Online Appendix: The Indirect Fiscal Benefits of Low-Skilled Immigration

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Contents

A Extensions Appendix

In this Appendix, we evaluate the indirect fiscal effects using several alternative model specifications. Appendices A.1 through A.3 consider alternative production functions utilized in the immigration literature. As we focus on differences in production functions, we consider the case with exogenous resident labor supply. Appendix A.4 considers the case when workers can endogenously choose their supply of communication- and manual-intensive tasks. Appendix A.5 considers the case with decreasing returns to scale. For the sake of readability, we have relegated most proofs to Appendix B.

A.1 Imperfectly Substitutable Education and Experience

In this Appendix, we evaluate the indirect fiscal effects using the model from Borjas (2003). Production takes the form of a two-level nested CES function.[1] The top level of the production function combines labor supplies of four education groups: high school dropouts, high school graduates, some college, and college graduates. Letting e index education groups, output Y is given by

$$Y = \left(\sum_e \theta_e \mathscr{L}_e^{\frac{\sigma_E - 1}{\sigma_E}} \right)^{\frac{\sigma_E}{\sigma_E - 1}},$$

where $\mathscr{L}_e$ is the labor aggregate of labor of education group e, σ_E is the elasticity of substitution between education groups, and θ_e is a factor-intensity parameter. Due to this finer stratification of skill groups, an increase in the number of high school dropouts, for example, affects the relative wages of dropouts to high school graduates, in addition to the relative wages of high-skilled versus low-skilled workers.

In turn, each education-specific labor aggregate is itself an aggregator of experience levels within a given education group. As in Borjas (2003), we divide workers into 8 experience

[1] We abstract away from physical capital (or alternatively assume that capital supply is perfectly elastic) in Sections A.1 through A.5. We discuss the role of capital in Section IV.B.

levels consisting of 5-year experience intervals, starting with 1-5 years experience until 36-40 years of experience. Letting a index these experience levels, we can write

$$\mathscr{L}_e = \left(\sum_a \theta_{ae} \mathscr{L}_{ae}^{\frac{\sigma_X - 1}{\sigma_X}} \right)^{\frac{\sigma_X}{\sigma_X - 1}}$$

where $\mathscr{L}_{ae}$ gives the labor supply of a given experience-education group and is given by $\mathscr{L}_{ae} = \int_{\mathcal{I}_{ae}} L_i \omega_i di$, and where $\mathcal{I}_{ae}$ is the set of types within a given experience-education group. The parameter σ_X is equal to the elasticity of substitution of experience levels within the same education group and θ_{ae} is a factor-intensity parameter. Therefore, within the same education level, workers of different experience levels are imperfectly substitutable in production. Immigrant inflows therefore change the relative wages of different experience groups within the same education level.

As we show in Appendix B.2, if labor supply is inelastic, the indirect fiscal benefit of an immigrant of type i in experience group a and education group e is given by

$$d\mathscr{R}_{ind}^{\text{Borjas}}(a, e, i) = y_i \left[\underbrace{\left(\bar{T}'_{a' \neq a, e} - \bar{T}'_{ae} \right) |\tilde{\gamma}_{ae,own}|}_{\text{Experience Effect}} + \underbrace{\left(\bar{T}'_{e' \neq e} - \bar{T}'_{e} \right) |\gamma_{e,own}|}_{\text{Education Effect}} \right], \qquad (1)$$

where $\tilde{\gamma}_{ae,own}$ is the own-wage elasticity of experience group a and education group e, holding the overall ratio of education groups constant, $\bar{T}'_{a' \neq a, e}$ is the income weighted average tax rate of all other experience groups in education group e, $\bar{T}'_{e' \neq e}$ is the income weighted tax rate of all other education groups, $\gamma_{e,own}$ is the own-wage elasticity of education group e, where the wage of an education group is defined as $\frac{\partial Y}{\partial \mathscr{L}_e}$. Therefore, we can decompose the indirect fiscal effect into two separate effects. The first effect, which we label the "experience effect" comes from the fact that an immigrant inflow of experience group a increases the supply of experience group a relative to all other experience groups within education group e. The "education effect" captures that the immigrant inflow also increases the ratio of labor from education group e relative to all other education groups.

Results Following Borjas (2003), we set $\sigma_X = 3.5$ and set $\sigma_E = 1.3$. The indirect fiscal effect associated with a worker in each of the experience groups for both high school dropouts and high school graduates are given in Table 1. The first column gives the indirect fiscal effect associated with high school dropouts and the second column gives the effect associated with high school graduates. Across all experience groups, the average high school dropout is associated with a \$1,446 indirect fiscal benefit and the high school graduate with a \$1,095 indirect fiscal benefit. The average low-skilled immigrant across education groups leads to a fiscal benefit of \$1,305.

Experience Group	HS Dropout	HS Graduate
1-5	1087	1042
6-10	1123	1184
11-15	919	1201
16-20	972	1276
21-25	952	1367
26-30	1073	1553
31-35	1224	1685
36-40	1370	1750
Education Average	1095	1446
Overall Average	1305	

Table 1: Indirect Fiscal Effects using model from Borjas (2003). Each entry gives the indirect fiscal effect associated with a worker in each narrow education and experience group. The "Education Average" gives the weighted average indirect fiscal effect within each education group and the "Overall Average" is the weighted average across all groups.

To better understand why the indirect fiscal effect here is larger than in the previous sections, we now perform several alternative calculations. First, to understand the role of the "experience effect", we calculate the indirect fiscal benefit when experience groups are perfect substitutes within education, by setting $\frac{1}{\sigma_X} = 0$. This has only a slight effect on the indirect fiscal effect: the average indirect fiscal effect increases from \$1,305 in the baseline case to \$1,326 in the case when experience groups are perfect substitutes within education group. Next, to understand the role of the elasticity of substitution parameter, we calculate the indirect fiscal benefit under the assumption that the elasticity of substitution is equal to 2 by setting $\sigma_E = 2$. This reduces the average fiscal benefit to \$862, similar in magnitude to the effect we found in Section I. Therefore, despite the key differences between the production function here and that presented in Section I, both production functions lead to similar estimates of the indirect fiscal effect of low-skilled immigration, once we use comparable parameter estimates.

A.2 Domestic-Born and Foreign-Born Complementarity

Ottaviano and Peri (2012) consider a model in which domestic- and foreign-born workers are imperfect substitutes within education and experience groups. Ultimately the production function takes the form of a four-level nested CES labor aggregate function, with a top nest corresponding to skill groups (high skill and low skill), a second nest corresponding with education groups within these two skill groups (high school graduate and dropout within low-skilled workers, some college and college graduate within high-skilled), a third nest corresponding with 8 experience groups within each education group, and a final nest aggregating domestic- and foreign-born workers.[2]

[2]We focus on "Model B" from Ottaviano and Peri (2012), which the authors show is the most consistent with the data. We use their estimates from column 7 of Table 6.

Specifically, the top nest of the production functions combines a high-skilled labor aggregate $\mathscr{L}_s$ and a low-skilled labor aggregate $\mathscr{L}_u$ using the following production function

$$Y = \left(\theta_s \mathscr{L}_s^{\frac{\sigma-1}{\sigma}} + \theta_u \mathscr{L}_u^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}.$$

$\mathscr{L}_s$ aggregates some college and college graduate labor while $\mathscr{L}_u$ aggregates high school dropout and high school graduate labor. Let e_1, e_2, e_3, and e_4 denote high school dropout, high school graduate, some college and college graduate labor, respectively. Then we can write

$$\mathscr{L}_s = \left(\theta_{e_3} \mathscr{L}_{e_3}^{\frac{\sigma_S-1}{\sigma_S}} + \theta_{e_4} \mathscr{L}_{e_4}^{\frac{\sigma_S-1}{\sigma_S}}\right)^{\frac{\sigma_S}{\sigma_S-1}}$$

and

$$\mathscr{L}_u = \left(\theta_{e_1} \mathscr{L}_{e_1}^{\frac{\sigma_U-1}{\sigma_U}} + \theta_{e_2} \mathscr{L}_{e_2}^{\frac{\sigma_U-1}{\sigma_U}}\right)^{\frac{\sigma_U}{\sigma_U-1}}.$$

Each of these education aggregates combine labor from 8 experience groups, indexed by a, as

$$\mathscr{L}_e = \left(\sum_a \theta_{ae} \mathscr{L}_{ae}^{\frac{\sigma_{EXP}-1}{\sigma_{EXP}}}\right)^{\frac{\sigma_{EXP}}{\sigma_{EXP}-1}}.$$

for $e \in \{e_1, e_2, e_3, e_4\}$. Finally, each of the education, experience labor aggregates, $\mathscr{L}_{ae}$ combines nativity groups (domestic-born and foreign-born) labor using

$$\mathscr{L}_{ae} = \left(\theta_{aef} \mathscr{L}_{aef}^{\frac{\sigma_{N,U}-1}{\sigma_{N,U}}} + \theta_{aed} \mathscr{L}_{aed}^{\frac{\sigma_{N,U}-1}{\sigma_{N,U}}}\right)^{\frac{\sigma_{N,U}}{\sigma_{N,U}-1}}$$

and low-skilled labor ($e \in \{e_1, e_2\}$) and

$$\mathscr{L}_{ae} = \left(\theta_{aef} \mathscr{L}_{aef}^{\frac{\sigma_{N,S}-1}{\sigma_{N,S}}} + \theta_{aed} \mathscr{L}_{aed}^{\frac{\sigma_{N,S}-1}{\sigma_{N,S}}}\right)^{\frac{\sigma_{N,S}}{\sigma_{N,S}-1}}$$

for high-skilled labor ($e \in \{e_3, e_4\}$). $\mathscr{L}_{aen}$ gives the labor supply of a given education-experience-nativity group ($n \in \{d, f\}$) and is given by $\mathscr{L}_{aen} = \int_{\mathcal{I}_{aen}} L_i \omega_i di$, and where $\mathcal{I}_{aen}$ is the set of types i within a given education-experience-nativity group.

The indirect fiscal benefit of an immigrant of type i in experience group a' and education group e' is given by

$$d\mathscr{R}_{ind}(a', e', i) = \frac{y_i}{\bar{y}_{a'e'f}} \sum_a \sum_e \sum_n \bar{T}'_{aen} \frac{N_{aen}}{N_{a'e'f}} \bar{y}_{aen} \gamma_{aen,a'e'f}$$

where $\bar{y}_{aen}$ is the average income of workers of experience group a, education group e, and nativity n, $\bar{T}'_{aen}$ is the income-weighted average marginal tax of workers in this group, and

Experience Group	HS Dropout	HS Graduate
1-5	627	625
6-10	702	697
11-15	584	686
16-20	575	752
21-25	555	766
26-30	637	875
31-35	738	972
36-40	790	1020
Education Average	651	831
Overall Average	759	

Table 2: Indirect Fiscal Effects using model from Ottaviano and Peri (2012). Each entry gives the indirect fiscal effect associated with a worker in each narrow education and experience group. The "Education Average" gives the weighted average indirect fiscal effect within each education group and the "Overall Average" is the weighted average across all groups. We focus on "Model B" from Ottaviano and Peri (2012), which the authors show is the most consistent with the data. We use estimates from column 7 of Table 6, which gives an elasticity of substitution between skill levels of 1.85.

$\gamma_{aen,a'e'f} = \frac{\partial w_{aen}}{\partial L_{a'e'f}} \frac{L_{a'e'f}}{w_{aen}}$ is the elasticity of wages of workers of experience group a and education e and nativity n with respect to labor supply of foreign-born workers of experience group a' and education e'. We refrain from further simplifying the formula in this case.

Results We quantify the model using parameters estimates from Ottaviano and Peri (2012). Table 2 gives the indirect fiscal effect associated with an immigrant with average income in each experience group for both high school dropouts and high school graduates. The average high school dropout immigrant leads to an indirect fiscal benefit of \$651 while the average high school graduate immigrant leads to an indirect fiscal benefit of \$831. Taken together, this implies the average low-skilled immigrant leads to an average indirect fiscal effect of \$759.

To better understand the implications of the nesting structure on the indirect fiscal effects, we sequentially recalculate the indirect fiscal effects under the assumptions that labor supplies in each of the CES nests are perfectly substitutable. First, we assume domestic- and foreign-born workers within experience-education-skill groups are perfect substitutes. This leads to a fiscal benefit of \$788. Next, we additionally assume workers of difference experience groups within the same education level are perfect substitutes. This implies a fiscal benefit of \$798. Finally, we remove imperfect substitutability between narrow education groups. This model now shares the same structure as the model presented in Section I, as all workers within the two skill groups are perfectly substitutable. In this case the indirect fiscal benefit is \$797.

A.3 Skills Defined by Position in Wage Distribution

In this Appendix, we calculate the indirect fiscal effects using the model presented in Dustmann et al. (2013), in which a worker's skill is given by her position in the wage distribution. Let total output be given by the CES aggregator

$$Y = \left(\sum_j \theta_j \mathscr{L}_j^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}},$$

where $\mathscr{L}_j$ gives the labor supply of a given skill group, and skill groups are defined by position in the wage distribution (for example percentiles or deciles). Formally, $\mathscr{L}_j$ is given by $\mathscr{L}_j = \int_{\mathcal{I}_j} L_i \omega_i di$, where $\mathcal{I}_j$ is the set of workers types within skill group j. The parameter σ gives the elasticity of substitution between skill groups and each θ_j parameter measures the factor intensity of skill type j. As we show in Appendix B.3, the indirect fiscal benefit associated with an immigrant of type i in skill group j is given by

$$d\mathscr{R}_{ind}^{\text{DFP}}(j,i) = y_i \times |\gamma_{j,own}| \times \left(\bar{T}'_{k \neq j} - \bar{T}_j \right),$$

where y_i is the income level of workers of type i, $\bar{T}'_{k \neq j}$ is the income weighted average marginal tax rate of all other groups $k \neq j$, and $\bar{T}'_j$ is the income weighted average marginal tax rate income group j. Given the CES production function, the own-wage elasticity has the simple expression $\frac{1-\kappa_j}{\sigma}$, where κ_j is the income share of workers in skill group j.

