Optimizing Migration Quotas: Per Capita GDP, Industry Allocation and Voter Preferences

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Abstract

This paper studies how migration quotas and the allocation of migrant workers across industries affect GDP per capita. We develop a tractable mechanism that assigns migrants to industries according to marginal labor productivity, identifying both the industry composition and the aggregate migration quota that maximize GDP per capita. The framework also characterizes workers' and nonworkers' preferences over migration quotas and determines the outcome of majority voting. In the model, the optimal migration quota depends on the share of nonworkers in the population and on the aggregate elasticity of output with respect to labor. The GDP-per-capita-maximizing quota does not generally coincide with the majority-voting outcome. We implement the mechanism using U.S. data for 65 industries over the period 2001–2018. Counterfactual simulations show that reallocating observed migrant inflows according to the mechanism would have generated substantially higher GDP per capita growth in most years. To match observed growth rates, the efficient migration quota implied by the model is typically lower than actual migrant inflows. Overall, we show that targeting migrant inflows toward high-productivity industries improves economic performance while remaining consistent with political constraints.

Keywords: Migration policy, Industry labor allocation, GDP per capita, Skill composition.

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1 Introduction

Migration is increasingly viewed as a policy tool to address population aging and low fertility in advanced economies, making it essential to design migration policies with clearly defined objectives. This paper proposes a mechanism to increase GDP per capita by allocating migrants efficiently across industries. The mechanism provides a systematic method for ranking industries by marginal productivity, thereby identifying where migrant inflows generate the highest returns. For any given migration quota, it determines the optimal composition of migrants that maximizes GDP per capita. It also identifies the overall optimal quota that achieves this maximum, as well as the quota preferred by the median voter. Taken together, this framework clarifies how migration policies can be designed to balance economic efficiency and political feasibility.

The mechanism is defined within a theoretical model of labor allocation across industries in an economy with a fixed population, composed of workers with industry-specific qualifications and nonworkers.[1] GDP depends on the amount of labor employed in each industry and exhibits a constant elasticity with respect to labor in each industry. The initial distribution of workers determines marginal productivity across industries, which in turn allows industries to be systematically ranked.

The model identifies the conditions under which migration increases GDP per capita. It assumes an unrestricted supply of migrants who possess the necessary skills. For any given migration quota, we propose an optimal allocation mechanism that strategically distributes migrants across industries to maximize GDP per capita. The mechanism begins by assigning appropriately skilled migrants to the industry with the highest marginal productivity. Allocation continues until marginal productivity is equalized with that of the next most productive industry. Once marginal productivities are equalized, the mechanism continues allocating migrants so that marginal productivity in both industries declines at the same rate. This process is repeated until the predetermined migration quota is reached.

Given the allocation rule for each migration quota, we compute the quota that maximizes GDP per capita. This quota determines which industries receive migrants (active industries) and which do not (inactive industries). Based on the industry ranking, the first industry without migrant inflows has a lower marginal productivity than the last industry that receives migrants.

The design of the mechanism not only allows us to identify the migration quota that maximizes GDP per capita, but also enables us to derive agents' preferences over migration quotas. We assume that nonworkers prefer higher GDP per capita to lower GDP per capita, while workers care about their wages. Workers in any industry experience wage increases as long as no new workers enter their own industry. Consequently, they prefer migrants to be allocated to other industries and

[1] Nonworkers include retirees and individuals whose skills do not meet the requirements for employment in any industry.

oppose additional entrants into their own. We then show that a majority-voting equilibrium exists, thereby determining migration policy in terms of both quota and composition.

The migration quota selected in the voting equilibrium does not necessarily coincide with the GDP-per-capita-maximizing quota. We also conduct a comparative statics analysis of how the majority-voting migration quota responds to structural changes. A reduction in the number of nonworkers or workers in inactive industries lowers the majority-voting equilibrium quota, whereas a decline in employment in active industries raises it. Similarly, when inactive industries become more productive, the voting-equilibrium quota falls and migration is reduced, while productivity improvements in active industries lead to a higher majority-voting equilibrium quota, facilitating the entry of new workers.

