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Abstract

This study investigates the retention rate of young people in firms that offer apprenticeship positions. While the majority of training firms hire apprentices with the aim of retaining them when the contract ends, only a small proportion of youths actually transition into full-time employment in the same firm. To explain this phenomenon, I rely on a tractable model that incorporates firm decision-making processes, enabling an analysis of the retention rate. By estimating the productivity distribution of apprentices based on observed wage data from French surveys, the findings indicate that training firms, on average, benefit more from separating from apprentices rather than hiring them as workers.

Keywords: Firm retention, Productivity, Apprenticeship, Maximum Likelihood
JEL codes: J24, M53, M51

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1 Introduction

Workplace-based education, known as apprenticeship, allows young people to divide their time between part-time studies at training centers, high schools, or universities, depending on their educational level, and part-time work in firms (Wolter and Ryan, 2011). These firms receive wage subsidies from public authorities to compensate for the part-time working arrangement.

Qualitative evidence among training firms in France indicate that personalized training serves more as motivation than wage subsidies for hiring apprentices and that 80% of them enter into apprenticeship with the objective of retaining apprentices upon completion (Beffa and Broc, 2019). However, only 20 to 30% of apprentices remain employed by their training firms after completing their apprenticeships.[1]

Among the potential factors that might explain this paradox, such as poaching from external firms, sectoral turnover, or house moves from apprentices, training firms use the duration of apprenticeship contracts to acquire knowledge about the apprentices' skills and productivity (Nafilyan and Speckesser, 2019).

To examine the decision of firms regarding the retention of apprentices as full-time workers based on their productivity, I rely on an extension of the model developed in Cahuc and Hervelin (2020) in which the authors analyze the impact of increasing the number of apprentices on the youth unemployment rate. Firms assess the cost of separating from apprentices at the conclusion of their contracts and the potential profit of hiring them as full-time employees. By utilizing French data on wages and retention, I am able to estimate the parameters associated with the distributions of both the separation cost and productivity through maximum likelihood estimation.

The results indicate that training firms end up at greater gains from separating from apprentices rather than hiring them as full-time workers. Some heterogeneity emerges based on the education level of the apprentice or the sector of the training firm. However, overall, the productivity of the majority of apprentices upon contract completion falls short of meeting the standards necessary for being hired by their training firm.

2 Model

The productivity of apprentices is known to firms in which they receive training. Employers decide to retain the apprentices only if it is economically advantageous. Termination of an apprentice's job incurs a cost denoted as κ. The cost can arise from administrative constraints or events such as damage to the firm's reputation when an apprentice is not retained. It is worth noting that κ can be negative, indicating a gain for the employer to not retain the

[1]Empirical evidence shows that the retention rate stands at around 20% in Spain (Bentolila et al., 2020) and Italy (Albanese et al., 2021), 30% in France (Brébion, 2019), and approximately 50% in Germany, Austria, and the Netherlands where the apprenticeship system is managed by firms (OECD, 2018).

apprentice.[2] This gain could result from the low cost of hiring another apprentice or the positive impact on the firm's reputation to offer many apprenticeship contracts.

In this context, the employer's gain is either $-\kappa$ if the apprentice is not retained or $J(y)$, representing the profit from the job with productivity y, if the apprentice is retained. Therefore, an apprentice will remain in the training firm iff:

$$J(y) \geq -\kappa \tag{1}$$

with $J(y) = y - w(y)$ where $w(y)$ stands for the wage whose value is determined by bargaining.

The bargaining process implies that apprentices hired as workers receive a share β of the job surplus. In case of agreement, workers obtain utility $w(y)$, while firms gain profits of $y - w(y)$. In case of disagreement, workers receive unemployment income z, and firms earn zero profits. Thus, the surplus of a job with productivity y is equal to $y - z$. Labor costs are subject to a lower bound set by the minimum wage $w_{\min}$, which exceeds the income of unemployed individuals. Consequently, wages are determined through bargaining, taking into account the minimum wage constraint:

$$w(y) = \begin{cases} z + \beta(y - z) & \text{if} \quad y > \bar{y} \\ w_{\min} & \text{if} \quad w_{\min} \leq y \leq \bar{y} \end{cases} \tag{2}$$

where $\bar{y} = {}^{[w_{\min} - (1-\beta)z]}/_{\beta}$.

