Research Group on Human Capital
Working Paper Series

Discrimination and the Fiscal Benefits of Immigration

Working Paper No. 24-01

Nicholas Lawson

January 2024

Groupe de recherche sur le
CAPITAL HUMAIN
ESG UQÀM

https://grch.esg.uqam.ca/en/working-papers-series/

Discrimination and the Fiscal Benefits of Immigration

Nicholas Lawson*
Université du Québec à Montréal

January 29, 2024

Abstract

In recent decades, there has been a lengthy debate about the fiscal costs or benefits of immigration, and much of the literature has found fiscal impacts that are close to zero. However, these studies have ignored the possibility that immigrants may be victims of wage discrimination in the labour market, despite evidence of such discrimination in various countries. In the presence of such discrimination, existing estimates of the fiscal impact of immigration will be biased: if immigrants are paid less than their marginal products, then someone else is receiving that income – mostly likely the firm's owners or other workers – and paying taxes on it, and that fiscal benefit is ignored by a model that disregards discrimination. In this paper, I evaluate the quantitative importance of this mechanism, by calibrating a search-and-matching model to Canadian data and simulating the fiscal impact of increases in immigration. When the model and calibration omits wage discrimination against immigrants, the average fiscal impact of immigration is negative, but it becomes positive if discrimination explains the wage gaps between natives and immigrant workers: at an economy-wide level, an annual fiscal cost of about $3 billion in the absence of discrimination becomes a fiscal benefit of about $4 billion in the presence of discrimination. My results indicate that wage discrimination against immigrants could significantly affect our estimates of the fiscal impact of immigration.

Keywords: discrimination, immigration, fiscal benefits

JEL Codes: H27, J61, J79

*lawson.nicholas@uqam.ca. I would like to thank Christ Kévin Bazié for excellent research assistance, and the Groupe de recherche sur le capital humain at UQAM for funding. I thank Casey Warman for comments and suggestions, as well as participants of the Canadian Public Economics Group 2023 Annual Meeting. Any errors or omissions are the responsibility of the author.

1 Introduction

Over the past few decades, there has been a lengthy debate about the fiscal costs or benefits of immigration, based on the question of whether an immigrant pays more in taxes than they receive in public benefits in their destination country.[1] This literature has included papers that focus on specific countries, such as Bødker et al. (2012) and Hansen et al. (2017) on Denmark, Bratsberg et al. (2014) on Norway, Ruist (2015) on Sweden, National Academies of Sciences, Engineering, and Medicine (2017) and Colas and Sachs (2022) on the United States, and Dustmann and Frattini (2014) on the United Kingdom. Other papers have surveyed the debate more broadly (Rowthorn, 2008; Kerr and Kerr, 2011; Preston, 2014; Vargas-Silva, 2015; Edo et al., 2020; Hennessey and Hagen-Zanker, 2020).[2] While there are a few outliers, much of this literature has found relatively small fiscal effects, whether positive or negative, leading to the general conclusion that immigration's fiscal impact is probably close to zero in many countries.[3]

However, these studies have ignored the possibility that immigrants may be victims of discrimination in the labour market. A growing literature provides evidence that immigrants are indeed subjected to discrimination, including direct estimates of wage discrimination in Germany in Bartolucci (2014) and Hirsch and Jahn (2015) and in Belgium in Kampelmann and Rycx (2016) and Fays et al. (2021), as well as more indirect evidence from studies using fake CVs such as Oreopoulos (2011) for Canada and Busetta et al. (2018) for Italy.[4] To the extent that such discrimination is based on racial and ethnic differences from the majority

[1]This question is related to but distinct from the question of the broader economic benefits or costs of immigration, which has also been the focus of a large literature, including Borjas (1995), Boubtane et al. (2014), Battisti et al. (2018), and a number of papers that also consider fiscal impacts (Kerr and Kerr, 2011; National Academies of Sciences, Engineering, and Medicine, 2017; Edo et al., 2020).

[2]Additionally, some papers have focussed on specific types of immigrants, such as Ruist (2015), who focusses on refugees, or Bødker et al. (2012), who consider high-skilled economic immigrants.

[3]This includes an interesting recent study by Yao et al. (2022) who used the famous Mariel Boatlift as a plausibly exogenous shock to the fiscal environment in Miami, and find no effect at the municipal level.

[4]An ongoing debate in the literature considers the extent to which immigrant wage gaps may be explained by productive characteristics such as lower host-country language ability (Ferrer et al., 2006; Warman et al., 2015) or lower-quality education (Fortin et al., 2016; Li and Sweetman, 2014). I do not take a position on this, to the extent that I present two cases, with and without discrimination, and demonstrate the impact that discrimination can have if it is present. However, it is important to note that lower returns to education or other skills does not rule out discrimination, as pointed out by Esses et al. (2014): "the ambiguity of immigrants' foreign-acquired skills and personal characteristics may provide a cover for the expression of bias toward immigrants who are religious and ethnic minorities."

population in destination countries – as suggested by Oreopoulos (2011), who finds evidence of unconscious bias against individuals with non-English names – this problem may become even more extensive in the future.

The reason why discrimination against immigrants is important when estimating the fiscal impact of immigration is simple: if immigrants are paid lower wages than comparably productive natives – and thus immigrants are paid less than their marginal products – then someone else is receiving that money as part of their income. That "someone else" could be the firm owner or shareholders, or possibly other workers who are able to negotiate larger wages out of the firm's "discrimination surplus";[5] but in any case, the recipient will presumably pay taxes on the additional income, which is a fiscal benefit that we should account for when considering the fiscal impact of immigration. In other words, discrimination may be a cost from the immigrant's point of view, but it is a benefit to someone else, and eventually to the government in the form of additional tax revenues. An analysis of the fiscal impact of immigration that does not account for such an effect is likely to be biased.

In this paper, I evaluate the quantitative importance of this mechanism. I present a search-and-matching model based on Battisti et al. (2018), which features 4 types of workers: high-skilled and low-skilled workers (those with and without university degrees) are each subdivided into natives and immigrants. I consider two versions of the model: one in which wage gaps between natives and immigrants are due to productivity differences, and a second in which discrimination is responsible for the wage gaps (in the form of a lower worker wage bargaining parameter). I then calibrate this model to data from Canada, which has a large and growing immigrant population and accordingly has been studied repeatedly in the literature on fiscal impacts of immigration (Grubel and Grady, 2011; Javdani and Pendakur, 2014; Grady and Grubel, 2014; Zhang et al., 2020; Kapsalis, 2021; Montcho et al., 2022).

Using the calibrated model, I simulate three different scenarios of increased immigration, and I find that, in a baseline model without wage discrimination against immigrants, the average fiscal impact of immigration is negative, though high-skilled immigrant workers do produce fiscal gains. When I assume instead that discrimination is the cause of immigrant

[5] This logic implies that it is also possible that papers that show positive effects of immigration on productivity, such as Peri (2012) and Mitaritonna et al. (2017), are partly picking up the spillover effects from discrimination benefitting the firm or the other workers.

wage gaps, the results change significantly: the fiscal contribution of both low- and high-skilled immigrants become more positive, and the overall fiscal impact becomes positive. At an economy-wide level, my estimates imply an annual fiscal cost of about \$3 billion in the absence of discrimination, which becomes a fiscal benefit of about \$4 billion in the presence of discrimination. In other words, accounting for discrimination in my model adds about \$7 billion to the fiscal surplus of Canadian governments.

I also present a series of alternative models and robustness checks: I model part of government expenditure as a pure public good, I apply different tax rates to different worker types, I add taxation on profits or capital to the model, and I use an alternative specification of discrimination. In each case, the numerical results change, but the impact of discrimination on the fiscal environment remains very similar and significant in each case.

