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Perfect Bayesian Equilibrium in Signaling Games: The Case of Credential Inflation in the Job Market

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Abstract. In modern labor markets, rising educational attainment among job applicants often fails to translate into corresponding productivity differences. This phenomenon, commonly referred to as "credential inflation," raises concerns about the signaling power of education. This paper explores credential inflation through the lens of signaling games in microeconomic theory and investigates how changing cost structures and labor market screening contribute to inefficient signaling. Specifically, a Perfect Bayesian Equilibrium (PBE) model is used, where job applicants privately know their ability level and choose their education level to signal productivity to employers. When the cost of education becomes less sensitive to ability, pooling equilibria emerge, where both high- and low-ability workers choose the same level of education. As a result, education loses its signaling power and inflation of educational requirements occurs. This paper concludes that credential inflation is a rational outcome under certain market conditions and propose policy responses to mitigate its effects on labor market sorting.

Keywords: Signaling game, Perfect Bayesian Equilibrium, Credential inflation, Labor market, Asymmetric information

1. Introduction

Over the past decades, educational attainment has steadily increased among job seekers across the globe. In many sectors, a university degree has become the minimum requirement, while master's degrees are increasingly expected for positions that historically required far less. This phenomenon, widely labelled credential inflation, is driven less by technological change alone than by a deeper shift in how employers cope with information asymmetry and how workers strategically signal their productivity.

According to Spence's job market signaling model, education serves as a costly signal of worker ability when firms cannot directly observe productivity. However, recent studies have shown that as higher education becomes more accessible, its value as a differentiating signal diminishes. For instance, Spence highlights how subsidized education and widespread degree programs weaken the separating equilibrium originally predicted in classical models [1]. Moreover, Weiss finds that employers begin to rely on alternative screening tools such as internships and standardized tests [2].

This paper employs a literature review methodology and focuses on developing a theoretical model to analyze the impact of educational signaling under Perfect Bayesian Equilibrium. The

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model investigates how shifts in the cost of education and belief updating by employers affect equilibrium outcomes. This research contributes to understanding how credential inflation emerges from strategic signaling behavior and offers policy insights for improving labor market efficiency in the face of distorted signals.

2. Theoretical framework

2.1. Signaling games and asymmetric information

A signaling game is a framework from game theory used to analyze situations in which one party (the sender) possesses private information and another party (the receiver) must make decisions based on a signal observed from the sender. In the context of labor markets, the sender is the job applicant (worker), and the receiver is the employer. The private information pertains to the worker's true productivity or ability, which is unobservable to the employer.

Education acts as a signal that job seekers use to convey their unobservable productivity. This signal is assumed to be costly to acquire, and the cost structure is often such that higher-ability individuals can obtain education at a lower cost compared to lower-ability individuals. Employers interpret education levels as indicators of likely productivity and offer wages accordingly. This creates incentives for high-ability individuals to differentiate themselves by investing in education, while low-ability individuals may find the cost prohibitive, resulting in a separating equilibrium [1-2].

However, the signaling mechanism can become inefficient when the cost of education falls uniformly across the population, or when institutional factors such as subsidies, grade inflation, or social pressures reduce the correlation between ability and the cost of education. In such cases, the signal loses its informativeness, and employers can no longer rely on education to effectively screen applicants. This shift underlies the credential inflation phenomenon [3-5].

2.2. Perfect Bayesian Equilibrium (PBE)

The Perfect Bayesian Equilibrium (PBE) concept refines the Nash equilibrium for dynamic games with incomplete information. In signaling games, PBE provides a framework for predicting the strategies of players and how beliefs are updated based on observed actions.

A PBE consists of three key components. First, each player adopts a sequentially rational strategy: the worker selects an education level, while the employer determines a wage offer based on the observed level of education. Second, employers maintain a belief system p(e), representing the probability that a worker with education level is of high ability. Third, these beliefs must be updated in a manner consistent with Bayes' rule whenever possible, using the information provided by the equilibrium strategies.

PBE is particularly useful for analyzing signaling in labor markets because it captures how employers adjust their expectations based on observed signals. Unlike a simple Nash equilibrium, PBE incorporates rational expectations and sequential consistency. This allows it to account for how strategies and beliefs interact over time, especially as educational norms evolve and labor market expectations shift. It is this dynamic nature of signaling and belief updating that makes PBE well-suited to model phenomena such as credential inflation, where equilibria can shift from separating to pooling as the parameters of the signaling game change [6-7].

