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**Does Money Change Who You Are?
Quasi-Experimental Evidence on the
Effects of Wage Increases on Personality**

Adam Ayaita

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Does Money Change Who You Are? Quasi-Experimental Evidence on the Effects of Wage Increases on Personality*

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Abstract

Using the 2015 introduction of a statutory minimum wage in Germany as a quasi-experiment, I investigate the effects of wage increases on personality. The degree to which each worker's wage is intended to be affected by the reform is used as an instrument for the relative increase in the worker's hourly wage in a two-stage least squares estimation based on nationally representative panel data ($N = 1,955$ individuals). The results show no significant effects of relative wage increases on personality traits. As the confidence intervals indicate, any substantial effects of wage increases on personality are largely rejected by the results.

Keywords: income, minimum wage, money, personality, quasi-experiment, wage

JEL classification: A12, D31, D63, J31, J38

Supplemental materials and analysis code:

https://osf.io/n3u9w/?view_only=c64541d0e99c4e859aa1473af59e6c1d

1. Introduction

In this study, I investigate the effects of wage increases on personality. Personality traits are practically relevant, as they have been found to predict various important outcomes, including that of work performance (e.g., Barrick, Mount, and Judge 2001), but also of health and of criminal activity (e.g., Almlund et al. 2011; Roberts et al. 2007). Although personality traits are defined as relatively stable patterns of thinking, feeling, and acting (Roberts 2009), they are not completely stable over a lifespan: Personality has been found to develop substantially until at least the age of 50 and is not fully stable even in late adulthood (e.g., Caspi, Roberts, and R. L. Shiner 2005; Roberts and DelVecchio 2000). Moreover, intra-individual personality changes in the general population and among employees have been found even within a period of only four years (Boyce, Wood, and Powdthavee 2013; Wu et al. 2020). Therefore, it might be possible to influence personality among adults. If wages affect personality, then policy makers may consider these effects when making decisions about labor market regulations, such as minimum wages, and firms may consider such effects when determining their wages.

So far, the effects of wages or income on personality have barely been investigated. Some studies have used observational designs. For example, Sutin et al. (2009) find that higher income is associated with increases in emotional stability over time, Hirschi et al. (2021) find that higher hourly earnings predict increases in openness and emotional stability, and Lüdtkke et al. (2011) find that a worsening of individuals' financial situation is associated with later decreases in extraversion and emotional stability. However, in the absence of an experiment or quasi-experiment, none of these studies could identify causal effects.

Akee et al. (2018) analyze the effects of a household income transfer in adolescence on changes in adolescents' personality traits, finding positive effects on conscientiousness and

agreeableness and a negative effect on emotional stability. However, that study is focused on non-adults and does not include two of the Big Five personality traits (i.e., openness and extraversion; Costa and McCrae 1992).

In a working paper, Powdthavee, Boyce, and Wood (2011) analyze the effects of lottery wins on personality within the subsequent year. They find positive effects on agreeableness and emotional stability and—in the case of substantial wins of at least £1000—also on conscientiousness. However, their study is restricted to a one-time shock in unearned income and does not investigate the effects of permanent increases in earnings or wages. Moreover, lottery wins affect only a small part of the population; especially in the case of substantial wins, the number of affected individuals is very small (38 individuals in the study by Powdthavee, Boyce, and Wood 2011).

In order to improve the understanding of income effects on personality, I investigate the causal effects of wage increases on personality among adults. I am following the Five Factor Model, which is an established and validated measure of personality (Costa and McCrae 1992). This model distinguishes the following so-called Big Five personality traits: openness (i.e., how open to experiences, how original, and how imaginative a person is); conscientiousness (i.e., how diligently, thoroughly, effectively, and efficiently a person is working); extraversion (i.e., how communicative, sociable, and outgoing a person is); agreeableness (i.e., how considerate, forgiving, and kind a person is to others); and emotional stability (i.e., how relaxed a person is and how well she or he can deal with stress (the inverse of neuroticism)). From a theoretical perspective, effects of wage increases on personality are plausible. An increase in hourly wages might increase monthly earnings and/or decrease working hours (if workers or employers reduce working hours as a response to higher wages). In line with these considerations, previous

empirical literature indicates that minimum wages have positive effects on monthly earnings (e.g., Burauel et al. 2020b) and might decrease working hours (e.g., Burauel et al. 2020a; Stewart and Swaffield 2008). Both of these potential mechanisms—i.e., higher monthly earnings and fewer working hours—might lead to personality changes: Openness and extraversion might increase (due to more social and other opportunities), agreeableness might increase (due to higher satisfaction with the financial situation), and emotional stability might increase (due to a reduction of financial worries or of stress).

In order to measure the effect of wage increases on personality, I make use of a quasi-experiment. On January 1, 2015, Germany introduced a statutory minimum wage for the first time in the history of that country. Since then, employers in Germany have been generally obliged to pay a gross (i.e., before-tax) hourly wage of at least €8.50 to each employee (the first increase of the minimum wage was in 2017, when it was set to €8.84). I use the degree to which each worker's wage is intended to be affected by the introduction of the minimum wage (the "reform bite") as an instrument for the relative increase in the worker's hourly wage from 2014 to 2017. Workers whose wages before the reform were below the minimum wage are assigned a positive reform bite; the bite is then operationalized as the relative difference between the original amount of the minimum wage (€8.50) and the hourly wage of the worker immediately before the reform (i.e., in 2014). Workers whose pre-reform wages were at least equal to the minimum wage are assigned a reform bite of 0. I apply an instrumental variables (IV) estimation with two-stage least squares (2SLS) to analyze the effects of relative wage increases on personality traits in 2017. The models include a large set of control variables, including individuals' pre-reform scores in personality traits (2013) and in demographic and job-related

factors (2014). The analysis is based on nationally representative data from the German Socio-Economic Panel (SOEP; Goebel et al. 2019) with a final sample of 1,588 individuals.

I also explore what mechanisms might explain the potential effects of wage increases on personality. In particular and as explained above, the increases in hourly wages might have led to increases in monthly earnings and/or decreases in working hours. Again using the reform bite as an instrument for the relative wage increase, I apply 2SLS in order to test the effects of the relative increase in hourly wage on the natural logarithm (log) of monthly earnings and the log of working hours in 2017 (controlling for the pre-reform values of these variables).¹

The results from the first stage show that the reform bite is highly significantly and substantially positively associated with relative wage increases. The second-stage results indicate no significant effects of relative wage increases on any personality traits. The confidence intervals from this analysis suggest that even a 100 percentage points larger relative wage increase has at most small to moderate effects on personality. Regarding potential mechanisms, the results show that relative wage increases have a significant positive effect on log monthly earnings but do not significantly affect log working hours, so any effects on personality would likely be driven by increases in monthly earnings rather than by changes in working hours.

I perform two robustness checks. First, I account for potential spillover effects by dropping individuals whose pre-reform wages are only slightly above the minimum wage. Second, I account for non-compliance by restricting the analysis to individuals who actually receive at least the minimum wage after the reform. The results of both robustness checks are largely in line with the baseline results.