My paper contributes to the overall literature on the fiscal impact of immigration, and particularly to the section of the literature that has focussed on Canada: my findings of small negative fiscal impacts in the absence of discrimination are fairly close to most of the existing estimates, with the exception of the much larger negative findings in Grubel and Grady (2011) and Grady and Grubel (2014). Only two papers in the overall literature seem to have addressed the question of discrimination: the first was Javdani and Pendakur (2014), who point out that immigrants might earn less due to discrimination, but claim that this would be a fiscal benefit of removing discrimination rather than recognizing that such a benefit already exists. More recently, Colas and Sachs (2022) mention that, in the monopsonistic labour markets studied by Amior and Manning (2022), immigration implies redistribution between workers and to firms, and that since immigrants are not paid their marginal product, "the economic pie accruing to residents would increase and thereby reinforce the indirect fiscal benefit." However, Colas and Sachs (2022) do not attempt to model or estimate such a fiscal impact of discrimination.

My argument about the importance of an indirect fiscal impact of immigration through discrimination is somewhat similar to that in Clemens (2021), who argues that existing methods to estimate fiscal impacts of immigration ignore the role of capital taxes paid by employers of immigrant labour. I will model such taxes in the extensions of my model in sections 4.3 and 4.4, but my paper is complementary to Clemens (2021) as my main focus is on discrimination, which is not present in the latter paper's model. Colas and Sachs (2022) also model indirect fiscal effects, through general equilibrium adjustments in wages and employment, which are present in my models.

Finally, it is important to note that there are many different ways that one could construct a model to study the fiscal impacts of immigration. The question of whether to adopt a static or dynamic approach has been addressed numerous times in the literature, including by Vargas-Silva (2015), who also discusses the distinction between simple partial-equilibrium and broader general-equilibrium approaches. Other important questions include how to model the tax system, as well as pensions and social benefits, and how to account for individuals with very high incomes, among many others. Edo et al. (2020) provide a useful summary of the existing research, with a description of the various methods used; to focus on the mechanism that I want to present, I use a relatively simple approach that doesn't account for retirement, childhood, or most government benefits, as I use the static model from Battisti et al. (2018).

The rest of the paper proceeds as follows. Section 2 presents the main model of the paper, while section 3 presents the calibration and the numerical simulations of the effect of discrimination on the estimated fiscal impact of immigration. Section 4 presents a series of alternative models and robustness checks, and section 5 concludes the paper.

2 Main Search and Matching Model

This paper aims to make a simple point: if immigrants face discrimination that leads to them receiving lower wages, the surplus must be received by somebody, and that somebody is likely to pay taxes on it, and this "discrimination surplus" should be taken into account when we estimate the fiscal gains or losses caused by immigration. For such a simple point, a very simple model could be sufficient: for example, if discrimination leads to immigrants' wages being 10% too low – which would be consistent with studies from Germany by Bartolucci (2014) and Hirsch and Jahn (2015) – we could assume that the firm receives that 10% as part of their profits, on which they pay taxes at a rate τ. In that case, the immigrant's fiscal contribution should simply be raised by $0.1\tau w$, if w is the wage of a comparable native worker. If the immigrant's average tax rate t was equal to τ, then we could simply raise their estimated fiscal contribution in the form of taxes paid by about 11%. Given how many studies have found that the taxes paid and benefits received by immigrants are roughly equal, such an adjustment due to discrimination could easily shift the findings in the literature to being unambiguously positive.

However, such a simple approach is not entirely convincing. First of all, the "discrimination surplus" may be not be entirely received by the firms' owners; native workers may also benefit if they are able to negotiate higher wages to share some of the surplus. Additionally, general equilibrium adjustments to immigration need to be taken into account, in the form of changes to bargained wages and employment rates. And it may be the case that the other people who benefit from discrimination against immigrants – owners and/or other workers – face higher or lower marginal tax rates than the immigrants themselves. To account for all of these factors, we need a more complete model, and that is what the current section of the paper will provide.

Section 4 will consider a variety of model specifications for the sake of robustness, but I start here with a search model based on Battisti et al. (2018), who used their model to estimate the welfare impact of immigration across 20 countries. This model features two skill levels of workers: low-skilled (denoted by L) and high-skilled (denoted by H), which in practice will be identified by whether a worker has completed a university degree. Within each skill type, immigrants and native workers are perfect substitutes and compete in the same skill-specific labour market. Each skill-type of worker produces a separate intermediate good, Y_L and Y_H, which are then combined with perfectly-mobile capital K to produce the single final good Y (for which the price is normalized to 1). As in Battisti et al. (2018), I take the stocks of each type of immigrant to be exogenously given, and thus I only model a single (destination) country. Worker type is denoted by $i \in \{L, H\}$ (skill) and $j \in \{N, I\}$ (native/immigrant). A government provides unemployment insurance (UI) benefits b_{ij} and a lump-sum transfer g, financed by a linear tax t on wage income.

The production technology is unchanged from Battisti et al. (2018):

$$Y = AK^{\alpha}Z^{1-\alpha}, \alpha \in (0,1)$$
$$Z = [xY_L^{\rho} + (1-x)Y_H^{\rho}]^{\frac{1}{\rho}}, \ \rho \in (0,1)$$
$$Y_i = \sum_{j \in N,I} (1-u_{ij})\pi_{ij}Q_{ij}, \ i \in \{L,H\}$$

where α is the output elasticity of capital, A is total factor productivity, ρ determines the elasticity of substitution between intermediate inputs Y_L and Y_H, $x \in (0,1)$ is a relative productivity parameter, Q_{ij} the is total number of individuals of type $\{i,j\}$, u_{ij} is the type-specific unemployment rate, and π_{ij} is labour productivity. Z is a CES composite of the intermediate goods Y_L and Y_H, and the latter are linear functions of each type of labour.[6]

Since capital is freely mobile on world markets, the return to capital r is fixed by its return in those markets. I assume that the stock of capital owned by natives is $\bar{K}$, which is divided equally among all natives; but the amount of capital K used in production is determined by the first-order condition $r + \delta = \alpha AK^{\alpha-1}Z^{1-\alpha}$, where δ is the depreciation rate. This gives us the condition:

$$(r+\delta)K = \alpha Y. \tag{1}$$

Meanwhile, the intermediate goods are produced under perfect competition, which means that $p_i = \frac{\partial Y}{\partial Y_i}$ for each good:

$$p_L = AK^{\alpha}(1-\alpha)xY_L^{\rho-1}\left[xY_L^{\rho} + (1-x)Y_H^{\rho}\right]^{\frac{1-\alpha-\rho}{\rho}} \tag{2}$$

$$p_H = AK^{\alpha}(1-\alpha)(1-x)Y_H^{\rho-1}\left[xY_L^{\rho} + (1-x)Y_H^{\rho}\right]^{\frac{1-\alpha-\rho}{\rho}}. \tag{3}$$

The two skill types have separate labour markets in which matches are formed continuously over time. Intermediate-goods firms pay a cost of c_i per unit of time for an open vacancy, and cannot target their vacancy at immigrants or natives within a skill type. The flow contact rate for each type is given by a Cobb-Douglas matching function over vacancies V_i and a mass $U_i = U_{iN} + U_{iI}$ of unemployed workers:

$$M(U_i, V_i) = \xi U_i^{\varepsilon} V_i^{1-\varepsilon}$$

[6]This sort of CES market structure has been used by a number of other papers that study immigration, including Chassamboulli and Palivos (2014), Chassamboulli and Peri (2020b), and Chassamboulli and Peri (2020a). Of course, such a model implies that, if there are enough high-skill workers, they will actually have lower productivity than low-skill workers, but what matters here is matching the data at and near the baseline equilibrium, where high-skill workers' wages are always higher.

