(0.049)		(0.049)
Education: College and above		−0.341		0.728***		0.724***		0.724***
		(0.292)		(0.051)		(0.050)		(0.050)
Partner status		0.066		−0.029		−0.027		−0.027
		(0.192)		(0.026)		(0.025)		(0.025)

(Continued)

Table 2. Continued

	Self-Employed		Logarithm of Earnings					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Wave dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Principal components	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	14,937	14,937	14,937	14,937	14,937	14,937	14,937	14,937
Number of individuals	4,571	4,571	4,571	4,571	4,571	4,571	4,571	4,571
p-value (χ^2)	0.009	<.001	0.009	<.001	<.001	<.001	<.001	<.001
R^2 (overall)			0.004	0.224	0.023	0.255	0.023	0.256

Notes. Standard errors in parentheses; ***$p < .01$, **$p < .05$, *$p < .10$; Coefficients for the constants, wave dummies and the 10 principal components are not reported here but are available upon request from the authors.

Table 3. Results of the Random Effects Panel Regression Explaining Self-Employment and the Logarithm of Earnings (Robustness Checks).

	Robustness Check 1: Individuals Aged 50–60			Robustness Check 2: Inclusion Self-Reported SWB			Robustness Check 3: Individuals Working >20 Hr Per Week		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Self-employed	Logarithm of earnings	Logarithm of earnings	Self-employed	Logarithm of earnings	Logarithm of earnings	Self-employed	Logarithm of earnings	Logarithm of earnings
Polygenic risk score of SWB	3.629*	0.479	0.450	3.248**	0.595**	0.574**	4.009**	0.469*	0.419*
	(1.945)	(0.299)	(0.282)	(1.541)	(0.287)	(0.275)	(1.719)	(0.257)	(0.248)
Self-employment			−0.557***			−0.553***			−0.512***
			(0.059)			(0.050)			(0.053)
Polygenic risk score of SWB × Self-employment			1.074			0.894			0.611
			(1.336)			(1.109)			(1.140)
SWB				0.085	−0.005	−0.004			
				(0.061)	(0.007)	(0.007)			
Sex (1 = male;2 = female)	−0.727***	−0.663***	−0.679***	−1.050***	−0.637***	−0.662***	−1.316***	−0.521***	−0.575***
	(0.175)	(0.027)	(0.026)	(0.138)	(0.025)	(0.025)	(0.165)	(0.023)	(0.023)
Age	0.029	−0.005*	−0.005	0.023	−0.016***	−0.016***	0.025	−0.008***	−0.010***
	(0.031)	(0.003)	(0.003)	(0.019)	(0.002)	(0.002)	(0.022)	(0.002)	(0.002)
Log of household assets (lagged)	0.672***	0.029***	0.041***	0.658***	0.018**	0.030***	0.656***	0.032***	0.040***
	(0.102)	(0.009)	(0.009)	(0.084)	(0.007)	(0.007)	(0.100)	(0.007)	(0.007)
Self-reported health	−0.108	−0.034***	−0.038***	−0.076	−0.026***	−0.029***	−0.092	−0.026***	−0.027***
	(0.095)	(0.010)	(0.009)	(0.078)	(0.009)	(0.009)	(0.083)	(0.008)	(0.008)
Education: Less than high school	*Reference*	*Reference*	*Reference*	*Reference*	*Reference*	*Reference*	*Reference*	*Reference*	*Reference*
Education: GED	−0.259	−0.038	−0.044	−0.066	−0.008	−0.013	−0.075	0.001	0.010
	(0.527)	(0.084)	(0.082)	(0.419)	(0.075)	(0.072)	(0.497)	(0.070)	(0.068)
Education: High-school graduate	−0.719**	0.238***	0.223***	−0.492*	0.188***	0.177***	−0.421	0.198***	0.185***
	(0.364)	(0.054)	(0.053)	(0.284)	(0.047)	(0.047)	(0.331)	(0.044)	(0.045)
Education: Some college	−0.248	0.419***	0.416***	−0.015	0.379***	0.380***	0.025	0.380***	0.381***
	(0.362)	(0.057)	(0.056)	(0.289)	(0.050)	(0.049)	(0.333)	(0.046)	(0.047)

(Continued)