Results We define skill groups using deciles of the wage distribution.[3] The results are not sensitive to the grouping of j. We use our central value for the elasticity of substitution between skill groups and set $\sigma = 2$.[4] Table 3 gives the indirect fiscal effect associated with the average immigrant of each decile of the wage distribution. The indirect fiscal effect is increasing in wage decile up until the 5th decile, reflecting the fact that income is increasing in the wage decile. Starting with the 6th decile, the indirect fiscal benefit decreases as the average marginal tax rates increase relative to the average marginal tax rates of other groups. The weighted average indirect fiscal effect is \$775, similar to the fiscal effect found in Section I when we set $\sigma = 2$.

[3] We calculate wages as total wage and self-employment income divided by weeks worked and average hours worked. In the 2017 ACS, weeks worked are intervalled, we use the midpoint of the interval.

[4] Using data from the UK, Dustmann, Frattini, and Preston (2013) find that an elasticity of substitution between skill group of 0.6 fits their reduced form evidence best. Using this value as the elasticity of substitution yields and an average indirect fiscal benefit of low-skilled immigrants of \$2,580. We believe the value of $\sigma = 2$ to be more appropriate for the US context.

Decile of Wage Distribution	Indirect Fiscal Effect	% of LS Immigrants
1	724	20
2	764	22
3	943	17
4	1263	10
5	1542	9
6	1612	7
7	1475	5
8	859	4
9	-141	3
10	-9572	2
Overall Average	775	

Table 3: Indirect Fiscal Effects using model from Dustmann, Frattini, and Preston (2013). The second columns gives the indirect fiscal effect for an immigrant in each decile of the wage distribution. The right column gives the percent of total low-skilled immigrants in each wage decile. The bottom row gives the weighted average of the indirect fiscal effects across the wage distribution.

A.4 Endogenous Occupational Choice of Residents

In this Appendix, we evaluate the indirect fiscal effects in a model with endogenous occupation choice, as in Peri and Sparber (2009). Perfectly competitive firms produce a numeraire output good using cognitive, communication and manual tasks. Cognitive tasks are supplied by high-skilled individuals. Communication and manual tasks are performed by low-skilled individuals. Denote by M total manual task supply and by C total communication task supply. In the bottom nest of the production function, these tasks combine to form the aggregate of low-skilled labor, $\mathscr{L}_u$, as

$$\mathscr{L}_u = \left(\theta_u M^{\frac{\sigma_u - 1}{\theta_u}} + (1-\theta_u)\, C^{\frac{\sigma_u - 1}{\sigma_u}}\right)^{\frac{\sigma_u}{\sigma_u - 1}}. \tag{2}$$

The parameter σ_u measures the elasticity of substitution between communication and manual tasks and θ_u measures the factor intensity of manual tasks. The task supplies M and C are given by the sum of each task supplied by both low-skilled domestic-born and foreign-born workers. Letting d index low-skilled domestic-born workers, and f index low-skilled foreign-born workers, we can write the total manual task supply as $M = N_f m_f + N_d m_d$ where N_f and N_d are the total number of low-skilled foreign-born and domestic-born workers in the economy and m_f and m_d are the amounts of manual tasks supplied by each low-skilled foreign- and domestic-born worker, respectively. Similarly, we can write the supply of communication tasks as $C = N_f c_f + N_d c_d$ where c_f and c_d are the endogenous amounts of communication tasks supplied by each low-skilled foreign- and domestic-born worker, respectively.

Each high-skilled worker inelastically supplies one unit of the cognitive task; aggregate high-skilled labor $\mathscr{L}_s$ is simply the total cognitive task supplied in the economy. High-skilled labor $\mathscr{L}_s$ and the aggregate of low-skilled labor, $\mathscr{L}_u$, are aggregated according to:

$$Y = A\left(\theta \mathscr{L}_u^{\frac{\sigma-1}{\sigma}} + (1-\theta)\,\mathscr{L}_s^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}, \tag{3}$$

where Y is the produced amount of the numeraire output good. The parameter σ corresponds with the elasticity of substitution between high-skilled labor and the low-skilled aggregate. Total factor productivity is given by A and θ gives the factor intensity of low-skilled labor.

Let w_c, w_m and w_s denote the compensation for one unit of communication, manual and cognitive tasks. As firms are perfectly competitive, these task prices are given by the marginal products of each task. Since high-skilled workers supply exactly one unit of the cognitive task, their income equals the task wage, hence we have $y_s = w_s$. For low-skilled workers, income is given by the sum of the worker's task supplies multiplied by the appropriate task prices. Letting $j \in \{f, d\}$ index low-skilled worker types (foreign-born or domestic-born), we can write the agent's income as $y_j = c_j w_c + m_j w_m$.

The indirect fiscal benefit resulting from an inflow of dN_f workers is given by

$$d\mathscr{R}_{ind}^{\text{PS}} = T_s' N_s \frac{dy_s}{dN_f} dN_f + T_f' N_f \frac{dy_f}{dN_f} dN_f + T_d' N_d \frac{dy_d}{dN_f} dN_f. \tag{4}$$

That is, the total indirect fiscal effect is given by the change in income of each type of worker multiplied by the number of workers of that type and the marginal tax rate. It's important to note that changes in income for low-skilled workers, $\frac{dy_f}{dN_f}$ and $\frac{dy_d}{dN_f}$, arise for two reasons. First, low-skilled immigrant inflows change task prices w_c and w_m, and therefore the incomes of foreign- and domestic-born workers. Second, income will change as a result of changes in task supplies in response to these inflows. For example, if low-skilled domestic-born workers respond to immigrant inflows by increasing the amount of communication task they supply (perhaps by moving into managerial occupations), this will lead to an additional change in their income in response to immigrant inflows. We show in Appendix B.4 how this formula can be written as a function of structural parameters and task supply elasticities.

Quantification We quantify the indirect fiscal effects by utilizing estimates of task intensities from ONET and selected parameter estimates from Peri and Sparber (2009). The procedure we use for estimating income and marginal tax rates are similar to those in other sections. Details can be found in Appendix C.6. Here we focus on the parameter estimates we take from Peri and Sparber (2009).

Peri and Sparber (2009) estimate the elasticity of substitution between manual and communication tasks, σ_u, using state level variation in immigrant inflows. We set $\sigma_u = 1$ and set the elasticity of substitution between low- and high-skilled workers as $\sigma = 1.75$, based on their estimates. Peri and Sparber (2009) also use this variation to estimate the elasticities of task supplies with respect to the immigrant share of low-skilled workers. We directly use these estimates of task supply elasticities. Most notably, they find that domestic-born workers respond to low-skilled immigrant inflows by increasing their communication task supply and that foreign-born workers do not change their task supplies in response to immigrant inflows.

Results First of all, we calculate the indirect fiscal effect which would result if workers did not adjust their occupation. We find this number to be \$857, which is in a similar ballpark as the numbers we found in Section III. However, once we allow for endogenous occupation choice, low-skilled domestic-born workers respond by switching into higher-paying communication-intensive occupations. This increases their incomes and thus their tax payments. Holding task prices constant, this occupation upgrading leads to an additional fiscal effect of \$967. Finally, these occupation changes lead to additional changes in the equilibrium task prices leading to an additional fiscal effect of \$93.[5] Ultimately, the indirect fiscal effect is equal to $d\mathscr{R}_{ind}^{PS}$ =\$1,918 with endogenous occupation choice.

A.5 Decreasing Returns to Scale

Consider a homogeneous production function with two inputs,

$$Y = F\left(\mathscr{L}_u, \mathscr{L}_s\right),$$

where, as before, $\mathscr{L}_u = \int_{\mathcal{I}_u} L_i \omega_i di$ and $\mathscr{L}_s = \int_{\mathcal{I}_s} L_i \omega_i di$. Let λ be the degree of homogeneity: $F\left(t\mathscr{L}_u, t\mathscr{L}_s\right) = t^{\lambda} F\left(\mathscr{L}_u, \mathscr{L}_s\right)$. With decreasing returns to scale ($\lambda < 1$), an immigrant inflow can also lead to changes in firm profits in addition to changes in wages. Therefore, holding labor supply constant, the indirect fiscal effects of immigration with decreasing returns are given by:

$$d\mathscr{R}_{ind}^{\mathrm{DRS}}(i) = h_i \omega_i \left[\tau_p \frac{\partial \pi}{\partial \mathscr{L}_u} + \int_{\mathcal{I}_s} T'\left(y_i, i\right) \frac{\partial w_s}{\partial \mathscr{L}_u} h_i \omega_i m_i di + \int_{\mathcal{I}_u} T'\left(y_i, i\right) \frac{\partial w_u}{\partial \mathscr{L}_u} h_i \omega_i m_i di\right],$$

where π represents total firm profits and τ_p is the tax rate on firm profits.

In the case of constant returns to scale, the indirect fiscal effects arose because of a change in relative incomes of high-skilled and low-skilled workers. With decreasing returns to scale, there is a second effect arising from an increase in firm profits relative to worker income. As we show in Appendix B.5 the indirect fiscal effect of an immigrant of type i with decreasing returns to scale is given by

$$d\mathscr{R}_{ind}^{\mathrm{DRS}}(i) = y_i \left[\underbrace{\left(\bar{T}_s' - \bar{T}_u'\right) \left|\tilde{\gamma}_{u,own}\right|}_{\text{Factor Ratio Effect}} + \underbrace{(1-\lambda)\left(\tau_p - \bar{T}_I'\right)}_{\text{Scale Effect}}\right]. \tag{5}$$

Consider the first term of (5), which we refer to as the "factor ratio effect". The term $\tilde{\gamma}_{u,own}$ gives the own-wage elasticity for low-skilled workers, holding total labor income constant.

[5] This term is positive because the increase in supply of communication tasks by low-skilled workers implies an increase in cognitive wages, an increase in manual wages but a decrease in communication wages.

Specifically, this term is given by $\tilde{\gamma}_{u,own} = \gamma_{u,own} + \kappa_u (1-\lambda)$, where $\kappa_u = \frac{\mathscr{L}_u w_u}{\mathscr{L}_s w_s + \mathscr{L}_u w_u}$ is the labor income share of low-skilled labor.[6] This factor ratio effect gives the indirect fiscal effect as a result of changing the relative wages of high-skilled relative to low-skilled workers.

In addition to changing the factor ratio, an influx of low-skilled labor also increases the scale of production and therefore increases profits at the cost of worker income. We refer to the resulting fiscal effect as the "scale effect", which is the second term in (5). The term $\bar{T}'_I$ gives the income-weighted average marginal tax of all workers. A smaller value of λ implies lower returns to scale and therefore a greater redistribution of surplus from workers to firms. The fiscal effects of the redistribution are scaled by the differences in the average tax rates between firms and workers, $\left(\tau_p - \bar{T}'_I\right)$.

Results To calculate the fiscal effects with decreasing returns to scale, we need estimates of the profit tax τ_p, income weighted marginal tax rates, the returns to scale, λ, and $\tilde{\gamma}_{u,own}$, the own-wage elasticity of low-skilled labor, holding labor income constant. For the profit tax, we use the weighted average of the state and federal corporate tax rates and the business income weighted average income tax rate, which is the tax rate that applies for pass-through businesses.[7] This gives us an estimate of $\tau_p = 36.8\%$. We estimate a marginal tax rate for all workers as $\bar{T}'_I = 35.3\%$. Finally, we take our value of $\lambda = .9$ from Burnside (1996), who estimates returns to scale for US industries.[8] Finally, $\tilde{\gamma}_{u,own} = -\frac{1}{\sigma}\kappa_s$, where again σ is the elasticity of substitution between low- and high-skilled labor.[9] Therefore, $\tilde{\gamma}_{u,own}$ is the same as the own-wage elasticity with constant returns to scale, given the same value for σ.

Putting this together, we estimate that if production exhibits decreasing returns to scale, the indirect fiscal effect associated with the average low-skilled immigrant is equal to \$802 given an elasticity of substitution of $\sigma = 2$. Recall that with constant returns to scale and $\sigma = 2$, we calculated an indirect fiscal effect with exogenous labor supply of \$753. The small increase in the fiscal effect with decreasing returns is due to the scale effect: profits increase relative to labor income and profits face a higher marginal tax rate than labor income.[10]

[6] Note that $-\kappa_u (1-\lambda)$ is the effect of immigration on low-skilled income that occurs through the scale effect – if total income changes but the share going to low-skilled workers stays constant. Therefore, we can think of $\tilde{\gamma}_{u,own}$ as as the change in low-skilled income from immigration minus the scale effect. Note that if the production function exhibits constant returns to scale, then this elasticity is independent of scale and we have $\tilde{\gamma}_{u,own} = \gamma_{u,own}$.

[7] Corporations account for 60% of total net income from business. We calculate τ_p as .6 times federal and average state corporate tax rate plus .4 times the business income weighted average effective tax rate arising from income taxes and transfers using our ACS data. In 2017, the federal corporate tax rate plus the average of the state income tax rates was 38.9%. Source: `https://taxfoundation.org/us-corporate-income-tax-more-competitive/` . We find a business income weighted effective tax rate of 33.9%.