¹ I use the logs in order to investigate relative changes in these variables, in line with the explanatory variable of interest (relative wage increase).

This study makes three contributions to the literature. First, I contribute to the literature on effects of wages or income. Many studies have investigated the effects of wages or income on life satisfaction (e.g., Blanchflower and Oswald 2004; Easterlin 1974; Ferrer-i-Carbonell and Frijters 2004; Frijters, Haisken-DeNew, and Shields 2004; Gardner and Oswald 2007; Kahneman and Deaton 2010; Layard, Mayraz, and Nickell 2008), partly using minimum wages as quasi-experiments (Gülal and Ayaita 2020; Kuroki 2018). Furthermore, estimated effects of income on life satisfaction have been found to be moderated by personality traits (Boyce and Wood 2011; Proto and Rustichini 2015; Syrén et al. 2020). However, what has barely been investigated is whether and how wages or income affect personality (Akee et al. 2018; Hirschi et al. 2021; Lüdtke et al. 2011; Powdthavee, Boyce, and Wood 2011; Sutin et al. 2009). I contribute to this literature with a quasi-experimental analysis of the effects of wage increases on personality among adults.

Second, I contribute to the literature on causal determinants of personality. So far, there is only limited evidence on causal effects on personality (e.g., Grosz, Rohrer, and Thoemmes 2020). Evidence from a behavioral genetic analysis indicates that changes in personality are—at least in early adulthood—largely driven by environmental factors (McGue, Bacon, and Lykken 1993) but does not answer the question of which specific events influence personality in what way. Some studies have investigated causal determinants of personality (e.g., Alan, Boneva, and Ertac 2019; Alan et al. 2021; Heckman, Pinto, and Savelyev 2013; Kosse et al. 2020; Roberts et al. 2017; Shan and Zölitz 2022) but have not analyzed the effects of wages or income. I contribute to this literature by investigating whether personality is influenced by wage increases.

Finally, I contribute to the literature on the relationship between personality and earnings. Some studies have investigated how personality is associated with earnings (e.g., Müller and

Plug 2006; Nyhus and Pons 2005) or predicts later earnings (e.g., Gensowski 2018). I contribute to this literature by investigating the reverse relationship, i.e., the effects of wage increases (that have been created by a reform) on personality.

2. Method

2.1. Sample

I use data from the SOEP (Goebel et al. 2019) for the analysis.² The SOEP is a representative longitudinal panel survey of the adult population in Germany. It is suitable for the present study as it includes information on individuals' personality traits, earnings, and demographic and job-related factors before and after the introduction of the minimum wage. Data from the 2013–17 surveys are used.

Based on the scope of the minimum wage reform—it does not apply to apprentices, some interns, self-employed individuals, and workers in sheltered workshops—individuals who belong to any of the following groups are excluded from the analysis: apprentices, interns, self-employed individuals, individuals who are not employed, and workers in sheltered workshops. Individuals who are above 65 years old are also dropped from the sample because they usually receive a pension in Germany (compare Güral and Ayaita 2020; Reeves et al. 2017). Furthermore, I drop individuals who report an hourly wage of zero and/or monthly earnings of zero, since such values are implausible among working-age individuals who are employed full-time, part-time, or marginally.

² SOEP-Core v36, EU Edition, 2021, data for years 1984-2019,

<https://doi.org/10.5684/soep.core.v36eu>.

Finally, in order to facilitate the comparability of workers in the sample (in particular, the comparability of workers whose wages before the reform are below vs. above the minimum wage), I drop individuals from the analysis whose pre-reform wages are much above the minimum wage. Specifically, I drop those individuals whose gross hourly wage in 2013 and/or 2014 is more than 100% higher than the original amount of the minimum wage (i.e., higher than €17.00). Similar choices have been made by other empirical studies on minimum wage effects (e.g., Bureau et al. 2020a; Bureau et al. 2020b; Dustmann et al. 2021; Güral and Ayaita 2020; Pusch and Rehm 2017).

The final sample includes 1,955 individuals (the final sample is organized into the wide format, so that there is one observation for each individual). Of these individuals, 367 have pre-reform (i.e., 2013 and 2014) wages below the original amount of the minimum wage, and the other 1,588 individuals have pre-reform wages of at least the minimum wage.

2.2. Variables

Personality traits (2017): The dependent variables are Big Five personality traits measured in 2017. The Big Five personality traits are assessed by the SOEP every four years, including 2013 and 2017.

The measure of the Big Five personality traits available in the SOEP data is the GSOEP Big Five Inventory (BFI-S; Gerlitz and Schupp 2005), which consists of 15 items (three for each personality trait). Example items are: “I am ...”:

- “original, someone who comes up with new ideas” (openness),
- “a thorough worker” (conscientiousness),
- “outgoing, sociable” (extraversion),
- “considerate and kind to others” (agreeableness),

– “relaxed, able to deal with stress” (emotional stability).

Each personality item is originally measured on a Likert scale from 1 (*does not describe me at all*) to 7 (*describes me perfectly*). Each personality trait is built as the average of the respective items, after the scores of reversed items have been inverted. For the analysis, each personality trait is z-standardized to have a mean of 0 and a standard deviation of 1 in the year 2017.

Although the personality measures are based on self-reports, this type of measure has been shown to have an acceptable degree of external validity, as assessed by using peer ratings of personality (Costa and McCrae 1992). Moreover, in order to save space and time in the survey, large surveys tend to use short scales for measuring personality traits. The use of such short scales comes at the expense of lower internal consistencies than the full Big Five scale (Costa and McCrae 1992). Nevertheless, the BFI-S scales have acceptable statistical properties: They show good levels of reliability and discriminant validity and are highly significantly correlated with the respective full Big Five scales (Hahn, Gottschling, and Spinath 2012).

Additional outcomes: In order to explore potential mechanisms through which the increase in hourly wage might affect personality traits, I consider additional dependent variables. First, I consider the log of gross monthly earnings in euros (€) in 2017. Second, I consider the log of actual weekly working hours (including potential overtime) in 2017.

Relative wage increase: The explanatory variable of interest is the relative increase in the gross hourly wage over time. In particular, the relative difference between the post-reform hourly wage at the last considered time point (i.e., in 2017) in € and the hourly wage immediately before the introduction of the minimum wage (i.e., in 2014) in € is calculated for each individual.³ I use

³ By considering the wage increase until 2017 (rather than only until 2015, which is directly after the introduction of the minimum wage), I account for the possibility that the reform has effects on wages in

the following formula to calculate the relative wage increase $\Delta w_i/w_i$ for each individual i based on her or his wages in 2017 ($w_{i,2017}$) and 2014 ($w_{i,2014}$):

$$\frac{\Delta w_i}{w_i} = \frac{w_{i,2017} - w_{i,2014}}{w_{i,2014}} = \frac{w_{i,2017}}{w_{i,2014}} - 1. \quad (1)$$

For example, if a worker's hourly wage doubles from 2014 to 2017, then the relative wage increase resulting from Equation (1) is equal to 1 (i.e., 100%).