Table 3. Continued

	Robustness Check 1: Individuals Aged 50–60			Robustness Check 2: Inclusion Self-Reported SWB			Robustness Check 3: Individuals Working >20 Hr Per Week		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Self-employed	Logarithm of earnings	Logarithm of earnings	Self-employed	Logarithm of earnings	Logarithm of earnings	Self-employed	Logarithm of earnings	Logarithm of earnings
Education: College and above	−0.552	0.760***	0.751***	−0.366	0.730***	0.725***	−0.304	0.734***	0.735***
	(0.365)	(0.059)	(0.058)	(0.293)	(0.050)	(0.050)	(0.336)	(0.047)	(0.048)
Partner Status	−0.229	−0.075***	−0.077***	0.052	−0.028	−0.026	−0.048	−0.003	−0.014
	(0.215)	(0.027)	(0.026)	(0.193)	(0.026)	(0.025)	(0.208)	(0.023)	(0.023)
Wave dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Principal components	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	10,381	10,381	10,381	14,937	14,937	14,937	13,591	13,591	14,078
Number of individuals	4,038	4,038	4,038	4,571	4,571	4,571	4,280	4,280	4,392
p-value (χ^2)	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
R^2 (overall)		0.245	0.279		0.224	0.256		0.245	0.270

Notes. Standard errors in parentheses; $^{***}p < .01$, $^{**}p < .05$, $^{*}p < .10$; Coefficients for the constants, wave dummies, and the 10 principal components are not reported here but are available upon request from the authors.

Activity in the Labor Market

In the main analysis, we only included those who reported being not retired and working. As an additional analysis, we further exclude those working 20 or fewer hours. Such part-time workers may represent a distinct group of elderly and may not be theoretically relevant to our arguments around working adults engaged in self-employment or employment on a full-time basis. Table 3 (Models 7–9) indicates that in this subsample the estimates are consistent with the main effects, although the effect for Hypothesis 1 is slightly larger and for Hypothesis 2 it is slightly smaller. Again, the interaction between the PRS of SWB and self-employment is insignificant in the model explaining earnings.

Discussion and Conclusion

Given that the literature in economics and vocational psychology has long established that SWB is inherently connected with occupational choice (Backman, 2004; Brown & Lent, 2016), it stands to reason that the genetic predisposition to SWB could have an important effect on the pursuit of, and performance in, self-employment. Although substantial amounts of previous research have centered on the relationship between work and well-being, our study diverges from past work by focusing on the relationship between a PRS of SWB and the likelihood of engaging in self-employment and the associated earnings for those with a higher genetic predisposition to SWB. Our results show that though the PRS of SWB influences the likelihood of self-employment and earnings, it does not differentially affect the earnings of the self-employed and wage employed.

These findings extend the existing literature as follows. First, we expand upon the growing stream of research centered on the relationship between self-employment and SWB. Whereas prior research has primarily focused on the SWB consequences that can result from self-employment (Carter, 2011; Nordstrom & Jennings, 2018), we instead examine how someone's genetic predisposition to SWB could be positively related to the likelihood that individuals will decide to pursue self-employment. In doing so, we provide a complementary perspective on the relationship between self-employment and SWB. While there are undoubtedly potential well-being benefits that individuals who become self-employed can experience, our results suggest that a relatively high genetic predisposition to SWB predisposes individuals to pursue self-employment. Our findings highlight the need to consider the potential selection effects that the genetic predisposition to SWB could have with regards to which individuals ultimately decide to pursue self-employment as an occupation.

Second, most research on the relationship between SWB and occupational choice has been concerned primarily with organizational settings (Backman, 2004; Brown & Lent, 2016). Our study extends upon these findings and provides evidence that SWB can also play an important role in the self-employment choice. Vocational interests remain relatively stable over an individual's lifetime, with relatively little variance from adolescence to middle adulthood (Low et al., 2005). While there are several factors that could partially account for this stability with regards to interest in self-employment, our results suggest that the genetic predisposition to SWB is perhaps an important factor to consider. Given the inherent difficulties associated with self-employment as an occupation (Patzelt & Shepherd, 2011), it is possible that individuals with an inherently high genetic predisposition to SWB could be uniquely capable of coping with the trials and tribulations they might face in self-employment, resulting in these individuals being more prone to pursue self-employment and persist in it.

Third, although several studies have tried to unravel the genetic architecture of self-employment (Quaye et al., 2012; Nicolaou & Shane, 2011; van der Loos et al., 2013), identification of single genetic variants that are associated with self-employment has remained elusive.

The present findings call upon future research to more closely examine the potential common genetic precursors that may exist between subjective well-being and self-employment. Genetic factors can oftentimes be pleiotropic by nature, meaning that the same genetic factors may influence multiple related outcomes (Nicolaou & Shane, 2009; Nofal et al., 2018). Indeed, recent evidence reinforces the notion that there could be common genetic factors that could help to explain the association between specific work characteristics (e.g., job control, job demands, etc.) and individual well-being (Li et al., 2016). To that end, it is possible that the specific genetic variants employed to determine the PRS of SWB are also related to a predisposition to self-employment. This will be an important aspect for future research to examine, as it might shed light onto a topic of growing interest that until now has produced rather limited results, namely what are the specific genetic factors associated with the pursuit of, and success in, self-employment (Nicolaou & Shane, 2009). Relatedly, despite our focus on both self-employment and earnings, there remains a major limitation in our inferences, namely possible endogenous selection into self-employment (Certo et al., 2016). Therefore, the tested associations are subject to endogenous treatment effects which might explain the lack of support for Hypothesis 3.[4] Still, our findings emphasize the importance of future research leveraging our knowledge of genetic and biological characteristics to help inform our understanding of selection into self-employment.