where $\varepsilon \in (0,1)$ is the matching elasticity and ξ is a scale parameter. Labour market tightness is given by $\theta_i \equiv \frac{V_i}{U_i}$, and the rate at which firms fill vacancies is $q(\theta_i) \equiv \frac{M_i}{V_i} = \xi\theta^{-\varepsilon}$, while unemployed workers find jobs at the rate $m(\theta_i) \equiv \frac{M_i}{U_i} = \xi\theta^{1-\varepsilon}$. Existing matches are destroyed at the exogenous rate s_{ij}.[7]

The Bellman equations for firms are identical to Battisti et al. (2018): if we denote as J_i^V the value of an open vacancy and J_{ij}^F as the value of a filled job:

$$rJ_i^V = q(\theta_i)\left[\phi_{iN}J_{iN}^F + \phi_{iI}J_{iI}^F - J_i^V\right] - c_i$$
$$rJ_{ij}^F = \pi_{ij}p_i - w_{ij} - s_{ij}\left[J_{ij}^F - J_i^V\right]$$

where $\phi_{ij} = \frac{U_{ij}}{\sum_k U_{ik}}$ is the share of the unemployed of skill level i that are of immigration status j, and w_{ij} is the worker's wage.[8] The free-entry condition means that $J_i^V = 0$ in equilibrium.[9]

Meanwhile, the Bellman equations for workers are almost the same as in Battisti et al. (2018): using J_{ij}^E as the value of employment and J_{ij}^U as the value of unemployment:

$$rJ_{ij}^E = g + rk_{ij} + (1-t)w_{ij} - s_{ij}\left[J_{ij}^E - J_{ij}^U\right]$$
$$rJ_{ij}^U = g + rk_{ij} + b_{ij} + m(\theta_i)\left[J_{ij}^E - J_{ij}^U\right]$$

where k_{ij} is capital per person, which will be an equal share of $\bar{K}$ for natives and zero for immigrants. The one difference with respect to Battisti et al. (2018) is that the latter included h_{ij} as the direct utility from unemployment, where $h_{iN} = 0$ and $h_{iI} < 0$; I drop this for simplicity and to make the distinction between versions of the model with and without discrimination easier to understand.[10]

[7] Battisti et al. (2018) divide this separation rate into a baseline separation rate plus a remigration rate for immigrants, but this distinction is without importance for my numerical analysis, so I combine them into a single type-specific rate s_{ij}.

[8] Of course, immigrants' wage trajectories could be different from those of native workers, but I will focus on average wages in the steady-state of this model.

[9] One could question whether firms would be open to hiring both immigrants and native workers; in particular, in the case in which immigrants are subject to wage discrimination, firms may find it particularly profitable to hire immigrants. However, as long as J_{ij}^F is positive for each type of worker, firms will indeed be willing to hire whichever type of worker they meet – and I have verified that this condition is satisfied in all simulations.

[10] h_{iI} could be set flexibly to explain the differences in wages between immigrants and natives, without any role for discrimination. Instead, in my model, wage differences between immigrants and natives will be explained by differences in π_{ij} or (in the case of discrimination) by differences in the bargaining power β_{ij}.

Wages are set by Nash bargaining where the worker's bargaining power is $\beta_{ij} \in (0,1)$; unlike in Battisti et al. (2018), I allow the bargaining power to potentially vary across worker type. The worker will then receive β_{ij} percent of the total surplus $J^F_{ij} + J^E_{ij} - J^U_{ij}$, which gives us the following condition:

$$(1-\beta_{ij})\left(J^E_{ij} - J^U_{ij}\right) = \beta_{ij} J^F_{ij}. \tag{4}$$

I focus on the steady state of the model,[11] in which flows in and out of unemployment must offset:

$$s_{ij}\left(Q_{ij} - U_{ij}\right) = m(\theta_i) U_{ij}$$

which gives us the following results for total employment E_{ij} and unemployment U_{ij} for each type of worker:

$$U_{ij} = \frac{s_{ij}}{s_{ij} + m(\theta_i)} Q_{ij}$$
$$E_{ij} = \frac{m(\theta_i)}{s_{ij} + m(\theta_i)} Q_{ij}.$$

The public sector consists of a government that raises revenues through a linear labour income tax and pays for UI benefits and the lump-sum transfer. I assume that there is no taxation of capital, because domestic capital ownership $\bar{K}$ is fixed by assumption (though utilized capital K adjusts freely in equilibrium) and the rate of return r is fixed by the assumption of a small open economy, so capital income is exogenously fixed; but two alternative models in sections 4.3 and 4.4 will allow for taxes on endogenous capital or on firms. The government budget constraint is:

$$\sum_i \sum_j b_{ij} U_{ij} + g \sum_i \sum_j Q_{ij} = t \sum_i \sum_j w_{ij} E_{ij} \tag{5}$$

where, as in Battisti et al. (2018), b_{ij} and g are assumed to be exogenous and t adjusts to satisfy the constraint.

[11] Of course, there could be dynamic effects over time, if employer learning causes workers' productivity to increase and potentially leads to a decrease in discrimination; Warman and Worswick (2015) and Warman et al. (2019) show that immigrant wage gaps in Canada tend to decline with the number of years since immigration, and Green and Worswick (2012) and Aydemir and Skuterud (2005) find that starting wages have declined for native workers as well. However, I will focus on – and estimate – the average wage gaps between immigrants and natives rather than their trajectories over time.

Finally, I close the model by combining the firm value functions and the free-entry condition to derive a job-creation condition:

$$q(\theta_i)\sum_j \phi_{ij}\frac{\pi_{ij}p_i - w_{ij}}{r + s_{ij}} = c_i. \tag{6}$$

The equilibrium of this model is defined by 10 equations: the capital first-order condition (1), the intermediate-good first-order conditions (2) and (3), the 4 wage conditions in (4), the government budget constraint (5), and the 2 job-creation conditions in (6). These equations define the equilibrium values for the 10 values $\{K, p_L, p_H, w_{LN}, w_{LI}, w_{HN}, w_{HI}, t, \theta_L, \theta_H\}$.

This completes the description of the theoretical model. As in Battisti et al. (2018), I will focus on a numerical analysis of the model, and particularly of the effect of immigration on equilibrium outcomes. The following section presents the calibration of the model in two different scenarios – with and without discrimination – and a comparison of the estimated fiscal impacts of immigration in those scenarios.

3 Calibration and Simulation

Given the large and increasing importance of immigration in the Canadian labour market, and the fact that Canada has been studied by numerous papers within the literature on the fiscal impact of immigration (Grubel and Grady, 2011; Javdani and Pendakur, 2014; Grady and Grubel, 2014; Zhang et al., 2020; Kapsalis, 2021; Montcho et al., 2022), I will calibrate my model to data for Canada, and use the calibrated model to simulate the fiscal effect of increases in the immigrant population. I will do this in each of two scenarios: one in which the model is calibrated under the assumption that wage differences between immigrants and natives are due to productivity differences, and one in which immigrants and natives are assumed to be of equal productivity and the wage differences are attributed to discrimination.

