Persistent and Transient Inefficiency in Adult Education

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This paper evaluates the efficiency of adult education programs. Using an advanced four-component Stochastic Frontier model on Belgian adult education data, we distinguish between persistent and transient inefficiency of adult education programs. Whereas persistent inefficiency is structural and difficult to tackle, transient inefficiency can be eliminated somewhat easily without a major structural change. Different inefficiency components may require different policy measures. Our results indicate that despite the presence of persistent inefficiency, the overall inefficiency is mainly due to the transient component, and hence, at the discretion of the adult education management. The findings suggest that social interaction is relevant in adult education as both more sessions and more learners per program increase educational efficiency. Moreover, adult education programs seem to be particularly useful for young low educated learners. (JEL C54, I21, I28).

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1. Introduction

A highly skilled and well-trained workforce is essential for economic growth (Hanushek & Woessmann, 2008). Yet, about 14% of the adult population aged 25 to 64 dropped out of high school in the OECD countries in 2017 (OECD, 2020). According to the European Commission, (2011), each percentage point reduction in high school dropout would lead to about half a million additional qualified employees. Given the importance of a qualified workforce and the relatively high dropout rates, most countries have introduced adult education to reintegrate school dropouts in the education system and to retrain them for the labour market (OECD, 2019). As adult education attracts an increasing share of the total education budget, it is particularly interesting to analyse its productive efficiency. Contrary to significant attention of scholars to the efficiency of the compulsory education system (see an overview by De Witte & Lopez-Torres, (2017)), evidence on the performance of adult education is rare (an exception is Schiltz, De Witte, and Mazrekaj, 2019).

This paper defines education production technology for adult education. Using a production function for education, it assesses the performance of adult education and analyses the determinants of efficiency differentials. Said otherwise, it investigates whether adult education programs are able to transform budget resources into highest attainable academic outcomes.

Using an advanced four-component Stochastic Frontier (SF) model on adult education data from the Flemish community in Belgium, we disentangle the overall inefficiency of adult education programs into two parts: the persistent inefficiency and the transient inefficiency. The persistent inefficiency refers to a long-term or structural inability of an adult education program to attain the potential level of academic outputs. The persistent inefficiency might originate from the target population of the adult education program, which is harder to reach than students in compulsory education and which requires different approaches such as online-learning or smaller class groups. Transient inefficiency, on the other hand, is a short-run deficit, which an adult education program manager can eliminate swiftly without a major structural change. Such short-term inefficiency implies that program outputs may be at their potential level in the next time period, or they may be below again. Distinguishing between persistent and transient inefficiency of adult education programs is important as different types of inefficiency may require different policy measures.

Our results indicate that the overall inefficiency of adult education programs amounts to 12%, suggesting that, given the available resources, the outputs (measured by exam scores, attendance rates and participation) could increase by 12%. Decomposing the overall inefficiency reveals that about 5 percentage points of the inefficiency are due to structural differences between the programs, whereas about 7 percentage points are at the discretion of the adult education management. Digging in the determinants of inefficiency provides insights into how efficiency can be enhanced. In particular, we show that social interaction is relevant as both more sessions and more learners per program increase efficiency. Moreover, adult education programs seem to be particularly useful for young low educated learners, suggesting that adult education might play a crucial role as second chance education for young people.

Previous literature has primarily focused on the efficiency of compulsory education and higher education (see De Witte and López-Torres (2017) for a review). To the best of our knowledge, only one paper has evaluated the efficiency of adult education programs (Schiltz, De Witte, & Mazrekaj, 2019). Using a conditional and bias-corrected Data Envelopment Analysis (DEA) model on Belgian data, Schiltz et al. (2019) found that adult education programs could improve their efficiency by 4%, on average. Moreover, they observed that teacher and program characteristics explain efficiency differentials between adult education programs. However, inefficiency was estimated as a single component, without considering whether this inefficiency is persistent and difficult to tackle, or whether it is transient and can be eliminated in the short run. In addition, due to multidimensionality issues with the non-parametric kernels, the applied conditional efficiency model does not allow for a broad variety of control variables, which the semi-parametric SF model can better capture.

Despite the lack of interest from efficiency analysis literature in adult education, earlier literature has shown that adult education can result in increased labour market outcomes (Blanden, Buscha, Sturgis, & Urwin, 2012; Martin, McNally, & Kay, 2013). For example, using fixed effects models on the British Household Panel Survey, Blanden et al. (2012) show that adult learning increases women's earnings by 10%, whereas their estimates for males seem to be driven by selection effects. In a meta-review focused on entrepreneurship education and training, Martin et al. (2013) found that this training leads to the development of a range of entrepreneurship competences with subsequent positive consequences on the labour market.