Equation (2) specifies that the wage is equal to $z + \beta(y - z)$ when the productivity exceeds $\bar{y}$ and is equal to the minimum wage when it falls within the interval $[w_{\min}, \bar{y}]$. If the productivity is lower than $w_{\min}$, which represents the reservation productivity level, the job remains unfilled.

The profit from a job with a retained apprentice is given by

$$J(y) = \begin{cases} (1-\beta)(y - z) & \text{if} \quad y > \bar{y} = \frac{w_{\min} - (1-\beta)z}{\beta} \\ y - w_{\min} & \text{if} \quad y \leq \bar{y} \end{cases}$$

Apprentices who are not retained by their training firm seek employment in the labor market and may either find a job in another firm or remain unemployed.[3]

[2] Here I dot not assume that the separation cost depends on the apprentice's or the training firm's productivity in order to have a general set-up and because of data constraints on firms during the apprenticeship.

[3] The other firms do not know the productivity of the workers until a match is formed. I do not explicitly model the job search process for non-retained apprentices, but I assume that job-vacancy matches are determined through an urn-ball matching process (Pissarides, 1979; Blanchard and Diamond, 1994; Cahuc and Hervelin, 2020). In this framework, some vacancies receive no applications while others may receive one or more as job seekers simultaneously apply for jobs without knowledge of where other job seekers are applying. This process captures the random search and matching dynamics, which allows us to identify the productivity of apprentices because it is explicitly assumed that apprentices' productivity is independent of firms' productivity.

For each value of y, the share of apprentices not retained by their employer is given by

$$\theta_n = \begin{cases} \Pr\left[\kappa < (1-\beta)\,(z-y)\right] = \Phi\left[(1-\beta)(z-y)\right] & \text{if} \quad y > \bar{y} = \frac{w_{\min}-(1-\beta)z}{\beta} \\ \Pr\left[\kappa < w_{\min} - y\right] = \Phi(w_{\min} - y) & \text{if} \quad y \leq \bar{y} \end{cases} \tag{3}$$

where Φ represents the cumulative density function (CDF) of the apprentice separation cost, with mean μ_κ and variance σ_κ^2. It is evident that more productive apprentices have a higher likelihood of being retained by their training firm, as the function Φ is monotonically increasing. If they are retained, apprentices engage in wage bargaining like other youth. If they leave the firm, they search for a job according to the process described above. Thus, an endogenous proportion of apprentices remains with their training firm, while the complementary proportion searches for jobs.

The CDF of y is denoted by G_a, with mean μ_a and variance σ_a^2, and its probability density function (PDF) by g_a. The retention rate, denoted by ρ, represents the share of apprentices retained in their training firm and is given by

