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Emotional stability and firm productivity.

Evidence from German matched employer-employee data

by

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Abstract

Using matched employer-employee data for Germany, we estimate firm production functions augmented with workers' personality traits. We find that emotional stability is the only trait that positively affects firm productivity. Its effect shows up mainly in large firms operating with a higher than median share of educated workers.

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Introduction.

Empirical research done by economists and psychologists has shown that personality traits matter for individual outcomes, including job performance (e.g. Barrick et al, 1991; Judge et al, 2001; Tett et al, 1991 and Salgado, 1997), health and academic achievement (e.g. Almund et al, 2011; Borghans et al, 2008 and Deary et al, 2010) and wages (e.g. Heckman et al, 2006; Mueller and Plug, 2006 and Alderotti et al, 2023).

Although the widespread use of personality tests in the recruitment process (e.g. Hogan and Hogan, 2007; Barrick and Mount, 1991 and Goodstein and Lanyon, 1999) suggests that workers' personality matters for firm productivity, we are not aware of any empirical evidence documenting that this is the case.[1] This paper tries to start filling this gap by estimating the relationship between workers' personality and firm productivity in a sample of German firms and workers.

We measure personality using the Big Five taxonomy, which consists of the following traits: openness to experience, conscientiousness, extraversion, agreeableness and emotional stability, or its opposite, neuroticism. John, 1990, and Costa and McCrae, 1992, argue that the Big Five may be thought as the longitude and latitude of personality, by which all more narrowly defined traits (or facets) may be categorized.

We draw our matched employer-employee data from the German Linked Personnel Panel (LPP), which has information - for each firm[2] - on a representative sample of workers, including their self-reported personality, and the IAB Establishment History Panel (BHP), which contains firm specific data on value added, employment, the capital stock and intermediate materials. For each firm in our sample, we compute both average personality traits (using sampling

[1] Personality tests have attracted some scepticism because they can be manipulated by candidates (see Beaz, 2012, Morgeson et al, 2007).
[2] In the language of this paper, we use the terms "firm" and "establishment" as synonymous.

weights) and the shares of workers whose traits are above a threshold (the median). We estimate production functions augmented with these shares.

We find that firms with a higher share of employees with at or above median emotional stability are more productive than other firms. The positive impact of emotional stability is driven by low anxiety and varies with firm employment size and the share of educated employees. There is no evidence in our data that the remaining four personality traits have a statistically significant impact on productivity.

A distinctive feature of our research is that we use non-experimental data on workers and firms. Although we cannot claim that our findings extend from our sample of 227 German firms to the entire German economy or to any other economy, our results for *firm* productivity do not confirm previous literature, mainly by psychologists and often based on experiments with students, showing positive effects of conscientiousness and extraversion (e.g. Barrick and Mount, 1991; Salgado, 1997; Thoresen et al, 2004; Cubel et al, 2016; Gavoille and Hazans, 2022), and negative or inconclusive effects of emotional stability (Corr & Gray, 1995; Furnham, Jackson and Miller, 1999; Smillie et al, 2006, and the references therein) on *individual* performance. They are instead in line with the few studies reporting mostly positive effects of emotional stability (Salgado, 1997; Tett et al, 1991; Cubel, 2016).

The paper is organized as follows. Section 1 introduces the empirical framework and Section 2 outlines the estimation strategy. We describe the data in Section 3 and the empirical results in Section 4. Conclusions follow.

1. The Empirical Framework

Our approach is based on previous work by Hellerstein et al., 1999, Bartel, 2001, and Konings et al, 2015, who estimate firm production functions augmented with average labour quality. Our main innovation is to treat workers' personality, measured by the Big Five traits, as a factor determining this quality.

Firm *i* produces value added using a Cobb Douglas production function. Its (real) value added Y at time t is given by

$$Y_{it} = \hat{L}_{it}^{\beta} K_{it}^{\gamma} \exp(q_{it}) \exp(\varepsilon_{it}) \quad (1)$$

where K is the capital stock, $\hat{L}$ is the labour index, q is unobserved technical efficiency and ε is a white noise error term. We assume that the labour index consists of employment and average labour quality, which depends both on cognitive skills and on personality traits.