The remainder of the paper is structured as follows. Section 2 describes the data and sample restrictions. Section 3 formulates the stochastic frontier model. Section 4 presents the empirical results. The paper ends with a discussion of the results and several limitations of the analysis in Section 5.

2. Empirical Methodology

2.1. Modelling Inefficiency

To evaluate the efficiency of the adult education program, we follow Hanushek (1986) and employ an education production function. The educational technology that we assume uses one input, e.g., the cost of an adult education program. The results of knowledge production are academic outcomes approximated by multiple outputs, e.g., the exam score and exam participation. Evidently, not all programs are able to equally employ resources and thus some of them are less efficient than others in achieving the academic outputs. We make an assumption that programs with the same inputs are theoretically able to obtain the same outputs.

In an education production function, outputs **y** are a result of utilising input **x**. This is a multi-output production process and one way to analyse it is to formulate the radial distance function. In output-based efficiency measurement, output distance function (ODF) is defined as

$$D^O = \max\{\theta: \mathbf{y}\theta \in P(\mathbf{x})\}, \quad (1)$$

where $P(\mathbf{x})$ is the outputs set, i.e., a set of outputs such that inputs-output combination is technologically feasible. The ODF is thus a function of input and outputs, viz.,

$$D^O = f(\mathbf{x}, \mathbf{y}; \boldsymbol{\beta}), \quad (2)$$

where $\boldsymbol{\beta}$ is a vector of parameters to be estimated once $f(\cdot)$ is specified parametrically. Since the ODF is homogeneous of degree 1 in feasible outputs vector **y**, (2) can be rewritten as

$$D^O y_1^{-1} = f(\mathbf{x}, \tilde{\mathbf{y}}_{-1}; \boldsymbol{\beta}), \quad (3)$$

where $\tilde{\mathbf{y}}_{-1} = (y_3/y_1, y_2/y_1)$. Taking the logs of both sides of (3) we obtain

$$-\log y_1 = \log f(\mathbf{x}, \tilde{\mathbf{y}}_{-1}; \boldsymbol{\beta}) - \log D^O. \quad (4)$$

In a panel data setting, we assume that the overall distance to the frontier, ODF, contains a persistent and transient component, so that for program i in time period t, we write

$$D_{it}^{O,overall} = D_{0i}^{O,persistent} \times D_{it}^{O,transient}. \quad (5)$$

Denoting $\log D_{it}^{O,transient} = u_{it} \geq 0$ and $\log D_{0i}^{O,persistent} = u_{0i} \geq 0$, adding a random error term to the ODF in (4) to make it stochastic, and accounting for program heterogeneity, we obtain a four-component cost stochastic frontier model[1]

$$-\log y_{1,it} = \log f(\mathbf{x}, \tilde{\mathbf{y}}_{-1,it}, \mathbf{c}; \boldsymbol{\beta}) + v_{0i} + u_{0i} + v_{it} + u_{it}, \tag{6}$$

where we also control for variables that do not affect the frontier, e.g., gender and socio-economic status. It is important to emphasize that we distinguish between persistent inefficiency and transient inefficiency.

2.2. Modelling Determinants of Inefficiency

Since our application focuses on explaining the differentials of the inefficiencies, we argue that both public servants and program providers are interested in knowing the factors that could influence persistent and transient inefficiency, and the magnitude of their marginal effects. Thus, some adult education programs are below their potential and we will seek to identify the determinants of such shortfall.

Although there are many ways to introduce determinants of inefficiency, we follow Baduenko & Kumbhakar (2017) and introduce them via the variance of the truncated normal error terms used to represent inefficiency. That is, we specify the (pre-truncated) variance of u_{0i} which is time-invariant, viz.,

$$u_{0i} \sim N^{+}\left(0, \sigma_{u_{0i}}^2\right), \text{where} \sigma_{u_{0i}}^2 = \sigma_{u_0}^2 \exp(\mathbf{z}_{u0i}\boldsymbol{\gamma}_{u0}), \quad i = 1, \cdots, n, \tag{7}$$

and $\mathbf{z}_{u0i}$ is the vector of covariates that are determinants of persistent inefficiency. By definition the variables in $\mathbf{z}_{u0i}$ are time-invariant. Since $E(u_{0i}) = \sqrt{(2/\pi)}\sigma_{u_{0i}} = \sqrt{(2/\pi)}\exp\left(\frac{1}{2}\mathbf{z}_{u0i}\boldsymbol{\gamma}_{u0}\right)$, the $\mathbf{z}_{u0i}$ variables can be viewed as determinants of persistent inefficiency. Consider efficiency change (EC) due to a change in z_{01} holding everything else fixed. Since the persistent efficiency is $\exp(-u_{0i})$, the rate of change in it due to a change in z_{01} (labeled as EC) is given by