[8] Burnside (1996) estimates a weighted average of industry specific returns to scale of .9.

[9] As we show in Appendix B.5, the own-wage elasticity with decreasing returns to scale is given by $\gamma_{u,own} = (\lambda - 1)\kappa_u - \frac{1}{\sigma}\kappa_s$. Therefore, the own-wage elasticity holding labor income constant is simply given by $\tilde{\gamma}_{u,own} = -\frac{1}{\sigma}\kappa_s$.

[10] It's worth noting that corporate tax rates dropped substantially in 2018 to a weighted average of 25.7%. Performing this calculating with 2018 corporate tax rates implies an indirect fiscal effect of \$561.

A.6 Further Potential Extensions

Endogenous Education Low-skilled residents may respond to low-skilled immigrant inflows by adjusting their education level (Llull, 2018). Natives further investing in their education in response to immigration would likely increase the indirect fiscal effects of immigration as increased education leads to increased lifetime income and therefore increased tax payments. As shown in Colas, Findeisen, and Sachs (2021), this fiscal externality associated with attending college is quantitatively important.[11]

Monopsonistic Labor Markets Amior and Manning (2020) emphasize that most of the immigration literature rests on the assumption of perfectly competitive labor markets. They argue that this assumption is problematic because markdowns on wages in a setting with monopsony power are likely to be endogenous to immigration since labor supply of immigrants tends to be relatively inelastic.[12] In this case, low-skilled immigration would not only imply redistribution from low- to high-skilled workers but also from workers to firms, similar to the decreasing-returns to scale extension in Appendix A.5. An important difference to Appendix A.5 is that immigrants are not paid their marginal product in such a setting. This implies that the economic pie accruing to residents would increase and thereby reinforce the indirect fiscal benefit.

Search Frictions We have abstracted from search frictions in the labor market. As has been pointed out by Battisti, Felbermayr, Peri, and Poutvaara (2018), immigration can attenuate search frictions on the labor market, which also implies indirect fiscal benefits.

Resident Migration Responses Low-skilled immigrant inflows into a given city can induce migration responses by residents (Borjas, Freeman, and Katz, 1997; Piyapromdee, 2020; Monras, 2020). These resident migration responses, either in the form of outflows of low-skilled or inflows of high-skilled residents, would mitigate the effect of immigration on local wage inequality and therefore reduce the indirect fiscal effect generated locally, but would increase wage inequality and therefore generate indirect fiscal effects in other cities. Concretely, if the economy consists of J cities with different population sizes but that are otherwise identical, the total indirect fiscal effect generated across all cities would be independent of the distribution of the low-skilled immigrants across cities and of any resident migration responses.[13] However, if cities differ in their wage levels, residents' incomes and tax payments will depend on their location and therefore resident migration will imply a fiscal externality. These effects

[11] Colas, Findeisen, and Sachs (2021) estimate average lifetime fiscal externalities of attending college ranging roughly \$60,000 to \$90,000, conditional on parental income.

[12] For the US, the authors show that the assumption that markdowns are exogenous is rejected by the data.

[13] This is because the indirect fiscal effect is independent of the size of the resident population. See also the discussion in Foonote 20.

could be jointly analyzed using a spatial equilibrium model with taxes, such as in Colas and Hutchinson (2021).

B Additional Theoretical Results

B.1 Theory: Welfare and Distributional Effects

Characterizing the welfare effects of immigration is difficult, as low-skilled immigration leads to winners and losers. The welfare effects therefore depend crucially on how the social planner weighs the utility of different income groups, foreign-born versus domestic-born workers, and, perhaps more difficultly, on potential immigrants versus individuals in the United States. The welfare gains of low-skilled immigrants are likely to be very large, given that low-skilled immigrants experience massive income gains after moving to the United States (Hendricks and Schoellman, 2018). In what follows, the welfare calculation do not account for the welfare gains of the immigrants themselves.

Concretely, let $g(i)$ denote the welfare weight of individual i, such that $g(i)$ gives the increase in social welfare – measured in units of public funds – associated with a one unit increase in income for individual i. These weights are normalized such that on average they are equal to one and one is the weight on government revenue (Saez and Stantcheva, 2016). The welfare surplus associated with one low-skilled immigrant is given by the following Proposition.

Proposition 1. *The weighted surplus accruing to residents for one low-skilled immigrant is given by:*

$$Surplus(i) = d\mathscr{R}_{dir}(i) + \text{FiscExternalities}(i) + \text{Distributional}(i) + \text{TaxMitigation}(i),$$

where

$$\text{FiscExternalities}(i) = \frac{y_i \times |\gamma_{u,own}|}{1 + \bar{\xi}^u|\gamma_{u,own}| + \bar{\xi}^s|\gamma_{s,own}|}\left(\overline{\varepsilon_s T'_s} - \overline{\varepsilon_u T'_u} + \overline{\eta_s T_{part,s}} - \overline{\eta_u T_{part,u}}\right), \quad (6)$$

$$\text{Distributional}(i) = \frac{y_i \times |\gamma_{u,own}|}{1 + \bar{\xi}^u|\gamma_{u,own}| + \bar{\xi}^s|\gamma_{s,own}|} \times \left(\overline{g_s} - \overline{g_u}\right),$$

$$\text{TaxMitigation}(i) = \frac{y_i \times |\gamma_{u,own}|}{1 + \bar{\xi}^u|\gamma_{u,own}| + \bar{\xi}^s|\gamma_{s,own}|} \times \left(\left(\bar{T}'_s - \overline{g_s\left(T'_s\right)}\right) - \left(\bar{T}'_u - \overline{g_u\left(T'_u\right)}\right)\right),$$

and where $d\mathscr{R}_{dir}(i)$ is the direct fiscal effect, $\overline{g_e}$ is the income-weighted average of the welfare weights conditional on skill e and $\overline{g_e\left(T'_e\right)}$ is the income-weighted average of the product of the welfare weights and marginal tax rates conditional on skill e.

Proof. See Appendix B.1.1. □

The fiscal externality (6) is the additional tax revenue generated by resident labor supply responses. Note that the fiscal externality term would be zero if (i) labor supply of residents were exogenous or (ii) the tax system were proportional and labor supply elasticities were common between low- and high-skilled workers. The endogeneity of labor supply combined with the progressivity of the tax system jointly imply a welfare surplus: while the labor supply responses do not directly affect resident welfare due to the envelope theorem, they affect resident welfare through their implied indirect fiscal effects (Hendren, 2015).

The term Distributional(i) captures the mechanical distributional effects between high-skilled and low-skilled residents resulting from the change in relative wages. These distributional effects are partially mitigated by the tax system, as captured by the term TaxMitigation(i). In particular, the term $\left(\bar{T}_e' - \overline{g_e\left(T_e'\right)}\right)$ captures that an increase (decrease) in wages for high-skilled (low-skilled) is partially offset by the tax code. We now discuss two special cases for the welfare weights and thereby relate modern approaches in public economics to the approaches in the immigration literature.

Kaldor-Hicks Immigration Surplus. The "immigration surplus", an application of the Kaldor-Hicks compensation test (Kaldor, 1939; Hicks, 1939, 1940), is a leading approach to study welfare in the immigration literature (see e.g. Borjas (2014)). The immigration surplus measures whether the residents hurt by immigration could hypothetically be compensated by those who benefit and is given by the sum of government revenue and the monetized gains and losses of all the residents. Note that the immigration surplus is simply a special case of the welfare effect in Proposition 1 with $g(i) = 1$ for all i. In this case, the welfare effect is simply given by the direct fiscal effects plus the fiscal externality. Both the distributional effects and tax mitigation effects are equal to zero because each dollar would be valued equally regardless of whether it accrues to high-skilled residents or low-skilled residents or to the government. The fact that this surplus is non-zero beyond the direct fiscal effect is novel.

Inverse-Optimum Weights. In our quantification of these welfare effects in Appendix D.1, we calculate the welfare effects of immigration using the so-called inverse optimum weights as in Hendren (2020). These are the welfare weights for which the current U.S. tax-transfers system is optimal according to optimality conditions from the optimal income tax literature. Hendren (2020) shows that by using these weights, one can extend the Kaldor-Hicks surplus to account for distortionary costs of compensation.[14] If the welfare effect is positive with such weights, then a Pareto improvement can be achieved because the losers can be compensated.[15]

[14] Going one step further, Schulz et al. (2022) generalize the compensation principle to a setting where distortive taxes also imply general equilibrium effects on wages, which creates a complicated fixed-point problem. The authors analytically describe the tax reform that achieves compensation in such a setting.

[15] One underlying assumption that this can be achieved with a standard tax schedule, is that for a given income level, all individuals are affected in the same way. This assumption is apparently violated in our model where at a certain income level, both low and high-skilled individuals are present and hence compensating policies would need to condition on skill.

For the U.S., Hendren (2020) calibrates a weight function which is generally decreasing in income and thus gives higher weight to low-skilled than high-skilled individuals. For such weights, low-skilled immigration will lead to negative distributional effects because the income losses of low-skilled receive a higher weight than the income gains of high-skilled.

We also consider an extension, in which the utility of previous immigrants are not weighted in welfare calculations.[16] As will become clear in the quantification of these welfare effects in Appendix D.1, whether previous immigrants are taken into account or not in the welfare analysis plays an important role for the welfare effects of further immigration.

B.1.1 Kaldor-Hicks Surplus

To obtain the Kaldor-Hicks surplus, one has to add up the monetized gains and losses of all citizens and the fiscal effects. Denote the direct fiscal effect by $d\mathscr{R}_{dir}$. The indirect fiscal effect is given by (see Proposition 2):

$$d\mathscr{R}_{ind}(i) = \frac{y_i|\gamma_{u,own}|}{1+\bar{\xi}^u|\gamma_{u,own}|+\bar{\xi}^s|\gamma_{s,own}|}\left(\bar{T}'_s - \bar{T}'_u + \overline{\varepsilon_s T'_s} - \overline{\varepsilon_u T'_u} + \overline{\eta_s T_{part,s}} - \overline{\eta_u T_{part,u}}\right).$$

The monetized utility effect of resident individuals is simply given by the change in income that arises due to the change in wages. The changes in income due to changes in labor supply do not matter for utility due to the envelope theorem. Hence, an individual of type i with $e_i = e$ has a utility change of

$$(1 - T'(y_i, i))y_i \frac{dw_e}{w_e},$$

where $\frac{dw_e}{w_e}$ is given in Lemma 4. Integrating over all residents and adding the monetized gains and losses to the tax revenue effects gives the immigration surplus:

$$Surplus_{Kaldor-Hicks}(i) = d\mathscr{R}_{dir} + \frac{y_i|\gamma_{u,own}|}{1+\bar{\xi}^u|\gamma_{u,own}|+\bar{\xi}^s|\gamma_{s,own}|}\left(\overline{\varepsilon_s T'_s} - \overline{\varepsilon_u T'_u} + \overline{\eta_s T_{part,s}} - \overline{\eta_u T_{part,u}}\right).$$

The indirect fiscal effects that were not caused by fiscal externalities and the monetized gains and losses from residents add up to zero. What the government gains is what resident taxpayers in aggregate lose.

Note that this only holds because all gains and losses are given equal weight. If we follow Hendren (2020) and weight the monetized utility gains and losses by the inverse optimum weights $g(y)$, then we obtain:

[16] This could e.g. be motivated by Alesina, Miano, and Stantcheva (2018, Figure 13), who find that less than 40% of Americans agree to the following statement “The government should care equally about everyone living in the country whether born there or not”.

$$Surplus_{weighted}(i) = d\mathscr{R}_{dir} + \frac{y_i|\gamma_{u,own}|}{1+\bar{\xi}^u|\gamma_{u,own}| + \bar{\xi}^s|\gamma_{s,own}|} \times$$
$$\left(\overline{g_s\left(1-T_s'\right)} - \overline{g_u\left(1-T_u'\right)} + \bar{T}_s' - \bar{T}_u' + \overline{\varepsilon_s T'_s} - \overline{\varepsilon_u T'_u} + \overline{\eta_s T_{part,s}} - \overline{\eta_u T_{part,u}} \right).$$

We provide a quantitative evaluation for the inverse-optimum approach in Appendix D.1.

B.2 Indirect Fiscal Effect with Four Education Groups and Imperfectly Substitutable Experience Groups

We consider an immigrant i with experience a and education e. The indirect fiscal effect is given by:

$$d\mathscr{R}_{ind}\left(a,e,i\right) = h_i\omega_i \left[\sum_{e'\neq e}\sum_{a'} \left(\bar{T}'_{a'e'}\mathscr{L}_{a'e'}\frac{\partial w_{a'e'}}{\partial \mathscr{L}_{ae}} \right) + \sum_{a'\neq a} \left(\bar{T}'_{a'e}\mathscr{L}_{a'e}\frac{\partial w_{a'e}}{\partial \mathscr{L}_{ae}} \right) + \left(\bar{T}'_{ae}\mathscr{L}_{ae}\frac{\partial w_{ae}}{\partial \mathscr{L}_{ae}} \right) \right],$$

The first term captures the wage changes of individuals with different education levels, whose wage unambiguously increases. The second term captures the wage change of those with the same education but different experience, whose wage may increase or decrease. The third term captures the wage change of those with the same education and experience, whose wage unambiguously decreases.

