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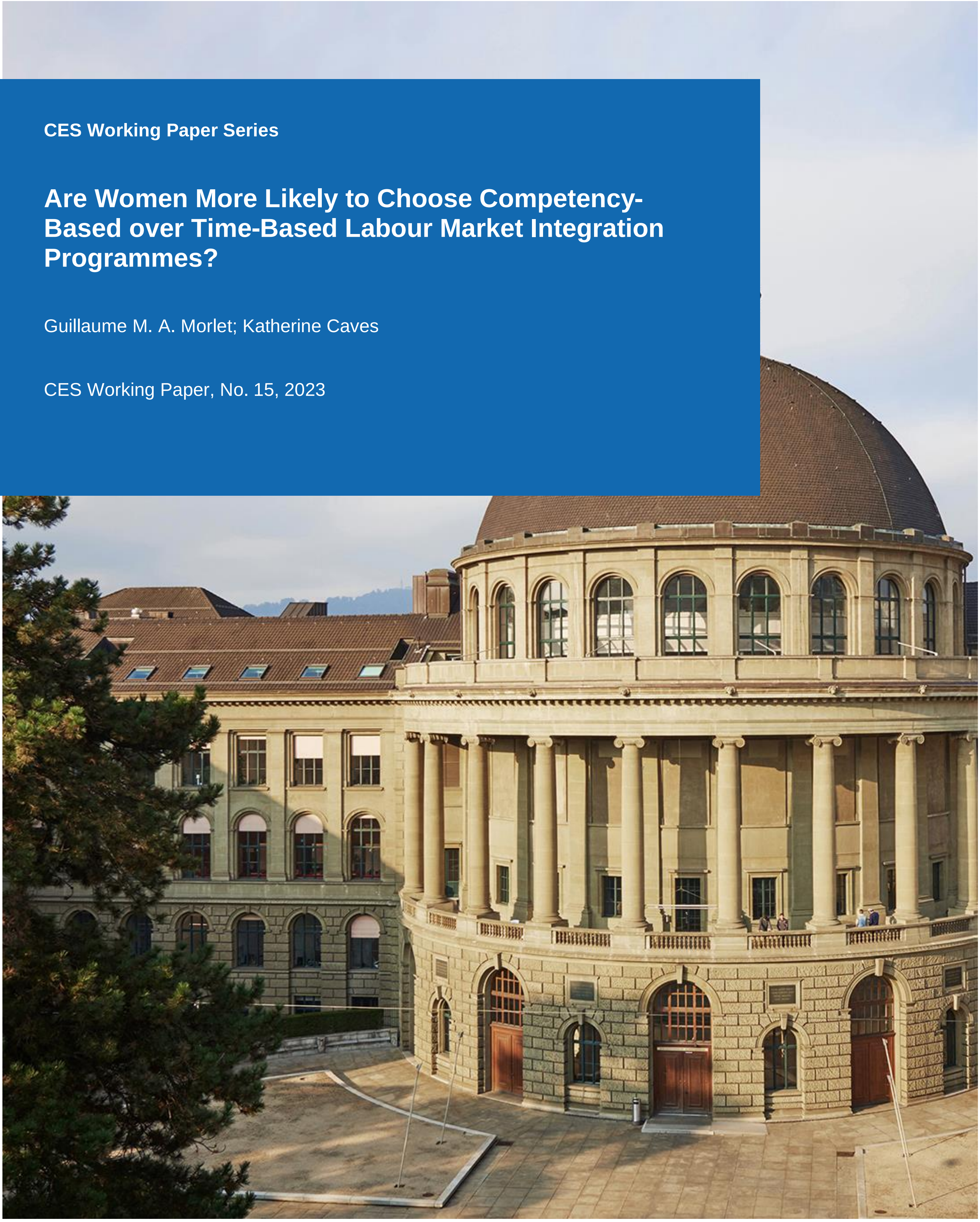

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Are Women More Likely to Choose Competency-Based over Time-Based Labour Market Integration Programmes?[1]

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Abstract

Registered Apprenticeships represent a growing labour market integration programme in the United States. The United States's Department of Labor implemented competency-based Registered Apprenticeship (CBRA) in 2008 to address skills mismatches and the chronic gaps traditional time-based Registered Apprenticeship (TBRA) had in serving women and minorities. This paper applies econometric strategies to investigate whether women are more likely to choose CBRA over TBRA as a labour market integration programme. We further analyse whether this effect is even stronger for women with uncertified but existing and occupational-relevant skills. Our empirical findings accompany both hypotheses. Women are significantly more likely to enrol into CBRA programmes, relative to TBRA. Furthermore, women with existing but uncertified skills are significantly more likely to enrol into CBRA, whereas women without skills or with college degrees are not significantly different from the baseline. Our findings are robust to various specifications, and we include a comprehensive set of fixed-effect vectors, addressing industrial, occupational and time-varying state specificities.

We discuss the implications of our findings, highlighting how CBRA may be an approach to better serving more diverse populations in Registered Apprenticeship. We also discuss the conditions that CBRA must fulfil to be an effective and beneficial labour market integration programme for its programme graduates.

Keywords: Training, gender, career choice, labour market integration, microeconometrics.

JEL Codes: J01; J10; J16

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1 Introduction

The United States implemented competency-based Registered Apprenticeship (CBRA) in 2008 to address skills mismatches and the chronic gaps traditional time-based Registered Apprenticeship (TBRA) had in serving women and minorities (Lerman et al., 2020, Kuehn, 2017, Taylor, 2006). The crucial difference between CBRA and TBRA is that the former allows certification to be based on the demonstration of adequate skills rather than simply the completion of a given number of training hours. Both CBRA and TBRA are available in the same occupations and provide training through the combination of on-the-job training and related technical instruction (Electronic Code of Federal Regulations, 2008). TBRA provides training and certification in a continuous process. On the other hand, CBRA recognises prior learning before training only the remaining competencies. In this paper, we thus evaluate whether this flexibility allows CBRA programmes to serve a wider population.

Berik et al. (2011) and Kuehn (2017) highlight that, prior to the creation of CBRA, women were underrepresented in Registered Apprenticeship programmes across the US. Even after accounting for occupation and training programme characteristics, women received significantly less training than their male peers. This observation is becoming increasingly obsolete, as Employment and Training Administration (ETA, 2023) data show that women are increasingly well represented in Registered Apprenticeship. Indeed, women make up the majority of CBRA participants despite being dramatically under-represented in Registered Apprenticeship overall (Kuehn, 2017).

In this paper, we argue that women may be more likely to choose CBRA over TBRA because women are on average more time constrained and CBRA has a lower opportunity cost of time (Anderson, 2018). We test whether women are more likely to choose CBRA than TBRA and find that they are. We further argue that women with some degree of uncertified but existing and occupation-relevant skills are more likely to enrol in CBRA than other groups because they are sensitive to the opportunity cost of time, have reason to expect the shortest training duration, and need a certification for the labour market. We find strong empirical evidence supporting this argument.

This paper makes five main contributions to the literature. We are the first to use econometric strategies to compare CBRA to TBRA. Second, we explore the relationship between CBRA and increased participation of women in Registered Apprenticeship programmes. Third, we examine the role of CBRA in facilitating the labour market integration of individuals with pre-existing but uncertified skills. Fourth, we argue that CBRA's ability to serve a broader population is due to its separation of the training and certification functions. Finally, we demonstrate how the ability of CBRA to serve a historically underserved population may become a risk if training quality is not ensured.