[1] The four-component homoscedastic model has been applied to analyse the efficiency in health care, agriculture, transportation (Colombi, Kumbhakar, Martini, & Vittadini, 2014; Kumbhakar, Lien, & Hardaker, 2014), and US banks (Tsionas & Kumbhakar, 2014).

$$\text{EC:} \equiv \Delta \mathrm{A}_i = -\frac{\partial u_{0i}}{\partial z_{01}} \approx -\frac{\partial E(u_{0i})}{\partial z_{0i}} = -\sqrt{\frac{2}{\pi}}\frac{\partial \sigma_{u_{0i}}}{\partial z_{0i}}. \quad (8)$$

Under the assumption $\sigma_{u_{0i}}^2 = \exp(\mathbf{z}_{u0i}\boldsymbol{\gamma}_{u0})$, Equation (8) becomes

$$-\sqrt{\frac{2}{\pi}}\frac{1}{2}\gamma_{u01}\exp\left(\frac{1}{2}\mathbf{z}_{u0i}\boldsymbol{\gamma}_{u0}\right). \quad (9)$$

Variables in $\mathbf{z}_{u0i}$ vary across programs, but are time-invariant. This means that $\sigma_{u_{0i}}^2$ is explained only by time-invariant covariates.

In a similar fashion, we introduce determinants of time-varying inefficiency via the pre-truncated variance of u_{it}. That is, we assume

$$u_{it} \sim N^+\left(0, \sigma_{u_{it}}^2\right), \text{where} \sigma_{u_{it}}^2 = \sigma_u^2 \exp(\mathbf{z}_{uit}\boldsymbol{\gamma}_u), \quad i = 1, \cdots, n, \quad t = 1, \cdots, T_i, \quad (10)$$

where $\mathbf{z}_{uit}$ denotes the vector of covariates that explains time-varying inefficiency. Since u_{it} is half-normal, $E(u_{it}) = \sqrt{(2/\pi)}\sigma_{u_{it}} = \sqrt{(2/\pi)}\exp\left(\frac{1}{2}\mathbf{z}_{uit}\boldsymbol{\gamma}_u\right)$, and therefore, anything that affects $\sigma_{u_{it}}$ also affects time-varying inefficiency. The marginal effects of time-varying determinants can be calculated using equations (8) and (9) replacing $\mathbf{z}_{u0i}$ and $\boldsymbol{\gamma}_{u0}$ with $\mathbf{z}_{uit}$ and $\boldsymbol{\gamma}_u$, respectively. As noted before, time-varying inefficiency can also be modeled assuming the pre-truncation mean of u_{it} to be a function of the z_{uit} variables.

2.3. Empirical Stochastic Frontier Model

Using the output distance function approach (6), we test the appropriate functional form (see section 4). Our final specification is a translog production function for one input (x_1) and three outputs (y_1, y_2, y_3). We include a non-linear time trend to control for technological change over time:

$$-\log y_{1it} = \beta_0 + \sum_{\mathrm{p}=2}^{3}\beta_{\mathrm{p}}\log\left(\frac{y_{\mathrm{p},it}}{y_{1,it}}\right) + 0.5\sum_{\mathrm{p}=2}^{3}\beta_{\mathrm{pp}}\left[\log\left(\frac{y_{\mathrm{p},it}}{y_{1,it}}\right)\right]^2 \quad (11)$$

$$+\beta_{12}\log\left(\frac{y_{2,it}}{y_{1,it}}\right)\log\left(\frac{y_{3,it}}{y_{1,it}}\right)$$

$$+\alpha_1 \log(x_{1,it}) + 0.5\alpha_{11}\left[\log(x_{1,it})\right]^2 + \sum_{p=2}^{3} \gamma_p \log(x_{1,it}) \log\left(\frac{y_{p,it}}{y_{1,it}}\right)$$

$$+\theta_{xt} t \log(x_{1,it}) + \sum_{\mathrm{p}=2}^{3} \theta_{\mathrm{ytp}} t \log\left(\frac{y_{\mathrm{p},it}}{y_{1,it}}\right) + \delta_1 t + \delta_2 t^2 + v_{0i} + u_{0i} + v_{it} + u_{it}.$$