Now we rewrite it in terms of elasticities

$$d\mathscr{R}_{ind}\left(a,e,i\right) = h_i\omega_i \left[\sum_{e'\neq e}\sum_{a'} \left(\bar{T}'_{a'e'}\frac{\mathscr{L}_{a'e'}w_{a'e'}}{\mathscr{L}_{ae}}\gamma_{a'e',ae} \right) + \sum_{a'\neq a} \left(\bar{T}'_{a'e}\frac{\mathscr{L}_{a'e}w_{a'e}}{\mathscr{L}_{ae}}\gamma_{a'e,ae} \right) + \left(\bar{T}'_{ae}w_{ae}\gamma_{ae,ae} \right) \right].$$

Let $Y_{ae} = w_{ae}\mathscr{L}_{ae}$ give aggregate income for a given education-experience group and let $Y_e = \sum_a Y_{ae}$ give aggregate income of a given education group. Further, let $\kappa_e = \frac{Y_e}{Y}$ give the income share of education group e and let $\kappa_{a,e} = \frac{Y_{ae}}{Y_e}$ give the income share of experience group a within education group e. Some standard algebra shows, that the wage elasticities read as follows for this nested CES production function:

$$\gamma_{e,e} = -\frac{1-\kappa_e}{\sigma_E}$$

and

$$\gamma_{e',e} = \frac{\kappa_e}{\sigma_E}.$$

Further, for $e' \neq e$, we have:

$$\gamma_{a'e',ae} = \frac{\kappa_e}{\sigma_E}\kappa_{a,e} = \gamma_{e',e}\kappa_{a,e}.$$

For $e' = e$, this becomes:

$$\gamma_{a'e,ae} = -\frac{1-\kappa_e}{\sigma_E}\kappa_{a,e} + \underbrace{\frac{\kappa_{a,e}}{\sigma_X}}_{:=\tilde{\gamma}_{a'e,ae}} = \gamma_{e,e}\kappa_{a,e} + \tilde{\gamma}_{a'e,ae}.$$

Finally, for $e' = e$ and $a' = a$, this becomes

$$\gamma_{ae,ae} = -\frac{1-\kappa_e}{\sigma_E}\kappa_{a,e} \underbrace{-\frac{1-\kappa_{a,e}}{\sigma_X}}_{:=\tilde{\gamma}_{ae,ae}} = \gamma_{e,e}\kappa_{a,e} + \tilde{\gamma}_{ae,ae}.$$

Plugging this into the indirect fiscal effect formulas gives:

$$\begin{aligned} d\mathscr{R}_{ind}^{\text{Borjas}}(a,e,i) =& h_i\omega_i\Bigg[\frac{\kappa_{a,e}}{\mathscr{L}_{ae}\sigma_E}\Bigg(\kappa_e\sum_{e'\neq e}\sum_{a'}\left(\bar{T}'_{a'e'}\mathscr{L}_{a'e'}w_{a'e'}\right) \\ & -(1-\kappa_e)\Bigg(\sum_{a'}\bar{T}'_{a'e}\mathscr{L}_{a'e}w_{a'e}\Bigg)\Bigg) \\ & +\frac{1}{\mathscr{L}_{ae}\sigma_X}\Bigg(\kappa_{a,e}\sum_{a'\neq a}\left(\bar{T}'_{a'e}\mathscr{L}_{a'e}w_{a'e}\right)-(1-\kappa_{a,e})\left(\bar{T}'_{ae}\mathscr{L}_{ae}w_{ae}\right)\Bigg)\Bigg]. \end{aligned}$$

This can be rewritten as

$$\begin{aligned} d\mathscr{R}_{ind}^{\text{Borjas}}(a,e,i) =& \underbrace{h_i\omega_i w_{ae}}_{y_i}\Bigg[\frac{\kappa_{a,e}}{Y_{ae}\sigma_E}\Bigg(\kappa_e\sum_{e'\neq e}(Y'_e)\times\bar{T}'_{e'\neq e}-(1-\kappa_e)Y_e\bar{T}'_e\Bigg) \\ & +\frac{1}{Y_{ae}\sigma_X}\Bigg(\kappa_{a,e}\sum_{a'\neq a}(Y_{a'e})\times\bar{T}'_{a'\neq a,e\cdot}-(1-\kappa_{a,e})Y_{ae}\bar{T}'_{ae}\Bigg)\Bigg]. \end{aligned}$$

Now use the definition of the income shares to write this as:

$$\begin{aligned} d\mathscr{R}_{ind}^{\text{Borjas}}(a,e,i) =& y_i\Bigg[\frac{\kappa_{a,e}(1-\kappa_e)Y_e}{Y_{ae}\sigma_E}\Bigg(\bar{T}'_{e'\neq e}-\bar{T}'_e\Bigg) \\ & +\frac{(1-\kappa_{a,e})Y_{ae}}{Y_{ae}\sigma_X}\left(\bar{T}'_{a'\neq a,e}-\bar{T}'_{ae}\right)\Bigg]. \end{aligned}$$

and hence

$$d\mathscr{R}_{ind}^{\text{Borjas}}(a,e,i) = y_i\left[\left(\bar{T}'_{a'\neq a,e}-\bar{T}'_{ae}\right)|\tilde{\gamma}_{ae,own}|+\left(\bar{T}'_{e'\neq e}-\bar{T}'_e\right)|\gamma_{e,own}|\right].$$

B.3 Indirect Fiscal Effects in Dustmann, Frattini, and Preston (2013)

The indirect fiscal effect for an immigrant of skill group j is given by

$$d\mathscr{R}_{ind}\left(j,i\right)=h_{i}\omega_{i}\sum_{k}\int_{\mathcal{I}_{k}}T'\left(y_{i}\left(\omega'\right)\right)L_{i}\frac{\partial w_{j}}{\partial\mathscr{L}_{i}}di=h_{i}\omega_{i}\sum_{k}\bar{T}'_{k}\mathscr{L}_{j}\frac{\partial w_{k}}{\partial\mathscr{L}_{j}}.$$

Since the production function is CRS, we know by Euler's equation that

$$\mathscr{L}_{j}\frac{\partial w_{j}}{\partial L_{j}}=-\sum_{k\neq j}\mathscr{L}_{k}\frac{\partial w_{k}}{\partial\mathscr{L}_{j}}.$$

Plugging this into the indirect fiscal effect and rearranging yields:

$$d\mathscr{R}_{ind}\left(j,i\right)=h_{i}\omega_{i}\sum_{k\neq j}\left(\bar{T}'_{k}-\bar{T}'_{j}\right)\mathscr{L}_{k}\frac{\partial w_{k}}{\partial\mathscr{L}_{j}}$$

which can be rewritten in terms of elasticities as

$$d\mathscr{R}_{ind}\left(j,i\right)=h_{i}\omega_{i}\sum_{k\neq j}\left(\bar{T}'_{k}-\bar{T}'_{j}\right)\frac{w_{k}\mathscr{L}_{k}}{\mathscr{L}_{j}}\gamma_{k,j}$$

where $\gamma_{k,j}=\frac{\partial w_{k}}{\partial\mathscr{L}_{j}}\frac{\mathscr{L}_{j}}{w_{k}}$ gives the cross-wage elasticity of k's wages with respect to $\mathscr{L}_{j}$.

Given the CES production function, these cross-wage elasticities are all given by $\gamma_{k,j}=\frac{1}{\sigma}\kappa_{j}$, where $\kappa_{j}=\frac{w_{j}L_{j}}{Y}$. Plugging in and rearranging yields

$$d\mathscr{R}_{ind}\left(j,i\right)=\frac{y_{i}}{\sigma}\left[\left(\sum_{k\neq j}\left(\bar{T}'_{k}\kappa_{k}\right)\right)-\bar{T}'_{j}\sum_{k\neq j}\kappa_{k}\right].$$

Dividing and multiplying by $\sum_{k\neq j}\kappa_{k}=1-\kappa_{j}$ yields

$$d\mathscr{R}_{ind}\left(j,i\right)=\frac{y_{i}}{\sigma}\left[\bar{T}'_{k\neq j}-\bar{T}'_{j}\right]\left(1-\kappa_{j}\right)$$

where $\bar{T}'_{k\neq j}=\frac{\sum_{k\neq j}T'(y_{k})\omega_{k}}{\sum_{k\neq j}\omega_{k}}$ is the income weighted tax of all other group $k\neq j$.

$$d\mathscr{R}^{DFP}_{ind}\left(j,i\right)=y_{i}\times\left(\bar{T}'_{k\neq j}-\bar{T}_{j}\right)\times\left|\gamma_{j,own}\right|=y_{i}\times\left(\bar{T}'_{k\neq j}-\bar{T}_{j}\right)\frac{1-\kappa_{j}}{\sigma},$$

where we used $\frac{1-\kappa_{j}}{\sigma}=\left|\gamma_{j,own}\right|$.

B.4 Indirect Fiscal Effect in Peri and Sparber (2009)

The starting point is equation (4)

$$d\mathscr{R}^{PS}_{ind}=T'_{s}N_{s}\frac{dy_{s}}{dN_{f}}dN_{f}+T'_{f}N_{f}\frac{dy_{f}}{dN_{f}}dN_{f}+T'_{d}N_{d}\frac{dy_{d}}{dN_{f}}dN_{f}.$$

We now show how this can be decomposed into three terms:

$$d\mathscr{R}_{ind} = \underbrace{d\mathscr{R}_{ind}^{SR}}_{\text{short run effect}} + \underbrace{d\mathscr{R}_{ind}^{SORT}}_{\text{sorting effect}} + \underbrace{d\mathscr{R}_{ind}^{PR}.}_{\text{secondary price effect}} \tag{7}$$

The first term captures the indirect fiscal effect that would arise if task choices were exogenous. The second term gives the change in tax revenue that is due to the change in task supplies – holding task wages constant. The third term is similar to the first term again in that it captures changes in wages for given task supplies. It captures the changes in tax payment due to wage changes that are due to the changes in task supply of low-skilled domestic-born workers and low-skilled foreign-born workers.

To arrive at this decomposition, first note that the effect of immigration N_f on task supplies can be written (note that cognitive task supply is by assumption exogenous):

$$\frac{dM}{dN_f} = m_f + N_d \frac{dm_d}{dN_f} + N_f \frac{dm_f}{dN_f} = m_f + \left(\frac{dM}{dN_f}\right)_{ind}$$

and

$$\frac{dC}{dN_f} = c_f + N_d \frac{dc_d}{dN_f} + N_f \frac{dc_f}{dN_f} = c_f + \left(\frac{dC}{dN_f}\right)_{ind},$$

where $(\cdot)_{ind}$ captures the indirect effect through changes in task supply. These indirect effect are given by

$$\left(\frac{dC}{dN_f}\right)_{ind} = c_d \eta_d^c (1-f)^2 + c_f \eta_c^f f^2$$

and

$$\left(\frac{dM}{dN_f}\right)_{ind} = m_d \eta_d^m (1-f)^2 + m_f \eta_f^m f^2$$

where

$$\eta_j^c = \frac{dc^j}{df}\frac{1}{c^j} \text{ and } \eta_j^m = \frac{dm^j}{df}\frac{1}{m^j}\ \forall\, j = f, d \text{ and } f = \frac{N_f}{N_f + N_d}.$$

Note that η_j and η_j^m are general equilibrium elasticities that captures all adjustments and higher order wage effects. The reason why we express – in contrast to our analysis in the main model – the formula in terms of such general equilibrium elasticities is that Peri and Sparber (2009) provide estimates for these general equilibrium elasticities.

As a next step, note that the wage changes of high-skilled, foreign and domestic low-skilled workers can be written as (recall that for high skilled we have $y_s = w_s$ – wage equals income since the high-skilled exogenously supply one unit of cognitive taks):

$$\frac{dy_s}{dN_f} = \frac{\partial y_s}{\partial M}\frac{dM}{dN_f} + \frac{\partial y_s}{\partial C}\frac{dC}{dN_f}$$

$$= \underbrace{\frac{\partial y_s}{\partial M} m_f + \frac{\partial y_s}{\partial C} c_f}_{\text{direct effect}} + \underbrace{\frac{\partial y_s}{\partial M}\left(\frac{dM}{dN_f}\right)_{ind} + \frac{\partial y_s}{\partial C}\left(\frac{dC}{dN_f}\right)_{ind}}_{\text{indirect price effect}},$$

for high skilled residents,

$$\frac{dy_f}{dN_f} = \frac{dw_m}{dN_f}m_f + \frac{dw_c}{dN_f}c_f + \underbrace{w_m\frac{dm_f}{dN_f} + w_c\frac{dc_f}{dN_f}}_{\text{sorting effect}},$$

for low-skilled foreigners and

$$\frac{dy_d}{dN_f} = \frac{dw_m}{dN_f}m_d + \frac{dw_c}{dN_f}c_d + \underbrace{w_m\frac{dm_d}{dN_f} + w_c\frac{dc_d}{dN_f}}_{\text{sorting effect}},$$

for low-skilled domestic-born workers. For the latter two, the changes in wages of the manual and communication tasks can be written as:

$$\frac{dw_m}{dN_f} = \underbrace{\frac{\partial w_m}{\partial M}m_f + \frac{\partial w_m}{\partial C}c_f}_{\text{direct effect}} + \underbrace{\frac{\partial w_m}{\partial M}\left(\frac{dM}{dN_f}\right)_{ind} + \frac{\partial w_m}{\partial C}\left(\frac{dC}{dN_f}\right)_{ind}}_{\text{indirect price effect}},$$

and

$$\frac{dw_c}{dN_f} = \underbrace{\frac{\partial w_c}{\partial M}m_f + \frac{\partial w_c}{\partial C}c_f}_{\text{direct effect}} + \underbrace{\frac{\partial w_c}{\partial M}\left(\frac{dM}{dN_f}\right)_{ind} + \frac{\partial w_c}{\partial C}\left(\frac{dC}{dN_f}\right)_{ind}}_{\text{indirect price effect}}.$$

Rearranging terms, we can now obtain (7). We describe the three terms one after another. All the terms are expressed in terms of empirical objects. For the quantification, see Appendix C.6.