2. Background: Competency-Based Registered Apprenticeships

Registered Apprenticeships in the United States are not part of the formal education system (Lerman et al., 2009), and the framework of these programmes is designed and regulated by the federal Department of Labor. Registered Apprenticeships can therefore be defined as a labour market integration programme. This greatly differs from European systems, where dual vocational education and training is often a formal education programme. For example, Caves et al. (2018) compare the Swiss dual vocational education and training approach to Registered Apprenticeship. Registered Apprenticeship is very focused on meeting employers' skills demands and facilitating (improved) employment for participants. This differs from the mission of formal education, which is broader and includes imparting general knowledge as well as contributing to social values.

Labour market integration programmes provide certifications that indicate competency in a given occupation. For TBRA, this involves two linked functions: training and certification. In the first function, training provides skills to individuals, thereby increasing their stock of human capital and helping them find or improve their employment. The certification function recognises individuals' skills to facilitate employment. In TBRA, certification is an outcome of a pre-set training process. In CBRA, in contrast, programme content is broken up into competencies that can be acquired either through training or through the recognition of prior learning before the programme starts (Electronic Code of Federal Regulations, 2008). This can potentially provide a shorter route to certification for skilled individuals.

Historically, TBRA programmes tend to serve a relatively narrow, predominantly male, demographic. CBRA, a more flexible programme, was therefore introduced in 2008 to broaden the scope of Registered Apprenticeship. CBRA requires the demonstrable achievement of manual, mechanical, or technical skills and expertise as stipulated by pre-defined occupational standards (Jobs for the Future, 2016). Therefore, participants must prove their skills and knowledge to their programme sponsors, in addition to minimum requirements for on-the-job and related technical instruction components (Electronic Code of Federal Regulations, 2008).

The creation of CBRA in 2008 coincided with an international trend towards competency-based education (Anderson, 2018, Eaton, 2016, Clawson and Girardi, 2021) and prior learning assessment, which has gained importance in the context of technological change and increased prevalence of adult learners (Anderson, 2018). Brown and Kurzweil (2017) underline that the increasing adoption of competency-based approaches shifts programmes towards an instructional approach, imparting knowledge in a more flexible manner to achieve learning outcomes. Through close monitoring of the evolution of learners' competencies, competency-based education offers more opportunities for prior learning assessment. This potentially enables CBRA to contribute to important social values like equity more than a time-based programme may be able to.

Anderson (2018) specifies that competency-based education programmes represent "lower cost pathway[s] to degree completion", while still tailoring the programme's pace to individual needs. Because CBRA focuses on measurable skill acquisition instead of training hours, apprentices can demonstrate competency through an accelerated process relative to TBRA. In certain states, prior learning assessments may further shorten CBRA, allowing participants to demonstrate mastery of certain skills at the start of their training. Anderson (2018) highlights that in 2017, twenty-six states adopted prior learning statement legislation. Klein-Collins and Wertheim (2013) add that CBRA represents a "natural fit" with these prior learning assessment methods as they allow rigorous and frequent learning assessment. CBRA, relative to TBRA, allows closer monitoring of participants during their training (Electronic Code of Federal Regulations, 2008).

The rollout of CBRA specifically aims to address gender gaps in Registered Apprenticeship by reducing the relative prevalence of long Registered Apprenticeship programmes, which was highlighted as a major entry barrier to underserved populations (Lerman, 2016, Taylor, 2006). The US Department of Labor's Women's Bureau (2021) provides a case study of a CBRA programme dispensed by the "National Restaurant Association Educational Foundation and American Hotel & Lodging Association". It describes CBRA as a "direct path" to skill certification, which subsequently may lead to management positions on the labour market.

One challenge for CBRA is the recognition of prior learning. In CBRA, existing skills are evaluated by companies, against curricula co-developed with colleges and universities, who often act as related technical instruction providers. Curricula are based on industry and occupational standards. In contrast, the execution of recognition of prior learning is firm-specific. This approach differs from how Maurer (2021, p.3) describes the recognition of prior learning, as a process through which a "designated organisation confirms that a person has acquired certain competencies in informal or non-formal ways". This kind of centralised recognition of prior learning is intricate, costly, and difficult to implement effectively (Bohlinger, 2017). It is unclear whether the employer-based approach to recognising prior learning is optimal.

3. Literature Review

Extant literature regarding women’s enrolment in CBRA is scarce. CBRA are indeed very young programmes, first created in 2008, and this study is the first to empirically assess women’s choices of labour market integration programme with respect to CBRA and TBRA. The scarcity of literature in this domain has several potential explanations.

Registered Apprenticeships are not formal education programmes, thus the number of databases recording information on participants and Registered Apprenticeship programmes is limited, as is the data quality itself. This may in turn dissuade researchers from conducting empirical studies on the matter, instead focussing on formal education programmes with rich databases. Consequently, most research conducted on CBRA - and Registered Apprenticeships more generally - is descriptive non-peer reviewed reports from the Department of Labor or non-profit organisations (e.g., Lerman et al., 2020; Copson et al., 2021; Walton et al., 2022).

The very light regulation of Registered Apprenticeships at the federal level may also contribute to the difficulty of creating an evidence base on Registered Apprenticeships. Unlike European models of vocational education and training, Registered Apprenticeship programmes do not have compulsory occupational curricula harmonised at a national level. Such variation in programme content hinders the generation information regarding outcomes, participation, and other key factors.

Extant literature does suggest the presence of a gender gap in all forms of training, whereby women receive significantly less firm-sponsored training than their equivalently qualified male counterparts (see for instance Loessbroek and Radl, 2019, Dieckhof and Steiber, 2011, Evertsson, 2004). Furthermore, the training dispensed to women may differ in content relative to training dispensed to men. Evertsson (2004) adds that forms of training in which women take part are more likely to be industry-specific and do not significantly affect their wages a posteriori. Men are more likely than women to partake in general forms of training, increasing their promotion opportunities and wages. Overall, evidence indicates that women receive less training than their male counterparts, and that training tends to differ in content and be less beneficial for their careers.

Competency-based forms of education may alleviate barriers to entry for traditionally underserved populations. Competency-based programmes, thanks to their flexibility, take experience and existing skills and previous learning into account, allowing faster certification with lower opportunity costs (Clawson and Girardi, 2021).

In Registered Apprenticeship specifically, the existence of barriers to entry for women is documented, leading to a gender discrepancy in training rates (Kuehn, 2017). These barriers notably included the high prevalence of long, unpaid Registered Apprenticeships or Registered Apprenticeships containing long periods of unpaid work and instruction (Taylor, 2006). Registered Apprenticeships are also concentrated in male-dominated occupations, namely construction (Kuehn, 2017). In traditional TBRA programmes, women received up to a quarter of hours of training less than men (Berik et al., 2011), exacerbating the gender training gap.

The number of women enrolled in Registered Apprenticeships has surged over the last two decades, not only in specific states such as South Carolina (see Kuehn, 2017) or Michigan (see e.g. Wein, 2016), but also nationwide (ETA, 2023). Kuehn (2017), Wein (2016), and Lerman (2014) all suggest that this follows the expansion of Registered Apprenticeship programmes beyond male-dominated occupations. Although not a causal relationship, Kuehn (2017) and Wein (2016) demonstrate that the surge of women enrolled in Registered Apprenticeships coincided with the programme's expansion to the healthcare sector.

While expansion to less male-dominated fields has increased women's enrolment in Registered Apprenticeship, evidence also indicates that changing certain programme characteristics may make training more accessible or effective for women. Berik and Bilginsoy (2006) show that women are significantly more likely to choose unionised programmes, notably in the construction trade, an occupation considered "non-traditional" for women. They also show that women have better performance in unionised programmes and are more likely to complete them than non-unionised alternatives. Stieritz (2009) argues that a major impediment to increased diversity in Registered Apprenticeships is the limited choice in educational pathways offered by the community colleges where related technical instruction for participants is often conducted. Although reports highlight women's increasing enrolment in Registered Apprenticeship and the increase in CBRA enrolment, the link between CBRA and women's enrolment has not yet been explored.