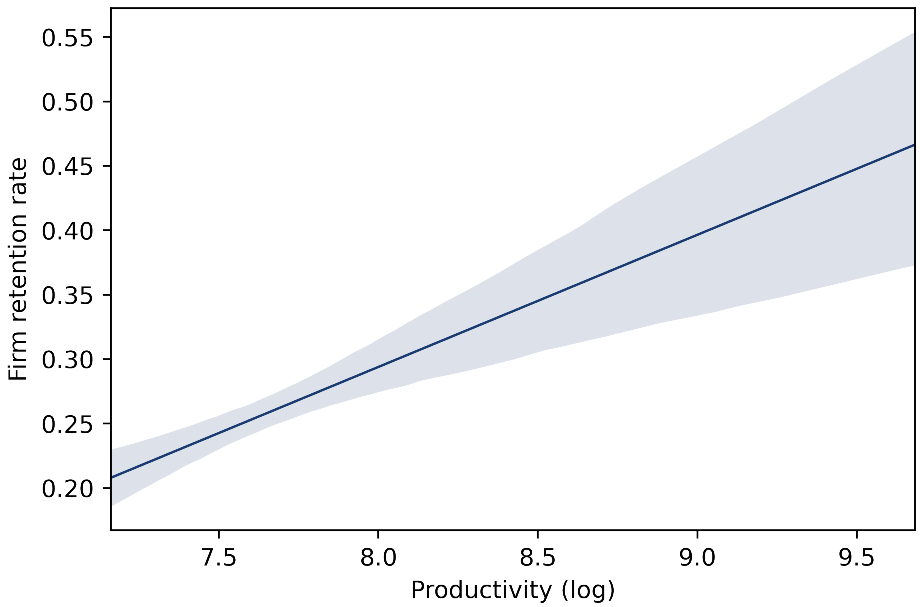
$$\rho = \int_0^{\bar{y}} \left[1 - \Phi(w_{\min} - y)\right] g_a(y)\mathrm{d}y + \int_{\bar{y}}^{+\infty} \left[1 - \Phi\left[(1-\beta)(z-y)\right]\right] g_a(y)\mathrm{d}y \tag{4}$$

Based on equations (3) and (4), I can derive the PDF of the productivity y for apprentices not retained by their training firm, $g_{an}(y)$, and compute both the share of non-retained and retained apprentices, for each value of y.

I finally assume that productivity follows a log-normal distribution, such that $y \sim \log\mathcal{N}(\mu_a, \sigma_a)$, and that the distribution of separation costs for apprentices from their training firms is normally distributed such that $\kappa \sim \mathcal{N}(\mu_\kappa, \sigma_\kappa)$. The parameters of these distributions are estimated using maximum likelihood. The log-likelihood, denoted as $\mathcal{L}$, accounts for different combinations of wages and retention status, specifically:

$$\begin{aligned}
\mathcal{L} = \sum_i \log\left(\left[1 - \Phi\left[\frac{(1-\beta)}{\beta}\,(z - w_i)\right]\right] g_a\left(z + \frac{w_i - z}{\beta}\right)\right) \mathbf{1}(w_i > w_{\min}, r_i = 1) \\
+ \sum_i \log\left(\int_{-\infty}^{\bar{y}} \left[1 - \Phi(w_{\min} - y)\right] g_a(y)\mathrm{d}y\right) \mathbf{1}(w_i = w_{\min}, r_i = 1) \\
+ \sum_i \log\left(\Phi\left[\frac{(1-\beta)}{\beta}\,(z - w_i)\right] g_a\left(z + \frac{w_i - z}{\beta}\right)\right) \mathbf{1}(w_i > w_{\min}, r_i = 0) \\
+ \sum_i \log\left(\int_{-\infty}^{\bar{y}} \Phi(w_{\min} - y) g_a(y)\mathrm{d}y\right) \mathbf{1}(w_i = w_{\min}, r_i = 0)
\end{aligned} \tag{5}$$

Figure 1: Correlation between firm retention rate and productivity of apprentices



Note: Productivity is computed with equation (2). The slope of the log-linear relationship is obtained from an OLS regression of the apprentices' retention status on their productivity level.
Source: pooled *Génération 2004-2010* surveys (CEREQ), author's calculations.

3 Data

I rely on the "Génération" surveys conducted in 2007 and 2013 on young people who left school in 2004 and 2010 respectively to bring the model to the data.

The sample consists of approximately 5,000 young people who prepared a diploma as apprentices, either at the secondary level or at the university level, representative of the whole population. In this survey, young people are asked to indicate their labor market situation each month for a period of three years after they finish school. I can detect whether young people work in firms where they were apprentices or not and restrict the labor market situations to the first situation after apprenticeship.

I observe that 61% of young apprentices were in employment right after their apprenticeship contract ended. Among them, 25% worked in their training firm while the remaining 75% found an employment elsewhere. Figure 1 shows a clear positive correlation between firm retention rate and the productivity of apprentices computed from equation (2). The slope of this log-linear relationship is such that a 1 percent increase in the productivity of apprentices leads to a 10 percentage points increase in the probability of firm retention.