In order to determine the gross hourly wage, gross monthly earnings are divided by actual monthly working hours. Actual monthly working hours are determined by multiplying actual weekly working hours by 4.3 (the average number of weeks in a month).

Reform bite: This variable is used as an instrument for the relative wage increase and measures to what extent the wage of each worker is intended to be affected by the introduction of the minimum wage (i.e., the “bite” of the reform). In particular, a worker is assigned a positive reform bite if her or his gross hourly wages in the years before the reform (i.e., in 2013 and 2014) are below the original amount of the minimum wage introduced in 2015 (i.e., below €8.50). The reform bite z_i is then calculated as the relative difference between the minimum wage (€8.50) and the worker's gross hourly wage in 2014 in €:

$$z_i = \frac{\text{€}8.50 - w_{i,2014}}{w_{i,2014}} = \frac{\text{€}8.50}{w_{i,2014}} - 1. \quad (2)$$

subsequent years, in addition to a potential effect in the first year. For example, some employers might not have paid the minimum wage in 2015 but started to pay it in 2016 or 2017, either because of initial non-compliance or because they made use of exceptional legal regulations that allowed them to pay less than the minimum wage until the end of 2016.

Workers whose pre-reform (i.e., 2013 and 2014) wages are identical to or above the minimum wage are assigned a reform bite of 0, as it is assumed that the wages of these workers are not intended to be affected by the minimum wage.

The advantage of such a metric (as opposed to a dichotomous) bite measure is that the metric measure not only captures *whether* the wage of a worker is intended to be affected by the minimum wage reform (i.e., the extrinsic margin) but also *how strongly* the wage is intended to be affected (i.e., the intrinsic margin). Many studies have used such a metric measure at the level of regions or establishments, thus capturing the bite of the minimum wage reform across regions or establishments (e.g., Ahlfeldt, Roth, and Seidel 2018; Bossler and Gerner 2020; Caliendo et al. 2018; Dustmann et al. 2021; Schmitz 2019). In contrast, I use a metric bite measure at the individual level, capturing the bite of the minimum wage reform across individuals (compare Caliendo, Wittbrodt, and Schröder 2019), as a regional approach would have reduced the sample size too strongly.

Control variables: I use control variables for factors that might influence the dependent variables (i.e., personality traits, log monthly earnings, or log working hours in 2017) and that might also affect the reform bite, because such factors would potentially bias the results if they are not accounted for. First, I control for the scores in personality traits, log monthly earnings, and log working hours before the reform. In particular, I include the Big Five personality traits measured in 2013 (as these are not measured in 2014), z-standardized in 2013; the log of gross monthly earnings in € in 2014; and the log of actual weekly working hours in 2014.

Second, I include the following demographic and job-related control variables: female (dummy), age (in years), squared age, marital status (six categories for married, civil union, separated, divorced, widowed, and single), number of children in the household, German

citizenship (dummy), migration background (three categories for no, direct, and indirect migration background), region (16 categories for the German federal states), education level (ten categories based on the CASMIN classification), employment status (three categories for full-time, part-time, and marginal employment), occupation (ten categories based on the KldB 2010 classification by the German Federal Employment Agency; see Bundesagentur für Arbeit 2011: 9), occupational position (15 categories; e.g., unskilled worker, salaried employee with extensive managerial duties), industry (21 categories based on the NACE Rev. 2 classification by Eurostat 2008: 57), public vs. private sector employment (dummy), and firm size (seven categories based on the number of employees). These control variables are measured in the year before the reform (i.e., in 2014). Categorical variables are transformed to sets of dummy variables for the analysis. The included control variables are similar to the control variables used in previous empirical studies on effects of the minimum wage (e.g., Bossler and Broszeit 2017; Güral and Ayaita 2020; Reeves et al. 2017).

2.3. Analysis

When empirically estimating the effects of wage increases on personality, one is faced with potential endogeneity problems. First, since the time intervals for the measures of wage increases and personality overlap, an ordinary least squares (OLS) regression would be unable to distinguish the effects of wage increases on personality from the potential effects of personality on wage increases (i.e., a simultaneity bias and reverse causality issue would be possible). Second, there might be unobserved factors that influence both wage increases and personality, therefore leading to spurious, non-causal relationships between wage increases and personality (omitted variable bias) in an OLS regression. For example, an unobserved change in social networks might lead to wage increases and changes in personality traits.

In order to avoid these endogeneity problems, I use an IV estimation. Specifically, I use the minimum wage reform in Germany, which is intended to increase hourly wages for many workers, as a quasi-experiment. The reform bite (i.e., the degree to which each worker's wage is intended to be affected by the introduction of the minimum wage) is used as an instrument for the relative wage increase.

I apply 2SLS as a standard method in IV estimation (e.g., Wooldridge 2010). In the first stage, the explanatory variable of interest (i.e., each individual i 's relative increase in hourly wage, $\Delta w_i/w_i$) is regressed on the instrument (i.e., reform bite z_i) and the control variables (c_i):

$$\frac{\Delta w_i}{w_i} = \beta_0 + \beta_1 z_i + \beta_2 c_i + \varepsilon_{it}, \quad (3)$$

where β_0 is the constant, β_1 and β_2 are the coefficients, and ε_i is the error term. From Equation (3), a predicted value of the relative wage increase ($\widehat{\Delta w_i/w_i}$) on the basis of the instrument and the control variables is obtained for each individual.

In the second stage, the dependent variables (i.e., personality traits p_i , measured in 2017) are regressed on the predicted value of relative wage increase and on the control variables:

$$p_i = \beta_0 + \beta_1 \frac{\widehat{\Delta w_i}}{w_i} + \beta_2 c_i + \varepsilon_{it}. \quad (4)$$

Since the control variables include each individual's pre-reform scores in personality traits (i.e., personality traits in 2013), Equation (4) tests how relative wage increases affect personality traits in 2017 conditional on personality traits in 2013 (and the other control variables).

Therefore, effects on personality *changes* are assessed.

A good instrument (that allows identification of the causal effects of interest) must fulfill several conditions (Wooldridge 2010). The first condition is relevance: The instrument (i.e.,

reform bite) must significantly predict the explanatory variable of interest (i.e., relative wage increase). The results from the first stage show whether this condition is fulfilled.

The second condition is exclusion: The instrument affects the dependent variables (i.e., personality traits) only through the observed explanatory variables and not directly or through other channels. Although there cannot be an empirical proof of this condition, the condition is likely to be fulfilled—at least to a large degree—in the present context: The main effect of the minimum wage reform on workers is the (relative) increase in the hourly wage among low earners, while it is unlikely that the reform would directly affect personality or through channels other than the wage increase.⁴

The third condition (which is sometimes combined with the exclusion restriction) is that of exogeneity: The instrument must not have an endogeneity problem; in particular, it should not be affected by unobserved variables that also affect the dependent variables. Due to the extensive use of potentially relevant control variables—including pre-reform scores in personality traits, monthly earnings, and working hours—it is unlikely that there are any remaining factors that (substantially) affect the reform bite and personality. Therefore, the third condition can be regarded as fulfilled.