4. Theoretical Framework

Registered Apprenticeship—like all training—is an investment in future productivity (Becker, 1965). Workers invest in training by accepting lower or no wages during the training period (Mincer, 1962) and through the opportunity costs they incur by investing their time (Smith, 1971). Two of the key factors in training decisions are, therefore, budget and time constraints. Individuals maximise expected utility according to a budget for the costs and benefits of training, which is separately constrained by the amount of time they have available to invest in training (Shaw, 1992). This second factor is also referred to as an individual's cost of time.

Smith (1971) shows that the opportunity cost of time is not simply equal to a worker's hourly wage. Individual opportunity costs of time increase when alternative uses of time are more valuable and when time more constrained. Alternative uses of time could be work outside the home, work in the home, and leisure activities. All of these may have varying monetary and non-monetary values to the individual and may not be observable. Extreme time constraints may make training impossible, and time constraints are also difficult to observe.

CBRA programmes have the potential to be shorter in duration than their time-based equivalents (Jobs for the Future, 2016). Kelchen (2016) highlights that competency-based education in general is particularly well-suited to individuals wanting to make quick progress towards a certification. The Bureau of Labor Statistics (2019) states that Registered Apprenticeships take between one and six years to complete but are completed in four years by most individuals. Whilst CBRA does require the fulfilment of a minimum number of training hours, this requirement can be reduced (ApprenticeshipTN, 2020). Employers must deem that participants demonstrate adequate competency to reduce training time requirements (Electronic Code of Federal Regulations, 2008).

Potential participants are likely to expect that CBRA will be shorter than TBRA. They may hear about CBRA as a shorter option either from other (potential) participants, from employers, or from official information on CBRA that highlights its potentially shorter duration. Publicly available information, under the format of leaflets, booklets, or other forms of communication, conveys the possibility of duration reduction in CBRA (see, e.g., ApprenticeshipTN, 2020). A Jobs for the Future (2016) report indeed recommends *time-constrained* prospective participants to choose CBRA programmes over TBRA programmes to "quickly get the apprenticeship to mastery of skills and competencies". Contrary to TBRA, it is possible to reduce duration in CBRA, representing a powerful signal for time-constrained prospective programme participants.

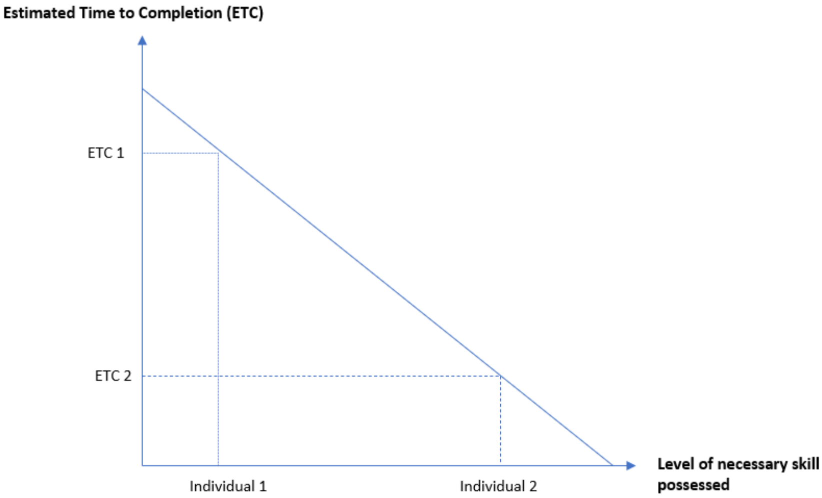
Given that TBRA and CBRA result in the same certification and potential participants have reason to expect a lower time investment with CBRA, we expect that time-constrained individuals may select CBRA over TBRA when the option is available. CBRA programme duration can only be shortened if participants demonstrate relevant skills, so not all participants should rationally expect that CBRA is a shorter path to the same qualification. However, there is a strong signal that CBRA can be shorter. This signal, combined with participants' incomplete information about the programme's skills requirements, should drive individuals with larger opportunity costs of time toward CBRA. Therefore, we argue that time-constrained individuals are more likely to sort into CBRA over TBRA to achieve the same certification in a shorter time, even if this effort is not always rational due to their incomplete information.

We would therefore expect to observe a shift toward CBRA especially for individuals with a higher cost of time (Anderson, 2018). Women are on average more time-constrained than men (e.g. Dungumaro, 2008, Shirgaokar and Lanyi-Bennett, 2020). Given the same expected value of the training itself, we expect that women’s’ relatively higher average time constraint will push them toward CBRA more often. This leads to our first hypothesis:

H1: Women are more likely to choose CBRA over TBRA.

CBRA programmes offer prior learning assessment, and programme duration can be shortened if participants demonstrate existing skills (Electronic Code of Federal Regulations, 2008). Figure 1 shows how skills reduce training time for CBRA: estimated time to programme completion is a decreasing function of programme-relevant skills that the individual possesses. In the example of Figure 1, individual 1 has a higher skill level, lowering their expected time to completion. In TBRA programmes, unlike CBRA, estimated time to completion is not a function of the level of necessary skills possessed. Estimated time to completion in TBRA would simply be a horizontal line at the y-axis intercept of the diagonal line in Figure 1.

Figure 1: Relationship between skills and training duration in CBRA



Source: Authors’ Own Elaboration

Therefore, we also expect a preference for CBRA among individuals with some cost of time and greater pre-existing skills without formal certification of those skills. Kelchen (2016) indeed states that individuals enrolling in competency-based education typically possess prior work and college experience. Individuals who already have formal certification of their skills can already signal those skills to potential employers, but (semi-)skilled and unqualified individuals would benefit from certifications on the labour market (Hungerford & Solon, 1987). Thanks to their existing skills, these individuals can expect the shortest training durations—even partially skilled individuals can expect some reduction in training time. For time-constrained individuals, even small reductions in training time will be important.

These arguments culminate in our second hypothesis H2:

H2: Women with existing, uncertified skills are more likely than men at the same skill level or women with either no skills or certifications to choose CBRA.

5. Data

5.1. Data Source

We employ administrative data from the Registered Apprenticeship Partners Information Systems (RAPIDS; ETA, 2023). Our sample is a repeated cross-section of participants over 24 years 2000-2023. The data contain apprentice-level and programme-level information.

In certain specifications, we include industry and occupation fixed effects. Industry information is on a 6-digit level sourced from the North American Industry Classification System. Occupational information uses the US Department of Labor's O*Net Soc Code System. Occupation is on a 6-digit level, with 774 distinct occupations and 816 distinct industries in the sample.

5.2. Summary Statistics: Regressor of Interest

Table 2 of subsection 5.4 shows that, on average, women are underrepresented in Registered Apprenticeships (9% of the pooled sample, versus approximately 50% of the population). There is however a substantial difference between the percentage of women in CBRA (55% of CBRA programme participants), and the percentage of women in TBRA (8% of programme participants).