3. Data

The Flemish education system provides adult education in six vocational sectors: technology, management, environment, food, design, and metal and wood. To enrol, participants must be at least 18 years old. Although adult education is primarily meant for high school dropouts, individuals with a high school diploma are not precluded from participating. The completion of an adult education program leads to a formally recognized certificate that can be used on the labour market to secure a job. All adult education programs are privately organized and publicly funded. There are five adult education centres that are subsidized in an output-oriented manner by the Flemish government. In general, each centre receives funding per participant who obtained an adult education certificate. Nonetheless, the length of programs can vary considerably the duration of the program is also considered, with longer programs receiving more funding. Although the length of an adult education program varies as determined by the specific centre, most programs last about one year. The centre managers can freely allocate the resources as they see fit.

The data is compiled from SYNTRA Flanders, the public organization that organizes adult education in Flanders. We estimate inefficiency at the program level and cover the period 2006-2015. Our sample includes 120 programs observed over 10 years, totalling 1,200 observations. **Table 1** provides summary statistics for the outputs, inputs, and the determinants of both persistent and transient inefficiency. The outputs are selected in accordance with the criteria for evaluation set by the Flemish government, and after several interviews with adult education program directors (see Schiltz, De Witte, & Mazrekaj, 2019). The output variables consist of (1) the average score on the final exam, (2) whether the learner was present during the classes as reported by the teacher, and (3) whether the learner participated in the exam. All outputs are measured as ratios, with a maximum ratio of 1. Summary statistics, provided in Table 1, suggest that 76% of the students are present in class, whereas 54% participate in the exams.

We consider a single available input (x), namely the cost per learner per session in euros. This input is calculated in two steps. First, we compute the total cost of a program by multiplying the average hourly wage of teachers assigned to the program and the total number of hours taught. This latter is set by the central government. In a second step, we divide the total cost of a program by the number of learners and the number of sessions. As presented in **Table 1**, there are about 4 sessions and 5 learners per program. The cost per learner per session is, on average, 9 euro. However, some programs are considerably cheaper, whereas others are very expensive (up to 110 euro per session per learner).

Next, we include determinants of the transient inefficiency (variables z1 to z8). Gender balance is calculated as the ratio of boys over girls. The descriptive statistics in **Table 1** suggest that about half of the student population in adult education is female. Other determinants include the age of the learner (on average 31 years), the share of low educated learners (learners who have finished high school at most), the number of sessions and learners per program, the average age of the teacher, the variation in teacher age within the programs and the variation in teacher hours allocated to different teachers within a program. Moreover, to explore potential scale economies, we control for the number of sessions and the number of learners per program. As they may have a nonlinear effect on inefficiency, they enter the production function in logs. Given that adult education programs are primarily followed by high school dropouts who have decided to return to education, we interact share of low educated learners with age to investigate if the younger low educated participants are more motivated to achieve better academic results. Finally, we also add a time trend to investigate whether adult education programs are on average more efficient over time.

TABLE 1 – DESCRIPTIVE STATISTICS

	Variable	Min	Mean	Median	SD	Max
y1	Average exam score	0.242	0.664	0.673	0.091	1
y2	Total presence in class	0.405	0.761	0.777	0.099	1
y3	Participation rate in exam	0.010	0.544	0.560	0.213	1
x	Cost per learner per session (€)	0.635	9.097	7.648	8.365	110.468
z1	Gender balance	0.000	0.491	0.480	0.340	1
z2	Age of the learner	19.875	30.822	30.345	4.634	47.5
z3	Low educated (%)	0	0.101	0.088	0.089	0.667
z4	Sessions per program	0.693	3.832	3.761	0.990	7.366
z5	Learners per program	1.386	4.541	4.543	0.582	6.045
z6	Age of the teacher	29.365	46.448	46.648	6.124	72.795
z7	Teacher age composition	0	8.816	8.958	2.960	20.506
z8	Teacher hours composition	0	3.941	3.976	0.582	5.425
	Number of programs			1,200		

Finally, we allow persistent inefficiency to vary by the type of the program as the program types (e.g., food, management, design) might attract a different student population and have a different production function. By adding the program type as a persistent inefficiency component, we effectively control for similar endogeneity issues (coming from selection and unobserved heterogeneity). We consider the six different types of programs as the determinants of persistent inefficiency in adult education. **Table 2** provides the frequency of different programs.

TABLE 2 – FREQUENCY OF THE PROGRAM TYPE

Type	Count
Design	230
Food	160
Management	210
Metal and wood	180
Environment	210
Technology	210
Total	1,200

4. Results

This section presents the results of the analysis. We first present the education production technology. Next, the persistent and transient inefficiency is analysed. A third subsection discusses the determinants of the efficiency differentials, which provide insight into how efficiency can be enhanced.