Longitudinal sampling weights are included in order to ensure the representativeness of the analyses (compare SOEPcompanion 2021).

3. Results

⁴ As described above, it is possible that the reform bite has effects on monthly earnings and working hours, but any such effects are probably created by the increase in the hourly wage and therefore belong to this channel.

3.1. Descriptive statistics

Table 1 shows the means and standard deviations of the main variables used in the present study, separately for (1) the full sample, (2) individuals with a positive reform bite (i.e., pre-reform wages below the minimum wage), and (3) individuals with a zero reform bite (i.e., pre-reform wages of at least the minimum wage). Among individuals with a positive reform bite, the average reform bite (i.e., relative difference between minimum wage and pre-reform wage) is 62%. The average relative wage increase (from 2014 to 2017) among these individuals is 72%. Individuals with a zero reform bite experience an average relative wage increase of 13%.

TABLE 1 ABOUT HERE

Figure 1 sketches the distribution of hourly wage before the reform (in 2014). Among individuals with a pre-reform wage below the minimum wage, very low wages below €4.50 are uncommon (13%).

FIGURE 1 ABOUT HERE

Figure 2 shows the trends of mean hourly wages before and after the reform among individuals with a positive reform bite and among individuals with a zero reform bite. While the latter group experiences a steady and weak wage increase, individuals with a positive reform bite experience a more substantial wage increase specifically from 2014 to 2015 (i.e., immediately around the introduction of the minimum wage) and—to a lesser extent—in the subsequent year. From 2016 to 2017, the mean wage among individuals with a positive reform bite slightly decreases.

FIGURE 2 ABOUT HERE

Figure 3 shows the trends of mean monthly earnings and mean working hours among individuals with a positive or a zero reform bite. Monthly earnings show a stable and weakly increasing trend among individuals with a zero reform bite. Among individuals with a positive

reform bite, there is a slightly more pronounced increase in monthly earnings after the introduction of the minimum wage (in particular, from 2014 to 2016). The relative increase in mean monthly earnings from 2014 to 2017 amounts to 38% among individuals with a positive reform bite and to 11% among individuals with a zero reform bite.

The trend of weekly working hours is largely stable among individuals with a zero reform bite. Among individuals with a positive reform bite, working hours decrease immediately after the reform (i.e., from 2014 to 2015) but return approximately to their pre-reform level in the subsequent years.

FIGURE 3 ABOUT HERE

Finally, Figure 4 shows the trends of mean personality traits (2013/17) in both groups. There is no evidence for any substantial differences in the trends between groups. Conscientiousness decreases slightly more among individuals with a positive reform bite than among individuals with a zero reform bite. Agreeableness remains largely stable among individuals with a positive reform bite and decreases slightly among individuals with a zero reform bite. It should be stressed that these graphs are purely descriptive, without a metric measure of the reform bite, without an IV estimation, and without control variables.

FIGURE 4 ABOUT HERE

3.2. 2SLS results

Table 2 shows the results from the first stage of the 2SLS estimation. The instrument (i.e., the reform bite) has a highly significant positive association with the explanatory variable of interest (i.e., the relative wage increase): A reform bite that is larger by 1 unit (i.e., 100 percentage points) is associated with an 83 percentage points larger relative wage increase ($p < .001$), holding the control variables constant. This implies that—as expected—workers whose wages

are more strongly intended to be affected by the reform experience a larger relative wage increase than other workers do, and the relevance condition in the IV estimation is fulfilled.

TABLE 2 ABOUT HERE

Table 3 shows the results from the second stage of the 2SLS estimation where each personality trait in 2017 is regressed on the predicted value of relative wage increase (as obtained from the first stage) and the control variables (including pre-reform personality traits). There are no significant effects of relative wage increase on personality. The estimated effect of a 1 unit (i.e., 100 percentage points) larger relative wage increase on openness amounts to 0.04 standard deviations (95% confidence interval (CI) $[-0.12, 0.20]$, $p = .621$). The estimated effect on conscientiousness amounts to 0.06 standard deviations (95% CI $[-0.10, 0.22]$, $p = .453$). The estimated effect on extraversion amounts to -0.16 standard deviations (95% CI $[-0.37, 0.05]$, $p = .129$). The estimated effect on agreeableness amounts to -0.01 standard deviations (95% CI $[-0.15, 0.13]$, $p = .890$). Finally, the estimated effect on emotional stability amounts to 0.05 standard deviations (95% CI $[-0.11, 0.21]$, $p = .543$).

TABLE 3 ABOUT HERE

In order to explore potential mechanisms that might explain effects of relative wage increases on personality, I also use log monthly earnings in 2017 and log working hours in 2017 as dependent variables in the second stage of the 2SLS estimation. These results are shown in Table 4. Relative wage increase has a positive effect on log monthly earnings: A 1 unit (i.e., 100 percentage points) larger relative wage increase is associated with 0.14 higher log monthly earnings (i.e., $e^{0.14} - 1 = 15\%$ higher monthly earnings; $p = .040$), holding the control variables (including the pre-reform monthly earnings) constant. In contrast, the estimated effect of relative wage increase on log weekly working hours is small and insignificant (-0.02 points, $p = .627$).

TABLE 4 ABOUT HERE

4. Robustness checks

4.1. Accounting for potential spillover effects

Researchers have noted that the minimum wage reform might have spillover effects on individuals whose wages are not intended to be affected by the reform (e.g., Caliendo, Wittbrodt, and Schröder 2019). In this case, workers who were assigned a reform bite of zero (i.e., who have pre-reform wages of at least the minimum wage; the “control group”) might have been affected by the reform as well. The stable unit treatment value assumption (SUTVA), which requires that the outcome of each individual be unaffected by the assignment of a treatment to other individuals (e.g., Cox 1958; Rubin 1980), would then not be perfectly fulfilled.

There are different potential reasons for spillover effects, including the following. First, workers in the control group might also receive a wage increase due to the reform (Gopalan et al. 2021), possibly because they have renegotiated their wage (Dittrich, Knabe, and Leipold 2014). Second, if firms increased their product prices to compensate for higher wage costs due to the minimum wage, then this action would reduce the *real* wage of individuals in the control group (although this effect is likely to be small, because the price increase is distributed among all consumers; see Ashenfelter and Jurajda 2022; Schmitt 2015). Third, the wage increase for individuals in the treatment group (i.e., those with pre-reform wages below the minimum wage) reduces the *relative* wages of individuals in the control group (i.e., their wages compared to those of others), which might affect them psychologically due to social comparison processes. Finally, if firms changed the distribution of tasks between workers following the reform, then the minimum wage might have affected job satisfaction in the control group (see Güral and Ayaita 2020), which might influence personality as well.