Following Bartel, 2001, and Konings et al, 2015, we specify the index as follows

$$\hat{L}_{it} = L_{it} * exp(\alpha_0 + \alpha_1 S_{it} + \boldsymbol{\alpha_2}' \boldsymbol{P_{it}} + Z_{it}) \quad (2)$$

where L is employment, S is workers' average education, $\boldsymbol{P}$ is a vector of workers' personality traits and Z is unobserved labour quality.[3] Placing (2) into (1) and taking logs yields

$$lnY_{it} = \theta + \beta lnL_{it} + \gamma lnK_{it} + \delta S_{it} + \boldsymbol{\pi}' \boldsymbol{P_{it}} + \omega_{it} + \varepsilon_{it} \quad (3)$$

where θ is a constant term, $\boldsymbol{\pi}$ a vector of parameters and

$$\omega_{it} = q_{it} + \beta Z_{it} \quad (4)$$

is unobserved productivity, which includes both technological progress and unobserved labour quality.

Each firm *i* can affect value added by altering both the production factors K and L and average labour quality, captured by S and $\boldsymbol{P}$. In this paper, we are particularly interested in the estimating the vector of parameters $\boldsymbol{\pi}$, which captures the marginal effect of each personality trait on firm productivity.

2. The estimation strategy

It is well known that the estimation of equation (3) is complicated by the fact that unobserved productivity ω is correlated with input choices. Because of this,

[3] We use bold letters for vectors of parameters and variables.

standard estimation methods such as OLS (ordinary least squares) produce biased results (Marschak and Andrews 1944).

We address this problem by using the control function approach proposed originally by Olley and Pakes, 1996, and refined by Levinsohn and Petrin, 2003, and Ackerberg, Caves and Frazer, 2015, (ACF in short). The key idea of this approach is that the endogeneity problem originates from the fact that ω_{it} is unobserved by the analyst. If an invertible function can make ω_{it} observable, the problem can be solved.

Following ACF, we make the following assumptions: (i) there exists a control function $lnM_{it} = f(lnK_{it}, lnL_{it}, S_{it}, \boldsymbol{P_{it}}, \omega_{it})$, where M is intermediate inputs, which is monotonic and invertible in ω; (ii) the capital stock K is decided at time t-1; (iii) employment L, average education S and personality traits P are decided between time t-1 and t.

Given these assumptions, invertibility implies that $\omega_{it} = f^{-1}(lnM_{it}, lnK_{it}, lnL_{it}, S_{it}, \boldsymbol{P_{it}})$, which can be substituted in equation (3) and approximated with a polynomial in lnM_{it}, lnK_{it}, lnL_{it}, S_{it} and P_{it}. ACF, 2015, estimate the parameters of equation (3) by assuming that the productivity shock ω_{it} follows a first-order Markov process, and by deriving moment conditions that are minimized using a GMM procedure. In this paper, we implement this method by using the Stata command "*prodest*" developed by Rovigatti and Mollisi, 2018. Following Lochner and Schutz, 2024, we bootstrap this command 100 times to produce larger and more conservative standard errors than the original command.

3. *The Data*

Our data on personality are drawn from the German Linked Personnel Panel, a repeated survey of a representative sample of German establishments with at least 50 employees (see Kampkotter et al, 2015) which covers the even years between 2012 and 2020. A key feature of these data is that, for each participating firm, a random sample of workers is interviewed. The average number of

interviewed workers per firm is 8.65 and the mean and median coverage rate, defined as the share of interviewed workers, are 3.9 and 3.2 percent respectively.

We measure average education with the share of workers who have completed at least 13 years of education, including vocational training programs.[4] Personality in LPP is measured using the 16-items version of the Big Five Inventory short scale (BFI-S) developed for the German Socio-economic Panel (SOEP) (Gerlitz and Schupp, 2005).[5] Four of the five personality dimensions are measured by three items, whereas openness to experience dimension includes four items. In the employee questionnaire, all statements begin with "I see myself as someone who". Answers are elicited using a five points Likert scale, which ranges from 1 (does not apply to me at all) to 5 (applies to me perfectly).

Table A1 in the appendix shows the 16 items and the corresponding five personality traits. We compute these traits for each of the close to 17 thousand interviewed workers by using principal components analysis for each sub-group of items and by applying the sampling weights provided by LPP. The outcomes are very similar to those obtained when using instead confirmatory factor analysis and general partial credit models.