4.1. Education production technology

To specify the education production function, we first estimate the most appropriate functional form. As a major disadvantage (over non-parametric models as estimated by Schiltz et al., 2019), the semi-parametric SF model requires an *a priori* specification of how the inputs translate into outputs. This important step is often ignored in the efficiency analyses, resulting in specification biases (Yatchew, 1998).

Therefore, we compare the basic Cobb-Douglas specification against a more flexible translog specification. The Cobb-Douglas specification is rejected in favor of the translog. The LR statistic is 614.81, which is in excess of the 1% critical value of the mixed chi-squared with 9 degrees of freedom of 20.97. As our output distance function is a full translog function in t, technical change contains both neutral and non-neutral components. Technical change is neutral if coefficients at interaction terms of time trend and outputs and input are not significant. The hypothesis that $\theta_{xt} = \theta_{yt2} = \theta_{yt2} = 0$ is rejected since the LR test statistic 62.71 exceeds 10.5, the critical value of the mixed chi-squared distribution at the 1 percent level. Thus, technological progress is non-neutral.

Having specified the production function, **Table 3** presents estimates of the education production technology. The results indicate that almost all output indicators are highly significant.

TABLE 3 – PRODUCTION TECHNOLOGY

Variable	Coefficient (SE)
(Intercept)	0.180*** (0.018)
log(y2/y1)	0.685*** (0.039)
log(y3/y1)	-0.039*** (0.014)
log(x)	0.023** (0.012)
t	-0.000 (0.006)
log(y2/y1)^2	0.577*** (0.029)
log(y3/y1)^2	-0.004 (0.003)
log(x)^2	-0.006** (0.003)
t^2	-0.000 (0.001)
log(y2/y1)*log(y3/y1)	-0.032** (0.013)
log(y2/y1)*log(x)	-0.119*** (0.016)
log(y2/y1)*t	-0.002 (0.004)
log(y3/y1)*log(x)	0.011** (0.005)
log(y3/y1)*t	0.003*** (0.001)
log(x)*t	0.001 (0.001)

Notes. *** Significance at the 1% level; ** Significance at the 5% level; * Significance at the 10% level.

4.2. Efficiency

Next, from the education production technology function, we can identify the programs that do not succeed in reaching the production frontiers. These programs have an efficiency shortfall, which might be due to persistent or transient reasons. The density plots of efficiencies are plotted in **Figure 1**. For comparison purposes, the range on the horizontal axis is the same in all three panels. The average overall efficiency of the programs amounts to 88.2%. This suggests a rather high overall efficiency level as the average program can only improve its outputs by 12%.

Further decomposing the efficiency, we observe that the overall inefficiency mainly stems from the transient inefficiency. The mean transient efficiency level is 93.2% suggesting that adult education's managers can improve efficiency by about 7% if they would learn from best practice observations. On the contrary, the overall efficiency is also to a large extent driven by persistent efficiency, which cannot be altered by the adult education programs. This source of efficiency amounts to 94.65% and is driven by the time-invariant differences between programs, stemming from, e.g., differences in difficulty level between the programs or differences in the cost structure of the programs.

It is interesting to notice that for all types of efficiency we observe rather long tails. This suggests that despite the overall efficiency is rather high, some programs clearly lag behind.