In order to account for potential spillover effects, I drop those individuals whose pre-reform wages are only slightly above the minimum wage, because spillover effects are more likely for them (compare Bossler and Broszeit 2017; Dustmann et al. 2021). Researchers have found evidence for wage spillovers only for workers whose pre-reform wages are up to €4 above the minimum wage (Dustmann et al. 2021). Furthermore, for such individuals with relatively low wages, price increases due to the minimum wage might have a more substantial effect on their consumption and thus on their personalities. In addition, such individuals might be more likely to compare themselves with individuals in the treatment group. And lastly, these individuals in the control group might work in similar positions to those of individuals in the treatment group, so changes in the distribution of tasks might more strongly influence their personality development.

Therefore, I perform a robustness check in which all individuals whose gross hourly wage in 2013 and/or 2014 is at least €8.50 and at most €12.50 are dropped from the sample. The new control group thus consists of individuals whose pre-reform wages are above €12.50 and at most €17.00 (compare Dustmann et al. 2021). The resulting sample includes 1,066 individuals, of whom 367 have a positive reform bite and 699 a zero reform bite.

The 2SLS results with the new control group are provided in Tables S.1–3 in the online supplemental materials. The results from the first stage (see Table S.1) are similar to the baseline results (see Section 3.2) and show a highly significant positive association between the reform bite and the relative wage increase (93 percentage points, $p < .001$). In the second-stage results for personality (see Table S.2), there is still no significant effect of relative wage increase on any personality trait (all $p > .10$). The second-stage results for potential mechanisms (see Table S.3) show, as before, that relative wage increase has a positive effect on log monthly earnings (0.11 points, $p = .036$) and no significant effect on log weekly working hours (-0.04 points, $p = .435$).

4.2. Accounting for non-compliance

Many workers who were intended to be affected by the reform (as measured by pre-reform wages below the original amount of the minimum wage) did not finally receive the minimum wage after the reform. In particular, in 2017, which is the last time point considered in this study, 54% of the individuals with a positive reform bite in the sample received a gross hourly wage below €8.84 (which was the German minimum wage at this time). In the control group, this is the case for only 5% of the individuals. The most likely reason for workers not receiving the minimum wage after the reform is non-compliance on the side of the employer. These workers might be disappointed, and this disappointment might in turn influence their personality development. This mechanism might then violate the exclusion restriction in IV estimation, which requires that the instrument (i.e., the reform bite) influences the dependent variables (i.e., personality) only through the explanatory variable of interest (i.e., relative wage increase) and not through any other mechanisms (such as disappointment due to non-compliance).

In order to account for the potential effects of non-compliance and to focus on workers who actually receive at least the minimum wage after the reform, I perform a robustness check in which all individuals whose post-reform wage is below the minimum wage are dropped from the sample. Specifically, based on the final sample of the baseline analysis (see Section 2.1), I drop individuals whose gross hourly wage in 2017 is below €8.84. The resulting sample includes 1,670 individuals, of whom 169 have a positive reform bite and 1,501 a zero reform bite.

The results of this robustness check are shown in Tables S.4–6 in the online supplemental materials. The results from the first stage of 2SLS (see Table S.4) are qualitatively equivalent to the baseline results, showing a highly significant positive association between reform bite and relative wage increase (131 percentage points, $p < .001$). In the second stage results for

personality (see Table S.5), the effects of relative wage increase remain largely insignificant, but a negative effect of relative wage increase on extraversion emerges (-0.09 standard deviations, $p = .027$). Regarding potential mechanisms (see Table S.6), relative wage increase is again found to have a positive effect on log monthly earnings (0.11 points, $p = .041$) and no significant effect on log weekly working hours (-0.02 points, $p = .638$).

5. Conclusion

Does money change who you are? In order to investigate the effects of wage increases on personality, I have used in my study quasi-experimental evidence arising from the introduction of a statutory minimum wage in Germany. In particular, I have used the individual “reform bite” (i.e., the extent to which the wage of each worker was intended to be affected by the introduction of the minimum wage) as an instrument for the relative increase in hourly wage and have applied 2SLS in order to determine the effects of relative wage increases on personality traits (controlling for pre-reform personality traits). The results indicate no significant effects of relative wage increases on personality. An analysis of potential mechanisms shows that relative wage increases have a positive effect on log monthly earnings but no significant effect on log working hours, so any effects of relative wage increases on personality would likely be driven by the increase in monthly earnings rather than by changes in working hours.

The point estimates for the effects of relative wage increases on personality suggest that even a 100 percentage points larger relative wage increase has only small effects on personality traits (each coefficient is between -0.16 and 0.06 standard deviations), if there are any effects at all. The 95% confidence intervals indicate that the effects of such a 100 percentage points larger relative wage increase on personality traits are all between -0.37 and 0.22 standard deviations,

which implies at most small to moderate effects. Therefore, any substantial effects of wage increases on personality are largely rejected by the results.

The results of the robustness checks are mostly in line with the baseline results, but a small negative effect of relative wage increase on extraversion emerges if only individuals who actually receive at least the minimum wage after the reform are considered (see Section 4.2). However, there are several reasons why this result should be interpreted with caution. First, dropping individuals who do not receive the minimum wage after the reform might create an endogeneity problem: Workers with specific unobserved characteristics might be more likely not to receive the minimum wage, so dropping these individuals—which primarily affects workers with a positive reform bite—potentially creates a correlation between these unobserved characteristics and the reform bite (i.e., the instrument), which might lead to an omitted variable bias. Second, the estimated size of the effect is remarkably small, indicating that a 100 percentage points larger relative wage increase has a negative effect on extraversion of only 0.09 standard deviations. Finally, the statistical significance of this result is in question. While the p -value is .027 and therefore fulfills the common criteria of $p < .10$ and $p < .05$, one should keep in mind that multiple dependent variables were tested (five in total, with theoretical expectations for four of them), so it might be appropriate to use a stricter criterion for statistical significance. If a Bonferroni correction is used, where the threshold for significance is divided by the number of hypotheses (Abdi 2007), then the resulting threshold is at most $p < .10/4 = .025$. The p -value of the apparent negative effect on extraversion does not fulfill this condition. Overall, the results do not provide clear evidence for effects of wage increases on personality traits.

The result that personality is not significantly influenced by wage increases is in line with the general perception (and common assumption) that the personality of adults does not easily

change. However, it should be noted that the present study focuses on short-term effects, considering personality changes only within four years (and until 2–3 years after the reform). It is not impossible that personality changes occur after a longer exposure to higher wages. For example, some low-wage workers might first use the wage increases for paying bills and loans before they use the money for social and other opportunities that might be associated with personality changes. In the last considered year (2017), 42% of the individuals with a positive reform bite in the sample report that they have a debt for housing or are paying off another loan. In the present study, it was impossible to consider longer-term effects, because more recent data on personality is not available in the SOEP survey as yet. In addition, the consideration of a longer time frame comes at the risk of a weaker first stage in the 2SLS estimation, because the wage development some years after the reform might not be (strongly) associated with the reform bite any longer.