A number of the parameter values are common between the two calibrations, and their values are summarized in Table 1. In particular, I follow Battisti et al. (2018) in choosing several of the parameters to match the values that they used for all 20 countries in their study: I set $\varepsilon = 0.5$, $\rho = 0.5$, $r = 0.004$, and $\delta = 0.0061$. The UI benefit b_{ij} is modelled as being equal to a replacement rate ϱ multiplied by after-tax wages $w_{ij}(1-t)$, and the tax-benefit calculator at OECD Benefits and Wages (2023) gives an effective replacement rate of $\varrho = 0.394$ for the default unemployed case in Canada in 2019.[12] The capital share is estimated at $\alpha = 0.345$, based on a share of labour compensation in GDP of 65.5% in 2019 in the Federal Reserve Bank of St. Louis FRED database (FRED Economic Data, 2023), and I assume that all capital used in the baseline equilibrium is domestically owned, so that $\bar{K} = K$ at baseline, though K – the capital actually used in production – is allowed to adjust in equilibrium if immigrant populations change. As in Battisti et al. (2018), I normalize $c_L = 0.5$ and $\pi_{iN} = 1$.[13]

For the population shares, as well as a number of the moments used in the calibrations, I use data from the Canadian Labour Force Survey (LFS) in 2019 (Statistics Canada, 2019). Specifically, I combine the data from all 12 months of the LFS in 2019, and drop all individuals aged 65 and over as well as those who are not in the labour force, leaving me with a sample of 726053 observations.[14] I identify high-skilled individuals as those with at least a bachelor's degree. To calculate the population shares, I normalize the size of the native population to 1, and then I can calculate $Q_{HN} = 0.270$, $Q_{LN} = 0.730$, $Q_{HI} = 0.157$, and $Q_{LI} = 0.186$.

The remaining parameters in each of the two calibrations are chosen to match a set of 11 moments which are presented in Table 2. Most of the moments are estimated in the data from the 2019 LFS, and the government expenditure as a percentage of GDP is taken from the data at IMF Datamapper (2022) for 2019; the two values for job durations from Battisti et al. (2018) were used for all 20 of their countries, including Canada.

In the first scenario, discrimination is absent from the model, which means that the worker bargaining power $\beta_{ij} = \beta$ does not vary by type, and in particular does not vary between natives and immigrants within a given skill type. To be precise, as in Battisti et al. (2018), β will be set equal to ε, with both equal to 0.5. I then have a set of 11

[12]The default case corresponds to a 40-year-old individual in a couple with 2 children (aged 4 and 6), unemployed for 2 months after working for 264 months over their career and with a previous wage equal to the average, and with a non-employed spouse.

[13]Note that setting $\pi_{LN} = \pi_{HN} = 1$ is without loss of generality since x can vary to determine the relative productivity of low- and high-skill workers.

[14]Of course, given the fact that the LFS surveys individuals over 6 consecutive months, many people appear in the data multiple times. This does not affect the representativeness of the overall sample, and I use the "standard final weight" (variable FINALWT) to weight all estimations.

Table 1: Common Parameters Taken from Available Data or Literature

Parameter	Description	Value	Source
β (or β_N)	worker bargaining power	0.5	Battisti et al. (2018)
ε	matching elasticity	0.5	Battisti et al. (2018)
ρ	controls substitution elasticity	0.5	Battisti et al. (2018)
r	monthly interest rate	0.004	Battisti et al. (2018)
δ	monthly depreciation rate	0.0061	Battisti et al. (2018)
ϱ	UI replacement rate	0.394	OECD Benefits and Wages
α	capital share	0.345	FRED Database
Q_{LN}	low-skilled natives	0.730	Labour Force Survey
Q_{HN}	high-skilled natives	0.270	Labour Force Survey
Q_{LI}	low-skilled immigrants	0.186	Labour Force Survey
Q_{HI}	high-skilled immigrants	0.157	Labour Force Survey
c_L	low-skilled vacancy cost	0.5	normalization
$\pi_{iN} = 1$	native labour productivity	1	normalization

Notes: The parameters in this table are taken from the sources listed in the final column, and are used in both calibrations of the model with and without discrimination, with the partial exception of β: in the scenario without discrimination, all $\beta_{ij} = \beta = 0.5$, whereas in the scenario with discrimination, $\beta_N = 0.5$ for natives, while the values for immigrants are chosen later to match moments in the data.

Table 2: Moments Matched in Calibration

Moment	Value	Source
average job durations, low-skilled (months)	29.4	Battisti et al. (2018)
average job durations, high-skilled (months)	52.6	Battisti et al. (2018)
native wage premium, low-skilled	1.085	Labour Force Survey
native wage premium, high-skilled	1.151	Labour Force Survey
skilled-unskilled wage ratio, native workers	1.449	Labour Force Survey
unemployment rate, low-skilled natives	0.065	Labour Force Survey
unemployment rate, low-skilled immigrants	0.065	Labour Force Survey
unemployment rate, high-skilled natives	0.034	Labour Force Survey
unemployment rate, high-skilled immigrants	0.054	Labour Force Survey
government expenditure as % of GDP	0.4065	IMF
real GDP per capita	1	normalization

Notes: The moments in this table are taken from the sources listed in the final column, and are used in both calibrations of the model with and without discrimination.

parameters given by $\{\xi, A, x, c_H, g, s_{ij}, \pi iI\}$ to calibrate, and the results of the calibration – the parameter values which cause the simulated model to match the moments in Table 2 – are presented in Table 3. Many of the parameter values are fairly close to the averages found by Battisti et al. (2018), though our model is somewhat different; unsurprisingly, job separation rates are higher for the low-skilled, and somewhat for high-skilled immigrants, to explain their higher unemployment rates. The values of the 10 variables in equilibrium (and in the immigration scenarios to come) can be found in appendix A.

Table 3: Calibrated Parameter Values with No Discrimination

Parameter	Description	Value
ξ	match efficiency parameter	0.818
A	total factor productivity	0.503
x	low-skill intermediate share	0.506
c_H	cost of high-skill vacancy	0.870
g	lump-sum transfer	0.295
s_{LN}	monthly job separation rate, low-skilled natives	0.0340
s_{LI}	monthly job separation rate, low-skilled immigrants	0.0341
s_{HN}	monthly job separation rate, high-skilled natives	0.0155
s_{HI}	monthly job separation rate, high-skilled immigrants	0.0252
π_{LI}	labour productivity, low-skilled immigrants	0.922
π_{HI}	labour productivity, high-skilled immigrants	0.874

Notes: The parameters in this table are the values that cause the simulated model to match the moments listed in Table 2 in the absence of discrimination.

Before proceeding to policy simulations, I can also present the results of the second calibration scenario, in which the wage gaps between natives and immigrants are explained by discrimination rather than productivity differences. In this scenario, natives and immigrants of a given skill type have the same productivity, so all productivity parameters π_{ij} are set to 1, but immigrants face discrimination in the form of lower levels of bargaining power: the bargaining power parameters are now β_N for all natives, and β_{LI} and β_{HI} for immigrants. In other words, in this scenario, the entire wage gap between immigrants and natives is explained by discrimination,[15] and once again I set $\beta_N = \varepsilon = 0.5$.[16] This specification for discrimination is a simple way of modelling the idea that immigrants are less able to bargain a fair wage than natives; however, a more traditional form of taste-based discrimination in

[15]Of course, this is not necessarily the maximum possible extent of discrimination: if immigrants are positively selected on unobservable characteristics such as determination or desire to work, immigrants' wages could actually be higher than native wages in the absence of discrimination and observable productivity differences.

[16]In additional results that are available upon request, I find that if β and β_N are smaller than 0.5 – so that even native workers are paid less than the efficient wage – the results in Table 5 are almost identical in the scenario without discrimination, whereas the simulation method gives slightly less positive effects of immigration in the scenario with discrimination. As a result, the effect of discrimination on the estimated fiscal impact of immigration is slightly smaller, but still very significant.

which employers receive disutility from hiring workers from a particular category (immigrants in this case) gives similar results, as demonstrated in section 4.5.

The parameter values that generate a match to the moments in Table 2 in the presence of discrimination are presented in Table 4. Most of the parameters are similar to their values from Table 3, with the exception of c_H, which is considerably larger to explain why firms don't create more high-skilled vacancies to take advantage of relatively low wages of high-skilled immigrants. The wage bargaining parameters for immigrants are quite low, as such values are required to explain the difference in wages with respect to natives in the absence of productivity differences. As before, the equilibrium values of the 10 variables can be found in appendix A.