We use the distributions of traits across all interviewed workers to compute trait – specific median values and, for any firm in the sample, the share of workers with values of each trait at or above the median. Firms with higher shares employ a higher percentage of workers with high personality values. We also compute firm – specific average traits, which we standardize so that each average trait has zero mean and unit standard deviation.

We merge LPP data with the IAB Establishment History Panel (BHP) to obtain firm-specific information on value added, employment, investment and intermediate goods. The capital stock is computed using the perpetual inventory formula $K_{it} = (1 - \varphi)K_{it-1} + I_{it-1}$, where φ is the rate of depreciation and

[4] 13 years is the national standard to enter tertiary education in Germany.
[5] The LPP collects information on personality only once for each worker.

investment I enters with the first lag. The transition between the original and the working sample is illustrated in Table A2. We start from 4,892 firms (1,172 in 2020) in the LPP dataset. After merging with the BHP data, we retain the 3,055 firms (521 in 2020) that do not operate in agriculture or the public sector and have no missing observations on value added, employment, the capital stock and intermediate goods. We also drop firms with fewer than 3 interviewed employees and with missing valued added, ending up with 1,584 firms (227 in 2020). The final sample includes 417 observations with imputed values replacing missing information on investment and intermediate inputs.[6]

Compared with the BHP sample, which covers 50 percent of German firms (see Table A3 in the Appendix), our working sample has a substantially larger share of firms: a) in industry (70.8 versus 28.5 percent); b) with at least 250 employees (39.5 versus 13.7 percent); c) located in the Eastern areas of the country (38.3 versus 18.1 percent). In addition, it has a much smaller share of female employees (26.9 versus 45.3 percent).[7]

4. The empirical estimates

4.1 Baseline results

We report our baseline estimates in Table 1, which presents the estimates of the production function (3), using either OLS (first column) or the ACF version of the control function approach (second column). In the table, each personality trait is measured by the share of workers with at or above median value of the trait. We also control for year, region, sector, firm age and size dummies, the share of female workers and workers' average age,[8] and include a binary variable equal

[6] Investment in euros is imputed using predicted values from the regression of investment on value added, firm size, the state of technology, wage levels, and exports. We predict the share of intermediate goods on revenue by regressing it on wage levels, exports, sector, firm size and regional dummies. We imput intermediate goods by multiplying the predicted share by revenue.
[7] Appendix Table A4 presents the summary statistics of the variables used in the empirical analysis.
[8] The size dummies refer to employment size in 2012. The firm's age dummy is equal to 1 if age is above 25 and to 0 otherwise.

to 1 if the share of workers in high skilled occupations (defined as ISCO codes 1, 2 and 3) in the firm is above the median, and 0 otherwise.[9]

Focusing on the second column of the table, we estimate that a 10 percent increase in employment and the capital stock raises value added by 8.41 and 2.14 percent respectively. We also find that a 10 percent increase in the share of workers with at least 13 years of education increases productivity by 5.2 percent. In addition, having a share of high skilled workers above the median is associated with a 22 percent increase in productivity.

The table also shows that only the share of workers with at or above median emotional stability has a statistically significant effect on productivity. We estimate that a 10 percent increase in the share raises productivity by 2.1 percent, which corresponds to rasing the share of highly educated workers by roughly 4 percent. .

A potential concern with these estimates is that our measures of personality at the firm level rely for some firms on few radomly selected interviewed workers. To attenuate this concern, we restrict our sample to include only firms with a coverage rate above the median (6.1 interviewed workers). The results in Table 2 confirm the qualitative results reported in Table 1.

Emotional stability is composed of three facets: a) low nervousness; b) the ability to handle stress; c) low anxiety. We investigate which facet is responsible of the positive effect of emotional stability on productivity by replacing in equation (3) the former with the share of workers with at or above median value of each facet. Table 3 shows that the results in Table 1 are driven by the share of workers with low anxiety.

4.2 *Robustnesses and heterogeneous effects.*

We replace the shares of workers with at or above median values of the five traits as measures of workers' personality in the firm with the (standardized) average

[9] ISCO codes 1, 2 and 3 refer to managers, professionals, technicians and associate professionals.

values of each personality trait. The results reported in Table A5 in the Appendix are qualitatively similar to those in Table 1.