5.3. Summary Statistics: Dependent Variable

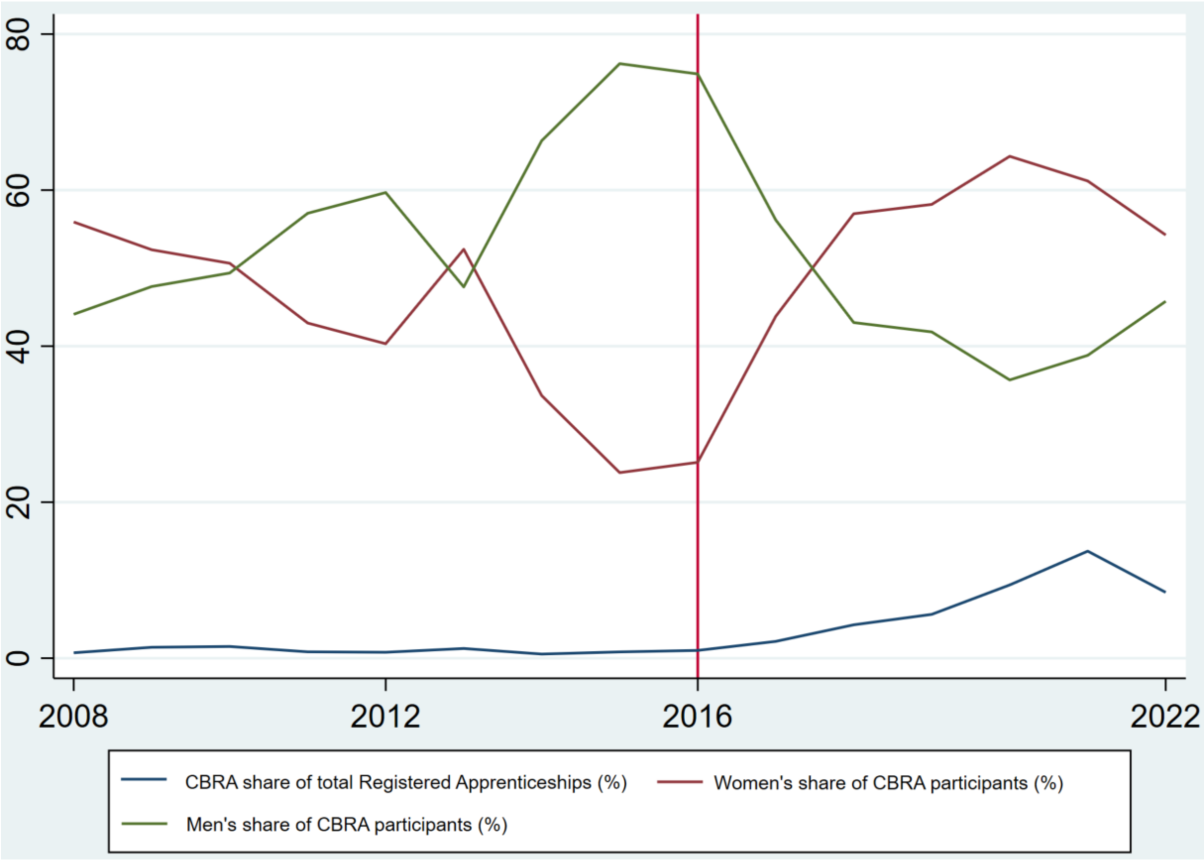
Only 2% of apprentices in the sample pursued CBRA. Figure 2 shows the share of all Registered Apprentices in CBRA between 2008 and 2022. The y-axis is to be interpreted in percentage. It also shows, within CBRA programmes, the evolution of the proportion of male and female participants. CBRA was introduced in 2008. From 2018 to 2022, the percentage of women enrolled in CBRA consistently exceeded the percentage of men enrolled and increased at a faster rate.

The prevalence of CBRA has risen considerably since its inception. From 2016 onwards, the Urban Institute established competency-based operational frameworks in seven different sectors[2]. These provide support to training companies by establishing guidelines. The vertical red line in Figure 2 marks the date when these frameworks were first released in 2016. This may have contributed to the approximately three-fold increase in the fraction of participants pursuing CBRA between 2017 and 2021. These frameworks are a joint effort of the Urban Institute, employers, educators and training experts,

[2] https://www.urban.org/policy-centers/center-labor-human-services-and-population/projects/competency-based-occupational-frameworks-registered-apprenticeships.

abiding by federal standards. The frameworks enable training companies to fast-track the development of CBRA programmes (Urban Institute, 2016).

Figure 2: Share of Competency-Based Registered Apprenticeships by Year, and Share of Female Programme Participants



Note: The vertical red line marks the date of competency-based operational frameworks' first establishment in 2016. The y-axis is to be interpreted in percentage (%). The graph's x-axis starts in 2008 rather than 2000 because CBRA were first introduced in 2008.

Source: Author using ETA data (2023)

5.4. Summary Statistics: Apprentice-Level and Programme-Level Variables

In H2, we argue that women with existing but uncertified skills are more likely to choose CBRA than men with similar skills or women with certifications. We cannot directly observe skill levels in the data, instead proxying with education levels. The education level we use to proxy existing but uncertified skills is "some college or associate's degree." The fact that individuals who have attended college without earning a degree are pooled with individuals holding associate's degrees is a limitation of the RAPIDS database. These two situations are different, as people with associate's degrees have a form of certification, unlike people having attended college but who left without a degree. However—especially given the importance of a bachelor's degree in the US labour market—it is the best proxy available. The education level we use to proxy qualified skills is a bachelor's degree or higher. Table 1 defines other control variables with non-self-explanatory names.

Table 1: Variable Names and Meanings

Control Variables	**Meaning**
Related Technical Instruction: Dispensed by Community College	Both federal and state regulations mandate that Registered Apprenticeship programmes comprise a classroom-based related technical instruction component and an on-the-job training component, supervised by a skilled mentor (Kuehn, 2019). Related technical instruction is often dispensed by community colleges, or by the programme sponsor itself (Kuehn, 2019).
Minority Individual	Individuals in the race or ethnicity categories Black-Hispanic, Black non-Hispanic, white-Hispanic, non-white Hispanic, native Hawaiian or other Pacific islander, or American Indian or Alaska native.
Individual Non-joint	Registered Apprenticeships dispensed by one single, non-unionised employer. "Individual" refers to the single employer, "non-joint" refers to non-union status.
Individual Joint	Registered Apprenticeships dispensed by one single, unionised employer.
Group Joint	Registered Apprenticeships dispensed by multiple, unionised employers. "Group" refers to multiple employers.
Group Non-joint	Registered Apprenticeships dispensed by multiple, non-unionised employers.
Some College or Associate's Degree	An associate's degree indicates a degree from a 2-year college program. In the data, it is pooled together with "some college, no degree." "Some college, no degree" indicates that a person has attended a 2- or 4-year college but that they did not receive any degree.
University Degree	Bachelor's degree, Master's Degree, Doctorate

Note: Individual Non-joint, Individual Joint, Group Joint, Group Non-joint defined in Glover and Bilginsoy (2005). The "Some College or Associate's Degree" group reflects the terminology used by the US Bureau of Labor Statistics and the Current Population Survey.

Table 2 shows descriptive statistics for control variables. 25% of our sample identified races or ethnicities we aggregate into the minority category. 92% of participants have a high school diploma or a higher academic qualification. 7% have an associate's degree or "some college", and 3% have a university degree.

53% of Registered Apprenticeships in the sample are dispensed by multiple, unionised employers. Conversely, only 7% of participants pursue programmes dispensed by individual unionised employers, (individual joint). Finally, 12% of participants have related technical instruction at a community college.

Table 2 further shows that women represent 55% of participants pursuing CBRA, but only 8% in TBRA. CBRA serves a much higher proportion of individuals with "some college or associate's degree[3]". Although individuals served by CBRA and TBRA are of comparable ages, more individuals in CBRA have university degrees and "some college or associate degree" compared to TBRA participants.