Table 4: Calibrated Parameter Values with Discrimination

Parameter	Description	Value
ξ	match efficiency parameter	0.638
A	total factor productivity	0.494
x	low-skill intermediate share	0.502
c_H	cost of high-skill vacancy	2.177
g	lump-sum transfer	0.295
s_{LN}	monthly job separation rate, low-skilled natives	0.0340
s_{LI}	monthly job separation rate, low-skilled immigrants	0.0341
s_{HN}	monthly job separation rate, high-skilled natives	0.0155
s_{HI}	monthly job separation rate, high-skilled immigrants	0.0252
β_{LI}	bargaining power, low-skilled immigrants	0.171
β_{HI}	bargaining power, high-skilled immigrants	0.104

Notes: The parameters in this table are the values that cause the simulated model to match the moments listed in Table 2 in the presence of discrimination.

Having calibrated the parameters of my model, I can now perform policy simulations in which I consider various scenarios of increased immigration, and calculate the impact of that immigration on the fiscal situation of the government. The 3 scenarios that I consider are (i) a 10% increase in Q_{LI}, (ii) a 10% increase in Q_{HI}, and (iii) a 10% increase in both Q_{LI} and Q_{HI} at the same time. I calculate the fiscal impact of each increase in immigrant numbers in two ways: first, a naive method that simply counts the taxes paid and benefits received by the new immigrants, and then a simulation method which allows for changes to all endogenous variables by solving for the new equilibrium after the increase in immigration, but holding the value of t fixed. I report the effect per immigrant, dividing the total effect on the government budget by the change in the immigrant population.

Table 5 presents the results of these simulations for both calibration scenarios. In the absence of discrimination, we can see in panel A that the naive method gives quite similar results to the simulation method; the only difference between the two approaches is that the latter permits general equilibrium adjustments to wages and other variables, but this does not significantly impact the results in this version of the model. The results indicate that low-skilled immigrants impose a fiscal cost on the rest of the population: the naive method finds that they pay average taxes of 0.2488 and receive benefits of 0.3025, for a net cost of about 5.4% of average income, and the simulation method gives similar results. High-skilled immigrants, on the other hand, produce a fiscal surplus of around 4% of average income, due to higher tax payments (0.3439, versus benefits received of 0.3035). A simultaneous increase in the size of both immigrant populations produces a small fiscal burden of slightly over 1% of average income per immigrant.

Table 5: Fiscal Impact of Increased Immigration

Method	Scenario 1 10% Increase in Q_{LI}	Scenario 2 10% Increase in Q_{HI}	Scenario 3 10% Increase in Both
Panel A: No Discrimination			
naive	-0.0537	0.0404	-0.0106
simulation	-0.0553	0.0374	-0.0120
Panel B: Discrimination			
naive	-0.0537	0.0404	-0.0106
simulation	-0.0269	0.0648	0.0161

Notes: This table presents the estimated fiscal impact of each new immigrant in each scenario.

To put these results into units that can be more easily interpreted, the average income of my Labour Force Survey sample is $1042, for an annual income of $52084 for an individual who works for 50 weeks per year, so my results suggest that, in the absence of discrimination, the average immigrant costs taxpayers about $624 per year, while low-skilled immigrants' costs are larger at about $2880 and high-skilled immigrants produce fiscal gains of about $1946. In additional results that are available upon request, I also calculate the effect of immigration on the welfare of each type of worker (now allowing t to adjust to balance the government budget), and I find that low-skilled immigration provides welfare gains to each type of worker except for the already-present low-skilled immigrant population, whereas high-skilled immigration helps the low-skilled and harms the high-skilled, and an increase in both types helps all but high-skilled immigrants. In each case, the impact on average welfare is positive.

In the scenario in which immigrant wage gaps are explained by discrimination, panel B presents the results; unsurprisingly, the results with the naive method are roughly identical to those without discrimination: the two versions of the model are calibrated to the same moments, including wages and unemployment rates, and so the calculations of the taxes paid and benefits received by different groups are extremely similar. However, the results from the simulation method tell a different story: the fiscal cost of a low-skilled immigrant is less than half as large as it was without discrimination, while the fiscal benefit of high-skilled immigrants is significantly larger at 6.5% instead of 3.7%. A simultaneous increase in the size of both immigrant populations now generates a fiscal benefit rather than a cost. In dollars, a low-skilled immigrant's fiscal cost is now \$1403 instead of \$2880, and the fiscal gain from a high-skilled immigrant rises from \$1946 to \$3373, while the average immigrant now benefits taxpayers by about \$839 instead of costing \$624.

The mechanism for this fiscal effect of discrimination against immigrants is fairly simple: discrimination against immigrants leads to an increased surplus for firms, who have the chance of hiring immigrants and making profits due to their lower wages, which leads to greater vacancy creation as the higher surplus raises the value of a vacancy above zero. Because of the zero-profit condition, intermediate-goods firms will continue creating vacancies up to the point at which the value drops to zero, meaning that their profits are unaffected in equilibrium, and final-good firms also make zero profits due to constant returns to scale. So the effect takes place through tax payments and benefit receipt of workers: increased vacancy creation means a higher probability of being employed, which means that workers pay more in taxes and receive UI benefits less often.

Accounting for wage discrimination against immigrants thus has the potential to significantly alter our conclusions about the fiscal impact of immigration; in particular, the overall effect of immigration would be estimated to be negative if we ignore discrimination, and is positive when discrimination is modelled. The Labour Force Survey suggests that the immigrant population of working age was 4.865 million in Canada in 2019, which suggests that the total fiscal burden of immigration would be \$3.04 billion if we don't account for discrimination, whereas accounting for discrimination leads to the conclusion that immigration produces a fiscal surplus of \$4.08 billion per year. Wage discrimination against immigrants clearly has a negative impact on the immigrants themselves, but my results suggest that it may generate a net fiscal benefit of \$7.12 billion per year to governments in Canada if it explains the wage gaps between native and immigrant workers.

As in the case of the model without discrimination, I can also calculate the effect of immigration on welfare, and the results (available upon request) show the same direction of effects, though with a more positive overall effect of immigration on welfare.

4 Alternative Models and Robustness Checks

In this section, I will extend the analysis of the previous section to consider several alternative modelling specifications. First, I consider a scenario in which part of government spending is on public goods, the cost of which does not increase with population size; then I model different tax rates applying to different groups, to account for progressive taxation. Subsequently, I present two important modifications to the main model: one in which final-goods firms vary by total factor productivity A and pay taxes on their profits, and one in which capital is taxed in a closed-economy setting. Finally, I model discrimination as classic taste-based discrimination on the part of employers. All simulation results can be found in Table 6; in each case, I show that the effect of discrimination on the fiscal impact of immigration remains significant, though the quantitative findings vary in each case.

4.1 Public Goods

In the main model in section 2, I assumed that the government only pays for the UI benefit b_{ij} and the lump-sum transfer g. However, part of government spending is on things like national defence and foreign affairs, among other things, which one might consider to be public goods that would not depend on the size of the population. In that case, immigration can produce an added fiscal benefit by spreading the cost of those public goods over a larger population; or, put another way, the marginal fiscal cost of a new person is lower than the average cost. To model this, I assume that some fraction of g is not a lump-sum transfer, but rather a public good that each new immigrant receives without the government needing additional funding; and I use 10% as the public-good fraction of g, since it is in the middle of the plausible range of $\{4.3\%, 10\%, 15\%\}$ of total tax revenues considered by Javdani and Pendakur (2014).