Short Run Effect: Collecting the terms that do not involve endogenous task responses yields:

$$d\mathscr{R}_{ind}^{SR} = T_s'N_s\frac{dy_s}{dN_f}|_{dc_j=dm_j=0}dN_f +$$
$$T_f'N_f\frac{dy_f}{dN_f}|_{dc_j=dm_j=0}dN_f + T_d'N_d\frac{dy_d}{dN_f}|_{dc_j=dm_j=0}dN_f,$$

where

$$\frac{dy_s}{dN_f}|_{dc_j=dm_j=0} = \frac{\partial y_s}{\partial M}m_f + \frac{\partial y_s}{\partial C}c_f$$

$$\frac{dy_f}{dN_f}|_{dc_j=dm_j=0} = m_f\left(\frac{\partial w_m}{\partial M}m_f + \frac{\partial w_m}{\partial C}c_f\right) + c_f\left(\frac{\partial w_c}{\partial M}m_f + \frac{\partial w_c}{\partial C}c_f\right),$$

and

$$\frac{dy_d}{dN_f}|_{dc_j=dm_j=0} = m_d\left(\frac{\partial w_m}{\partial M}m_f + \frac{\partial w_m}{\partial C}c_f\right) + c_d\left(\frac{\partial w_c}{\partial M}m_f + \frac{\partial w_c}{\partial C}c_f\right)$$

give the income elasticities of the three worker groups, holding all task supplies of a given worker constant.

Holding task supplies constant, the production function exhibits constant returns to scale in labor from the three worker types. Therefore, using Euler's theorem, we know that

$$\frac{dy_d}{dN_f}|_{dc_j=dm_j=0} + \frac{dy_s}{dN_f}|_{dc_j=dm_j=0} = -\frac{dy_f}{dN_f}|_{dc_j=dm_j=0}.$$

Plugging this in and writing in terms of elasticities yields:

$$\begin{aligned}
\mathscr{R}_{ind}^{SR} =& \frac{N_d}{N_f}\left(T'_d - T'_f\right) y_d \times \gamma_{y_d,M}\Big|_{dc_j=dm_j=0} m_f dN_f \\
&+ \frac{N_d}{N_f}\left(T'_d - T'_f\right) y_d \times \gamma_{y_d,C}\Big|_{dc_j=dm_j=0} c_f dN_f \\
&+ \frac{N_s}{N_f}\left(T'_s - T'_f\right) y_s \times \gamma_{y_s,M}\Big|_{dc_j=dm_j=0} m_f dN_f \\
&+ \frac{N_s}{N_f}\left(T'_s - T'_f\right) y_s \times \gamma_{y_s,C}\Big|_{dc_j=dm_j=0} c_f dN_f.
\end{aligned}$$

where $\gamma_{y_d,M}\Big|_{dc_j=dm_j=0}$, $\gamma_{y_d,C}\Big|_{dc_j=dm_j=0}$, $\gamma_{y_s,M}\Big|_{dc_j=dm_j=0}$, and $\gamma_{y_s,C}\Big|_{dc_j=dm_j=0}$ are 'short run' elasticities that capture how the incomes of low- and high-skilled residents change in response to changes in task supplies under the assumption that low-skilled foreign-born and domestic-born residents do not react. $\gamma_{y_d,M}\Big|_{dc_j=dm_j=0}$ and $\gamma_{y_d,C}\Big|_{dc_j=dm_j=0}$ can be written in terms of resident task elasticities as

$$\gamma_{y_d,C}\Big|_{dc_j=dm_j=0} = \gamma_{w_c,C}\frac{w_c c_d}{y_d} + \gamma_{w_m,C}\frac{w_m m_d}{y_d}$$

and

$$\gamma_{y_d,M}\Big|_{dc_j=dm_j=0} = \gamma_{w_c,M}\frac{w_c c_d}{y_d} + \gamma_{w_m,M}\frac{w_m m_d}{y_d}.$$

Finally, the task price elasticities can be solved for via CES algebra as

$$\gamma_{y_s,M}\Big|_{dc_j=dm_j=0} = \gamma_{w_s,M} = \frac{\kappa_m}{\sigma},$$

$$\gamma_{y_s,C}\Big|_{dc_j=dm_j=0} = \gamma_{w_s,C} = \frac{\kappa_c}{\sigma},$$

$$\gamma_{w_c,C} = \left(\frac{1}{\sigma}\right)\kappa_c + \left(\frac{1}{\sigma_u} - \frac{1}{\sigma}\right)\kappa_c^u - \frac{1}{\sigma_u},$$

$$\gamma_{w_m,M} = \left(\frac{1}{\sigma}\right)\kappa_m + \left(\frac{1}{\sigma_u} - \frac{1}{\sigma}\right)\kappa_m^u - \frac{1}{\sigma_u},$$

$$\gamma_{w_c,M} = \left(\frac{1}{\sigma}\right)\kappa_m + \left(\frac{1}{\sigma_u} - \frac{1}{\sigma}\right)\kappa_m^u,$$

and

$$\gamma_{w_m,C} = \left(\frac{1}{\sigma}\right)\kappa_c + \left(\frac{1}{\sigma_u} - \frac{1}{\sigma}\right)\kappa_c^u,$$

where κ_j for $j \in \{c, m\}$ is the fraction of total income paid to factor j, and κ_j^u is the fraction of total low-skilled income paid to factor j.

Sorting Effect: The fiscal effect of sorting is given by

$$\underbrace{T_f' N_f \left(w_m \frac{dm_f}{dN_f} + w_c \frac{dc_f}{dN_f} \right) dN_f}_{\text{Foreign-Born Sorting Effect}} + \underbrace{T_d' N_d \left(w_m \frac{dm_d}{dN_f} + w_c \frac{dc_d}{dN_f} \right) dN_f}_{\text{Domestic-Born Sorting Effect}} .$$

The terms in brackets multiplied by dN_f give the change in income per foreign-born and domestic-born worker. Multiplying this with their amount and the marginal tax rate gives the implied tax effects.

We can rewrite this formula in terms of task supply elasticities η_j^c and η_j^m, for $j = f, d$ as

$$\underbrace{T_f' N_f \left(w_m m_f \eta_f^m \frac{df}{dN_f} + w_c c_f \eta_f^c \frac{df}{dN_f} \right) dN_f}_{\text{Foreign-Born Sorting Effect}} + \underbrace{T_d' N_d \left(w_m m_d \eta_d^m \frac{df}{dN_f} + w_c c_d \eta_d^c \frac{df}{dN_f} \right) dN_f}_{\text{Domestic-Born Sorting Effect}} .$$

Using $\frac{df}{dN_f} = \frac{N_d}{\left(N_d + N_f\right)^2}$, we can rewrite this term again solely in terms of shares and independent of population size:

$$d\mathscr{R}_{ind}^{SORT} = \underbrace{T_f' f(1-f) \left(w_m m_f \eta_f^m + w_c c_f \eta_f^c \right) dN_f}_{\text{Foreign-Born Sorting Effect}} + \underbrace{T_d' (1-f)^2 \left(w_m m_d \eta_d^m + w_c c_d \eta_d^c \right) dN_f}_{\text{Domestic-Born Sorting Effect}} .$$

Secondary Price Effect: Collecting the remaining terms yields the indirect price effect:

$$\begin{aligned} & d\mathscr{R}_{ind}^{PR} = \\ & T_s' N_s \left[\frac{\partial y_s}{\partial M} \left(\frac{dM}{dN_f} \right)_{ind} + \frac{\partial y_s}{\partial C} \left(\frac{dC}{dN_f} \right)_{ind} \right] + \\ & T_f' N_f \left[m_f \left(\frac{\partial w_m}{\partial M} \left(\frac{dM}{dN_f} \right)_{ind} + \frac{\partial w_m}{\partial C} \left(\frac{dC}{dN_f} \right)_{ind} \right) + c_f \left(\frac{\partial w_c}{\partial M} \left(\frac{dM}{dN_f} \right)_{ind} + \frac{\partial w_c}{\partial C} \left(\frac{dC}{dN_f} \right)_{ind} \right) \right] + \\ & T_d' N_d \left[m_d \left(\frac{\partial w_m}{\partial M} \left(\frac{dM}{dN_f} \right)_{ind} + \frac{\partial w_m}{\partial C} \left(\frac{dC}{dN_f} \right)_{ind} \right) + c_d \left(\frac{\partial w_c}{\partial M} \left(\frac{dM}{dN_f} \right)_{ind} + \frac{\partial w_c}{\partial C} \left(\frac{dC}{dN_f} \right)_{ind} \right) \right] . \end{aligned} \tag{8}$$

We can rearrange this to yield

$$\begin{aligned} & d\mathscr{R}_{ind}^{PR} = \\ & \left(\frac{dM}{dN_f} \right)_{ind} \left[T_s' N_s \frac{\partial y_s}{\partial M} + T_f' N_f \frac{\partial y_f}{\partial M} + T_d' N_d \frac{\partial y_d}{\partial M} \right] + \\ & \left(\frac{dC}{dN_f} \right)_{ind} \left[\bar{T}_s' N_s \frac{\partial y_s}{\partial C} + T_f' N_f \frac{\partial y_f}{\partial C} + T_d' N_d \frac{\partial y_d}{\partial C} \right] . \end{aligned} \tag{9}$$

Using again Euler's theorem again, this yields:

$$\begin{aligned}\mathscr{R}^{PR}_{ind} =& \frac{N_d}{N_f}\left(T'_d - T'_f\right) y_d \times \gamma_{y_d,M}\Big|_{dc_j=dm_j=0}\left(\frac{dM}{dN_f}\right)_{ind} dN_f \\ &+\frac{N_d}{N_f}\left(T'_d - T'_f\right) y_d \times \gamma_{y_d,C}\Big|_{dc_j=dm_j=0}\left(\frac{dC}{dN_f}\right)_{ind} dN_f \\ &+\frac{N_s}{N_f}\left(T'_s - T'_f\right) y_s \times \gamma_{y_s,M}\Big|_{dc_j=dm_j=0}\left(\frac{dM}{dN_f}\right)_{ind} dN_f \\ &+\frac{N_s}{N_f}\left(T'_s - T'_f\right) y_s \times \gamma_{y_s,C}\Big|_{dc_j=dm_j=0}\left(\frac{dC}{dN_f}\right)_{ind} dN_f.\end{aligned}$$

B.5 Indirect Fiscal Effect with Decreasing Returns to Scale

The indirect fiscal effect associated with an immigrant of type i is

$$d\mathscr{R}^{\mathrm{DRS}}_{ind}(i) = h_i\omega_i\left[\tau_p\frac{\partial\pi}{\partial\mathscr{L}_u} + \int_{\mathcal{I}_s} T'(y_i,i)\frac{\partial w_s}{\partial\mathscr{L}_u}h_i\omega_i m_i di + \int_{\mathcal{I}_u} T'(y_i,i)\frac{\partial w_u}{\partial\mathscr{L}_u}h_i\omega_i m_i di\right].$$

We can rewrite this as

$$d\mathscr{R}^{\mathrm{DRS}}_{ind}(i) = h_i\omega_i\left[\tau_p\frac{\partial\pi}{\partial\mathscr{L}_u} + \bar{T}'_s\mathscr{L}_s\frac{\partial w_s}{\partial\mathscr{L}_u} + \bar{T}'_u\mathscr{L}_u\frac{\partial w_u}{\partial\mathscr{L}_u}\right].$$

where $\bar{T}'_u$ and $\bar{T}'_s$ are the income-weighted marginal tax rates of low and high skilled labor and τ_p is the tax on profits. First, we derive a relation between a change in profits and the change in labor income. Consider the effect of the inflow on profits:

$$\frac{\partial\pi}{\partial\mathscr{L}_u} = \left(\frac{\partial\pi}{\partial w_s}\frac{\partial w_s}{\partial\mathscr{L}_u} + \frac{\partial\pi}{\partial w_u}\frac{\partial w_u}{\partial\mathscr{L}_u}\right).$$

By Hotelling's lemma $\frac{\partial\pi}{\partial w_s} = -\mathscr{L}_s$ and same for low-skilled labor. Therefore we can write:

$$\frac{\partial\pi}{\partial\mathscr{L}_u} = -\left(\mathscr{L}_s\frac{\partial w_s}{\partial\mathscr{L}_u} + \mathscr{L}_u\frac{\partial w_u}{\partial\mathscr{L}_u}\right).$$

Denote by I aggregate labor income. Then we of course have

$$\frac{\partial I}{\partial\mathscr{L}_u} = \mathscr{L}_s\frac{\partial w_s}{\partial\mathscr{L}_u} + \mathscr{L}_u\frac{\partial w_u}{\partial\mathscr{L}_u}$$

and we can write

$$\frac{\partial\pi}{\partial\mathscr{L}_u} = -\frac{\partial I}{\partial\mathscr{L}_u}.$$

With constant returns to scale, we of course have that both sides are equal to zero. With decreasing returns, profits increase and labor income decreases. Aggregate resident income (sum of profits and labor income) is not affected, however. We can therefore write the indirect fiscal effect as:

$$d\mathscr{R}_{ind}^{\mathrm{DRS}}(i) = h_i\omega_i\left[-\tau_p\frac{\partial I}{\partial \mathscr{L}_u} + \bar{T}_s'\mathscr{L}_s\frac{\partial w_s}{\partial \mathscr{L}_u} + \bar{T}_u'\mathscr{L}_u\frac{\partial w_u}{\partial \mathscr{L}_u}\right],$$