Future research might aim at using a sample with more individuals whose pre-reform wages were below the minimum wage. It is possible that there are small effects of wages on personality that could not be shown in the present study due to the limited number of individuals in that group and the resulting limited statistical power. This was unavoidable here because the number of these individuals in the SOEP data is not large. Future research with more observations in that group might detect—probably small—effects of wages or income on personality.

Based on the results of the present study, it does not seem that policy makers should consider effects of wage increases on personality when making decisions about labor market regulations or that employers should consider such effects when determining their workers' wages.

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Table 1

Descriptive statistics: means and standard deviations

Variable	(1) Full sample (<i>N</i> = 1,955)	(2) Reform bite > 0 (<i>n</i> ₁ = 367)	(3) Reform bite = 0 (<i>n</i> ₂ = 1,588)
Openness (2017)	4.50 (1.12)	4.30 (1.13)	4.54 (1.11)
Conscientiousness (2017)	5.86 (0.88)	5.81 (0.93)	5.87 (0.87)
Extraversion (2017)	4.85 (1.13)	4.81 (1.10)	4.86 (1.14)
Agreeableness (2017)	5.33 (0.94)	5.41 (0.94)	5.32 (0.94)
Emotional stability (2017)	4.20 (1.22)	4.04 (1.17)	4.24 (1.22)
Monthly earnings in € (2017)	2094.87 (974.04)	1152.15 (740.16)	2312.74 (888.14)
Weekly working hours (2017)	35.65 (11.88)	29.97 (13.87)	36.96 (10.96)
Relative wage increase	0.24 (1.52)	0.72 (3.43)	0.13 (0.26)
Reform bite	0.12 (1.21)	0.62 (2.74)	0.00 (0.00)
Openness (2013)	4.46 (1.13)	4.29 (1.15)	4.50 (1.12)
Conscientiousness (2013)	5.92 (0.86)	5.95 (0.83)	5.91 (0.87)
Extraversion (2013)	4.88 (1.12)	4.80 (1.10)	4.89 (1.12)
Agreeableness (2013)	5.38 (0.93)	5.39 (0.93)	5.38 (0.93)
Emotional stability (2013)	4.25 (1.18)	4.06 (1.18)	4.29 (1.18)
Monthly earnings in € (2014)	1844.85 (822.61)	836.26 (472.10)	2077.94 (701.54)
Weekly working hours (2014)	35.80 (12.04)	29.85 (14.07)	37.17 (11.08)
Female	0.61 (0.49)	0.73 (0.44)	0.58 (0.49)
Age	45.47 (10.50)	45.61 (12.10)	45.44 (10.10)
Squared age	2178.02 (914.80)	2226.02 (1046.55)	2166.93 (881.55)
Number of children in household	0.51 (0.81)	0.47 (0.78)	0.52 (0.82)
German citizenship	0.95 (0.21)	0.95 (0.22)	0.96 (0.21)
Public sector	0.24	0.10	0.27

(0.43)

(0.30)

(0.44)

Notes: Personality traits are measured on a Likert scale from 1 (lowest) to 7 (highest). Wages (earnings) are gross wages (gross earnings). Working hours are actual working hours. Standard deviations are in parentheses.

Table 2

2SLS, first stage: multiple linear regression of relative wage increase on reform bite and control variables

Variable	Relative wage increase
Reform bite	0.83** (0.18)
Openness (2013)	-0.03 (0.02)
Conscientiousness (2013)	-0.01 (0.01)
Extraversion (2013)	0.01 (0.01)
Agreeableness (2013)	0.01 (0.01)
Emotional stability (2013)	0.02 (0.01)
Log monthly earnings (2014)	0.03 (0.16)
Log weekly working hours (2014)	0.10 (0.15)
Female	-0.04 (0.03)
Age	-0.02 (0.01)
Squared age	0.00 (0.00)
Number of children in household	-0.03 (0.02)
German citizenship	-0.16 (0.11)
Public sector	-0.04 (0.05)
Constant	0.32 (0.99)
Observations	1955
R-squared	0.54

Notes: Wages (earnings) are gross wages (gross earnings). Personality traits are z-standardized.

Working hours are actual working hours. Control variables on marital status, migration background, region, education, employment status, occupation, occupational position, industry, and firm size are additionally included. Robust standard errors are in parentheses. ** $p < .01$. * $p < .05$. + $p < .10$.

Table 3

2SLS, second stage: multiple linear regressions of personality traits on predicted value of relative wage increase and on control variables

Variable	(1) Openness (2017)	(2) Conscientiousness (2017)	(3) Extraversion (2017)	(4) Agreeableness (2017)	(5) Emotional stability (2017)
Relative wage increase	0.04 (0.08)	0.06 (0.08)	-0.16 (0.11)	-0.01 (0.07)	0.05 (0.08)
Openness (2013)	0.58** (0.03)	0.01 (0.03)	0.05+ (0.03)	0.06* (0.03)	0.03 (0.02)
Conscientiousness (2013)	0.05 (0.04)	0.55** (0.04)	0.01 (0.03)	0.02 (0.03)	0.00 (0.03)
Extraversion (2013)	0.06* (0.03)	0.12** (0.03)	0.70** (0.02)	-0.03 (0.03)	0.06* (0.03)
Agreeableness (2013)	-0.03 (0.03)	-0.00 (0.03)	-0.06* (0.03)	0.55** (0.03)	0.05+ (0.03)
Emotional stability (2013)	-0.01 (0.03)	-0.04+ (0.03)	0.03 (0.03)	0.02 (0.03)	0.61** (0.03)
Log monthly earnings (2014)	0.10 (0.10)	-0.03 (0.12)	-0.14 (0.11)	-0.09 (0.11)	-0.02 (0.10)
Log weekly working hours (2014)	-0.29* (0.13)	0.05 (0.15)	0.17 (0.14)	0.02 (0.16)	-0.25 (0.16)
Female	0.06 (0.07)	0.09 (0.08)	-0.14* (0.06)	0.18** (0.07)	-0.16* (0.07)
Age	-0.02 (0.02)	0.00 (0.02)	-0.04* (0.02)	-0.01 (0.02)	0.04* (0.02)
Squared age	0.00 (0.00)	0.00 (0.00)	0.00+ (0.00)	0.00 (0.00)	-0.00* (0.00)
Number of children in household	-0.01 (0.04)	0.01 (0.04)	0.07+ (0.04)	0.07+ (0.04)	0.04 (0.04)
German citizenship	0.20 (0.20)	-0.12 (0.16)	0.06 (0.15)	0.05 (0.15)	-0.03 (0.17)
Public sector	0.03 (0.07)	0.08 (0.09)	-0.04 (0.07)	0.11 (0.08)	0.12 (0.08)
Constant	0.35 (0.81)	0.25 (0.90)	1.29+ (0.71)	0.55 (0.79)	0.20 (0.75)
Observations	1955	1955	1955	1955	1955
R-squared	0.46	0.43	0.56	0.43	0.49

Notes: Personality traits are z-standardized. Wages (earnings) are gross wages (gross earnings).