We reduce dimensionality and potential concerns with multiple hypothesis testing[10] by replacing the Big Five traits (measured as shares of workers with at or above median value of each traits) with a revised version of the Big Two traits (Digman, 1997; DeJong, 2015), which consist of plasticity (the mean of openness and extraversion) and stability (the mean of conscientiousness, agreeableness and emotional stability). In our revision, we highlight the role of emotional stability by using it separately from the mean of conscientiousness and agreeableness. As in Table 1, we measure each personality trait with the share of workers with at or above median value of the trait. Our estimates with three rather than five factors is reported in Table A6 and confirm the qualitative relults of Table 1.

We also replicate the estimates in Table 1 on the sub-sample of 1,167 observations that excludes imputed values for the capital stock and intermediate goods. The empirical results reported in Table A7 also confirm our findings.

Finally, we investigate whether the effects of workers' personality on firm productivity vary with firm size and the share of highly educated workers by running separate estimates for firms with at or above median employment / share of highly educated workers and firms with below median employment / share of highly educated workers.

Our results in Table A8 in the Appendix suggest that the effect of the share of workers with at or above median emotional stability is statistically significant in larger firms and in firms with a higher than median share of highly educated workers and imprecisely estimated in smaller firms or in firms with a less than median share of highly educated workers. We also find that in larger firms

[10] The probability of obtaining false statistically significant values for the Big Five in Table 1 is $1 - 0.95^5 = 0.22$. This probability declines to 0.14 with three factors.

productivity is significantly reduced by a higher share of workers with at or above median extraversion.

Conclusions

Using matched employer-employee data for Germany and a control function approach, we have estimated firm production functions augmented with workers' average personality traits. We have shown that emotional stability is the only trait that positively affects firm productivity, independently of whether we measure it with the share of workers with at or above median values of the trait or with the average value of the trait in the firm. This positive effect is driven by low anxiety.

For the remaining four traits, we have found no evidence that they have a statistically significant association with firm productivity, except for extraversion, which contributes negatively in larger firms. We have also shown that the positive effect of emotional stability on productivity shows up mainly in larger firms and in firms with a higher than median share of highly educated workers.

We can think of both negative and positive effects of emotional stability on productivity. On the one hand, emotionally stable individuals are less anxious and insecure, more self-confident and with a higher ability to focus. They also have high motivation, are less exposed to burnout (Judge and Ilies, 2002; Wright and Staw, 1999) and are strivers (Nettle, 2002), who are better able to handle negative information (Tamir and Robinson, 2004) and more realistic about self. All these features are expected to raise productivity. On the other hand, emotionally stable individuals are less vigilant, cautious and have lower attention to potential threats (Eysenck, 1967; Gray, 1987; Perkins and Corr, 2005), which reduce productivity. Our results suggest that, in the specific context studied in this paper, the positive aspects dominate the negative ones, and that firms with a more emotionally stable workforce are more productive.

Since our sample covers a specific sub-sample of German firms and personality is observed only for a limited number of workers per firm, we are cautious in extrapolating our findings to the entire German economy or to any other economy. Clearly, the issue of external validity is important but can only be addressed in future research that has access to more detailed data. However, by exploiting matched employer–employee data, we believe that our paper makes a unique contribution to the literature and represents a first step in investigating the effect of worker personality on firm productivity.

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Tables.

Table 1. Production function estimates with the Big Five personality traits. Each trait is measured as the share of workers with values of personality at or above the median.

	OLS	ACF
Log employment	0.831***	0.841***
	(0.070)	(0.073)
Log capital stock	0.202***	0.214***
	(0.026)	(0.027)
Share with higher than median extraversion	-0.143	-0.132
	(0.099)	(0.096)
Share with higher than median openness	-0.011	-0.002
	(0.103)	(0.118)
Share with higher than median agreeableness	0.057	0.066
	(0.092)	(0.080)
Share with higher than median conscientiousness	-0.091	-0.083
	(0.106)	(0.083)
Share with higher than median emotional stability	0.201**	0.211**
	(0.093)	(0.089)
Percent with higher education	0.511***	0.521***
	(0.114)	(0.114)
Percent high skilled above median	0.211***	0.220***
	(0.044)	(0.050)
Number of observations	1,584	1,584

Note: OLS: ordinary least squares; ACF: Ackerberg, Caves and Frazer's method. Each regression includes a constant, year dummies, region dummies, sector dummies, firm age dummies, size dummies, the share of females and the mean age of employees. Percent with higher education: percent with at least 13 years of education. Percent high skilled above median: binary variable equal to 1 if the share of workers in ISCO occupations 1,2,3 is above the median, 0 otherwise. Bootstrapped standard errors clustered at the firm level in the second column. *p<0.1,**p<0.05,***p<0.01.