Fourth, in a recent special issue on entrepreneurship and well-being (Wiklund et al., 2019), well-being was defined as "*the experience of satisfaction, positive affect, infrequent negative affect, and psychological functioning in relation to developing, starting, growing, and running an entrepreneurial venture"* (p. 1). While reliable self-reports and physiological measures of well-being exist, the use of self-reports comes with several challenges (Bond & Lang, 2014). We take a step further and highlight the importance of the PRS of SWB as an alternative time-invariant measure. Among the potential areas for research highlighted by Ryff (2019) we focus on well-being as an aspect of the entrepreneurial motive (H1) and by focusing on a sample of individuals over 50 we assess the implications of well-being for those in their entrepreneurial journey towards the waning years in the labor force. Although the experience of well-being in entrepreneurship as an outcome (Bhuiyan & Ivlevs, 2018) or the effects of self-employment on local well-being (Abreu et al., 2019), our study assessed the long-term intra-individual effects of well-being in later life self-employment outcomes. Hmieleski and Sheppard (2019) found that females (males) realize higher well-being by leveraging masculine (feminine) characteristics, in our ancillary analysis (results available upon request) the interaction effect, perhaps due to a different empirical context, were not significant.

Limitations and Future Research Directions

Our findings must be interpreted in light of their limitations. First, similar to a variety of studies drawing on PRSs to predict later life outcomes (Clarke et al., 2016; Papageorge & Thom, 2018; Pehkonen et al., 2019), the explanatory power of our PRS is small. In making inferences related to the practical effect sizes of findings, we ask researchers to take the low explanatory power into consideration. Our evidence is preliminary and the findings in the context of low explanatory power call for closer examination of genetic predictors in future studies. Still, although it is clear that future studies drawing on even larger GWAS analyses will be able to draw on PRSs for SWB explaining larger shares of the variance, we believe it is of importance that the time-invariants genetic predisposition to SWB which we can currently construct already has significant associations with self-employment and earnings. Moreover, the PRS captures the genetic predisposition of SWB only, while the level of contemporaneous SWB is also dependent on environmental circumstances. Relatedly, a complex interaction between genetic and environmental factors could influence SWB. Hence, a more comprehensive life-cycle analysis based on gene-environment models would further shed light on the relative variance explained by genetic and environmental factors. From this perspective, finding ways to reduce factors such as work/family conflict (Matthews et al., 2014) and stress (Edwards & Rothbard, 1999) or to increase aspects such as mindfulness (Brown & Ryan, 2003) or even income (Headey & Wooden, 2004) could result in higher levels of well-being, which in turn could increase the possibility that individuals will engage in self-employment.

Second, in a set of studies reviewed by Åstebro and Chen (2014), some studies find support for hypotheses on self-employment earnings when controlling for self-selection while others do not (refer to Table 1 in Åstebro & Chen, 2014). Identifying a unique instrument that influences entry in self-employment but less so the earnings from self-employment are difficult, and the use of genetic information for this purpose is perhaps even more challenging (van Kippersluis & Rietveld, 2018). We already acknowledged that the estimates for income from self-employment could be biased by self-selection. However, our sample has the advantage of having both information on the earnings of the self-employed and wage workers, and hence our study does provide clear evidence on the positive relation between the PRS of SWB and earnings in the general labor market (H2). In assessing the evidence for H3, future studies could further model the possible endogenous selection into self-employment and the challenges coming from distributional differences in the earnings profiles of the self-employed compared to wage workers. Still, because of the small effect of the PRS of SWB, our insignificant result for H3 may also be the result of low statistical power and is therefore not directly at odds with the finding of Shane and Nicolaou (2013) that a substantial portion of the variance in self-employment income can be explained by genetic factors.

Third, while we present evidence for the influence that well-being can have on self-employment, we do not provide specific details regarding the implicit mechanisms captured by the PRS. It is possible that genetic variants affect a number of complex physiological, neurological, and psychological process that serves as the mechanism for the relationship between well-being and self-employment. Furthermore, it is possible, even likely, that external environmental factors and individual life experiences could mediate and/or moderate this relationship. Therefore, people with certain genes might be more likely to experience specific life events, that in turn lead them to self-employment, or individuals with specific genetic configurations could be more likely to become self-employed under specific environmental conditions.