We implement an empirical application of the mechanism in the context of the U.S. economy, covering the period from 2001 to 2018 and a total of 65 industries. The analysis begins by estimating the elasticity of aggregate output with respect to labor in each industry, capturing both the direct effect on that industry's output and downstream intermediate-input spillovers (Vollrath 2024, Baqaee & Farhi 2020).

In our model, the marginal productivity of labor in each industry is proportional to the ratio of the industry's labor elasticity to its share of total employment. We then rank industries according to this ratio, thereby identifying those in which reallocating additional workers would have the greatest aggregate impact, either through their centrality in final demand or their importance as providers of intermediate goods and services. Building on this ranking, we implement the mechanism to allocate migrants to the industries that generate the largest gains in GDP per capita.

In the final part of the empirical analysis, we quantify the year-by-year impact of implementing our mechanism using observed data. The first exercise examines the counterfactual growth in GDP per capita that would have occurred if the actual inflow of migrants had been allocated according to our mechanism. The second exercise repeats this analysis but restricts the migration quota to the number of work visas issued. The third exercise estimates the migration quota that would have been required to replicate the observed growth in GDP per capita. In addition, we assess how the migration quota changes when migrants are assumed to bring accompanying nonworking individuals.

The results indicate that the actual performance of the economy closely matches the growth predicted by the mechanism during periods of strong GDP per capita expansion. However, in most other years, the mechanism predicts substantially higher growth rates than those observed. To replicate the observed growth in GDP per capita, our estimates suggest that the efficient quota would have been consistently lower than the actual number of migrants, even when migrants are accompanied by nonworking individuals.

The remainder of the paper is organized as follows. Section 2 reviews the related literature, and Section 3 develops the theoretical model. Section 4 examines the frictionless case in which workers can freely move across industries, while Section 5 introduces qualification-based restrictions on mobility. Section 6 analyzes the preferences of workers and nonworkers and characterizes the majority-voting equilibrium. Section 7 presents the empirical implementation of our mechanism, and Section 8 concludes.

2 Literature review

The labor-market impact of migration has long been a central question in economics. Foundational theoretical work shows that migrant labor can substitute for or complement native labor. As a result, migrant inflows may raise wages and employment for high-skilled natives while exerting short-term downward pressure on low-skilled natives (Borjas 2003, Ottaviano & Peri 2012, Peri 2012). However, empirical evidence remains mixed. Some studies document negligible effects of migration on native outcomes, while others find short-term impacts consistent with these mechanisms (Card 2001, Peri & Sparber 2009, d'Amuri et al. 2010, Manacorda et al. 2012, Foged & Peri 2016, Peri 2016, Dustmann et al. 2017, Peri & Yasenov 2019, Monras 2020).

One strand of the literature studies the political economy of migration. This work examines the determinants of migration quotas and the skill composition of migrant inflows. Macro-quantitative studies show that existing migration policies are far more restrictive than what global efficiency would prescribe. Clemens (2011) documents that reducing barriers to labor mobility would yield welfare gains far exceeding those from further trade liberalization, while Di Giovanni et al. (2015) quantify large bilateral gains from both observed and counterfactual flows in a global general-equilibrium setting. Historical evidence reinforces these results. Abramitzky & Boustan (2017) show that migration generates substantial long-term benefits with limited harm to natives. Political-economy models explain why democracies nevertheless adopt restrictive and skill-biased policies. Benhabib (1996) and Ortega (2005) show that majority voting leads to quotas that protect native factor incomes and internalize the future political power of migrants, while Dolmas & Huffman (2004) highlights how expectations about redistribution shape equilibrium migration and taxation.