[3] See Shapiro et al. (2019) for further details about "some college."

Table 2: Descriptive Statistics

Variables	Mean Pooled Sample	Mean Competency-based	Mean Time-based
Dependent Variable			
Competency-based	2%		
Apprentice-level Regressors			
Veteran	9%	8%	9%
Less that High-school Diploma	8%	2%	8%
High-school Diploma	82%	60%	82%
Some College or Associate Degree	7%	25%	7%
University Degree	3%	11%	3%
Age	29	31	29
Women	9%	55%	8%
Minority Individual	25%	31%	25%
Asian	1%	5%	1%
Non-Hispanic Whites	69%	67%	69%
Programme-level Covariates			
Individual non-joint	22%	55%	21%
Individual joint	7%	2%	7%
Group non-joint	17%	40%	16%
Group joint	53%	1%	54%
Related Technical Instruction Provider is Community College	12%	24%	12%
N	1,458,947	25,275	1,433,672

Note: “Minority individual”, “Asian” and “Non-Hispanic Whites” do not sum to 100% exclusively due to the presence of missing observations in the “Race” variable of our dataset.

6. Methods

This section describes our econometric methods. We apply ordinary least squares (OLS) to a Linear Probability Model (LPM) to analyse the effect of multiple regressors on the probability of choosing a CBRA programme. The use of LPMs is controversial in the literature (Horrace and Oaxaca, 2006, Lewbel, 2012), so we perform extensive analyses to verify the consistency and robustness of our results.

6.1. Baseline Statistical Analysis

We execute the following LPM as baseline equation, applying OLS to equation (1):

$$CompetencyBased_{i,m,t} = \alpha + \theta_1 Woman_i + \varphi_{s,t} + \mu_m + \delta_{ind} + \gamma_o + X_i'\theta_2 + X_p'\theta_3 + \varepsilon_{i,m,t} \qquad (1)$$

The dependent variable assumes the value of 1 if the Registered Apprenticeship is CBRA, 0 otherwise. Indices refer to apprentice i, industry ind, state s, occupation o, calendar month m and year t. φ_{st}, δ_{ind} are respectively vectors of state-by-year and industry FE, X_p' a vector of programme-level covariates, and X_i' a vector of registered apprentice-level controls, all described above in Table 1. These covariates are highly similar to covariates considered by Kuehn (2019). μ_m and γ_o are respectively calendar month and occupation fixed effects. $\varepsilon_{i,ind,p,o,m,t}$ is the error term. θ_1 is of primary interest. It directly captures the average marginal effect of apprentice i being a woman on the probability of choosing CBRA, after conditioning on remaining regressors:

$$P\left(CompetencyBased = 1 \mid Woman = 1, \varphi_{s,t}, \mu_m, \delta_{ind}, \gamma_o, X_i{}'\theta_2, X_p'\theta_3\right) = \theta_1 \qquad (2)$$

Fixed-effects vectors in equation (1) shield against unobserved heterogeneity, which could confound β_1. State-year fixed effects net out the confounding impact of other initiatives or programmes that might affect women's participation in Registered Apprenticeship. The fixed effects further account for unobserved heterogeneity in terms of cyclicality (captured by calendar month fixed-effects), industry or occupation-level.

The comparison group in equation (1) is non-Hispanic white men with less than a high school diploma, pursuing TBRA with a single, non-unionised employer. These men are not veterans, and their related technical instruction provider is not a community college.

6.2. Inclusion of Fixed-Effects: Bad Controls Problem?

The inclusion of occupation and industry fixed effects may cause the “bad controls” problem (Angrist and Pischke, 2009). This problem arises when one conditions on a control variable that affects the outcome but that is itself affected by the regressor of interest. Doing this suppresses one channel through which the regressor of interest affects the outcome, but also introduces selection bias by segmenting the sample *within* the strata of the added endogenous control variable. Nonetheless, failing to control for occupational and industrial characteristics may induce omitted variable bias.

Women do not randomly choose industries and occupations; women and men have different influences in their occupational decision-making processes (Wu et al., 2015), leading them to sort into different occupations (Gatsby, 2014). Therefore, by not including our fixed-effects, we allow confounding industry and occupation-specific factors (e.g. being more people-oriented) to be reflected in θ_1. By including occupation and industry fixed effects, we account for non-random occupational choices by gender. This allows more precise identification of the effect of being a woman on the probability of choosing CBRA over TBRA.

However, including these controls may create problems. By including δ_{ind} and γ_o, we may suppress a mechanism through which gender and CBRA are related. Concretely, women might select a particular occupation or industry because it has more CBRA. This mechanism is ignored if δ_{ind} and γ_o are controlled for. In addition, conditioning on occupation and/or industry in equation (1) creates selection bias (Angrist and Pischke, 2009). When controlling for occupation, we are conducting a conditional comparison of women’s choice of CBRA or TBRA *within* one occupation.

The trade-off is that including the fixed effects reduces omitted variable bias but may increase selection bias by segmenting the sample. Literature finds a strong effect of occupation and industry on women’s participation in Registered Apprenticeship (see e.g. Kuehn, 2017, Berik et al., 2011). We therefore argue that the omitted variable bias is more problematic than the bad controls problem. We reduce omitted variable bias by accounting for occupational and/or industry characteristics through fixed effects.

6.3. Heterogeneity

We further investigate whether having unrecognised competences (proxied through the “some college or associate degree” variable) exacerbates the probability that participants choose CBRA over TBRA, given that they are women:

$$CompetencyBased_{i,m,t} = \alpha + \beta_1 Woman_i + \beta_2 Woman_i * HighSchoolDiploma_i + \beta_3 Woman_i * SomeCollegeAssociateDegree_i + \beta_4 Woman_i * UniversityDegree_i + \beta_5 Woman_i * Age_i + \varphi_{s,t} + \mu_m + \delta_{ind} + \gamma_o + X_i{}'\beta_5 + X_p'\beta_6 + \varepsilon_{i,m,t} \quad (3)$$

Vectors X_i and X_p remain identical to equation (1). We are now additionally interested in β_3, which, if positive and significant, would indicate that women with “some college or an associate’s degree” are more likely to pursue CBRA. To assess H2, we therefore compare the likelihood of women *within* the “some college or associate’s degree” category of choosing CBRA over TBRA, to the likelihood of women with less than a high school diploma of choosing CBRA over TBRA, *ceteris paribus*.

6.3. Statistical Model Limitations

LPMs have shortcomings in certain situations (Lewbel et al., 2012; Horrace & Oaxaca, 2006). The main problem is the potential prediction of outcome values outside the [0;1] bounds (Angrist and Pischke, 2009). This tends to occur as the LPM's conditional expectation function is linear, overweighting extreme observations at the tails of the distribution. In certain configurations, logistic models can solve this problem. Logit and probit cumulative distribution functions are approximately linear near the centre of the distribution, but "S-shaped" overall. Logit and probit models therefore perform better at the tails of the distribution (Norton and Dowd, 2018). However, Li et al. (2022) argue that, when independent variables are exogenous and normally distributed, the LPM coefficient recovers their average partial effects[4].

As a robustness check against this issue with the LPM, Horrace and Oaxaca (2006) suggest a trimmed estimator. The researcher initially estimates the coefficient, and then uses the estimate to predict values of the dependent variable. The researcher then removes observations whose predicted values are out of the [0;1] bounds and runs the estimation again, on the trimmed sample. We follow this procedure on equation (1), and find qualitatively similar results, notably regarding our regressor of interest ("Woman"), which keeps its sign, significance level and remains of comparable magnitude (results can be produced upon request).