The calibration of the model is unchanged, and the new simulations of the immigration experiments produce the results that can be found in Table 6. In the absence of discrimination, the results from the two methods once again agree, but on a fiscal impact of immigration that is much more positive than in section 3, because immigrants don't require as much additional government spending as was assumed there. In the presence of discrimination, the naive results are unchanged as before, but the simulation method results are even more positive: even low-skilled immigrants now produce a fiscal benefit. However, the overall effect of discrimination on the fiscal impact of immigration is very similar to the baseline model: the total fiscal surplus from immigration in Canada is estimated at \$7.26 billion without discrimination and \$14.38 billion with discrimination, so the effect of discrimination is estimated at \$7.12 billion, exactly as in section 3.

4.2 Different Tax Rates

In this subsection, I consider an alternative modification to the model: individuals of different types may face different income tax rates, due to their different income levels and the progressive nature of the income tax in Canada. Specifically, natives tend to receive higher incomes, and thus are likely to pay higher marginal tax rates – and when considering the effect of discrimination, which may shift income between individuals of different types, the marginal tax rate is the relevant value.

To account for this possibility, I apply the federal and provincial income taxes from 2019 to my Labour Force Survey data: I use weekly wages, multiplying by 50 on the assumption that people work for 50 weeks per year, and I apply the tax schedules accounting only for the personal exemption. I find that the marginal tax rate is lowest for low-skilled immi-

Table 6: Fiscal Impact of Increased Immigration (Robustness Analyses)

Method	Scenario 1 10% Increase in Q_{LI}	Scenario 2 10% Increase in Q_{HI}	Scenario 3 10% Increase in Both
Panel A: No Discrimination			
naive (public goods)	-0.0130	0.0810	0.0300
sim. (public goods)	-0.0146	0.0780	0.0287
naive (different taxes)	-0.0723	0.0459	-0.0182
sim. (different taxes)	-0.0685	0.0344	-0.0205
naive (Melitz)	-0.1003	-0.0266	-0.0666
sim. (Melitz)	-0.1170	-0.0511	-0.0865
naive (closed economy)	-0.0857	-0.0041	-0.0483
sim. (closed economy)	-0.0552	0.0372	-0.0120
Panel B: Discrimination			
naive (public goods)	-0.0130	0.0810	0.0300
sim. (public goods)	0.0137	0.1054	0.0568
naive (different taxes)	-0.0718	0.0457	-0.0180
sim. (different taxes)	-0.0404	0.0613	0.0072
naive (Melitz)	-0.1018	-0.0269	-0.0676
sim. (Melitz)	-0.0957	-0.0304	-0.0654
naive (closed economy)	-0.0866	-0.0051	-0.0493
sim. (closed economy)	-0.0267	0.0679	0.0177
naive (taste-based)	-0.0693	0.0187	-0.0291
sim. (taste-based)	-0.0402	0.0741	0.0132

Notes: This table presents the estimated fiscal impact of each new immigrant in each scenario.

grants, while low-skilled natives pay a rate that is 2.3% higher on average, and high-skilled immigrants and natives pay rates that are 4.3% and 6.9% higher respectively. I assume, for simplicity, that the UI tax rate is constant across types and equal to the lowest rate. I then recalibrate the model with and without discrimination, with the results found in Tables 7 and 8; unsurprisingly, the parameter values change very little.

I then evaluate the fiscal impact of immigration as before, with results that can be found in Table 6. Given that the modification to the model involves applying lower tax rates to low-skilled immigrants, it is not surprising that the fiscal impact of low-skilled immigration is more negative now, while the impact of high-skilled immigration is roughly the same as before. But the impact of discrimination remains very similar to the baseline model: accounting for discrimination significantly lowers the fiscal cost of low-skilled immigrants,

Table 7: Calibrated Parameter Values with No Discrimination with Different Tax Rates

Parameter	Description	Value
ξ	match efficiency parameter	0.813
A	total factor productivity	0.502
x	low-skill intermediate share	0.506
c_H	cost of high-skill vacancy	0.766
g	lump-sum transfer	0.294
s_{LN}	monthly job separation rate, low-skilled natives	0.0340
s_{LI}	monthly job separation rate, low-skilled immigrants	0.0340
s_{HN}	monthly job separation rate, high-skilled natives	0.0155
s_{HI}	monthly job separation rate, high-skilled immigrants	0.0251
π_{LI}	labour productivity, low-skilled immigrants	0.923
π_{HI}	labour productivity, high-skilled immigrants	0.875

Notes: The parameters in this table are the values that cause the simulated model to match the moments listed in Table 2 in the absence of discrimination and allowing for different marginal tax rates for each type.

Table 8: Calibrated Parameter Values with Discrimination with Different Tax Rates

Parameter	Description	Value
ξ	match efficiency parameter	0.638
A	total factor productivity	0.494
x	low-skill intermediate share	0.502
c_H	cost of high-skill vacancy	2.108
g	lump-sum transfer	0.295
s_{LN}	monthly job separation rate, low-skilled natives	0.0340
s_{LI}	monthly job separation rate, low-skilled immigrants	0.0340
s_{HN}	monthly job separation rate, high-skilled natives	0.0155
s_{HI}	monthly job separation rate, high-skilled immigrants	0.0252
β_{LI}	bargaining power, low-skilled immigrants	0.180
β_{HI}	bargaining power, high-skilled immigrants	0.099

Notes: The parameters in this table are the values that cause the simulated model to match the moments listed in Table 2 in the presence of discrimination and allowing for different marginal tax rates for each type.

raises the fiscal benefit of high-skilled immigrants, and reverses the sign of the average effect of immigration, with the total fiscal impact going from a cost of \$5.21 billion to a benefit of \$1.81 billion, or an impact of discrimination of \$7.02 billion.

4.3 Simplified Melitz Model

The model used so far allowed for indirect fiscal effects of immigration through the employment of other workers, as discussed in section 3: discrimination against immigrants generates a surplus that encourages vacancy creation, producing fiscal gains from higher income tax payments and lower UI spending. The assumptions of the model meant that this was the only possible channel for a fiscal impact of discrimination: intermediate-good firms face a zero-profit condition, and final-good firms make zero profits due to constant returns to scale.

In the current subsection, I will modify the model to allow for profits for firms, and thus for corporate taxation. Specifically, while intermediate-goods firms are unaltered, I assume that the productivity A of final-goods firms comes from a distribution $G(A)$; while I do not model firm entry, this is essentially a simplified form of a model in the spirit of Melitz (2003) in which entrepreneurs enter the market and draw a random productivity parameter. As in such models, I assume that only firms with positive profits will operate, which will be all those firms with A above an endogenous zero-profit cutoff value $\bar{A}$, accounting for a fixed cost of production f. However, to avoid degenerate results for firm size and profits, I have to model decreasing returns to scale in production, and I also abstract from capital for simplicity; rather than receiving the returns from capital, the native workers all receive an equal share of the firms' profits after they are taxed at rate τ. In the calibration, I model τ as being in a fixed proportional relationship with t: in 2019, OECD.Stat (2023b) found that the average corporate tax rate in Canada was 26.62%, whereas the marginal income tax rate (the "total tax wedge"), averaged across four income levels, was 38.375% in OECD.Stat (2023a), so I model $\tau = \frac{0.2662}{0.38375} t$.