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3. Model construction

3.1. Assumptions

A parsimonious signalling model, cast within the Perfect Bayesian Equilibrium framework, captures the mechanics of credential inflation. The model operates under several key assumptions. First, the workforce is composed of two types of workers: High Ability (H) and Low Ability (L), with the proportion of high-ability individuals denoted by $\theta \in (0,1)$. Education functions as a signal of worker ability, where $e \in R+$ represents the level of education attained. The cost of acquiring education varies by type: high-ability workers incur a lower marginal cost, denoted CH(e), than their low-ability counterparts, CL(e), such that CH(e)<CL(e) for all e>0. Employers are unable to directly observe a worker's type but can observe their education level. Upon observing eee, they form a belief p(e) about the likelihood that the worker is high ability and offer a wage w(e) based on this belief [1, 6].

3.2. Strategy and payoff structure

Each worker chooses an education level to maximize their expected utility, defined as the wage received minus the cost of education. The employer offers a wage based on the expected productivity, which is a function of the worker's type:

$$Let:\ v_H = productivity\ of\ high-ability\ worker$$

$$v_L = productivity\ of\ low-ability\ worker,\ with\ v_H > v_L$$

$$p(e) = employer's\ posterior\ belief\ that\ a\ worker\ with\ education\ level\ e\ is\ high\ ability$$

Then the wage function is:

$$w(e) = p(e) \cdot v_H + (1 - p(e)) \cdot v_L$$

The expected utility for each worker type is:

$$U_H(e) = w(e) - C_H(e)$$

$$U_L(e) = w(e) - C_L(e)$$

Each worker selects the education level that maximizes their utility given the employer's strategy. Employers, in turn, choose a wage strategy based on observed e and update their beliefs according to Bayes' Rule where applicable.

3.3. Equilibrium analysis

Two equilibrium outcomes govern the interaction between workers and employers: separating and pooling.

In a separating equilibrium, each type chooses a distinct education level, allowing the employer to perfectly infer the worker's type. Let e_H and e_L denote the optimal education levels chosen by high- and low-ability workers, respectively. For a separating equilibrium to hold: U_H(e_H) ≥ U_H(e_L) and U_L(e_L) ≥ U_L(e_H).

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This requires that the net benefit of signaling is sufficiently high for the high-ability type and prohibitively costly for the low-ability type. Employers then offer w(e_H) ≈ v_H and w(e_L) ≈ v_L, correctly matching wage to type [1-2].

A pooling equilibrium arises when both types of workers choose the same education level e*. In this case, the employer cannot distinguish worker types and must offer a uniform wage based on the average expected productivity:

$$w(e*) = \theta \cdot v_H + (1 - \theta) \cdot v_L$$

The pooling equilibrium becomes attractive when the cost difference between types is small enough that low-ability workers can mimic high-ability ones without incurring prohibitive costs. This can happen due to subsidies, online education, or social incentives reducing C_L(e) [3, 4, 8].

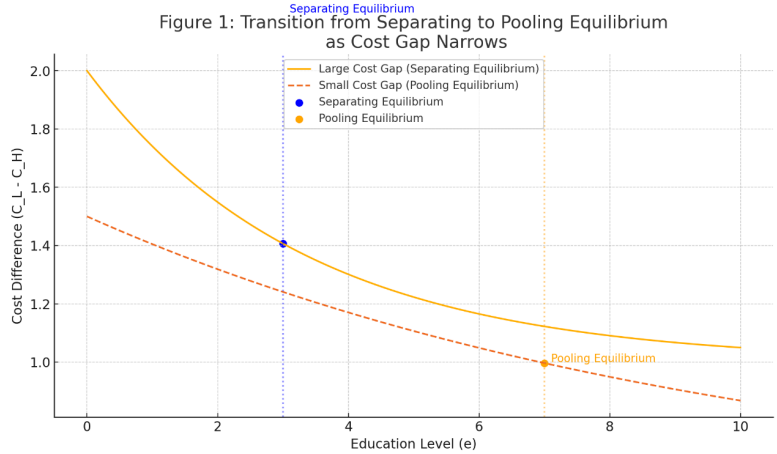

Figure 1. Transition from separating to pooling equilibrium as cost gap narrows

Figure 1 visually represent how as the cost gap between C_H and C_L narrows, the equilibrium transitions from separating to pooling.

The equilibrium outcomes have direct implications for labor market efficiency. In a separating equilibrium, education effectively conveys information about worker productivity. In contrast, a pooling equilibrium leads to credential inflation, as education becomes a weak signal and firms must find alternative methods to screen applicants [7, 9].

4. Real-world implications

4.1. Case studies of credential inflation

Credential inflation is not a theoretical abstraction—it is increasingly observable in global labor markets. For instance, the OECD's "Education at a Glance" report shows a consistent upward trend in tertiary education attainment across member countries. Between 2000 and 2022, the share of young adults (aged 25–34) with a university degree increased by more than 20 percentage points in countries such as South Korea, Canada, and Ireland [8]. However, wage premiums for degree holders have stagnated or declined, suggesting that degrees no longer differentiate worker ability as effectively as in the past.