A second strand of the literature studies individual attitudes toward migration and the microfoundations of migration policy. Early work shows that preferences reflect expected labor-market competition: low-skilled natives, who face greater wage pressure, are more likely to oppose migration (Scheve & Slaughter 2001). Cross-country evidence confirms that the relationship between skills and migration preferences depends on relative factor endowments (Mayda 2006). Fiscal considerations also matter. Facchini & Mayda (2009) show that more redistributive welfare states amplify

opposition among low-skilled natives who fear the fiscal burden imposed by migrants. These attitudes are closely linked to policy outcomes. Facchini & Mayda (2008) show that migration policy mirrors the preferences of the median voter, and Alesina & Tabellini (2024) synthesize evidence on how migration shapes political behavior, identity, and redistribution.

This paper contributes to the migration literature in several dimensions. Our framework complements work on wage and employment effects by showing that, even for a fixed quota, aggregate outcomes hinge on where migrants are allocated across industries. It also complements political-economy models of quotas by deriving a majority-voting (median-voter) quota from workers' industries-specific wage incentives and nonworkers' preference for higher GDP per capita. Finally, we provide a simple, operational mechanism, and an empirical application for the U.S. (2001–2018) that translates efficiency and political constraints into concrete recommendations on both quota and composition.

3 Theoretical Model

Consider an economy with a finite population of size n^0, who can be either workers or nonworkers. Let l^0 denote the total number of workers and l_u^0 the number of nonworkers. We assume that there are q productive industries, $Q = \{1, 2, \ldots, q\}$, and that each worker supplies one unit of labor.

Aggregate output (GDP) is given by $Y = f(l_1, \ldots, l_q)$, where l_s denotes labor employed in industry s. We assume that f is strictly increasing in labor in each industry, twice continuously differentiable, concave, and exhibits constant elasticity with respect to labor in each industry.[2] Let $(\gamma_1, \ldots, \gamma_q)$ denote the vector of labor elasticities, with $\sum_{s=1}^{q} \gamma_s < 1$. Let y denote GDP per capita, defined as $y = Y/n^0$. An economy is therefore fully characterized by the vector $(n^0, (\gamma_s)_{s \in Q})$.

Given the labor allocation across industries $(l_1, \ldots, l_q)$, let $\pi_s = l_s/l$ denote the share of workers employed in industry s, where $l = \sum_{s=1}^{q} l_s$ is total employment. The marginal productivity of labor in industry s can then be written as

$$\frac{\partial f(l_1, \ldots, l_q)}{\partial l_s} = \frac{\gamma_s}{\pi_s} \frac{f(l_1, \ldots, l_q)}{l}. \tag{1}$$

It follows immediately that marginal labor productivity in industry s exceeds that in industry s' if and only if $\gamma_s/\pi_s > \gamma_{s'}/\pi_{s'}$. Thus, marginal labor productivity in a given industry is determined by the elasticity of output with respect to labor in that industry, relative to its share of total employment, and by the average product of labor.

[2]The assumption of constant elasticity in the production function, as in a Cobb–Douglas specification, substantially simplifies the analysis. It allows industries to be ranked not only in the initial economy but also as labor allocations change over time. We adopt this reduced level of generality in favor of a clearer characterization of the economy's evolution as new workers are incorporated.

The primary objective of the paper is to identify the migration quota and skill composition that best serve the economy's needs while securing the support of a majority of agents. Subsequent sections examine how selecting migrants with skills tailored to specific industries can maximize GDP per capita and, consequently, the utility of nonworkers. This strategic perspective is key to understanding workers' preferences regarding the integration of industry-specific skilled migrants into the economy. To conduct this analysis, we begin by establishing a benchmark frictionless economy in which workers can freely move across industries without qualification-based restrictions.