Table 2. Production function estimates with the Big Five personality traits. Only firms with coverage at or higher than median. Each trait is measured as the share of workers with values of personality at or above the median.

	OLS	ACF
Log employment	0.727***	0.737***
	(0.199)	(0.189)
Log capital stock	0.192***	0.201***
	(0.030)	(0.048)
Share with higher than median extraversion	-0.117	-0.108
	(0.134)	(0.157)
Share with higher than median openness	-0.034	-0.023
	(0.145)	(0.133)
Share with higher than median agreeableness	-0.030	-0.019
	(0.127)	(0.135)
Shaere with higher than median conscientiousness	-0.111	-0.097
	(0.142)	(0.169)
Share with higher than median emotional stability	0.280**	0.285**
	(0.116)	(0.118)
Percent with higher education	0.421***	0.432***
	(0.150)	(0.156)
Percent high skilled above median	0.228***	0.234***
	(0.053)	(0.055)
Number of observations	815	815

Note: OLS: ordinary least squares; ACF: Ackerberg, Caves and Frazer's method. Each regression includes a constant, year dummies, region dummies, sector dummies, firm age dummies, size dummies, the share of females and the mean age of employees. Percent with higher education: percent with at least 13 years of education. Percent high skilled above median: binary variable equal to 1 if the share of workers in ISCO occupations 1,2,3 is above the median, 0 otherwise. Bootstrapped standard errors clustered at the firm level in the second column. *p<0.1,**p<0.05,***p<0.01.

Table 3. Production function estimates with the Big Five personality traits and emotional stability decomposed into three traits. Each trait is measured as the share of workers with values of personality at or above the median. ACF estimates.

	(1)	(2)
Log employment	0.827***	0.838***
	(0.070)	(0.074)
Log capital stock	0.201***	0.215***
	(0.026)	(0.025)
Share with higher than median extraversion	-0.094	-0.083
	(0.095)	(0.095)
Share with higher than median openness	0.015	0.024
	(0.104)	(0.119)
Share with higher than median agreeableness	0.096	0.107
	(0.093)	(0.079)
Share with higher than median conscientiousness	-0.018	-0.009
	(0.106)	(0.088)
Share with lower than median nervousness	-0.196	-0.186
	(0.131)	(0.132)
Share with higher than median ability to handle stress	-0.104	-0.092
	(0.130)	(0.130)
Share with lower than median anxiety	0.215**	0.225**
	(0.105)	(0.113)
Percent with higher education	0.479***	0.489***
	(0.114)	(0.118)
Percent high skilled above median	0.211***	0.223***
	(0.044)	(0.051)
Number of observations	1,584	1,584

Note: each regression includes a constant, year dummies, region dummies, sector dummies, firm age dummies, size dummies, the share of females and the mean age of employees. Percent with higher education: percent with at least 13 years of education. Percent high skilled above median: binary variable equal to 1 if the share of workers in ISCO occupations 1,2,3 is above the median, 0 otherwise. Bootstrapped standard errors clustered at the firm level. *p<0.1,**p<0.05,***p<0.01.

Appendix.

Table A1. The Big Five inventory scale in LPP (and SOEP).