Table 1: Values related to the model

Description	Notation (1)	Value (2)
Panel A: Value of exogenous parameters		
Share of the job surplus going to workers	β	0.5
Level of unemployment benefits	z	755.00
Level of net minimum wage	w_{min}	1,021.27
Panel B: Value of estimated parameters		
Separation cost of apprentices		
mean	μ_κ	-2,565.59
standard deviation	σ_κ	2,784.43
Productivity of apprentices		
mean	μ_a	7.64
standard deviation	σ_a	0.31

Note: This table reports the values associated with the exogenous parameters of the wage equation as defined in equation (2). The level of the unemployment benefit and of the net minimum wage are in Euros (base 2010). The parameters related to the separation cost of apprentices (μ_κ; σ_κ) and productivity of apprentices (μ_a; σ_a) are estimated with maximum likelihood as described in Section 2 using the pooled *Génération 2004-2010* surveys.

4 Results

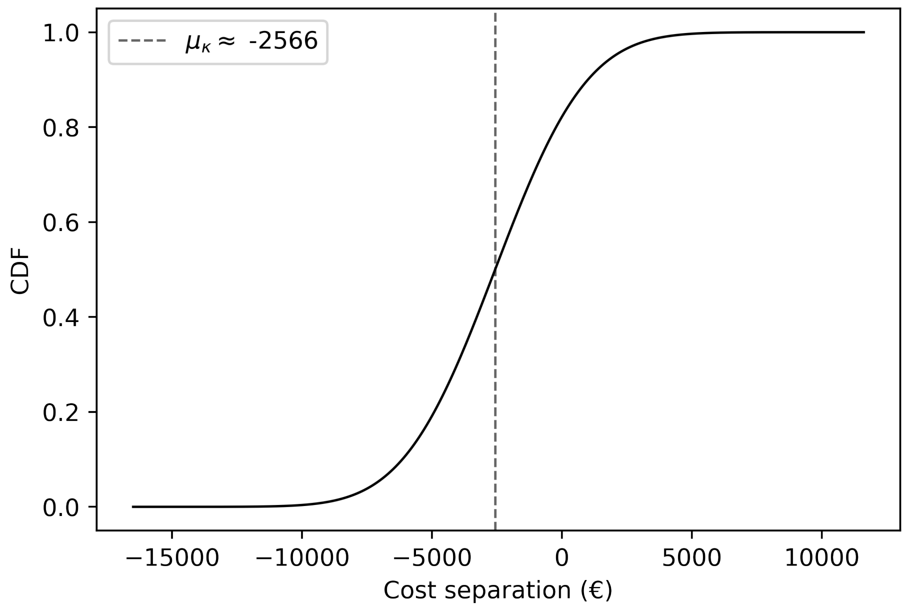
Table 1 shows the value of the exogenous variables in Panel A and the value of the parameters estimated from the log-likelihood function defined in equation (5) in Panel B.

Firms have an average cost to separate from an apprentice of about €-2,566. This negative cost indicates that training firms incur a gain if they decide to not retain their apprentices for a full-time position. As stated in the model though, this gain has to be compared with the profit that is made if the apprentice does become a full-time worker. Estimations indicate that the expected productivity of an apprentice, when turning in a full-time worker, is €2,186. This value being lower than the gain of terminating the apprenticeship contract, apprentices suffer a higher risk of being non-retained by their training firm than the opposite. This result helps explaining why training firms aim to retain their apprentices when signing an apprenticeship contract at the beginning but do not at the end because of an insufficient productivity.

Figures 2 and Figure 3 show that 80% of firms have a gain from separating from their apprentices at the end of their contract and that the productivity of retained apprentices first-order dominates the productivity of non-retained apprentices. These results suggest that training firms decide to retain their apprentices by hiring only those with sufficient productivity.