In Canada, research indicates that the share of bachelor's degree holders among applicants for entry-level jobs has increased sharply since 2005, even when the job responsibilities have not

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changed [5]. Similar patterns are seen in China, where the proliferation of undergraduate and master's programs has led to a mismatch between education levels and job requirements. Employers now routinely require postgraduate degrees for positions that previously accepted undergraduate degrees, even though the tasks performed remain essentially the same.

Table 1. Tertiary education and job matching in selected OECD countries [8]

Country	Tertiary Degree Holders (%)	Jobs Requiring Degree (%)	Country
Canada	65%	42%	Canada
South Korea	70%	45%	South Korea
Germany	32%	35%	Germany

Table 1 provides a cross-country comparison of tertiary education rates and the percentage of jobs actually requiring such qualifications. The gap between credential possession and job requirement reflects the inflationary pressures in education signaling. In countries with high tertiary attainment, many graduates are effectively overqualified for their roles, undermining the signaling efficiency of degrees.

4.2. Causes of education cost convergence

Several structural and technological developments have contributed to narrowing the cost gap between high- and low-ability individuals, thereby weakening education's role as a separating signal in the labor market. The rise of online education—particularly Massive Open Online Courses (MOOCs) and online degree programs from platforms such as Coursera, edX, and Western Governors University—has significantly lowered both the monetary and time costs associated with obtaining academic credentials [4]. Government subsidies and student loan programs have further expanded access to higher education, enabling individuals across the ability spectrum to enroll at similar financial costs. While these policies enhance educational inclusivity, they also allow low-ability individuals to obtain degrees that once served as credible signals of high ability. In addition, evolving social norms and peer pressure reinforce the pursuit of academic qualifications, as degrees are often perceived as symbols of social status or vehicles of upward mobility, independent of actual labor market utility [3, 5]. Finally, technological advancements have led to the standardization and widespread accessibility of curricula, which has diminished the comparative advantage that high-ability individuals traditionally held in mastering complex academic material [9-10].

As a result, the marginal cost of acquiring additional education has fallen, particularly for low-ability individuals. This erodes the cost-based differentiation that underpins separating equilibria in classical signaling models and leads to the emergence of pooling outcomes in practice.

These real-world developments validate the model's theoretical predictions and illustrate the conditions under which credential inflation becomes a stable equilibrium outcome in labor markets.

5. Policy considerations

Addressing credential inflation needs coordinated efforts from different sectors. These efforts should mainly aim at making education a clearer signal of worker ability and better matching education to job market needs. Companies are starting to use new methods to evaluate job applicants. Instead of just looking at educational qualifications, they are using methods such as internships, apprenticeships, and skill tests. These methods focus on directly measuring the actual skills and

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abilities of applicants. Research shows that these practical methods often predict job performance better than traditional educational credentials.

Governments and educational institutions also occupy a pivotal position in arresting credential inflation. Expanding high-quality vocational education and training—exemplified by the apprenticeship systems of Germany and Switzerland—integrates classroom instruction with paid, workplace-based experience. Graduates emerge with competencies that map precisely onto industry needs, reducing the mismatch between parchment and performance.

Policymakers can further sharpen the signal value of education by establishing transparent, occupation-specific qualification standards. Mandating that job postings list only the skills and credentials genuinely necessary for competent performance discourages degree inflation and channels talent toward the most efficient pathway. Additionally, schools and universities can support these rules by offering different pathways for students to gain credentials. These alternative pathways include micro-credentials and skill certifications, which clearly show what specific skills a student has. These new credential types can help employers better understand a candidate's real abilities and whether they match job requirements.

Together, these measures realign educational signals with underlying productivity, restoring their informational content. They ensure that credentials become accurate indicators of what a worker can actually do. As a result, this would lead to a better and more efficient job market and would help individuals achieve better career outcomes.

6. Conclusion

This paper develops a signaling game framework under Perfect Bayesian Equilibrium to explain the increasingly common phenomenon of credential inflation in labor markets. By modeling worker-education-employer interactions under asymmetric information, the findings show that as education costs converge across worker types, pooling equilibria become more likely, reducing the effectiveness of education as a signal. The findings highlight a structural inefficiency: under certain rational conditions, agents respond in ways that ultimately distort the labor market's ability to differentiate talent. This has implications for both job seekers, who invest in increasingly costly education with diminishing returns, and employers, who struggle to identify high-ability candidates based solely on academic credentials.

However, this study is limited by its theoretical nature and the absence of empirical validation. Future research could incorporate field experiments or survey-based data to test the predictions of the model. Additionally, more complex models incorporating continuous ability types or multidimensional signals may yield richer insights.

Looking forward, labor markets may shift toward alternative screening systems that value demonstrated skills over formal degrees. Recognizing the limits of educational signaling is a critical step toward building more efficient and equitable hiring systems.

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