4 Optimizing Labor Allocation Across Industries: Benchmark

In this section, we characterize the optimal allocation of workers across industries to maximize GDP, assuming that all workers are equally qualified to work in any industry. Given a total number of workers l, the optimal allocation across industries solves

$$\begin{aligned} &\underset{\{l_1,\ldots,l_q\}}{\text{Maximize}} \quad f(l_1,\ldots,l_q) \\ &\text{s.t.} \qquad\qquad \sum_{s=1}^{q} l_s = l. \end{aligned} \tag{2}$$

The first-order conditions imply that, for any $s, s' \in Q$, $\partial f/\partial l_s = \partial f/\partial l_{s'}$. Using the expression for marginal labor productivity derived above, this condition is equivalent to $\gamma_s/\pi_s = \gamma_{s'}/\pi_{s'}$. Together with the constraint $\sum_{s=1}^{q} \pi_s = 1$, this yields the solution to problem (2):

$$\frac{\gamma_s}{\pi_s} = \sum_{j=1}^{q} \gamma_j \quad \text{or, equivalently,} \quad \frac{l_s}{l} = \frac{\gamma_s}{\sum_{j=1}^{q} \gamma_j}. \tag{3}$$

Thus, the proportion of workers allocated to industry s is proportional to the elasticity of output with respect to labor in that industry. Industries with higher labor elasticities relative to the economy-wide average employ a larger share of the workforce. We refer to this allocation as the efficient distribution of labor across industries. Under this allocation, marginal labor productivity is equalized across industries.

Having characterized the optimal allocation of a given labor force, we next examine whether admitting additional workers can increase GDP per capita. This analysis assumes that the entire labor force, including new entrants, can be optimally reallocated across industries. Given an initial labor force l^0 and m new entrants, efficiency therefore requires

$$\frac{l_s}{l^0 + m} = \frac{\gamma_s}{\sum_{j=1}^{q} \gamma_j}.$$

We assume that admitting new entrants may be beneficial for GDP per capita, as formalized by the following assumption.

A.0 $\quad n^0 \sum_{s=1}^{q} \gamma_s - l^0 > 0.$

Assume first that there is no upper bound on the number of potential entrants. The planner chooses the number of entrants m to maximize GDP per capita:

$$\begin{aligned} \underset{m}{\text{maximize}} \quad & \frac{f(l_1, \ldots, l_q)}{n^0 + m} \\ \text{s.t.} \quad & l_s = (l^0 + m)\frac{\gamma_s}{\sum_{j=1}^{q} \gamma_j}, \quad \forall s \in Q, \\ & m \geq 0. \end{aligned} \tag{4}$$

The first-order condition is

$$\frac{\sum_{s=1}^{q} \left(\frac{\partial f}{\partial l_s} \frac{\partial l_s}{\partial m} (n^0 + m) \right) - f(l_1, \ldots, l_q)}{(n^0 + m)^2} = 0.$$

Using $\partial l_s / \partial m = \gamma_s / \sum_{j=1}^{q} \gamma_j$; $\partial f(l_1, ..., l_q)/\partial l_s = (f(l_1, ..., l_q)/l_s)\gamma_s$; $\gamma_s / l_s = (1/(l^0 + m))(\gamma_s / \pi_s)$, and $\gamma_s / \pi_s = \sum_{j=1}^{q} \gamma_j$, this condition simplifies to

$$\sum_{s=1}^{q} \gamma_s \frac{n^0 + m}{l^0 + m} = 1.$$

Notice that the second order condition holds, ensuring a unique optimum. The optimal number of migrants is therefore

$$m^* = \frac{n^0 \sum_{s=1}^{q} \gamma_s - l^0}{1 - \sum_{s=1}^{q} \gamma_s}, \tag{5}$$

which is strictly positive under Assumption A.0.

The term $\sum_{s=1}^{q} \gamma_s$ captures the aggregate responsiveness of output to labor input. The numerator reflects the gap between the potential labor demand implied by productivity and the existing labor force, while the denominator adjusts this gap by the degree of decreasing returns. Together, these terms determine the optimal scale of migration required to maximize GDP per capita.