Let $\kappa_s = \frac{\mathscr{L}_s w_s}{\mathscr{L}_s w_s + \mathscr{L}_u w_u}$ be the high-skilled fraction of labor income. Adding and subtracting $\left(\bar{T}_s'\kappa_s + \bar{T}_u'\kappa_u\right)\frac{\partial I}{\partial \mathscr{L}_u}$:

$$\begin{aligned} d\mathscr{R}_{ind}^{\mathrm{DRS}}(i) =& h_i\omega_i\Big[-\tau_p\frac{\partial I}{\partial \mathscr{L}_u} + \bar{T}_s'\left(\mathscr{L}_s\frac{\partial w_s}{\partial \mathscr{L}_u} - \kappa_s\frac{\partial I}{\partial \mathscr{L}_u}\right) + \bar{T}_u'\left(\mathscr{L}_u\frac{\partial w_u}{\partial \mathscr{L}_u} - \kappa_u\frac{\partial I}{\partial \mathscr{L}_u}\right) + \\ & \left(\bar{T}_s'\kappa_s + \bar{T}_u'\kappa_u\right)\frac{\partial I}{\partial \mathscr{L}_u}\Big]. \end{aligned}$$

Rearranging the above equation yields

$$d\mathscr{R}_{ind}^{\mathrm{DRS}}(i) = h_i\omega_i\left[\left(\bar{T}_I' - \tau_p\right)\frac{\partial I}{\partial \mathscr{L}_u} + \bar{T}_s'\left(\mathscr{L}_s\frac{\partial w_s}{\partial \mathscr{L}_u} - \kappa_s\frac{\partial I}{\partial \mathscr{L}_u}\right) + \bar{T}_u'\left(\mathscr{L}_u\frac{\partial w_u}{\partial \mathscr{L}_u} - \kappa_u\frac{\partial I}{\partial \mathscr{L}_u}\right)\right],$$

where $\bar{T}_I' = \bar{T}_s'\kappa_s + \bar{T}_u'\kappa_u$ is income weighted average income tax. Note that

$$\mathscr{L}_s\frac{\partial w_s}{\partial \mathscr{L}_u} + \mathscr{L}_u\frac{\partial w_u}{\partial \mathscr{L}_u} = \kappa_u\frac{\partial I}{\partial \mathscr{L}_u} + \kappa_s\frac{\partial I}{\partial \mathscr{L}_u}$$

So we can plug in $\mathscr{L}_s\frac{\partial w_s}{\partial \mathscr{L}_u} - \kappa_s\frac{\partial I}{\partial \mathscr{L}_u} = -\left(\mathscr{L}_u\frac{\partial w_u}{\partial \mathscr{L}_u} - \kappa_u\frac{\partial I}{\partial \mathscr{L}_u}\right)$ which yields

$$d\mathscr{R}_{ind}^{\mathrm{DRS}}(i) = h_i\omega_i\left[\left(\bar{T}_I' - \tau_p\right)\frac{\partial I}{\partial \mathscr{L}_u} + \left(\bar{T}_u' - \bar{T}_s'\right)\left(\mathscr{L}_u\frac{\partial w_u}{\partial \mathscr{L}_u} - \kappa_u\frac{\partial I}{\partial \mathscr{L}_u}\right)\right].$$

The term $\kappa_u\frac{\partial I}{\partial \mathscr{L}_u}$ is the effect of immigration on low-skilled income that occurs through the scale effect that arises from changing the total income but keeping share going to low-skilled workers constant. Therefore, we can think of the whole term $N_u h_u\frac{\partial w_u}{\partial \mathscr{L}_u} - \kappa_u\frac{\partial I}{\partial \mathscr{L}_u}$ as the total change in low-skilled income from immigration minus the scale effect. Therefore, this whole term captures the effect of immigration on wages, holding total labor income constant. Define $\frac{\partial \tilde{w}_u}{\partial \mathscr{L}_u} = N_u h_u\frac{\partial w_u}{\partial \mathscr{L}_u} - \kappa_u\frac{\partial I}{\partial \mathscr{L}_u}$ as the effect of immigration on wages, holding total labor income constant. Let's further assume that the production function is homogenous of degree λ, where $\lambda < 1$ if we have decreasing returns to scale. Hence, $F(t\mathscr{L}_u, t\mathscr{L}_s) = t^\lambda F(\mathscr{L}_u, \mathscr{L}_s)$. Taking derivatives w.r.t. to t and normalizing $t = 1$ yields :

$$\mathscr{L}_u w_u + \mathscr{L}_s w_s = \lambda F,$$

Now taking derivatives of both sides w.r.t. $\mathscr{L}_u$ yields:

$$w_u + \mathscr{L}_u\frac{\partial w_u}{\partial \mathscr{L}_u} + \mathscr{L}_s\frac{\partial w_s}{\partial \mathscr{L}_u} = \lambda w_u.$$

Therefore (recall $\frac{\partial I}{\partial \mathscr{L}_u} = \mathscr{L}_u \frac{\partial w_u}{\partial \mathscr{L}_u} + \mathscr{L}_s \frac{\partial w_s}{\partial \mathscr{L}_u}$)

$$\frac{\partial I}{\partial \mathscr{L}_u} = (\lambda - 1)\, w_u.$$

Inserting this into the indirect fiscal effect yields

$$d\mathscr{R}_{ind}^{\text{DRS}}(i) = h_i \omega_i w_u \left[\left(\tau_p - \bar{T}_I'\right)(1-\lambda) + \left(\bar{T}_s' - \bar{T}_u'\right)\left(\left|\gamma_{u,own} + \kappa_u (1-\lambda)\right|\right)\right],$$

which yields

$$d\mathscr{R}_{ind}^{\text{DRS}}(i) = y_i \left[\left(\tau_p - \bar{T}_I'\right)(1-\lambda) + \left(\bar{T}_s' - \bar{T}_u'\right)\left(\left|\tilde{\gamma}_{u,own}\right|\right)\right],$$

where $\tilde{\gamma}_{u,own} = \gamma_{u,own} + \kappa_u (1-\lambda)$ is own-wage elasticity, holding total labor income constant.

To solve for $\tilde{\gamma}_{u,own}$ as a function of the elasticity of substitution, note that as shown in Appendix A.A1, we can use the definition of the elasticity of subsitution to write:

$$-\frac{1}{\sigma} = \gamma_{u,own} - \gamma_{s,cross}. \tag{10}$$

From Euler's homogenous function theorem we know that

$$w_u \mathscr{L}_u + w_s \mathscr{L}_s = \lambda Y.$$

Taking derivatives with respect to $\mathscr{L}_u$ and rearranging yields

$$\gamma_{s,cross} = -\gamma_{u,own} \frac{w_u \mathscr{L}_u}{w_s \mathscr{L}_s} + (\lambda - 1) \frac{w_u \mathscr{L}_u}{w_s \mathscr{L}_s}.$$

Plugging this into (10) yields

$$-\frac{1}{\sigma} = \gamma_{u,own} \underbrace{\left(1 + \frac{w_u \mathscr{L}_u}{w_s \mathscr{L}_s}\right)}_{= \frac{\lambda Y}{w_s \mathscr{L}_s}} - \frac{w_u \mathscr{L}_u}{w_s \mathscr{L}_s}(\lambda - 1).$$

Solving for $\gamma_{u,own}$ yields

$$\gamma_{u,own} = (\lambda - 1) \frac{w_u \mathscr{L}_u}{\lambda Y} - \frac{1}{\sigma} \frac{w_s \mathscr{L}_s}{\lambda Y}.$$

Using $\frac{w_u \mathscr{L}_u}{\lambda Y} = \kappa_u$ and $\frac{w_s \mathscr{L}_s}{\lambda Y} = \kappa_s$ by Euler's homogenous function theorem yields

$$\gamma_{u,own} = (\lambda - 1)\, \kappa_u - \frac{1}{\sigma} \kappa_s.$$

Therefore, we can write

$$\tilde{\gamma}_{u,own} = -\frac{1}{\sigma} \kappa_s.$$

B.6 Indirect Fiscal Effect with Capital

We show the proof for the more general CES production function. Let production Y be given by

$$Y = \left(\theta_k K^\rho + \theta_l G\left(\mathscr{L}_u, \mathscr{L}_s\right)^\rho\right)^{1/\rho}.$$

We begin by solving for the relationship of factor price elasticities when capital supply is elastic and capital supply is inelastic. For this, first consider the case when capital supply is perfectly elastic. In this case, the capital labor ratio is constant. In this case, we can write $K = CG\left(\mathscr{L}_u, \mathscr{L}_s\right)$ where C is the constant capital labor ratio. The production function can be written as

$$Y = \bar{A}G\left(\mathscr{L}_u, \mathscr{L}_s\right),$$

where $\bar{A}$ is a constant.[17] The elasticities of wages with respect to low-skilled labor with perfectly elastic capital supply are given by

$$\gamma_{s,cross}^{elast} = \frac{\partial \log \frac{\partial G}{\partial \mathscr{L}_s}}{\partial \log \mathscr{L}_u}$$

and

$$\gamma_{u,own}^{elast} = \frac{\partial \log \frac{\partial G}{\partial \mathscr{L}_u}}{\partial \log \mathscr{L}_u}.$$

Following the arguments in Appendix A.A1, we can write these as $\gamma_{s,cross}^{elast} = \frac{1}{\sigma}\kappa_u$ and $\gamma_{u,own}^{elast} = -\frac{1}{\sigma}\left(1 - \kappa_u\right)$, where $\kappa_u = \frac{w_u \mathscr{L}_u}{w_u \mathscr{L}_u + w_s \mathscr{L}_s}$ is the share of wage payments that go to low-skilled labor.

Next, consider the case in which capital supply is perfectly inelastic. Let $\kappa_L = \frac{w_u \mathscr{L}_u + w_s \mathscr{L}_s}{Y}$ be the share of factor payments that go to labor, let $\kappa_K = 1 - \kappa_L$, and let r give the price of capital. Standard CES algebra yields the capital price elasticity

$$\gamma_{r,u} = \frac{\kappa_L}{\sigma}\kappa_u.$$

Further, note that log wages for each skill group are given by

$$\log w_u = \log \frac{\partial Y}{\partial G} + \log \frac{\partial G}{\partial \mathscr{L}_u}$$

and

$$\log w_s = \log \frac{\partial Y}{\partial G} + \log \frac{\partial G}{\partial \mathscr{L}_s}.$$

Taking derivatives of these log wage functions with respect to $\log \mathscr{L}_u$ yields

$$\gamma_{s,cross} = \underbrace{\frac{\partial \log \frac{\partial Y}{\partial G}}{\partial \log \mathscr{L}_u}}_{=-\frac{\kappa_K}{\sigma}\kappa_u} + \underbrace{\frac{\partial \log \frac{\partial G}{\partial \mathscr{L}_s}}{\partial \log \mathscr{L}_u}}_{\gamma_{s,cross}^{elast}}$$

[17] Concretely, note that $Y = \left(\theta_k \left(CG\right)^\rho + \theta_l G^\rho\right)^{1/\rho}$ and hence $Y = \left(\theta_k C^\rho + \theta_l\right)^{\frac{1}{\rho}} G$. Hence, the constant is given by $\bar{A} = \left(\theta_k C^\rho + \theta_l\right)^{\frac{1}{\rho}}$.

and

$$\gamma_{u,own} = \underbrace{\frac{\partial \log \frac{\partial Y}{\partial G}}{\partial \log \mathscr{L}_u}}_{=-\frac{\kappa_K}{\sigma}\kappa_u} + \underbrace{\frac{\partial \log \frac{\partial G}{\partial \mathscr{L}_u}}{\partial \log \mathscr{L}_u}}_{\gamma_{u,own}^{elast}},$$

which give the relationship between own wage elasticity with elastically supplied and inelastically supplied capital.