These average results hide some heterogeneity. Table 2 shows both the observed retention rate and the simulated one computed from equation (4), and breaks down the average sepa-

Figure 2: CDF of firm separation cost from apprentices (κ)



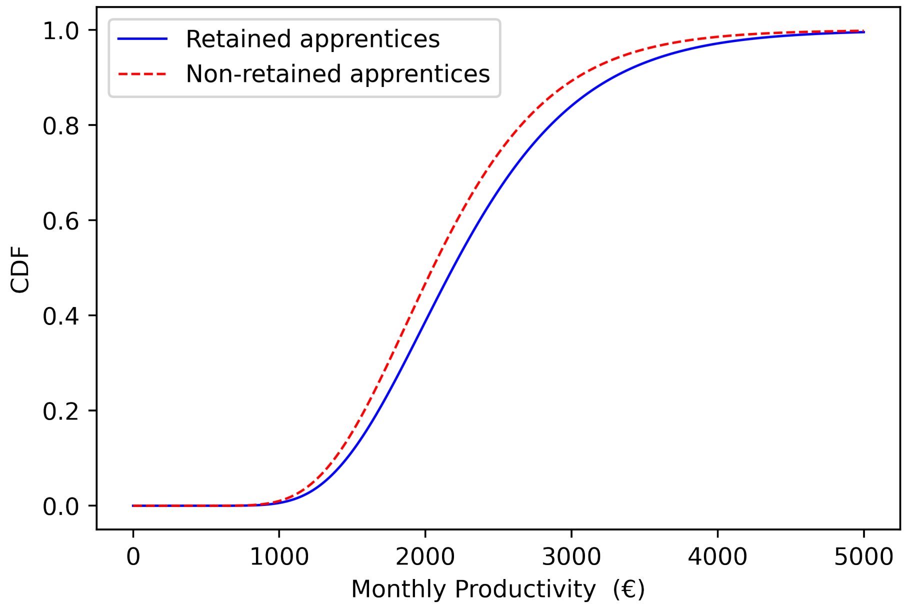
Source: pooled *Génération 2004-2010* surveys (CEREQ), author's calculations.

ration cost from an apprentice and its mean productivity, first by education level and then by firm sector. We see that firms gain from separating from their apprentices, whether they work and study at the high school or university level, although this gain is lower when apprentices are at the university level. This fact may be explained by the larger set of skills needed at the university level. We also see that the expected productivity of apprentices is higher than the separation cost at the university level while it is lower at the high school level. These results allow us to explain why the retention rate is higher at the university level than at the high school level, 33.7% vs 21.2% respectively.

Turning to the sector of the training firm, we also see some differences in the average cost of separation and in the mean productivity levels. However in all of the four sectors that are analyzed, firms expect to gain more by separating from their apprentices when the contract ends rather than by employing them in a full-time position.

All in all, we see that the model predicts retention rates that are similar to the ones observed in the data.

Figure 3: CDF of productivity for apprentices (y)



Source: pooled *Génération 2004-2010* surveys (CEREQ), author's calculations.

Table 2: Estimated value of the retention rate and of the first moments of productivity

Population	ρ	$\hat{\rho}$	$\mathbb{E}[\kappa]$	$\mathbb{E}[y]$	$\mathbb{E}[y_r]$	$\mathbb{E}[y_{nr}]$
	(1)	(2)	(3)	(4)	(5)	(6)
All	0.2549	0.2544	-2,565.59	2,186.81	2,301.73	2,147.60
By education level						
High-school	0.2121	0.2115	-2,734.83	1,942.61	2,002.15	1,926.64
University	0.3367	0.3355	-2,254.87	2,677.53	2,842.41	2,594.27
By firm sector						
Agriculture	0.2894	0.2721	-2,107.01	1,914.45	1,996.24	1,883.88
Industry	0.2501	0.2525	-2,720.82	2,289.76	2,413.19	2,248.07
Construction	0.2883	0.2817	-2,113.57	2,075.84	2,176.56	2,036.35
Services	0.2399	0.2445	-2,752.50	2,209.76	2,324.70	2,172.56