Item	Big Five trait	Range	Correlation with Big Five	Mean	Standard deviation	Workers
Original	Open	1: does not apply; 5: applies	0.707	3.685	0.879	17,722
Artsy	Open	1: does not apply; 5: applies	0.610	3.202	1.183	17,665
Imaginative	Open	1: does not apply; 5: applies	0.707	3.556	1.036	17,707
Curious	Open	1: does not apply; 5: applies	0.599	4.153	0.781	17,667
Thorough	Conscientious	1: does not apply; 5: applies	0.771	4.474	0.608	17,745
Lazy	Conscientious	1: applies; 5: does not apply	0.674	4.331	0.825	17,739
Efficient	Conscientious	1: does not apply; 5: applies	0.751	4.257	0.603	17,735
Communicative	Extravert	1: does not apply; 5: applies	0.803	4.061	0.906	17,746
Reserved	Extravert	1: applies; 5: does not apply	0.677	3.027	1.136	17,735
Sociable	Extravert	1: does not apply; 5: applies	0.813	3.825	0.944	17,717
Rude	Agreeable	1: applies; 5: does not apply	0.646	3.710	1.102	17,723
Forgiving	Agreeable	1: does not apply; 5: applies	0.653	4.152	0.756	17,743
Friendly	Agreeable	1: does not apply; 5: applies	0.789	4.263	0.641	17,744
Nervous	Neurotic	1: does not apply; 5: applies	0.807	3.489	1.089	17,747
Relaxed	Neurotic	1: applies; 5: does not apply	0.749	3.641	0.937	17,741
Worried	Neurotic	1: does not apply; 5: applies	0.646	3.242	1.149	17,735

Table A2. From the original to the working sample

	Observations	Firms in 2020
Original sample	4,892	1,172
After merging with IAB BHP	3,055	521
After removing firms with less than 3 interviewed workers	2,084	302
After dropping firms with missing value added	1,584	227

Table A3. Characteristics of the working sample (LPP) and of the German population of firms.

	BHP share	LPP share
Industry	0.285	0.708
Size 50-99	0.552	0.378
Size 250+	0.137	0.395
Percent females	0.453	0.269
Average age of employees	42.081	45.923
Located in the North	0.164	0.166
Located in the East	0.181	0.383
Located in the South	0.301	0.189
Observations	267,657	1,584

Note: BHP is the IAB Establishment History Panel.

Table A4. Summary statistics of the variables used in the empirical section.

	Mean	SD
Log value added	16.68	1.35
Log employment	5.26	0.99
Log capital	17.10	1.41
Log intermediate goods	16.77	1.72
Share workers with > 13 years education	0.80	0.22
Worker share in ISCO 1,2,3	0.31	0.28
Firm's age 16-25	0.35	0.48
Firm's age above 25	0.48	0.50
Share of workers with extraversion above median	0.67	0.25
Share of workers with conscientiousness above median	0.63	0.26
Share of workers with openness above median	0.66	0.25
Share of workers with emotional stability above median	0.62	0.27
Share of workers with agreeableness above median	0.66	0.26
Observations	1,584	

Note: the median for each trait is computed using the original sample of employees.

Table A5. Production function estimates with the Big Five personality traits. Using standardized mean values rather than shares.

	OLS	ACF
Log employment	0.832***	0.843***
	(0.070)	(0.073)
Log capital stock	0.201***	0.211***
	(0.026)	(0.026)
Mean extraversion	-0.037	-0.028
	(0.024)	(0.028)
Mean openness	-0.012	-0.000
	(0.024)	(0.026)
Mean agreeableness	-0.002	0.010
	(0.023)	(0.026)
Mean conscientiousness	-0.036	-0.025
	(0.022)	(0.024)
Mean emotional stability	0.038*	0.048*
	(0.021)	(0.027)
Percent with higher education	0.479***	0.491***
	(0.114)	(0.116)
Percent high skilled above median	0.203***	0.209***
	(0.044)	(0.050)
Number of observations	1,584	1,584

Note: OLS: ordinary least squares; ACF: Ackerberg, Caves and Frazer's method. Each regression includes a constant, year dummies, region dummies, sector dummies, firm age dummies, size dummies, the share of females and the mean age of employees. Percent with higher education: percent with at least 13 years of education. Percent high skilled above median: binary variable equal to 1 if the share of workers in ISCO occupations 1,2,3 is above the median, 0 otherwise. Bootstrapped standard errors clustered at the firm level in the second column. *p<0.1,**p<0.05,***p<0.01.

Table A6. Production function estimates with three personality traits. Each trait is measured as the share of workers with values of personality at or above the median.