We conclude this section by conducting comparative statics with respect to $\sum_{s=1}^{q} \gamma_s$, l_u^0, and l^0. Rewriting equation (5) yields

$$m^* = \frac{\sum_{s=1}^{q} \gamma_s}{1 - \sum_{s=1}^{q} \gamma_s} l_u^0 - l^0. \tag{6}$$

An increase in $\sum_{s=1}^{q} \gamma_s$ raises the optimal number of migrants, as higher elasticities imply greater productivity gains from additional labor. An increase in the number of nonworkers l_u^0 also raises the

optimal migration quota, as more workers are required to sustain GDP per capita. Conversely, a larger initial labor force l^0 reduces the optimal number of migrants, reflecting diminishing marginal returns to labor.

5 Optimizing Labor Allocation Across Industries with a Fixed Initial Workforce and Flexible Entrant Allocation

In this section, we assume an initial distribution of workers across industries and that workers cannot move between industries, perhaps because they lack the necessary capabilities or skills to work in industries other than those to which they are initially assigned. Furthermore, we assume that workers cannot be dismissed from a specific industry. Given the restrictions, we explore how to assign m new workers across industries to maximize GDP. Implicitly, we assume that the m new entrants can be selected so as to possess the necessary capabilities to work in industries that need more workers.

Suppose that the initial distribution of workers among industries is given by $(l_1^0, ..., l_q^0)$ and π_s^0 is the proportion of workers in industry s. In what follows, we assume without loss of generality that

$$\frac{\gamma_1}{\pi_1^0} \leq \frac{\gamma_2}{\pi_2^0} \leq ... \leq \frac{\gamma_q}{\pi_q^0}. \tag{7}$$

The ratio γ_s/π_s^0 can be seen as a measure of how much each worker in industry s contributes to GDP relative to the share of the labor force in that industry. It can be interpreted as a measure of the industry's relative marginal productivity of labor. For example, consider an industry with a small γ_s but with very few workers (a low π_s^0). Although total output is not highly sensitive to labor in this industry (low elasticity), the small proportion of workers implies relatively high productivity per worker.

As shown in the previous section, given a potential quota of migrants m, the optimal allocation of workers in the industry s without restrictions should be

$$l_s = \frac{\gamma_s}{\sum_{j=1}^{q} \gamma_j}(l^0 + m) \tag{8}$$

However, since the initial workers cannot be reallocated, the assignment of the new workers across industries should satisfy:

$$m_s = \frac{\gamma_s}{\sum_{j=1}^{q} \gamma_j}(l^0 + m) - l_s^0 \;\; \forall s \in Q. \tag{9}$$

The analysis of m_s when $m = 0$ is useful in identifying which industries are experiencing a

shortage of workers and which have surplus. When m is sufficiently large, $m_s \geq 0$ for all industries, indicating the necessary industry composition of m to maximize GDP.

In Lemma 1, we show that the order of industries based on relative productivities ($\gamma_1/\pi_1^0 \leq \ldots \leq \gamma_q/\pi_q^0$) corresponds to the order obtained by comparing the ratios of new entrants to the initial labor force in each industry (m_s/l_s^0). This shows that industries with higher relative productivity attract a larger share of new entrants, aligning labor allocation with economic efficiency.

Lemma 1. *For any $m \geq 0$ and $s, s' \in Q$,*

$$\frac{\gamma_s}{\pi_s^0} \leq \frac{\gamma_{s'}}{\pi_{s'}^0} \quad \textit{if and only if} \quad \frac{m_s}{l_s^0} \leq \frac{m_{s'}}{l_{s'}^0}.$$

Proof. Taking any $s < s'$, we have the

$$m_s = \frac{\gamma_s}{\sum_{j=1}^{q} \gamma_j}(l^0 + m) - l_s^0.$$

Multiplying and dividing the first term by l_s^0/l^0,

$$m_s = \frac{\gamma_s}{\sum_{j=1}^{q} \gamma_j}\frac{l_s^0}{l^0}\frac{l^0}{l_s^0}(l^0 + m) - l_s^0$$

and rearranging terms

$$m_s = l_s^0\left(\frac{\gamma_s}{\pi_s^0}\frac{1}{\sum_{j=1}^{q} \gamma_j}\frac{1}{l^0}(l^0 + m) - 1\right)$$

By assumption $\gamma_s/\pi_s^0 \leq \gamma_{s'}/\pi_{s'}^0$ and therefore

$$\frac{\gamma_s}{\pi_s^0}\frac{1}{\sum_{j=1}^{q} \gamma_j}\frac{1}{l^0}(l^0 + m) - 1 \leq \frac{\gamma_{s'}}{\pi_{s'}^0}\frac{1}{\sum_{j=1}^{q} \gamma_j}\frac{1}{l^0}(l^0 + m) - 1$$

Then $m_s/l_s^0 \leq m_{s'}/l_{s'}^0$.