Note: This table reports the observed retention rate (ρ) as the mean of apprentices retained in their training firm after apprenticeship using the *Génération 2004-2010* surveys in column (1). Column (2) shows the simulated retention rate ($\hat{\rho}$) that is computed from equation (4). Column (3) shows the mean cost of terminating an apprentice job at the end of the apprenticeship contract ($\mathbb{E}[\kappa]$). Columns (4) to (6) shows the expected productivity of all apprentices ($\mathbb{E}[y]$), retained apprentices ($\mathbb{E}[y_r]$), and non-retained apprentices ($\mathbb{E}[y_{nr}]$) respectively (in net Euros, base 2010), given the values of parameters estimated from the log-likelihood function as defined in equation (5). High-school education level includes the 2-year and the 3-year French vocational diplomas. University education level includes the 2-year, 3-year and 5-year French post-baccalaureate diplomas.

5 Conclusion

Relying on a tractable model of firm decision-making, this study examines the decision of firms to retain young individuals as full-time employees following the completion of their apprenticeship contracts. Firms compare the benefits of separating from their apprentices to the profits they would gain by hiring them. The productivity of apprentices is then estimated through a structural approach using maximum likelihood estimation, leveraging wage data from surveys conducted in France.

Given the job-specific nature of the match between firms and apprentices, the apprenticeship period serves as a means for firms to screen and assess the productivity of the workers. The results indicate that training firms derive greater benefits from separating from apprentices rather than hiring them as full-time workers. As firms may have limited incentives to provide a comprehensive set of skills to young individuals (Acemoglu and Pischke, 1998; Garicano and Rayo, 2017; Fudenberg and Rayo, 2019) and as training firms may have different characteristics than non-training firms, access to administrative data holds promise for extending the model and analyzing the formation of productivity and separation costs during apprenticeship.

References

Acemoglu, Daron and Jorn-Steffen Pischke, "Why Do Firms Train? Theory and Evidence," *The Quarterly Journal of Economics*, 1998, *113* (1), 79–119.

Albanese, Andrea, Lorenzo Cappellari, and Marco Leonardi, "The effects of youth labour market reforms: evidence from Italian apprenticeships," *Oxford Economic Papers*, 2021, *73* (1), 98–121.

Beffa, Maïder and Rémy Broc, "Les conditions d'embauche des apprentis en France," Technical Report, Viavoice 2019.

Bentolila, Samuel, Antonio Cabrales, and Marcel Jansen, "Does Dual Vocational Education Pay Off?," *Manuscript*, 2020.

Blanchard, Olivier Jean and Peter Diamond, "Ranking, Unemployment Duration, and Wages," *The Review of Economic Studies*, 1994, *61* (3), 417–434.

Brébion, Clément, "Apprenticeship training, better professional "efficiency" in France than in Germany," *Formation Emploi*, 2019, *146* (2), 101–127.

Cahuc, Pierre and Jérémy Hervelin, "Apprenticeship and Youth Unemployment," *CEPR Discussion Paper Series*, 2020, *DP14621*.

Fudenberg, Drew and Luis Rayo, "Training and Effort Dynamics in Apprenticeship," *American Economic Review*, 2019, *109* (111), 3780–3812.

Garicano, Luis and Luis Rayo, "Relational Knowledge Transfers," *American Economic Review*, 2017, *107* (9), 2695–2730.

Nafilyan, Vahé and Stefan Speckesser, "The longer the better? The impact of the 2012 apprenticeship reform in England on achievement and labour market outcomes," *Economics of Education Review*, 2019, *70*, 192–214.

OECD, *Seven Questions about Apprenticeships. Answers from international experience*, OECD Publishing, Paris, 2018.

Pissarides, Christopher, "Job Matchings with State Employment Agencies and Random Search," *The Economic Journal*, 1979, *89* (356), 818–833.

Wolter, Stefan C. and Paul Ryan, "Apprenticeship," *The Handbook of the Economics of Education*, 2011, *3*, 521–576.