In this version of the model, the final output for a firm with a given A is now given by:

$$Y = A \left[x Y_L^{\rho} + (1-x) Y_H^{\rho} \right]^{\frac{\alpha}{\rho}}, \alpha \in (0,1), \rho \in (0,1)$$

where $\alpha < 1$ generates decreasing returns to scale. Aside from replacing rk_{ij} with a share of the profits in the workers' Bellman equations, nothing else in the basic structure of the model changes, but the market-clearing conditions in intermediate goods are a bit different: a profit-maximizing firm with productivity A will demand Y_L and Y_H according to $\frac{\partial Y}{\partial Y_i} = p_i$, which means:

$$A \alpha x Y_L^{\rho - 1} \left[x Y_L^{\rho} + (1-x) Y_H^{\rho} \right]^{\frac{\alpha - \rho}{\rho}} = p_L$$
$$A \alpha (1-x) Y_H^{\rho - 1} \left[x Y_L^{\rho} + (1-x) Y_H^{\rho} \right]^{\frac{\alpha - \rho}{\rho}} = p_H.$$

This means that the ratio of Y_H to Y_L is independent of A:

$$\frac{Y_H}{Y_L} = \left(\frac{(1-x)p_L}{xp_H}\right)^{\frac{1}{1-\rho}}$$

but firms with high A will be larger:

$$Y_L = \left(\frac{A\alpha x}{p_L}\right)^{\frac{1}{1-\rho}} \left[x + (1-x)\left(\frac{(1-x)p_L}{xp_H}\right)^{\frac{\rho}{1-\rho}}\right]^{\frac{\alpha-\rho}{\rho(1-\alpha)}}$$

$$Y_H = \left(\frac{A\alpha(1-x)}{p_H}\right)^{\frac{1}{1-\rho}} \left[x + (1-x)\left(\frac{(1-x)p_L}{xp_H}\right)^{\frac{\rho}{1-\rho}}\right]^{\frac{\alpha-\rho}{\rho(1-\alpha)}}.$$

Therefore, equations (2) and (3) are replaced by equations that define the prices p_L and p_H such that the integrals of values of Y_L and Y_H demanded by firms that produce are equal to the amounts of Y_L and Y_H produced by intermediate firms.

For the calibration, I no longer need to choose a value of δ, since there is no capital in the model, and r is now just the discount rate and still equal to 0.004. α is now the decreasing-returns-to-scale parameter rather than the capital share, and I arbitrarily set it to 0.75; otherwise, there is no change to the set of parameters from Table 1. Meanwhile, I still have the same set of 11 parameters to fit based on the moments, except that I need to replace A with parameters of the distribution $G(A)$: I assume a Pareto distribution with a minimum value of x_m (and a maximum value of 10) and a shape parameter η, so that $G(A) = \frac{\eta x_m^\eta}{A^{\eta+1}}$. I also need to choose a value for f, the fixed cost of production, and so in the absence of discrimination the set of 13 parameters to calibrate is $\{\xi, x_m, f, \eta, x, c_H, g, s_{ij}, \pi i I\}$, whereas π_{iI} are replaced by β_{iI} in the presence of discrimination.

The 11 moments previously used in the calibration are used again here, along with 2 new moments: the percentage of workers in firms with at least 100 employees (where I treat workers who produce the intermediate goods used by a final firm as being employees of that final goods firm), which was 61% in 2019 according to Statistics Canada (2022); and the 10-year survival rate of new firms (which I model as the percentage of entrepreneurs in the distribution of A that actually produce), which was 45.3% during the period of 2001-2017 according to Innovation, Science and Economic Development Canada (2020).

The calibration results can be found in Tables 9 and 10, where we can see that the parameters that existed in the baseline model are not dramatically different here.[17] The fiscal impact of immigration can be found in Table 6, and the overall effect of immigration on the government's budget balance is much more negative now, because income taxes are lower and immigrants are assumed to have no share in the profits, so their fiscal contribution is smaller. There is also a larger difference between the naive and simulation methods, with the simulation method being even more negative in the absence of discrimination. However, the effect of discrimination remains similar when we compare the results from the simulation methods in the two cases:[18] in each case, accounting for discrimination makes the effect of immigration significantly less negative. At an economy-wide level, the fiscal cost of immigration is \$21.93 billion in the absence of discrimination and \$16.57 billion in its presence, for an effect of discrimination of \$5.35 billion.

Table 9: Calibrated Parameter Values with No Discrimination in Melitz Model

Parameter	Description	Value
ξ	match efficiency parameter	0.701
x_m	minimum value of A	0.514
η	shape parameter of $G(A)$	2.281
f	fixed cost of production	0.0062
x	low-skill intermediate share	0.506
c_H	cost of high-skill vacancy	0.972
g	lump-sum transfer	0.291
s_{LN}	monthly job separation rate, low-skilled natives	0.0340
s_{LI}	monthly job separation rate, low-skilled immigrants	0.0341
s_{HN}	monthly job separation rate, high-skilled natives	0.0155
s_{HI}	monthly job separation rate, high-skilled immigrants	0.0252
π_{LI}	labour productivity, low-skilled immigrants	0.922
π_{HI}	labour productivity, high-skilled immigrants	0.875

Notes: The parameters in this table are the values that cause the simulated model to match the moments listed in Table 2, as well as the percentage of workers in firms with at least 100 employees and the 10-year survival rate of new firms, in the absence of discrimination in the Melitz-type model.

[17]Unlike the other models, it was not possible to perfectly match the moments in these calibrations, due to the discretization of the distribution of A and the greater complexity of the model; but minimizing the sum of squared deviations between moments in the data and the simulation, the fit remained very close, corresponding to an average absolute deviation of 0.0015 or less.

[18]The naive method does not properly account for discrimination, so comparing it to the simulation method in the presence of discrimination is not a valid comparison.

Table 10: Calibrated Parameter Values with Discrimination in Melitz Model

Parameter	Description	Value
ξ	match efficiency parameter	0.553
x_m	minimum value of A	0.515
η	shape parameter of $G(A)$	2.316
f	fixed cost of production	0.0065
x	low-skill intermediate share	0.502
c_H	cost of high-skill vacancy	1.976
g	lump-sum transfer	0.292
s_{LN}	monthly job separation rate, low-skilled natives	0.0341
s_{LI}	monthly job separation rate, low-skilled immigrants	0.0338
s_{HN}	monthly job separation rate, high-skilled natives	0.0155
s_{HI}	monthly job separation rate, high-skilled immigrants	0.0252
β_{LI}	bargaining power, low-skilled immigrants	0.197
β_{HI}	bargaining power, high-skilled immigrants	0.127

Notes: The parameters in this table are the values that cause the simulated model to match the moments listed in Table 2, as well as the percentage of workers in firms with at least 100 employees and the 10-year survival rate of new firms, in the presence of discrimination in the Melitz-type model.

4.4 Closed-Economy Model

I next return to the original model with its single value of A and constant-returns-to-scale production including capital, but I now assume a closed economy in which capital is supplied by natives and demanded by firms according to $r + \delta = \alpha A K^{\alpha-1} Z^{1-\alpha}$. If natives face a discount rate of r, then in a dynamic model they will supply capital through their savings up to the point at which its return is r; as a result, r will remain fixed at its initial value of 0.004, but now domestically-held capital $\bar{K}$ adjusts one-for-one with K. I model the steady-state, so I do not need to account for the gradual accumulation of capital over time.

As a result, all that changes relative to the baseline model is the native utility function, as the amount of capital held in steady-state varies rather than remaining constant, and I assume that that capital is now taxed at the same rate that firm profits were in the Melitz-type model in section 4.3. I calibrate the model to the same moments from Table 2, using the values from Table 1 for the other parameters, and the results of the calibration can be found in Tables 11 and 12; the parameter values are very similar to those from the baseline model.

The immigration scenario simulations take the same form as before, and the results can

Table 11: Calibrated Parameter Values with No Discrimination in Closed-Economy Model

Parameter	Description	Value
ξ	match efficiency parameter	0.776
A	total factor productivity	0.502
x	low-skill intermediate share	0.506
c_H	cost of high-skill vacancy	0.870
g	lump-sum transfer	0.294
s_{LN}	monthly job separation rate, low-skilled natives	0.0340
s_{LI}	monthly job separation rate, low-skilled immigrants	0.0341
s_{HN}	monthly job separation rate, high-skilled natives	0.0155
s_{HI}	monthly job separation rate, high-skilled immigrants	0.0252
π_{LI}	labour productivity, low-skilled immigrants	0.922
π_{HI}	labour productivity, high-skilled immigrants	0.875

Notes: The parameters in this table are the values that cause the simulated model to match the moments listed in Table 2 in the absence of discrimination in the closed-economy model.