Working hours are actual working hours. Control variables on marital status, migration background, region, education, employment status, occupation, occupational position, industry, and firm size are additionally included. Robust standard errors are in parentheses. ** $p < .01$. * $p < .05$. + $p < .10$.

Table 4

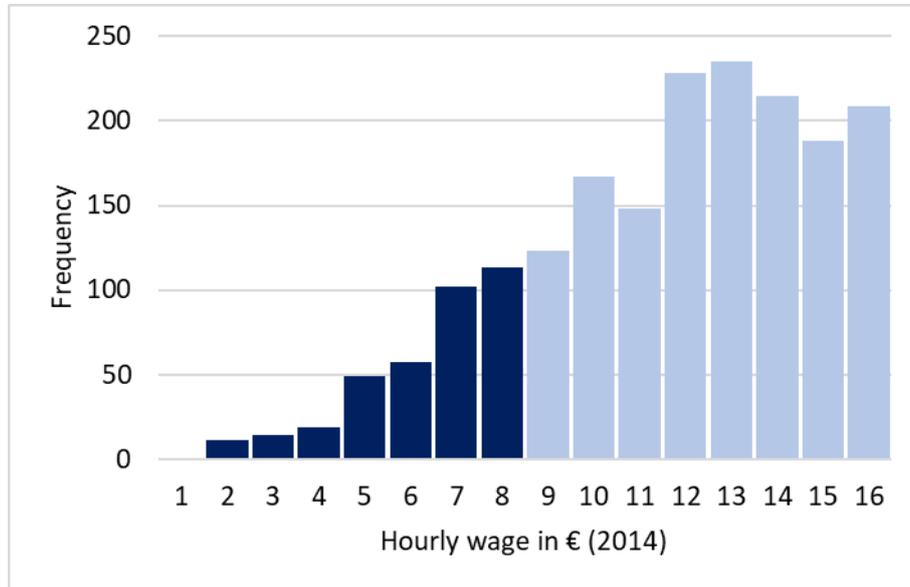
2SLS, second stage: multiple linear regressions of log monthly earnings and log working hours on predicted value of relative wage increase and on control variables

Variable	(1) Log monthly earnings (2017)	(2) Log weekly working hours (2017)
Relative wage increase	0.14* (0.07)	-0.02 (0.05)
Openness (2013)	0.01 (0.01)	0.02* (0.01)
Conscientiousness (2013)	0.00 (0.01)	0.00 (0.01)
Extraversion (2013)	-0.01 (0.01)	-0.01 (0.01)
Agreeableness (2013)	-0.01 (0.01)	-0.00 (0.01)
Emotional stability (2013)	0.02+ (0.01)	0.01 (0.01)
Log monthly earnings (2014)	0.79** (0.06)	0.03 (0.04)
Log weekly working hours (2014)	-0.07 (0.09)	0.61** (0.07)
Female	-0.05 (0.03)	-0.04 (0.03)
Age	0.03** (0.01)	0.03** (0.01)
Squared age	-0.00** (0.00)	-0.00** (0.00)
Number of children in household	-0.04* (0.02)	-0.00 (0.01)
German citizenship	-0.15* (0.07)	-0.10 (0.06)
Public sector	0.07+ (0.04)	0.09* (0.04)
Constant	1.66** (0.43)	0.76* (0.35)
Observations	1955	1955
R-squared	0.72	0.59

Notes: Wages (earnings) are gross wages (gross earnings). Working hours are actual working hours. Personality traits are z-standardized. Control variables on marital status, migration background, region, education, employment status, occupation, occupational position, industry, and firm size are additionally included. Robust standard errors are in parentheses. ** $p < .01$. * $p < .05$. + $p < .10$.

Figure 1

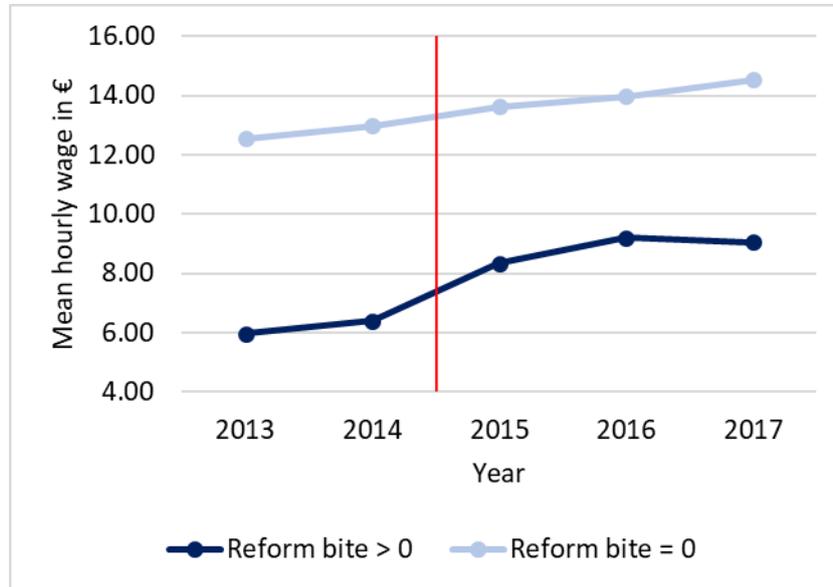
Distribution of hourly wage before the reform



Notes: This figure shows the distribution of gross hourly wage immediately before the minimum wage reform (i.e., in 2014) in €, rounded to the nearest integer value (for example, “8” represents wages of at least €7.50 and below €8.50). Dark bars represent wages below the minimum wage and light bars represent wages of at least the minimum wage that was introduced in 2015 at €8.50. The figure is restricted to individuals with hourly wages between €0.50 and €16.50. $N = 1,879$ individuals.