Now, consider the indirect fiscal effect with inelastically supply supplied capital:

$$d\mathscr{R}_{ind}(i) = h_i\omega_i \left[\tau_k K \frac{\partial r}{\partial \mathscr{L}_u} + \bar{T}_s' \mathscr{L}_s \frac{\partial w_s}{\partial \mathscr{L}_u} + \bar{T}_u' \mathscr{L}_u \frac{\partial w_u}{\partial \mathscr{L}_u}\right].$$

We can rewrite this as

$$d\mathscr{R}_{ind}(i) = h_i\omega_i \left[\tau_k \frac{rK}{\mathscr{L}_u}\gamma_{r,u} + \bar{T}_s'\frac{\mathscr{L}_s w_s}{\mathscr{L}_u}\gamma_{s,cross} + \bar{T}_u' w_u \gamma_{u,own}\right].$$

Plugging in the factor price elasticities from above yields

$$\begin{aligned} d\mathscr{R}_{ind}(i) =& h_i\omega_i \Bigg[\frac{\kappa_u}{\mathscr{L}_u\sigma}\left(\tau_k r K \frac{w_u\mathscr{L}_u + w_s\mathscr{L}_s}{Y} - \bar{T}_s'\mathscr{L}_s w_s \frac{rK}{Y} - \bar{T}_u'\mathscr{L}_u w_u \frac{rK}{Y}\right) + \\ & \bar{T}_s'\frac{\mathscr{L}_s w_s}{\mathscr{L}_u}\gamma_{s,cross}^{elast} + \bar{T}_u' w_u \gamma_{u,own}^{elast}\Bigg]. \end{aligned}$$

Factorizing $\kappa_K = \frac{rK}{Y}$ in the first line yields

$$\begin{aligned} d\mathscr{R}_{ind}(i) =& h_i\omega_i \Bigg[\kappa_K \frac{\kappa_u}{\mathscr{L}_u\sigma}\left(\tau_k(w_u\mathscr{L}_u + w_s\mathscr{L}_s) - \bar{T}_s'\mathscr{L}_s w_s - \bar{T}_u'\mathscr{L}_u w_u\right) + \\ & \bar{T}_s'\frac{\mathscr{L}_s w_s}{\mathscr{L}_u}\gamma_{s,cross}^{elast} + \bar{T}_u' w_u \gamma_{u,own}^{elast}\Bigg]. \end{aligned}$$

Letting $\bar{T}_I' = \frac{\bar{T}_s'\mathscr{L}_s w_s + \bar{T}_u'\mathscr{L}_u w_u}{w_u\mathscr{L}_u + w_s\mathscr{L}_s}$, we can rewrite this as:

$$d\mathscr{R}_{ind}(i) = h_i\omega_i \left[(w_u\mathscr{L}_u + w_s\mathscr{L}_s)\kappa_K \frac{\kappa_u}{\mathscr{L}_u\sigma}\left(\tau_k - \bar{T}_I'\right) + \bar{T}_s'\frac{\mathscr{L}_s w_s}{\mathscr{L}_u}\gamma_{s,cross}^{elast} + \bar{T}_u' w_u \gamma_{u,own}^{elast},\right]$$

which can be simplified to

$$d\mathscr{R}_{ind}(i) = h_i\omega_i \left[w_u \frac{\kappa_K}{\sigma}\left(\tau_k - \bar{T}_I'\right) + \bar{T}_s'\frac{\mathscr{L}_s w_s}{\mathscr{L}_u}\gamma_{s,cross}^{elast} + \bar{T}_u' w_u \gamma_{u,own}^{elast}.\right]$$

Further, we know that F is constant returns to scale, which implies that $w_u \gamma_{u,own}^{elast} = -\frac{\mathscr{L}_s w_s}{\mathscr{L}_u} \gamma_{s,cross}^{elast}$ (recall Lemma 1). We can therefore write

$$d\mathscr{R}_{ind}(i) = h_i \omega_i \left[w_u \frac{\kappa_K}{\sigma} \left(\tau_k - \bar{T}_I' \right) + \left(\bar{T}_s' - \bar{T}_u' \right) w_u |\gamma_{u,own}^{elast}| \right].$$

Rearranging this equation yields

$$d\mathscr{R}_{ind}(i) = y_i \left[\left(\bar{T}_s' - \bar{T}_u' \right) |\gamma_{u,own}^{elast}| + \frac{\kappa_K}{\sigma} \left(\tau_k - \bar{T}_I' \right) \right]. \tag{11}$$

If the production function is Cobb-Douglas in capital and the labor aggregate, then $\frac{\kappa_K}{\sigma} = \alpha$.

C Empirical Appendix

C.1 Data Cleaning in the ACS and Calculation of Tax Rates

We use data from the 2017 ACS. We limit the sample to individuals between ages 18 and 65 who do not live in group quarters. We limit our sample to household heads and their spouses, as tax filling status is less clear for other individuals. This leaves us with a sample of over 1.2 million individuals.

When calculating taxes, we account for an individual's wage income and business income as sources of taxable income. All income weighted averages are weighted by wage incomes and sample weights. When calculating the income-weighted pass-through tax rate in Section A.5, we weight by business income.

To calculate marginal income and payroll tax rates, we begin by calculating the total income for each household head and their spouse for all households in the ACS. We then use TAXSIM to calculate the marginal income and payroll taxes for each individual, taking into account the individual's marital status (which determines filing status), number of children (a determinant in personal exemptions), age of children (a determinant in eligibility of the Dependent Care Credit, the Child Credit, and the Earned Income Tax Credit), location (which determines state income tax schedules), and age of the household head and spouse (which determine eligibility for various deductions and exemptions).

C.2 Calculation of Marginal Phase-Out Rates and TANF and SNAP

We begin by calculating total monthly SNAP benefits and TANF benefits for each household in the SIPP. One issue is that benefit receipts are generally underreported in household surveys, including the SIPP (Meyer, Mok, and Sullivan, 2015). To deal with this, we utilize data from the U.S. Bureau of Economic Analysis' National Income and Product Accounts (NIPA) tables, which report annual government spending on various U.S. programs. We multiply benefit receipt amounts in the SIPP by a multiplicative constant such that the total population-weighted benefit receipts in the SIPP are consistent with the aggregates from the NIPA tables. Specifically, we utilize data from NIPA Table 3.12. We multiply SNAP benefits in the SIPP by a constant such they are consistent with SNAP benefits from this table and multiple TANF benefits in the SIPP by a constant such they are consistent with "Family assistance" benefits from this table multiplied by the fraction of TANF benefits which are spend on basic assistance.

Next, we divide households by household size and estimate monthly TANF and SNAP benefits as a linear spline in household income. We estimate a separate spline for each household size. Next, using these function of benefits as a function of income, we can calculate the *marginal* average monthly benefits as a function of monthly income and household size. We aggregate these monthly estimates to yearly estimates by taking the income-weighted average across months for each household in the SIPP.

C.3 Calculation of Government Medicaid Costs

First, we calculate the number and age of all household members who are on Medicaid for each month for each household in the SIPP. To calculate the government cost associated with each household member on Medicaid, we use estimates of the average government cost for adults and for children from the Kaiser Family Foundation.[18] Specifically, we assign the national average costs for adults and children for each medically enrolled adult and child in our data.

Next, as with our calculation of TANF and SIPP phase-out rates, we divide households by household size and estimate monthly Medicaid costs as a linear spline in household income, using a separate spline for each household size. We can then calculate the marginal average monthly government cost as a function of monthly income and household size by using these functions of cost as a function of income. We then take the income-weighted average across months for each household to aggregate these monthly estimates to yearly estimates.

C.4 Calculation of Marginal Replacement Rates of Social Security Benefits

An individual's social security benefits are calculated as a function of their average indexed monthly earnings (AIME). If the current year's income is one of the 35 highest earning years, a \$1 increase in current year income will increase an individual's AIME by \$1/35. If the current year's income is not one of the 35 highest earning years, a marginal increase in current year income will have no effect on social security benefits. Further, if current year's income is above the maximum taxable earnings threshold, an increase in current income has no effect on social security benefits.

[18] https://www.kff.org/medicaid/state-indicator/medicaid-spending-per-enrollee/

We assume an individual receives social security from age 66 until their death.
Let $MRR(AIME_i)$ denote the marginal increase in yearly social security benefits as a function of an individual's AIME and let T_i represent an individual's life expectancy. The discounted marginal replacement rate associate with current earnings of an individual of age age_i is given by:

$$DRR_i = MRR(AIME_i)\frac{1}{35}\left(\frac{1+g}{1+r}\right)^{65-age_i}\sum_{t=66}^{T_i}\left(\frac{1}{1+r}\right)^{t-65} \tag{12}$$

if current year income is one of the individual's 35 highest earning years and income is below the maximum taxable earnings threshold, and 0 otherwise, where g is the aggregate growth rate and r is the interest rate. This gives the increase in yearly social security benefits associated with a $1 increase in AIME. An increase in the current year's income increase the average career income by 1/35, which in turn increases yearly future social security benefits from the agents retirement until death.

We estimate an individual's AIME and 35th highest year of earning as a function of current income and household characteristics using data from the NLSY79. The NLSY79 is a nationally representative panel dataset which provides data on respondents from 1979 until 2016. There are a few issues with missing data that we need to resolve. First, starting in 1994, individuals are only interviewed in even numbered years. We therefore assume that data in odd numbered years post 1994 is the same as in the previous year. Further, in 2016, the last year from which data are available, respondents are between age 53 and 60. We therefore do not have income information for the last few years of individual's working lives. We therefore assume that income for the remainder of the working life is equal to a respondent's last observed income.

After dealing with these data issues, we can calculate an individual's AIME as the average of their 35 highest income years, adjusted for inflation, and an individual's 35th highest income year. We calculate the average of these two statistics conditional the following characteristics:

1. An individual's education - high school dropout, high school graduate, some college, or college graduate
2. Whether or not an agent is married
3. 5-year age bins
4. Whether or not the agent has children living in their household
5. Quintiles of the income distribution, conditional on working and conditional on the above characteristics.

For individuals in the ACS, we impute AIME and 35th highest earning year as the average of these two statistics conditional on the characteristics above.

	Elasticity of Substitution		
	1.5	2.0	2.5
I. No Labor Supply Responses	1004	753	602
II. Endogenous Labor Supply			
Common Elasticity	1133	913	765
By Income and Marital Status	1034	791	641
By Income, Gender and Marital Status	1006	769	623

Table 4: Indirect Fiscal Effects of low-skilled immigrants using estimates of labor supply elasticities from Bargain, Orsini, and Peichl (2014). The three columns show the indirect fiscal effect under different assumptions of the elasticity of substitution, ranging from $\sigma = 1.5$ to $\sigma = 2.5$. Each row displays the indirect fiscal effect for different assumptions about the labor supply elasticity.

Finally, a crucial element of this calculation is an individual's life expectancy, which determines how many years the individual receives benefits. To calculate life expectancy, we use estimates of life expectancy conditional on income from Chetty et al. (2016), who estimate life expectancy for household income percentiles using data from 1.4 billion tax and social security death records.[19]

C.5 Results Using Labor Supply Elasticities from Bargain, Orsini, and Peichl (2014)

Table 4 shows the indirect fiscal effect when we use estimates of labor supply elasticities from Bargain, Orsini, and Peichl (2014), who estimate a discrete choice model to estimate elasticities. The first two rows show the calculated indirect fiscal effect with no labor supply responses, and when using an estimate of extensive and intensive labor supply elasticities from Chetty (2012). In the third row, we allow labor supply elasticities to vary by gender and marital status. We use estimates of gender and marital status specific intensive and extensive labor supply elasticities from Bargain, Orsini, and Peichl (2014). Finally, in the fourth row, we consider the scenario in which labor supply elasticities can vary by gender, age, and income. For this we use estimates of intensive and extensive labor supply elasticities by gender, marital status and quintile of the income distribution from Bargain, Orsini, and Peichl (2014).[20]

Tables 5 and 6 display the extensive and intensive labor supply elasticities estimated in Bargain, Orsini, and Peichl (2014). The first column displays the income quintile. The next four columns display the labor supply elasticities for married females, single females, married males, and single males, respectively.

[19] We calculate each individuals household's income percentile within their age. We then use the gender specific life expectancy associated with this income percentile.

[20] We choose to utilize the labor supply estimates from Bargain, Orsini, and Peichl (2014) because they estimate gender and income specific intensive and extensive margin elasticities using a common estimation procedure. Our results are very similar if we use estimates on extensive labor supply elasticities by wage

Income Quintile	Females		Males	
	Married	Single	Married	Single
1	0.12	0.19	0.07	0.20
2	0.12	0.31	0.05	0.25
3	0.12	0.23	0.05	0.20
4	0.12	0.16	0.04	0.16
5	0.11	0.09	0.02	0.10

Table 5: Estimates of extensive margin labor supply elasticities from Bargain, Orsini, and Peichl (2014) by income quintile, gender, and marital status.

Income Quintile	Females		Males	
	Married	Single	Married	Single
1	0.02	0.03	0.02	0.01
2	0.02	0.03	0.03	0.02
3	0.02	0.04	0.03	0.02
4	0.02	0.05	0.03	0.02
5	0.04	0.06	0.05	0.04

Table 6: Estimates of intensive margin labor supply elasticities from Bargain, Orsini, and Peichl (2014) by income quintile, gender, and marital status.

C.6 Quantifying the Fiscal Effect in Peri and Sparber (2009)

We now calculate the indirect fiscal benefits and its decomposition as expressed in equation 7. In order to evaluate this equation, we need estimates of the following:

1. (w_m, w_c, w_s) – the task prices of manual, communication, and cognitive tasks.
2. (σ, σ_u) – the elasticities of substitution between high-skilled and low-skilled workers, and between manual tasks and cognitive tasks.
3. $\left(\eta_c^f, \eta_f^m, \eta_d^c, \eta_d^m\right)$ – the elasticities of task intensities with respect to immigrant inflows.
4. (N_f, N_d, N_s) – the number of low-skilled foreign-born, low-skilled domestic-born and high-skilled workers.
5. (c_f, c_d, m_f, m_d) – the task intensities of low-skilled foreign-born and domestic-born workers
6. $\left(\bar{T}'_f, \bar{T}'_d, \bar{T}'_s\right)$ – marginal tax rates faced by low-skilled foreign-born, low-skilled domestic-born, and high-skilled workers.

We take estimates of items (1) - (3) directly from Peri and Sparber (2009). Specifically, Peri and Sparber (2009) estimate the state level task prices of manual and cognitive tasks, w_m and w_c, using variation in task supplies and wages across occupations. We take the national

percentile from Juhn, Murphy, and Topel (2002), who estimate extensive margin elasticities using a sample of U.S. men.

average of these task prices for our measures of w_m and w_c. Peri and Sparber (2009) estimate the elasticity of substitution between manual and communication tasks, σ_u, using state level variation in immigrant inflows. We set $\sigma_u = 1$ as the preferred estimates from Peri and Sparber (2009) and set the elasticity of substitution between low- and high-skilled workers as $\sigma = 1.75$, based on the calibration in Peri and Sparber (2009). Peri and Sparber (2009) also use across-state immigrant variation to estimate the elasticities of task supplies with respect to the immigrant share of low-skilled workers. They find that domestic-born workers respond to low-skilled immigrant inflows by increasing their communication task supply but do not change their manual task supply, and that immigrants do not change their task supplies in response to immigrant inflows. We therefore set $\eta_f^c = \eta_f^m = \eta_d^m = 0$ and take $\eta_d^c = 0.33$ from their estimates.