□

Given an $m > 0$, but not sufficiently large, we may encounter industries for which m_s is negative. By Lemma 1, if m_s is negative in industry s, $m_{s'}$ is also negative for all $s' < s$, and if m_s is positive in industry s, $m_{s'}$ is positive for all $s' > s$. As a result, no migrants enter the industry with the lowest relative productivity, but to determine what happens in the remaining industries, we must take a new snapshot of the economy, excluding industry 1 from consideration. The following mechanism elaborates on this idea by iteratively refining the allocation of workers across industries. Based on equation (9) and Lemma 1, the mechanism ensures convergence to an allocation of workers that maximizes GDP, under the assumption that workers cannot initially switch industries.

Mechanism to Efficiently Allocate a Given Quota of Migrants Across Industries

Step 1. If $m_1 \geq 0$, the optimal number of new workers in each industry is given by (9). If $m_1 < 0$, fix $l_1 = l_1^0$ and go to step 2.

Step 2. Since industry 1 is now fixed, the problem is equivalent to one involving industries in $Q \setminus \{1\}$ with $l^0 - l_1^0$ initial workers. For this new problem, m_s is given by:

$$m_s = \frac{\gamma_s}{\sum_{j=2}^{q} \gamma_j}(l^0 - l_1^0 + m) - l_s^0 \geq 0 \quad \forall s \in Q \setminus \{1\} \tag{10}$$

Note that similarly as in Lemma 1, we have that $m_2/l_2 \leq \ldots \leq m_q/l_q$. If $m_2 \geq 0$, the optimal assignment of new workers is $l_1 = l_1^0$ and $l_s = l_s^0 + m_s$ for any $s \in Q \setminus \{1\}$, where m_s is given by 10. If $m_2 < 0$, fix $l_1 = l_1^0, l_2 = l_2^0$ and go to step 3.

...

Step q. If we arrive at this step, the optimal allocation of the m workers among industries is: $l_s = l_s^0$ for all $s \in Q \setminus \{q\}$, and $l_q = l_q^0 + m$

Since the economy consists of a finite number of industries q, the mechanism converges in a finite number of steps. At each step, the size of the problem is reduced by fixing the labor allocation for at least one industry and reducing the number of industries among which the remaining migrants can be distributed. This ensures progress towards a solution. The mechanism checks at each step if the calculated optimal number of migrants for the next industry, m_s, is non-negative. If all industries can positively absorb migrants according to the calculation, the mechanism finds a solution before reaching the last industry. If not, it systematically excludes industries from the distribution calculation, ensuring that the remaining migrants are allocated to industries that can absorb them until they reach the final industry. By the final step, the mechanism has either successfully allocated migrants to industries or reached the last industry with a remaining number of migrants to be assigned. Given the constraints and the iterative process, the final allocation will always satisfy the initial conditions and the optimization criteria.

The mechanism implies that, for industry s to admit migrants, the migrant quota, m must be at least $\bar{m}_s$, where $\bar{m}_s$ is such that

$$\frac{\gamma_s}{\sum_{j=s}^{q}\gamma_j}(\sum_{j=s}^{q} l_j^0 + \bar{m}_s) - l_s^0 = 0 \tag{11}$$

Lemma 2 shows that the necessary quota to integrate migrants in industry s is greater than in industry $s+1$.