Table 12: Calibrated Parameter Values with Discrimination in Closed-Economy Model

Parameter	Description	Value
ξ	match efficiency parameter	0.617
A	total factor productivity	0.494
x	low-skill intermediate share	0.502
c_H	cost of high-skill vacancy	2.089
g	lump-sum transfer	0.294
s_{LN}	monthly job separation rate, low-skilled natives	0.0340
s_{LI}	monthly job separation rate, low-skilled immigrants	0.0342
s_{HN}	monthly job separation rate, high-skilled natives	0.0155
s_{HI}	monthly job separation rate, high-skilled immigrants	0.0251
β_{LI}	bargaining power, low-skilled immigrants	0.184
β_{HI}	bargaining power, high-skilled immigrants	0.114

Notes: The parameters in this table are the values that cause the simulated model to match the moments listed in Table 2 in the presence of discrimination in the closed-economy model.

be found in Table 6. As in the Melitz model, the fiscal impact tends to be more negative here, and for a similar reason: immigrants are assumed to own no capital. However, in the no-discrimination case, the fiscal impact is more positive in the simulation method, in which immigrants do implicitly contribute to capital tax revenues, and indeed those results are very similar to those from the baseline model. In the case with discrimination, the results of the simulation method are more positive still, again much like in the baseline model, and at an economy-wide level discrimination raises the overall fiscal impact of immigration from a cost of \$3.04 billion to a benefit of \$4.48 billion. The results of this model are thus very similar to those from the baseline model.

4.5 Alternative Form of Discrimination

Finally, I consider one additional model to test the robustness of my results: I model discrimination as classic taste-based discrimination on the part of employers, rather than in the form of a lower β_{ij} parameter for immigrants. In this setting, of course, the results of the model without discrimination are unchanged, so I only need to consider the second calibration scenario with discrimination

The main change to the baseline model is that I now introduce a new parameter d_{ij} representing the disutility to the employer (an intermediate-good firm) from hiring a worker of type $\{i, j\}$; I normalize $d_{iN} = 0$ and interpret d_{iI} as the discrimination against immigrants of skill level i. Since it is no longer clear that firms will benefit from hiring immigrants – since they pay a disutility cost from doing so – profits may increase in equilibrium and there may not be an increase in vacancy creation when immigrant numbers increase, and so I need to allow the income of firms to be subject to taxation, which I suppose takes place at the same rate as worker income. As a result, while the Bellman equation for the value of an open vacancy is unchanged, the Bellman equation for the value of a filled job is now given by:

$$rJ_{ij}^F = (1-t)(\pi_{ij}p_i - w_{ij}) - d_{ij} - s_{ij}\left[J_{ij}^F - J_i^V\right]$$

The free-entry condition still means that $J_i^V = 0$ in equilibrium, but now that no longer means that average profits are zero, because of the disutility term d_{ij} which is not part of the profits of the firm, but rather a disutility to the firm's owner.

The rest of the model is unchanged from the baseline setting, except that the job-creation condition changes in parallel with the value function for a filled job, and government revenue is now equal to $t\sum_i\sum_j \pi_{ij}p_iE_{ij}$ instead of $t\sum_i\sum_j w_{ij}E_{ij}$. In the calibration, I set all $\beta_{ij} = \beta = 0.5$, while all the productivity parameters π_{ij} are set to 1 as in the usual discrimination setting; the d_i parameters are now set to explain the immigrant wage gaps. The results of the calibration can be found in Table 13, where the main differences from the baseline model are a somewhat higher value of ξ and a significantly lower value of c_H.

Table 13: Calibrated Parameter Values with Taste-Based Discrimination

Parameter	Description	Value
ξ	match efficiency parameter	0.830
A	total factor productivity	0.494
x	low-skill intermediate share	0.504
c_H	cost of high-skill vacancy	0.865
g	lump-sum transfer	0.295
s_{LN}	monthly job separation rate, low-skilled natives	0.0340
s_{LI}	monthly job separation rate, low-skilled immigrants	0.0341
s_{HN}	monthly job separation rate, high-skilled natives	0.0154
s_{HI}	monthly job separation rate, high-skilled immigrants	0.0253
d_L	discrimination term, low-skilled immigrants	0.0257
d_H	discrimination term, high-skilled immigrants	0.0565

Notes: The parameters in this table are the values that cause the simulated model to match the moments listed in Table 2 in the presence of taste-based discrimination.

The immigration scenario simulations can be found at the bottom of Table 6, and are generally similar to those from Table 5: the fiscal impact of low-skilled immigrants is more negative, and the impact of high-skilled immigrants is more positive, but the average effect is quite similar. The aggregate fiscal benefit from immigration is now estimated at \$3.34 billion, or about \$6.38 billion more than in the case without discrimination. The mechanism of the effect is different from the baseline model, relying largely on increased revenues from employers (whose profits increase with immigration while they experience greater disutility from hiring immigrants), but the overall impact is very similar.

5 Conclusion

This paper has addressed the question of wage discrimination against immigrants, and how it might affect our conclusions about the fiscal impact of immigration. I have demonstrated that, in the presence of such discrimination, the fiscal benefit of immigration to a destination country could be much more positive than existing studies have found, because when immigrants are paid less than their marginal product, someone else is receiving that income and paying taxes on it. I have presented a search-and-matching model in the style of Battisti et al. (2018), which I calibrate to data from Canada, and I show that the impact of discrimination on the fiscal impact of immigration can be significantly positive, perhaps on the order of $7 billion per year. These results are robust to a variety of modifications and robustness checks.

This analysis is based on a simple model that abstracts from differences in fiscal impact over the life-cycle, as well as certain complexities of the tax and transfer system, among other things; a completely convincing estimate of the true fiscal impact of immigration in Canada would require a more complete model. But the current analysis has shown that discrimination could have a significant quantitative impact on the conclusion of the analysis of any realistic model, and gives reason to believe that the fiscal impact of immigration on destination countries may be more positive than had previously been believed.

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A Equilibrium Values of Variables

In Table 14 below, I present the values of the 10 model variables in equilibrium, in the two baseline scenarios (with and without discrimination) and in each of the increased-immigration scenarios. The values of t do not change across scenarios (for a given calibration) by construction, because the immigration scenarios involve calculating the effect of immigration on the government budget balance holding t fixed.

Table 14: Equilibrium Values of Variables

	No Discrimination				Discrimination			
Variable	Baseline	Scenario 1	Scenario 2	Scenario 3	Baseline	Scenario 1	Scenario 2	Scenario 3
K	45.875	46.395	46.482	47.005	45.875	46.455	46.567	47.151
p_L	0.627	0.624	0.631	0.628	0.609	0.606	0.614	0.611
p_H	0.900	0.905	0.891	0.896	0.875	0.880	0.865	0.871
t	0.471	0.471	0.471	0.471	0.485	0.485	0.485	0.485
θ_L	0.358	0.356	0.361	0.359	0.589	0.607	0.594	0.612
θ_H	0.291	0.292	0.287	0.288	0.477	0.481	0.491	0.494
w_{LN}	0.613	0.610	0.617	0.614	0.596	0.593	0.600	0.598
w_{LI}	0.565	0.562	0.568	0.566	0.549	0.547	0.553	0.552
w_{HN}	0.888	0.893	0.879	0.884	0.863	0.869	0.854	0.859
w_{HI}	0.771	0.776	0.764	0.768	0.750	0.755	0.743	0.748

Notes: The values in this table are the equilibrium values of the 10 variables in each possible scenario; t does not change between the baseline and immigration scenarios by construction, since the immigration scenario simulations estimate the fiscal impact holding t constant.