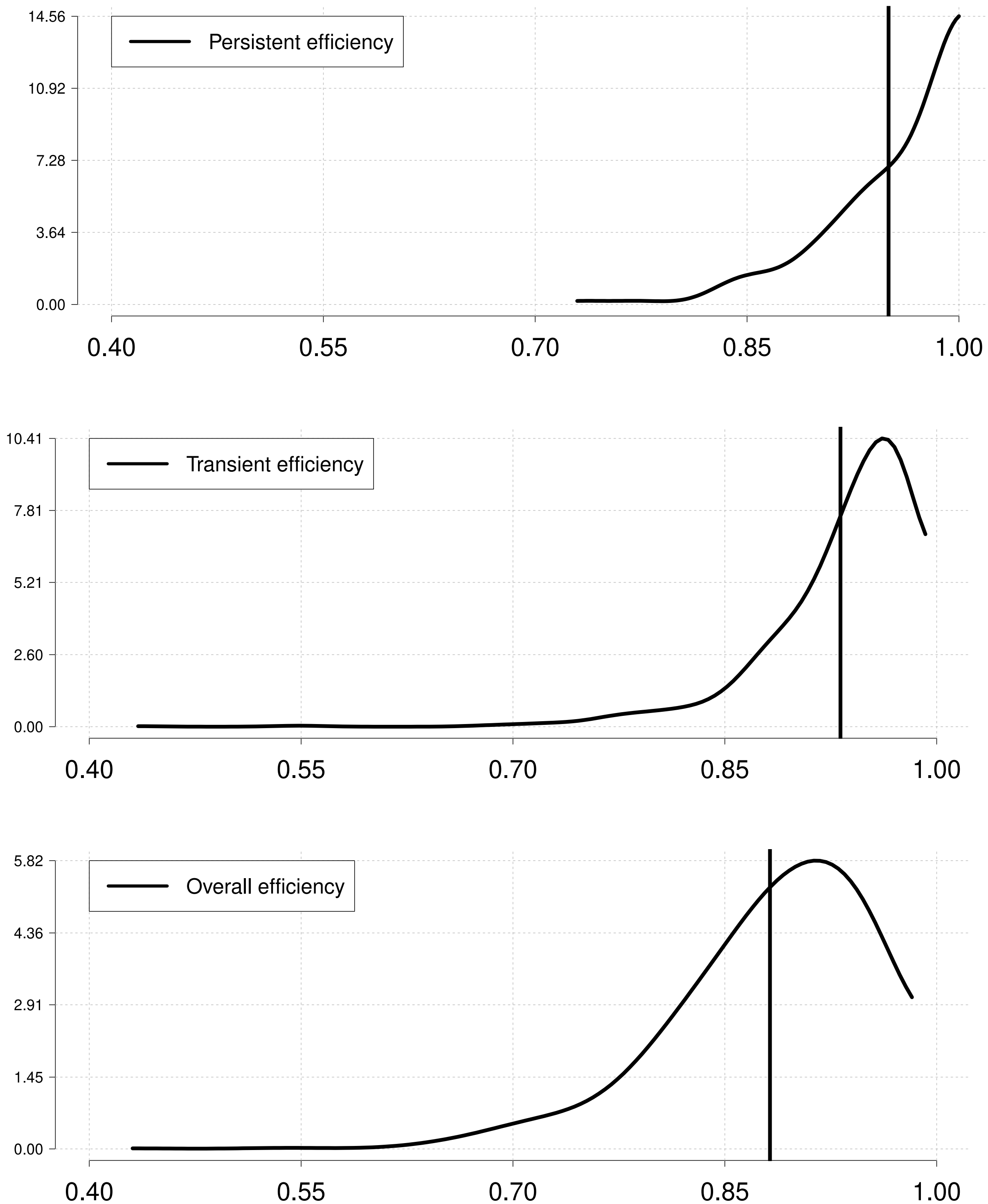

FIGURE 1 – KERNEL ESTIMATED DENSITY OF THE PERSISTENT, TRANSIENT, AND OVERALL EFFICIENCY

Note. Solid vertical lines show the respective means.

4.3. Determinants of efficiency differentials

In the final step, we explain the differences in the efficiencies. This is a relevant step as it allows the adult education programs to open the black box and observe the underlying determinants of the (in)efficiency. The estimation results of the efficiency determinants are presented in **Table 4**. A positive coefficient suggests a larger σ_{u}^2 and, therefore, a larger inefficiency if the corresponding variable increases. By contrast, a negative coefficient implies that the factor is favorable for efficiency.

TABLE 4 – ESTIMATES OF THE PARAMETERS OF THE ERROR COMPONENTS

Variable	Coefficient (SE)
PANEL A. Persistent inefficiency component, LHS variable is $\log \sigma_{u_{oi}}^2$	
(Intercept)	-10.313** (3.646)
Type1_Design	6.200* (3.591)
Type2_Food	1.479 (3.900)
Type3_Management	6.842* (3.616)
Type5_Environment	5.348 (3.589)
Type6_Technology	5.525 (3.603)
PANEL B. Transient inefficiency component, LHS variable is $\log \sigma_{u_{it}}^2$	
(Intercept)	-0.090 (0.825)
z1 (Gender balance)	-0.333** (0.170)
z2 (Age of the learner)	-0.038** (0.016)
z3 (% low educated)	-5.276 (3.825)
z4 (Sessions per program)	-0.774*** (0.071)
z5 (Learners per program)	-0.155* (0.094)
z6 (Age of the teacher)	-0.002 (0.009)
z7 (Teacher age composition)	0.045** (0.018)
z8 (Teacher hours composition)	0.062 (0.100)
t	-0.044* (0.026)
z2*z3	0.132 (0.119)

Notes. *** Significance at the 1% level; ** Significance at the 5% level; * Significance at the 10% level.