We conduct two Monte Carlo simulations[5] to compare bias in logit and LPM marginal effects. Marginal effects are evaluated at observed value of covariates, in line with Hanmer and Ozan (2013). We are interested in the marginal effect of the "female" variable. In the first simulation, we conduct 10,000 replications with 1,000 observations. The latent model is given by:

$$y^* = 0.03 + 0.4 * age - 0.02 * age^2 + 3 * highschool - 0.06 * union + 5 * female + 1 * Black + 1 * Hispanic \qquad (4)$$

$y = y^* + \varepsilon_i > 0$ where ε_i follows a logistic distribution with mean 0. The average of the outcome is 0.171. Age follows a uniform distribution on the (18-65) interval. $Highschool, union, female$ each follow binomial distributions with success probabilities of 0.8, 0.3 and 0.1 respectively. 20% of the simulated sample is Black, 10% is Hispanic and 70% is white.

Panel A of Table A1 displays the average bias of both LPM and logit models for this simulation. Logit and LPM marginal effects overestimate the true marginal effect. However, both LPM and logit perform very well. LPM has an infinitesimally smaller bias on average.

[4] We run logistic regressions of equation (1). Marginal effects emanating from these logistic regressions are qualitatively aligned with corresponding OLS estimates (results can be produced upon request). Both OLS and logit are sensitive to the outcome base rate. OLS can be expected to perform better when the outcome base rate is around 0.5, as the true conditional expectation function is more likely to be linear in this area (Jaccard and Brinberg, 2021). Logit is also sensitive to the outcome base rate (King and Zeng, 2001). Furthermore, we cannot execute conditional maximum likelihood as we do not have a sufficient statistic for the various fixed-effect vectors. Correlated random effects using a Chamberlain-Mundlak device are also difficult here as it is unclear over which sources of variation (e.g. occupation, industry, state) to average our regressors. Pooled logistic models with fixed effects may be prone to the incidental parameters problem (Chamberlain, 1980). This is not of primary concern here as we have many observations to estimate the coefficient on each fixed effect.

[5] We do not use simulations for estimator selection (Advani et al., 2019). Simulations are simply indicative of the comparative performance of the LPM.

Panel B of Table A1 displays the results of the second simulation. The latent variable is generated according to (4), however the error term ε_i is standard normal. The models we test are still logit and the LPM. The average bias of logit and probit increases in absolute value, however both estimation methods now underestimate the true average marginal effect. In this highly simplified simulation, we conclude that the LPM does not substantially underperform relative to logit regression.

7. Results

This section presents our empirical results. The first subsection presents baseline results from equation (1), testing H1. The second subsection presents results from equation (3), testing H2.

7.1. Baseline Results

The results of equation (1) are shown in columns (4) and (5) of Table 3. In column (5), education is specified as high school diploma, some college or associate degree, and at least a university degree. The base group's education level is less than high school.

In all six specifications depicted in Table 3, we find that women are significantly more likely than men to choose CBRA over TBRA. This supports H1. Although it remains significant, the magnitude of the "Woman" coefficient decreases as we add fixed-effect vectors. The inclusion of industry and occupation fixed effects (column (4) versus column (3)) caused the magnitude of the coefficient on "woman" to decline by circa 95%, though again it remains significant.

Column (6) of Table 3 serves as a robustness check. In that specification, to check whether the healthcare industry is driving the results, we remove all healthcare and social assistance industries as defined by the first two digits 62 of the North American Industry Classification System. We compare the coefficient on the "Woman" regressor in column (6) to the same coefficient in column (5). The standard error slightly increases, reflecting the fewer observations included in column (6). The coefficient's magnitude diminishes by circa 14%, and the significance level drops to 10%. This suggests that the healthcare and social assistance industry does play a role in our results. However, it is not the only driver. Our results remain robust.

Table 3: Baseline Regression Results

Dependent Variable: CBRA	(1)	(2)	(3)	(4)	(5)	(6)
Woman	0.0893***	0.0830***	0.0784***	0.00377**	0.00366**	0.00316*
	(0.0219)	(0.0215)	(0.0208)	(0.00186)	(0.00182)	(0.00183)
High School Diploma or More	0.00199	0.00189	-0.000982	-0.000393		
	(0.00310)	(0.00257)	(0.00196)	(0.000680)		
Only High School Diploma					-0.000700	-0.000443
					(0.000746)	(0.000660)
Some College or Associate's Degree					0.00343*	0.00308
					(0.00204)	(0.00206)
University Degree (Bachelor or More)					0.00649	0.00669
					(0.00593)	(0.00604)
Observations	1,458,947	1,458,947	1,458,947	1,458,947	1,458,947	1,430,875
Adjusted R-squared	0.092	0.105	0.191	0.717	0.717	0.694
Individual-level Covariates	No	Yes	Yes	Yes	Yes	Yes
Programme-level Covariates	No	Yes	Yes	Yes	Yes	Yes
State-by-year FE	No	No	Yes	Yes	Yes	Yes
Industry and Occupation FE	No	No	No	Yes	Yes	Yes

Notes: The Table shows OLS coefficients and robust standard errors clustered by state in parentheses. *** p<0.01, ** p<0.05, * p<0.1. FE = fixed effects. CBRA is the dependent variable in all columns. Individual-level and programme-level covariates are listed in Table 1. Our base group are non-minority, non-veteran, non-Asian males with less than a high school diploma, pursuing a Registered Apprenticeship dispensed by a single non-unionised employer and whose RTI provider is not a community college. All specifications include calendar month FE and year FE (columns 3, 4 and 5 contain state FE through state-by-year FE). Column (6) excludes all 2-digit Healthcare and Social Assistance industries.

7.2. Heterogeneity Analysis Results

We now show results of heterogeneity analysis (equation (3)), to investigate hypothesis H2. Table 4 below displays results of equation (2) in columns (3) and (4). Columns (1) and (2) specify education as a binary variable: 1 if the participant possesses a high school diploma or greater qualification, 0 otherwise. Columns (3) and (4) decompose the education level into three categories: only high school diploma, some college or associate degree, and at least university degree. The comparison group remains less than high school. Specifications displayed in columns (1) and (3) do not contain occupation and industry fixed effects, which are included in columns (2) and (4).

Adding occupation and industry fixed effects in columns (2) and (4) causes the coefficient on “Woman” to decline in magnitude and become insignificant. In all columns of Table 4, this coefficient now represents the effect of being a woman *with less than a high school diploma* on the probability of choosing CBRA over TBRA. On the other hand, the coefficient on the “some college or associate’s degree” and “woman” interaction term supports H2. Women with “some college or associate’s degree” – existing, uncertified skills – are significantly more likely to enrol in CBRA than men or women with less than a high school diploma.

The “some college or associate’s degree” regressor does not have significant impact on the probability of choosing CBRA by itself. Because of the interaction term, that coefficient now denotes the impact of holding “some college or associate’s degree” on the probability of choosing CBRA *for men*.

Based on our discussion in subsection 6.2, Column (4) of Table 4 shows our preferred specification. Column (4) shows that women *with* some college or an associate’s degree have significantly higher probability of enrolling in CBRA programmes than women with less than high school diploma. Less than high school diploma proxies the absence of skills to be certified. This provides evidence that possessing an associate degree or having attended but not completed college significantly increases the probability that women choose CBRA. The “some college or associate degree” and “woman” interaction term also significantly positively affects the probability of choosing CBRA over TBRA in column (3), in which we compare individuals across occupations and industries. Consequently, we find strong evidence in favour of hypothesis H2.