To measure (4)-(6) we follow Peri and Sparber (2009) closely using data from the 2017 ACS downloaded from IPUMS (Ruggles, Flood, Goeken, Schouweiler, and Sobek, 2021) and data on task composition of occupations from ONET. We define low-skilled workers as workers with a high school degree or less. We can therefore calculate N_f, N_d and N_s directly from the 2017 ACS as the number of low-skilled foreign-born, low-skilled domestic-born and high-skilled workers. To estimate the task supplies, we proceed in two steps. The ONET dataset measures the task requirement for each census occupation code. We use the procedure described in Peri and Sparber (2009) to assign a manual and communication intensity to each occupation. Then, for each worker in the ACS, we calculate the manual and communication task requirements associated with the worker's occupation. Let $\tilde{c}_j$ and $\tilde{m}_j$ represent the average communication and manual task intensity of workers of type j.

Recall that the task supplies are defined as the task intensities multiplied by labor supply: $c_j = h_j \tilde{c}_j$ and $m_j = h_j \tilde{m}_j$. Note that the worker's budget constraint can be rewritten as

$$y_j = h_j \left(\tilde{c}_j w_c + \tilde{m}_j w_m \right),$$

where task prices, w_c and w_m, are known values from Peri and Sparber (2009), and the average income of workers of type j, y_j, can be estimated directly from the ACS. We can therefore use this equation to solve for h_j for low-skilled foreign-born and domestic-born and therefore for all four task supplies, c_f, c_d, m_f, and m_d.

D Further Quantitative Results

D.1 Quantification: Welfare and Distributional Effects

We calculate the welfare effects of immigration using the so-called inverse optimum weights as in Hendren (2020), see Appendix B.1 for the theory. These are the welfare weights for which the current U.S. tax-transfers system is optimal according to optimality conditions

Object	Value	Desription	Source
Task Prices			
w_m	773	Manual task wage	PS inflated to 2017
w_c	820	Communication task wage	PS inflated to 2017
w_s	$69,311$	Skilled income	ACS
Production Parameters			
σ	1.75	Elasticity of substitution, skilled and unskilled workers	PS
σ_u	1	Elasticity of substitution, manual and communication tasks	PS
Task Supply Elasticities			
η_c^d	.33	Elasticity of domestic-born communication task supply with respect to immigrants	PS
$\eta_m^d, \eta_m^f, \eta_c^f$	0	Other task supply elasticities	PS
Population Shares			
$\frac{N_f}{N}$	0.069	Low-skilled foreign-born as fraction of population	ACS
$\frac{N_d}{N}$	0.318	Low-skilled domestic-born as fraction of population	ACS
$\frac{N_s}{N}$	0.613	High-skilled workers as fraction of population	ACS
Task Supplies			
c_f	12.47	Communication task supply of low-skilled foreign-born	ONET and ACS
c_d	19.15	Communication task supply of low-skilled domestic-born	ONET and ACS
m_f	27.71	Manual task supply of low-skilled foreign-born	ONET and ACS
m_d	29.18	Manual task supply of low-skilled domestic-born	ONET and ACS
Marginal Tax Rates			
$\bar{T}_f'$	0.31	Marginal tax rate of low-skilled foreign-born	Tax quantification
$\bar{T}_d'$	0.30	Marginal tax rate of low-skilled domestic-born	Tax quantification
$\bar{T}_s'$	0.37	Marginal tax rate of high-skilled workers	Tax quantification

Table 7: Summary of data sources and calibrated values. "PS" refers to estimates taken from Peri and Sparber (2009).

from the optimal income tax literature. Hendren (2020) shows that by using these weights, one can extend the Kaldor-Hicks surplus to account for distortionary costs of compensation.[21] If the welfare effect is positive with such weights, then a Pareto improvement can be achieved because the losers can be compensated.[22]

For the U.S., Hendren (2020) calibrates a weight function which is generally decreasing in income and thus gives higher weight to low-skilled than high-skilled individuals. For such weights, low-skilled immigration will lead to negative distributional effects because the income losses of low-skilled receive a higher weight than the income gains of high-skilled.

Table 8 summarizes the welfare effects associated with the distributional effects and the indirect fiscal effects of immigration as formalized in Proposition 1. In the first three columns, we calculate the welfare effects using the welfare weights of Hendren (2020), where the utility of all residents, both domestic-born and foreign-born, are considered. Given the intermediate value of $\sigma = 2$, quantification of the formula in Proposition 1 reveals a distributional effect of -\$1,318. This quantifies the welfare costs caused by the increase in inequality associated with low-skilled immigration. The magnitude of this distributional effect is sensitive to how the social welfare weights differ with income: here we use the welfare weights of Hendren (2020), which are the welfare weights implicitly used by the U.S. government.[23]

[21] Going one step further, Schulz et al. (2022) generalize the compensation principle to a setting where distortive taxes also imply general equilibrium effects on wages, which creates a complicated fixed-point problem. The authors analytically describe the tax reform that achieves compensation in such a setting.

[22] One underlying assumption that this can be achieved with a standard tax schedule, is that for a given income level, all individuals are affected in the same way. This assumption is apparently violated in our model where at a certain income level, both low and high-skilled individuals are present and hence compensating policies would need to condition on skill.

[23] Note that generally, the weights that Hendren (2020) obtained, depend on his calibration of the income distribution, the tax-transfer system calibration and the elasticities, which is not the same calibration for these objects as in our paper. We consider it as a reasonably good approximation to work with his weights,

However, this distributional effect is partially offset by the two welfare effects related to indirect fiscal effects: the fiscal externalities associated with changes in resident labor supply and the tax mitigation effect. Evaluating (6) with common labor supply elasticities and $\sigma = 2$, we find a fiscal externality of $330, roughly one third of the entire indirect fiscal effect.[24] The distributional effect is further mitigated by the fact that the tax burden for low-skilled residents decreases while the tax burden for high-skilled residents increases. This tax mitigation effect creates an additional surplus of $525. Therefore, the two novel welfare effects associated with the indirect fiscal effect — the fiscal externality and the tax mitigation effect — imply an additional, so far neglected, surplus of $855. All together, this implies a welfare effect beyond the direct fiscal effect of -$463 compared to a pure distributional effect of -$1,318.

In the last three columns, we calculate the effects on domestic-born welfare by only assigning non-zero welfare weights to domestic-born individuals.[25] The distributional effects are significantly muted as domestic-born are more likely to be skilled than previous immigrants. For $\sigma = 2$, we find a distributional effect for domestic-born of -$932. This implies a welfare effect beyond the direct fiscal effect of -$212.

Overall, these welfare effects of residents are rather small in magnitude compared to estimates of wage gains that low-skilled immigrants experience as a result of coming to the United States. Clemens, Montenegro, and Pritchett (2008) find that U.S. immigrants from the countries in their sample have 200% to 1500% higher wages than observably identical individuals who remain in their home country. For a low-skilled Mexican male immigrant, this implies an income gain of nearly $20,000 annually.[26] Hendricks and Schoellman (2018) find that immigrants from low- and middle-income countries increase their wages by 200% to 300% upon arriving in the United States. This suggests that the overall welfare effects are likely to be positive if the welfare of the immigrants themselves are accounted for.

D.2 Total Marginal and Participation Tax Rates

Figure 1 shows the total marginal and participation tax rates by individual earnings as the sum of the effective tax rates arising from income taxes, social security, and transfer payments. Panel (a) gives the marginal effective tax rates as the sum of marignal races from income taxes,

in particular because the welfare results are not the main results of this paper. The weights of Lockwood and Weinzierl (2016) are very similar, who study how welfare weights implicitly used by the U.S. government have changed over time.

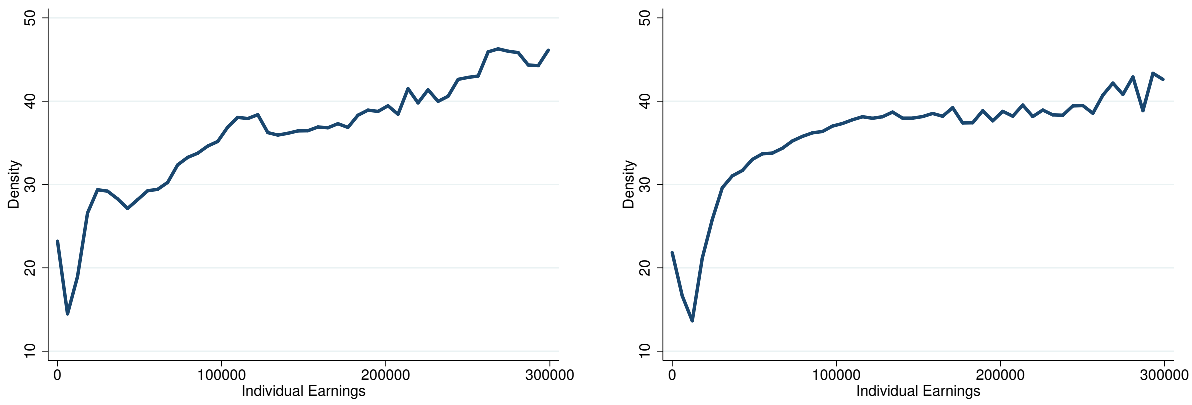
[24] Note that holding labor supply elasticities constant, the fiscal externality is the same fraction of the indirect fiscal effect for any value of the elasticity of substitution, σ. Therefore, the result that the fiscal externality is over one third of the fiscal surplus is true for any value of the elasticity of substitution.

[25] We again utilize the use the welfare weights of Hendren (2020) and set the weights for foreign-born individuals to zero. We then we normalize the welfare weights such that are equal to one on average.

[26] The average low-skilled male Mexican immigrant in our dataset has an average wage income of $32,841. Clemens, Montenegro, and Pritchett (2008) estimate that Mexican immigrants have wages 2.53 times higher than observably identical Mexicans who do not immigrate. We calculate the average income gain as $32,841 - \frac{32,841}{2.53} = 19,860$.

	All Residents			Domestic-Born Only		
	1.5	2.0	2.5	1.5	2.0	2.5
I. Distributional Effect	-1634	-1318	-1104	-1157	-932	-781
II. Fiscal Externality	409	330	276	409	330	276
III. Tax Mitigation	651	525	440	484	391	327
Total	-574	-463	-388	-263	-212	-178

Table 8: Welfare effects of low-skilled immigrants absent direct fiscal effects. The right panel displays the welfare effects when only domestic-born residents receive positive social welfare weights. Within each panel, the three columns show the indirect fiscal effect under different assumptions of the elasticity of substitution, ranging from $\sigma = 1.5$ to $\sigma = 2.5$ with common labor supply elasticities.



(a) Marginal Taxes

(b) Participation Taxes

Figure 1: Total marginal and participation tax rates by individual earnings. Panel (a) gives the marginal effective tax rates as the sum of marginal races from income taxes, the social security system, and transfer programs. Panel (b) reports the total participation tax rates implied by income taxes, the social security system, and transfer programs.

	Elasticity of Substitution		
	1.5	2.0	2.5
I. No Labor Supply Responses	846	634	508
II. Endogenous Labor Supply	971	783	656

Table 9: Indirect Fiscal Effects with intensive and extensive margin labor supply responses with real interest rate of 2%.

	Elasticity of Substitution		
	1.5	2.0	2.5
I. No Labor Supply Responses	960	720	576
II. Endogenous Labor Supply	1079	870	728

Table 10: Indirect Fiscal Effects with intensive and extensive margin labor supply responses with alternative skill definition.

the social security system, and transfer programs. Panel (b) reports the total participation tax rates implied by income taxes, the social security system, and transfer programs.

D.3 Indirect Fiscal Effects in Baseline Model with Real Interest Rate of 2%

In Section I we chose a real interest rate of 1%. In Table 9 we replicated our baseline results under the assumption of a real interest rate of 2%. The table shows the indirect fiscal effects of the average low-skilled immigrant.

D.4 Indirect Fiscal Effects in Baseline Model with Alternative Skill Definitions

In Section I, we defined low-skilled workers as those with no college experience and defined high-skilled workers as individuals with some college and college graduates. An alternative way to delineate skills is to divide individuals with some college between low-skilled and high-skilled workers, as in Card (2009) or Katz and Murphy (1992).

In this section we replicate our baseline results from Section III, except we define skill groups as in Card (2009), by dividing individuals with some college evenly between the groups. Overall, the indirect fiscal effects here are slightly smaller than our baseline result. This makes sense, the skill definitions we use in this section imply a smaller high-skilled share of income and therefore a smaller own-wage elasticity for low-skilled workers, holding the parameter σ constant. However, the results are still in the same ballpark as those presented in Section III.

	Elasticity of Substitution		
	1.5	2.0	2.5
I. No Labor Supply Responses	857	642	514
II. Endogenous Labor Supply	966	779	653

Table 11: Indirect Fiscal Effects for high school dropouts with intensive and extensive margin labor supply responses. See description from Table 2.

	Elasticity of Substitution		
	1.5	2.0	2.5
I. No Labor Supply Responses	1108	831	665
II. Endogenous Labor Supply	1250	1008	844

Table 12: Indirect Fiscal Effects for high school graduates with intensive and extensive margin labor supply responses. See description from Table 2.

D.5 Indirect Fiscal Effects in Baseline Model with for High School Dropouts and High School Graduates

Tables 11 and 12 show the indirect fiscal effects for the average high school dropout immigrant and the average high school graduate immigrant.

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