First, consider the determinants of persistent inefficiency. The results in Panel A of **Table 4** suggest that 'Wood and Metal' type of program is the most efficient in the long run. However, the difference with the other program types is rather small as only the design and management programs are statistically less efficient than the reference category. The observation that 'design' and ‘management’ are persistently less efficient is rather surprising as particularly management programs should be able to succeed in acquiring significant scale economies (given that management programs can be taught in larger groups and with fewer resources). On the other hand, compared to the other types of adult education programs, design and management programs might attract a student population that is different from other programs in unobserved characteristics (e.g. motivation).

Panel B of **Table 4** provides the determinants of persistent inefficiency. Except for the teacher’s age and hours, all estimated coefficients are negative, suggesting a favorable influence of these variables on the efficiency. As the estimated coefficients only provide the direction of the effect, we also compute marginal effects. **Table 5** presents summary statistics of elasticities of the transient inefficiency with respect to explanatory variables. The marginal effects suggest that more boys in the program have a significantly favorable influence on the efficiency scores. Also, more mature learners, as proxied by the age of the learners, have a significantly favorable influence on the efficiency scores. For each year that the average age of the learners increases, the efficiency improves by 0.37 percentage points. We do not observe a significant correlation between being a low educated learner and transient inefficiency.

The next few variables deal with the program design and are fully at the discretion of the adult education program’s management. First, we observe that having more sessions significantly increases efficiency. This result is in line with findings from instruction design that indicates that the social component of learning is relevant, particularly for adult education (e.g. Salomon and Perkins (1998)). Also, sufficient group size is needed. For each additional learner in the program, the efficiency score increases significantly by 0.07 percentage points. Exploring quadratic functions of this variable suggests that this relationship is linear. The age of the teacher seems to be irrelevant for the efficiency estimation, whereas the variation in teachers’ age is unfavorable for efficiency. This is an interesting finding which should be further researched as traditional theories assume that diversity in teacher composition is favorable for the learning outcomes of students. The composition of teachers’ workload does not seem to have a significant influence on the program efficiency, as does the mean interaction between the age of learners and the percentage of low educated learners. Analysing the latter more carefully, we observe that the interaction variable is favorable for transient efficiency, but only until the age of learners reaches 40 years. After that, its effect is negative. Figure 2 suggests that managers can reach larger efficiencies not only with younger learners, but when the proportion of low educated is smaller. This finding suggests that adult education might play a crucial role as a second chance education for young people.

TABLE 5 – ELASTICITIES OF THE TRANSIENT INEFFICIENCY

	Variable	Min	Mean	Median	Max
z1	Gender balance	-0.166	-0.082	-0.080	0
z2	Age of the learner	-0.895	-0.378	-0.388	1.080
z3	Low educated (%)	-0.748	-0.065	-0.049	0.132
z4	Sessions per program	-0.387	-0.387	-0.387	-0.387
z5	Learners per program	-0.077	-0.077	-0.077	-0.077
z6	Age of the teacher	-0.061	-0.039	-0.039	-0.024
z7	Teacher age composition	0	0.200	0.203	0.464
z8	Teacher hours composition	0	0.030	0.030	0.031