Fourth, despite the advantages of using the HRS for the present analysis as highlighted in the introduction it also comes with some disadvantages. First of all, our sample is restricted to observations where information on the included variables was non-missing. The loss of sample size may have resulted in bias in the inclusion of participants, which makes the results more difficult to generalize. Moreover, our sample is limited to individuals between the age of 50 and 65. The prohibitive costs of collecting DNA samples from a large number of participants and the longitudinal nature of the HRS make it nevertheless attractive to use the present dataset for answering the research question. Still, future studies can focus on individuals from a younger age group to explore and maybe replicate the relationships investigated in the present study.

In conclusion, we find that the PRS of SWB is positively associated with the choice of self-employment. As the PRS of SWB is established during conception, it does not change over time. While self-employment could certainty influence SWB during the life course, the evidence presented here at least strongly suggests that the direction of effect of the genetic basis of SWB to self-employment is positive and significant. Moreover, the PRS of SWB is positively associated with earnings, although not different in self-employment than in wage employment. Hence, individuals do not seem to leverage their genetic potential for SWB differently in these two occupational groups in improving earnings. We believe this study primes research on the benefits and tradeoffs of PRSs for entrepreneurship research and contributes to our understanding of the predisposition to SWB as an important determinant of the choice of self-employment.

Appendix

Construction of the Polygenic Risk Score of Subjective Well-Being

A polygenic risk score (PRS) is a weighted sum of a particular type of genetic variation, namely variation from single nucleotide polymorphisms (SNPs). Most genetic differences across individuals can be attributed to SNPs. An SNP is defined as a location in the DNA strand at which 2 different nucleotides are present in the population. Each of the two possible nucleotides is called an allele for that SNP. The allele that is less common in the population is called the minor allele; the other allele is called the major allele. For each SNP, an individual's genotype is coded as a 0, 1 or 2, depending on the number of minor alleles present. According to an estimate in a recent study, there are about 85 million SNPs with a minor allele frequency of 1% in the population (Auton et al., 2015). Individual SNPs only explain a tiny bit of the variation in a trait on the population level (Visscher et al., 2017). Therefore, it is common to include multiple SNP into so-called polygenic risk scores (PRSs).

When constructing the PRS, all SNPs in the datasets are summed up with weights for each SNP proportional to the estimated effect size of the genetic variant on the outcome of interest as estimated in a genome-wide association study (GWAS). The larger the analysis sample in a GWAS, the more precise effects sizes will be estimated. Therefore, the predictive accuracy of the PRS is positively related to the sample size in the GWAS (Dudbridge, 2013). The PRS of SWB used in the present study is based on Turley et al. (2018) who amended the analysis sample of the original GWAS on SWB by (Okbay et al., 2016). The total GWAS sample size in Turley et al. (2018) approaches 400,000 individuals. The PRS $\hat{g}_i$ for individual, i is constructed as:

$$\hat{g}_i = \sum_{j=1}^{K} x_{ij} w_j$$

where K is the count of SNPs (~700,000 in the HRS sample), x is the SNPs and w is the weight (weights are adjusted using the software LD-Pred to take into account the correlation structure of the genome). The resulting PRS of SWB has been standardized to have mean 0 and standard deviation 1.

Author Contributions

The authors Pankaj C. Patel, Cornelius A. Rietveld and Marcus T. Wolfe contributed equally to the work.

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Notes

1. The polygenic risk score of SWB is not a proxy for the traditional measure of self-reported SWB. In the remainder of the paper, it is only stated as proxy for SWB when used as such in a cited study.
2. The predictive accuracy of PRSs is an increasing function of the GWAS sample size (Dudbridge, 2013). Ultimately, a PGS constructed based on the results of an infinite large GWAS analysis will explain the so-called SNP-heritability of SWB. This is the heritable portion of SWB that can be explained by SNPs. Rietveld et al. (2013) estimated this proportion to be around 5-10% for single-question survey measures of SWB. Turley et al. (2018) also constructed a PRS based on multivariate GWAS results. We abstain from using this "MTAG" score, because Okbay and Turley (2018) indicate that the coefficient of an MTAG-based PRS comprises multiple channels (e.g., neuroticism and depression) rather than subjective well-being alone. For additional details, see: https://www.ssc.wisc.edu/wlsresearch/documentation/GWAS/Turley_et_al_(2018)_PGS_WLS.pdf.
3. Population stratification is the presence of genetic differences between subpopulations in a population, which might be correlated with other non-genetic differences (e.g., culture, regional features).
4. We thank an anonymous reviewer for this suggestion.

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