	OLS	ACF
Log employment	0.832***	0.842***
	(0.070)	(0.076)
Log capital stock	0.201***	0.211***
	(0.026)	(0.024)
Share with higher than median plasticity	-0.114	-0.103
	(0.093)	(0.095)
Share with higher than median stability	-0.025	-0.014
	(0.092)	(0.093)
Share with higher than median emotional stability	0.170*	0.180**
	(0.087)	(0.086)
Percent with higher education	0.515***	0.524***
	(0.113)	(0.117)
Percent high skilled above median	0.214***	0.225***
	(0.044)	(0.050)
Number of observations	1,584	1,584

Note: OLS: ordinary least squares; ACF: Ackerberg, Caves and Frazer's method. Plasticity: mean of openness and extraversion. Stability: mean of agreeableness and conscientiousness. Each regression includes a constant, year dummies, region dummies, sector dummies, firm age dummies, size dummies, the share of females and the mean age of employees. Percent with higher education: percent with at least 13 years of education. Percent high skilled above median: binary variable equal to 1 if the share of workers in ISCO occupations 1,2,3 is above the median, 0 otherwise. Bootstrapped standard errors clustered at the firm level in the second column. *p<0.1,**p<0.05,***p<0.01.

Table A7. Production function estimates with the Big Five personality traits. Sample without imputed values. Each trait is measured as the share of workers with values of personality at or above the median.

	OLS	ACF
Log employment	0.740***	0.750***
	(0.090)	(0.082)
Log capital stock	0.210***	0.223***
	(0.029)	(0.035)
Share with higher than median extraversion	-0.112	-0.102
	(0.107)	(0.104)
Share with higher than median openness	-0.074	-0.065
	(0.102)	(0.088)
Share with higher than median agreeableness	0.092	0.103
	(0.103)	(0.105)
Share with higher than median conscientiousness	-0.156	-0.146
	(0.113)	(0.113)
Share with higher than median emotional stability	0.215**	0.223**
	(0.104)	(0.104)
Percent with higher education	0.454***	0.463***
	(0.123)	(0.124)
Percent high skilled above median	0.190***	0.199***
	(0.042)	(0.038)
Number of observations	1,167	1,167

Note: OLS: ordinary least squares; ACF: Ackerberg, Caves and Frazer's method. Each regression includes a constant, year dummies, region dummies, sector dummies, firm age dummies, size dummies, the share of females and the mean age of employees. Percent with higher education: percent with at least 13 years of education. Percent high skilled above median: binary variable equal to 1 if the share of workers in ISCO occupations 1,2,3 is above the median, 0 otherwise. Bootstrapped standard errors clustered at the firm level in the second column. *p<0.1,**p<0.05,***p<0.01.

Table A8. Production function estimates with the Big Five personality traits. By employment size and share of highly educated labour. Each trait is measured as the share of workers with values of personality at or above the median.

	Firms with employment above or at median	Firms with employment below median	Firms with share of highly educated labour at or above median	Firms with share of highly educated labour below median
Log employment	0.843***	0.982***	0.849***	0.873***
	(0.064)	(0.130)	(0.123)	(0.066)
Log capital stock	0.226***	0.214***	0.234***	0.171***
	(0.051)	(0.048)	(0.049)	(0.039)
Share with higher than median extraversion	-0.409**	-0.022	-0.178	-0.038
	(0.176)	(0.140)	(0.149)	(0.132)
Share with higher than median openness	0.099	-0.071	-0.148	0.149
	(0.201)	(0.133)	(0.114)	(0.112)
Share with higher than median agreeableness	-0.084	0.175*	0.181	-0.069
	(0.178)	(0.105)	(0.128)	(0.109)
Share with higher than median conscientiousness	-0.000	-0.111	-0.018	-0.105
	(0.198)	(0.135)	(0.153)	(0.167)
Share with higher than median emotional stability	0.404**	0.122	0.247**	0.167
	(0.173)	(0.093)	(0.113)	(0.112)
Percent with higher education	0.560***	0.486***	0.270	0.497***
	(0.201)	(0.144)	(0.565)	(0.161)
Percent high skilled above median	0.187***	0.240***	0.309***	0.105***
	(0.060)	(0.053)	(0.058)	(0.061)
Number of observations	792	792	792	792

Note: OLS: ordinary least squares; ACF: Ackerberg, Caves and Frazer's method. Each regression includes a constant, year dummies, region dummies, sector dummies, firm age dummies, size dummies, the share of females and the mean age of employees. Percent with higher education: percent with at least 13 years of education. Percent high skilled above median: binary variable equal to 1 if the share of workers in ISCO occupations 1,2,3 is above the median, 0 otherwise. Bootstrapped standard errors clustered at the firm level in the second column. *p<0.1,**p<0.05,***p<0.01.