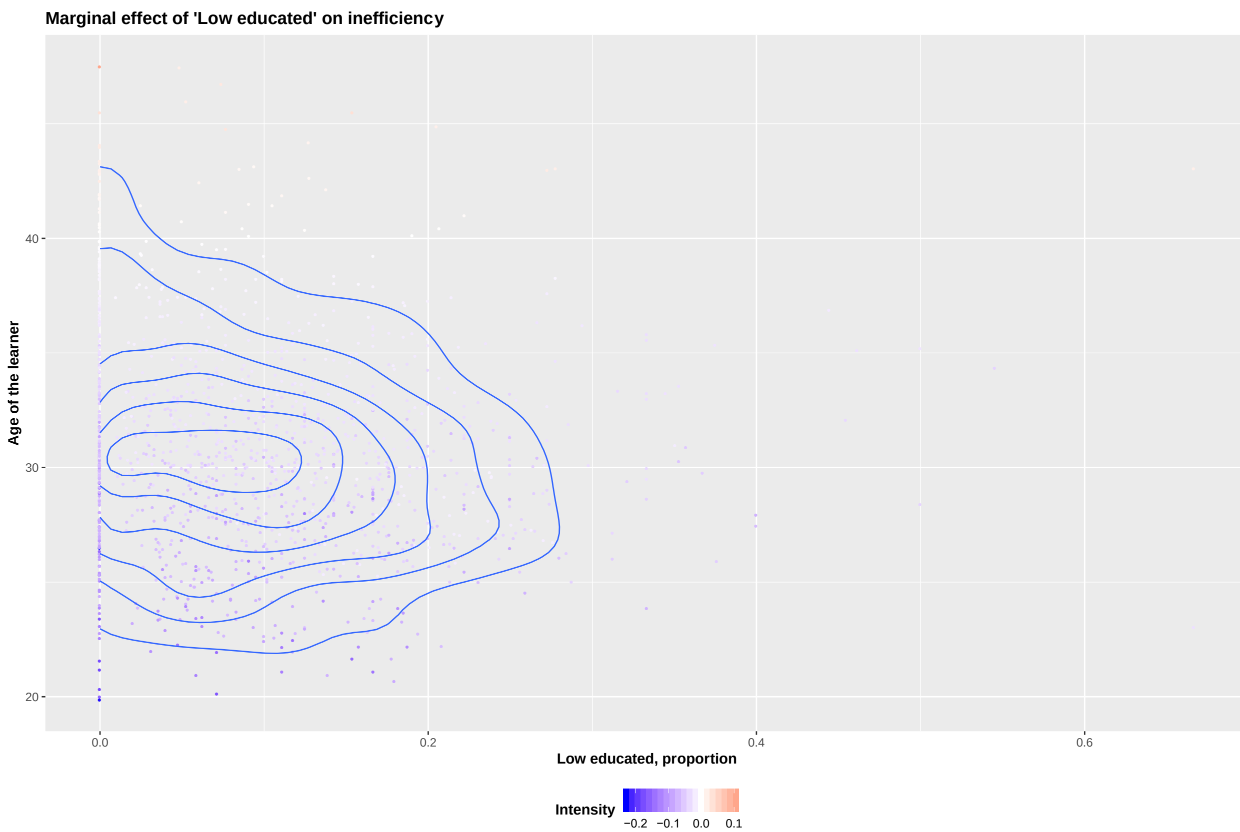

FIGURE 2 – SCATTERPLOT OF MARGINAL EFFECT OF AGE OF THE LEARNER AND PROPORTION OF LOW EDUCATED ON TRANSIENT INEFFICIENCY

Notes. The blue curves show density of the age of the learner and the proportion of low educated. The most negative marginal effect is coloured blue, while the most positive is coloured red. A zero marginal effect is coloured white.

5. Discussion

This paper distinguished between the persistent and transient inefficiency of adult education programs using an advanced stochastic frontier analysis model on Belgian data. We found that adult education programs could, given the available resources, improve their efficiency by 12% on average. About 5 percentage points of the inefficiency are persistent and difficult to tackle, whereas about 7 percentage points are at the discretion of the adult education management. We also investigated the determinants of inefficiency. The results indicate that social interaction is relevant as both more sessions and more learners per program increase efficiency. Moreover, adult education programs seem to be particularly useful for young low educated learners. Consequently, young people are especially likely to benefit from adult education programs after they have dropped out of high school.

Compared to the only other available study on the efficiency in adult education (Schiltz, De Witte, & Mazrekaj, 2019), our estimate of inefficiency is rather high. Specifically, Schiltz et al. (2019) used a DEA model and found that adult education programs could improve their efficiency by 4% on average, whereas our estimate of inefficiency is 12%. This difference is likely to stem from the DEA model not allowing for a broad variety of control variables due to multidimensionality issues with the non-parametric kernels. We account for this by using the semi-parametric SF model which can better capture a large number of determinants of inefficiency.

Nonetheless, this paper is not without limitations. First, although we contribute to the literature by differentiating between persistent and transient inefficiency, we do not claim to present causal evidence. It is possible that unobserved factors are influencing our results. Future research could expand the range of control variables or use efficiency models in combination with causal inference methods. Second, although we considered three different outcomes, all the outcomes were educational. Future research may expand the range of outcomes to also include some labour market and social outcomes. Third, we solely considered a single input based on the teachers' wages. Although this represents the largest share of the total adult education costs, the costs of the material may also be important. Finally, it is unclear how the results from Flanders could be applied to other adult education systems. Further research should address these limitations.

6. Compliance with Ethical Standards

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All four authors declare that they have no conflict of interest. Further, authors declare that they have no relevant or material financial interests that relate to the research described in this paper.

Ethical approval: This article does not contain any studies with human participants performed by any of the authors.

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