Column (5) of Table 4 serves as a robustness check. As in column (6) of Table 3, we remove all healthcare and social assistance industries. We compare the coefficient on the “Some College or Associate’s Degree * Woman” interaction term in column (5) to the same coefficient in column (4). The standard error is virtually unchanged. The coefficient’s magnitude diminishes by circa 20%, but the significance level and sign remain the same. This suggests that the healthcare and social assistance industry plays only a very minor role in our results.

Table 4: Regression Results – Interaction Terms

Dependent Variable: CBRA	(1)	(2)	(3)	(4)	(5)
Woman	0.0707* (0.0358)	-0.00291 (0.00686)	0.0771** (0.0367)	-0.00189 (0.00683)	-0.000750 (0.00744)
High School Diploma or More * Woman	0.0348 (0.0236)	0.00486 (0.00344)			
Only High School Diploma * Woman			0.0131 (0.0241)	0.00272 (0.00335)	0.00268 (0.00335)
Some College or Associate's Degree * Woman			0.133*** (0.0434)	0.0152*** (0.00474)	0.0122*** (0.00434)
University Degree (Bachelor or More) * Woman			0.0794 (0.0969)	0.00568 (0.00579)	0.00491 (0.00525)
High School Diploma or More	-0.00300** (0.00142)	-0.000684 (0.000640)			
Only High School Diploma			-0.00497*** (0.00165)	-0.000850 (0.000722)	-0.000580 (0.000649)
Some College or Associate's Degree			0.00455 (0.00451)	0.00174 (0.00187)	0.00198 (0.00197)
University Degree (Bachelor or More)			0.0353 (0.0268)	0.00605 (0.00546)	0.00625 (0.00559)
Observations	1,458,947	1,458,947	1,458,947	1,458,947	1,430,875
Adjusted R-squared	0.191	0.717	0.203	0.717	0.694
Individual-level Covariates	Yes	Yes	Yes	Yes	Yes
Programme-level Covariates	Yes	Yes	Yes	Yes	Yes
State-by-year FE	Yes	Yes	Yes	Yes	Yes
Industry and Occupation FE	No	Yes	No	Yes	Yes

Notes: The Table shows OLS coefficients and robust standard errors clustered by state in parentheses. *** p<0.01, ** p<0.05, * p<0.1. FE = fixed effects. CBRA is the dependent variable in all columns. Individual-level and programme-level covariates are listed in Table 1. Our base group are non-minority, non-veteran, non-Asian males with less than a high school diploma, pursuing a Registered Apprenticeships dispensed by a single non-unionised employer and whose RTI provider is not a community college. All specifications include calendar month FE and year FE (through state-by-year FE). Column (5) excludes all 2-digit Healthcare and Social Assistance industries.

8. Discussion

In our preferred specification (column 4 in Table 3), we compare individuals within state-year cells, within one occupation, and within one industry via fixed effects. As a concrete example, we are comparing within the group of individuals who started Registered Apprenticeships in Florida in 2016 as nurse practitioners in optometry offices. By including these vectors of fixed effects, we close off numerous potentially confounding factors. For example, if CBRA was encouraged in certain states, years, occupations and/or industries, that would bias results without fixed effects. Even after eliminating the effect of being in a given state at a given time, in a given occupation, or in a given industry[6], we find that women, even more so women with “some college or associate’s degree”, participate in CBRA at higher rates.

Another potential issue is that women may be systematically more inclined to sort into specific industries and/or occupations. Again, this is mostly solved by the fixed effects for industry and occupation. These mean that we are comparing within industry and occupation groups, not across industries or occupations. In our robustness check, we drop healthcare to further test this issue. Our main results—that women with “some college or associate’s degree” participate in CBRA at higher rates—do not change.

Given that our results indicate women choose CBRA over TBRA, we must ask whether that selection is a good thing. Essentially, CBRA may have lower costs for women than TBRA, but does that come at the price of programme benefits? The main benefit of training programmes—especially labour market integration programmes like Registered Apprenticeship—is increased employability. However, programmes do not always achieve this goal. In the UK for example, evidence suggests that for women, the returns to apprenticeship[7] can be negative or non-existent relative to no training (Tan, 1991; McIntosh, 2005).

In the worst case, certification might reduce employability instead of improving it – this negative signal comes down to two main issues: negative selection of individuals into the programme and poor training quality. In certain circumstances, a negatively selected certification can deter employers from hiring because they know that only individuals with no other options would have that certification. However, we observe that the selection of women into CBRA is driven by those with “some college or an associate’s degree.” Therefore, we argue that the selection of women into CBRA is due to partially skilled participants’ opportunity for shorter programme duration, not negative selection of the lowest achievers. Alternatively, low quality in CBRA—especially as compared to TBRA—could also jeopardise the benefits of programme participation for individuals. The level of skill imparted by CBRA content should be the same as TBRA, but if the recognition of prior learning process is weak, it could jeopardise that equivalency. Women’s choice to pursue CBRA over TBRA does not seem to be a case of negative selection, but the training quality avenue for negative employability outcomes is less clear.

The first potential weakness of CBRA is its recognition of prior learning procedure. CBRA and TBRA should provide the same level of skill, but while TBRA programmes provide all skills through training and related instruction, CBRA allows for the recognition of prior learning and then training or related instruction for the remaining skills. Typically, recognition of prior learning for formal education

[6] We do not interact state-year, occupation, and industry fixed effects. This means that we cannot exclude the effects of an intervention that applies to a single occupation or industry in a single state. However, if that intervention applies to two (or more) occupations/industries or two states, we can exclude its effects. After searching, we cannot identify any problematic interventions. For example, designations like “trades” or “non-traditional occupations” cover many specific occupations.

[7] Apprenticeship in the UK is a completely different programme from Registered Apprenticeship in the US. However, both are training programmes aimed at labour market integration.

programmes is carried out by centralised institutions or processes, and these can be quite costly and intricate (Assinger, 2022; Bohlinger, 2017). In CBRA, the recognition of prior learning is outsourced to individual companies at their own discretion.

Outsourcing the recognition of prior learning to companies may have negative consequences for the value of a CBRA certification. Assinger (2022) states that workplace recognition of prior learning is more difficult than simply carrying out the process according to established concepts and recognised institutions. Bohlinger (2017) underlines how difficult it is for companies to conduct recognition of prior learning and argues that many companies do not possess the time or financial resources to carry it out effectively. Furthermore, suboptimal recognition of prior learning procedures may add to equity problems if some participants acquired skills through nontraditional means, as these may be more difficult to demonstrate using standard criteria (Bohlinger, 2017). If companies are unable to effectively recognise prior learning, CBRA ceases to offer the same skills as TBRA and the certification may lose value.

The second potential weakness of CBRA is that its employer-driven approach to might bias skills content towards firm-specific skills. CBRA should have the same balance of general and firm-specific skills as TBRA, ideally benefitting both employers and participants. The Department of Labor reports (e.g. Copson et al., 2021) that employers say CBRA allows their workforce to be adaptive, responsive, and more resilient in the face of changing client needs. One reading of this adaptability is that CBRA allows employers to impart firm-specific skills more easily. Since employers are responsible for the recognition of prior learning, they may—possibly unintentionally—focus on firm-specific skills. Assinger (2022) argues that recognition of prior learning in the workplace is typically aimed at recognising very specific skillsets and specific work-relevant goals. In addition, employers have an incentive to focus on firm-specific skills to retain trainees and reduce training costs (Acemoglu & Pischke, 1998). CBRA apprentices' skills may be biased too far away from general and transferable skills, reducing the value of the programme for their employability.