Figure 2

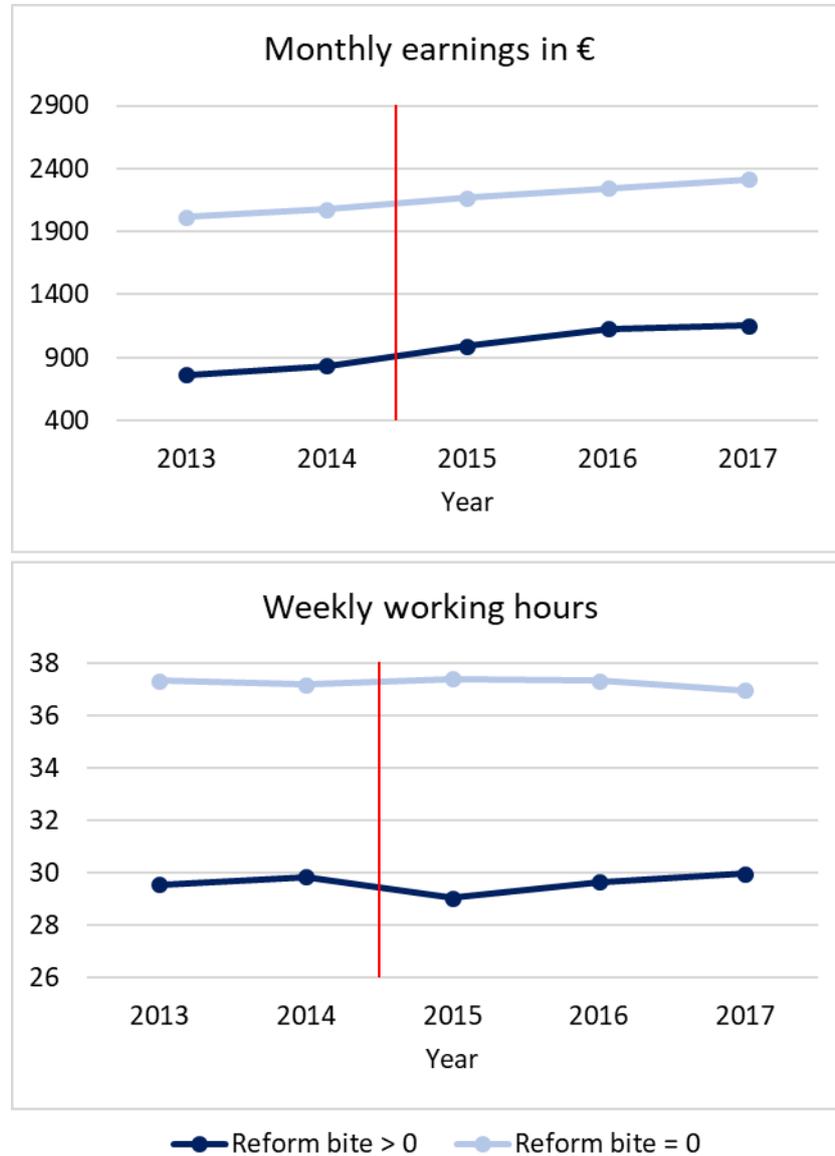
Mean hourly wages before and after the reform



Notes: This figure shows the mean values of gross hourly wage in € in different years, separately for individuals with a positive reform bite ($n_1 = 367$) and individuals with a zero reform bite ($n_2 = 1,588$). The vertical line shows the time of the minimum wage reform. $N = 1,955$ individuals.

Figure 3

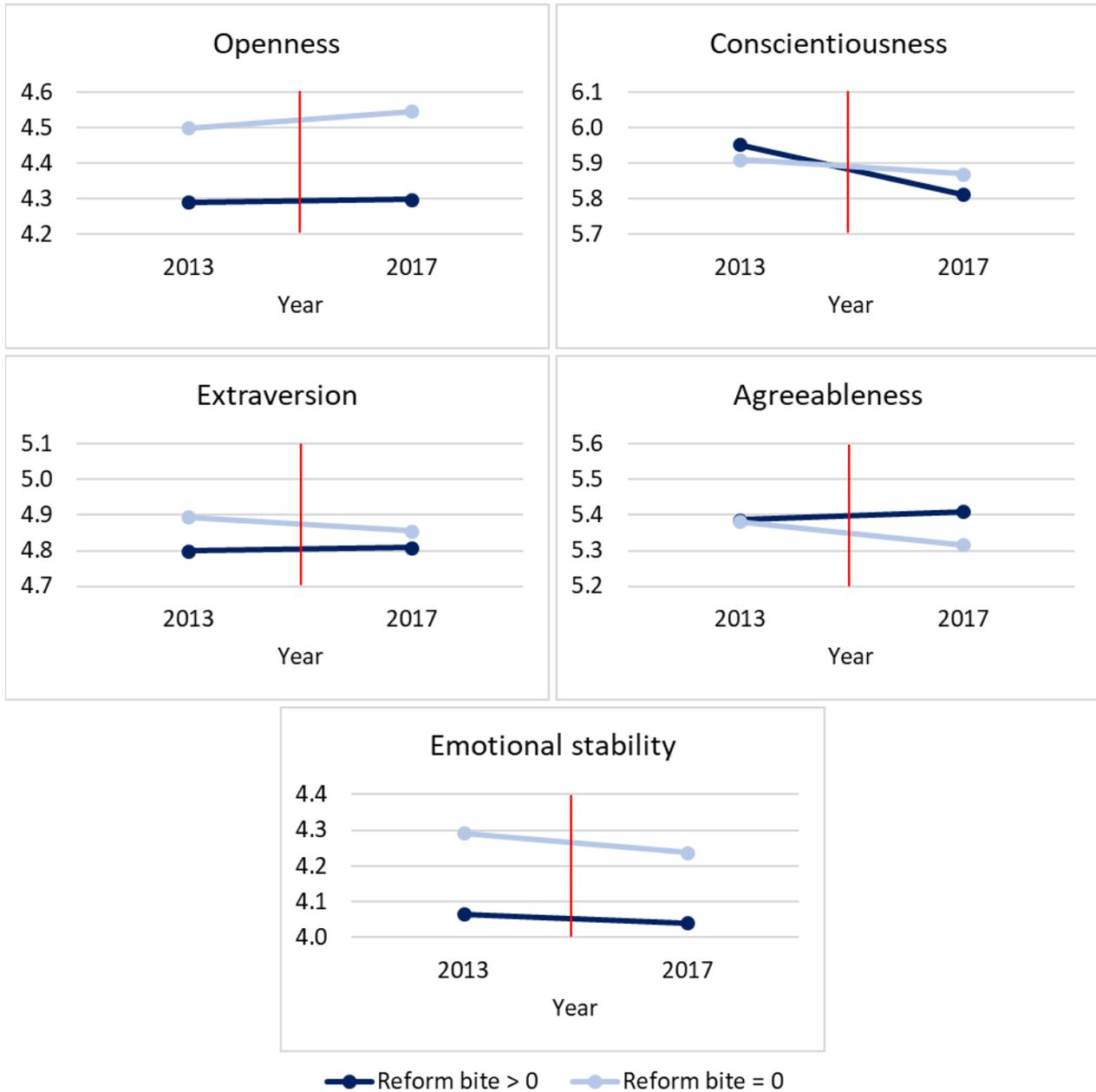
Mean monthly earnings and mean working hours before and after the reform



Notes: This figure shows the mean values of gross monthly earnings in € (above) and the mean values of actual weekly working hours (below) in different years, separately for individuals with a positive reform bite ($n_1 = 367$) and individuals with a zero reform bite ($n_2 = 1,588$). The vertical lines show the time of the minimum wage reform. $N = 1,955$ individuals.

Figure 4

Mean personality trait scores before and after the reform



Notes: This figure shows the mean values of each Big Five personality trait in different years, separately for individuals with a positive reform bite ($n_1 = 367$) and individuals with a zero reform bite ($n_2 = 1,588$). Each personality trait is measured on a Likert scale from 1 (lowest) to 7 (highest). The vertical lines show the time of the minimum wage reform. $N = 1,955$ individuals.