Subsidies intended to support participation in Registered Apprenticeship may jeopardise training quality in CBRA because of the programme's flexibility. Multiple federal and state interventions have provided subsidies or tax credits to Registered Apprenticeship providers. Given that many subsidies and tax credits are on a per-apprentice basis, and that the average programme duration of CBRA is shorter than TBRA (ETA, 2023), offering CBRA would allow companies to capture more subsidies in the same time. When combined with subsidies, the shorter potential duration of CBRA could cause distortions in training incentives for companies.

This could be especially problematic for CBRA because subsidies affect not just how many firms offer training, but which firms choose to do so. Muehlemann et al. (2007) show that training companies non-randomly sort into offering training positions. This is important as it ensures quality of training; only companies with the capacity and necessary resources to train should do so. It is not desirable for companies with negative expected returns to sort into training, as they may not possess the training staff, resources nor experience required to train. Subsidies, then, either induce non-optimal companies to offer low-quality training or represent a dead-weight loss because they simply pay companies who would already be training. Because of the shorter duration of CBRA, it may attract more of these subsidy-motivated training companies, meaning that CBRA participants could be at risk of lower training quality compared to TBRA participants.

Our results indicate that women, especially those with some prior skills, select into CBRA over TBRA when pursuing Registered Apprenticeship. This could present a risk for programme participants if CBRA is worse for employability outcomes compared to TBRA. This potentially comes from two sources: negative selection of individuals into the programme or worse training quality. We find no sign of negative individual selection into CBRA—women are not choosing the programme because they cannot access TBRA. However, the specific features of CBRA—specifically its outsourcing of the recognition of prior learning to companies and its potential shorter duration—do put participants at risk for lower training quality in CBRA than TBRA. Companies may not be able to adequately recognise prior learning, especially for non-firm-specific skills. The shorter duration of CBRA, especially when combined with subsidies on a per-apprentice basis, may incentivise lower training quality and attract companies that cannot provide high-quality training. These factors cast doubt on the idea that women entering Registered Apprenticeship via CBRA is always a good thing.

9. Conclusion

The introduction of CBRA has broadened the spectrum of populations served by Registered Apprenticeship. We argue that time-constrained individuals are sensitive to programme duration. Therefore, they are more able to pursue training when they can expect an even slightly shorter investment period. This is exacerbated when potential participants have some degree of pre-existing skills but no certification. Relative to men, women are significantly more likely to enrol in CBRA over TBRA. This finding is robust to a wide range of various specifications and estimation methods. We further find evidence that this effect is driven by women with uncertified skills, specifically with some college or associate degrees. Women with only a high school diploma or less and those with college degrees are not different from men in their choice of CBRA. Our findings indicate that women with unqualified skills choose CBRA over TBRA, which we explain by their higher cost of time and the shorter duration of the CBRA programme.

Ideally, CBRA offers an alternative format for an established programme that facilitates participation among a broader and more diverse group of individuals. The competency-based format should support time- or otherwise-constrained individuals by providing a shorter programme for individuals who already have skills. This is especially important for situations like migrants coming from another labour market with unqualified skills, individuals who have worked but not had time to pursue formal or non-formal training, and individuals who started to pursue formal or non-formal training but had to stop for any reason. CBRA can also allow for a slower pace of training for individuals who learn more slowly for any reason (Anderson, 2018), which further enables a broader scope and greater equity. Our findings support the argument that CBRA is better suited to broader training provision, with time-constrained women and skilled-but-unqualified individuals two groups that appear to be better served by CBRA.

However, it is not obvious that the increased participation of women in Registered Apprenticeship through CBRA is necessarily beneficial. Employers have a great deal of leeway to offer lower skill levels and more firm-specific skills due to the very minimal regulations over recognition of prior learning procedures. In addition, the shorter programme duration combined with per-apprentice subsidies for training companies can incentivise low-quality training. Increased participation in CBRA among already marginalised groups may not benefit their employment outcomes if CBRA is a lower quality program.

This paper makes five main contributions to the literature. First, we are the first to empirically compare CBRA and TBRA using econometric strategies. CBRA is a relatively new programme, and it has not been possible to rigorously evaluate its effects. We stop short of causality in this analysis, but this is the first attempt in that direction. Our second contribution is to investigate whether inherent characteristics of CBRA increase the probability that women—a demographic underserved by registered apprenticeships—choose to enrol in the programme. Our third contribution is to show that CBRA also attracts individuals with uncertified skills who can expect a shorter programme duration. This has important implications because Registered Apprenticeship is a labour market integration programme. Increasing employment is therefore one of its key goals. Fourth, we argue that CBRA's ability to serve a broader population is due to its separation of the training and certification functions. Because CBRA allows for certification with less training—when prior skills are present—it can serve a more diverse population more efficiently. Finally, we demonstrate how the ability of CBRA to serve a historically underserved population may become a risk if training quality is not ensured.

This study has two main sources of limitations. First, our empirical test of hypothesis H2 is hindered by the construction of the “some college or associate’s degree” indicator variable in RAPIDS data. “Some college” is very different from an associate’s degree. Individuals with some college are more interesting from a policy standpoint since their skills are truly uncertified. It is not strictly correct for us to categorise associate degrees as uncertified, but with this formulation it is unavoidable. Second, and partially due to the first limitation, our empirical test of H2 is not completely conclusive. We had to choose between omitted variable bias and selection bias. Because of the demonstrated importance of the occupation and industry variables in existing literature, we chose to prioritise including those variables at the risk of selection bias. Occupation and industry fixed effects reduce, but do not eliminate, omitted variable bias.

To address the first limitation, the RAPIDS database, which has substantially improved since 2021, should specify the educational attainment of participants on a more granular level. As Registered Apprenticeships gain importance in the US workforce, the RAPIDS database may need to link to other databases of individuals enrolled in formal education programmes. Ideally it could also track individuals after their graduation and record their employment status, wages, and more general occupational and demographic information. An example of such a dataset that already exists is the Swiss longitudinal study of vocational education (LABB)[8].

Although our study has limitations, we include a wide range of covariates as well as fixed effects vectors to account for a variety of confounding factors. The results are robust across different specifications. Women select into CBRA, especially when they have some pre-existing skills.

[8] See https://www.bfs.admin.ch/bfs/home/statistiques/education-science/enquetes/labb.html (not available in English as at 2023).

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Appendix

Table A1: Monte Carlo Simulation Results – Bias from Estimated Marginal Effects

Panel A: Monte Carlo Simulation Results, N = 1,000 and 10,000 Simulations	
Average Marginal Effect of "female" in each Model	**Average Bias**
Logit	0 .0001283
LPM	0.0001007
Panel B: Monte Carlo Simulation Results, N = 1,000 and 10,000 Simulations: Mean Comparison Tests Between Logit and LPM Marginal Effects	
Average Marginal Effect of "female" in each Model	**Average Bias**
Logit	-0.0002469
LPM	-0.0003793

Notes: Linear Probability Model = LPM. Bias is computed relative to the true marginal effect. The true marginal effect in Panel A is computed as $\frac{e^{(\hat{y},female=1)}}{1+e^{(\hat{y},female=1)}} - \frac{e^{(\hat{y},female=0)}}{1+e^{(\hat{y},female=0)}}$ by plugging in the true coefficients of equation (4). The true marginal effect in Panel B is computed as $\Phi(\hat{y}, female = 1) - \Phi(\hat{y}, female = 0)$, where Φ is the standard normal cumulative distribution function. In Panel A, the average true marginal effect is 0.1424192. In Panel B, the true average marginal effect is 0.1426102. The average outcome base rate in Panel A is 0.1889. The average outcome base rate in Panel B is 0.193.

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