Lemma 2. *For any industry s, $\bar{m}_s \geq 0$. Furthermore, $\bar{m}_s \geq \bar{m}_{s+1}$.*

Proof. From (11), $\bar{m}_s$ can be written as

$$\bar{m}_s = l_s^0 \frac{\sum_{j=s}^{q}\gamma_j}{\gamma_s} - \sum_{j=s}^{q} l_j^0$$

$$\bar{m}_s = l_s^0 \sum_{j=s+1}^{q} (\frac{\gamma_j}{\gamma_s} - \frac{l_j^0}{l_s^0})$$

$$\bar{m}_s = \frac{l_s^0}{\gamma_s} \sum_{j=s+1}^{q} l_j^0 (\frac{\gamma_j}{l_j^0} - \frac{\gamma_s}{l_s^0})$$

$$\bar{m}_s = \frac{\pi_s^0}{\gamma_s} \sum_{j=s+1}^{q} l_j^0 (\frac{\gamma_j}{\pi_j^0} - \frac{\gamma_s}{\pi_s^0})$$

Since for any $j > s$, $\gamma_j/\pi_j^0 \geq \gamma_s/\pi_s^0$, we obtain the desired conclusion. Finally, observe that $\bar{m}_s \geq \bar{m}_{s+1}$, because

$$\sum_{s+1}^{q} \gamma_j (\frac{l_s^0}{\gamma_s} - \frac{l_{s+1}^0}{\gamma_{s+1}})$$

and given that $\gamma_s/\pi_s^0 \leq \gamma_{s+1}/\pi_{s+1}^0$, then $l_s^0/\gamma_s \geq l_{s+1}^0/\gamma_{s+1}$ □

By the definition of $\bar{m}_s$ and the lemma (2), the optimal number of workers in each industry, when the initial workforce cannot move across industries, can be expressed as a function of the migration quota as follows:

$$l_s(m) = \begin{cases} l_s^0 & \text{if } m \leq \bar{m}_s, \\ \frac{\gamma_s}{\sum_{j=t}^{q}\gamma_j}(\sum_{j=t}^{q} l_j^0 + m) & \text{if } \bar{m}_t < m \leq \bar{m}_{t-1},\ t \leq s \end{cases} \tag{12}$$

In the following lemma, we show that the optimal number of workers in each industry is a continuous function of the migration quota. The proof of Lemma 3 is provided in Appendix A.1.

Lemma 3. *$l_s(m)$ is continuous for all m*

Lemma 2 and the definition of $l_s(m)$ in Equation (12) allow for a more intuitive reinterpretation of the mechanism.

Reinterpretation of the Mechanism

We begin by assigning migrants to industry q, the most productive industry, until the relative productivity of industry q is equal to that of industry $q-1$ (that is, $\gamma_q/\pi_q = \gamma_{q-1}/\pi_{q-1}$). This happens when the number of migrants reaches $\bar{m}_{q-1}$. It is important to note that as migrants are assigned to the industry q, their relative productivity decreases, while the relative productivity of the other industries increases.

When the number of migrants m exceeds $\bar{m}_{q-1}$, the migration allocation extends to include the industry $q-1$, along with the ongoing placements in the industry q. Migrants are distributed between these two industries to maintain equal relative productivity. This balance continues, adjusting as m increases, until the relative productivity between industries q, $q-1$, and the next less productive industry $q-2$ is equalized. This balance is achieved when m reaches $\bar{m}_{q-2}$, requiring the inclusion of the industry $q-2$ in the allocation process. The allocation mechanism proceeds similarly, ensuring that productivity parity extends iteratively to all subsequent industries as migration quotas are met. Note that the mechanism allows us to distinguish between industries that admit the entry of new workers and those that do not: given a quota m, new workers enter all industries for which $\bar{m}_s < m$, whereas no new workers enter industries for which $\bar{m}_s > m$.

To conclude this section, we examine the optimal number of migrants required to maximize per capita GDP. We first demonstrate that this maximum is both unique and positive. The proof of Lemma 4 can be found in Appendix A.1.

Lemma 4. *Let $y(m) = f(l_1(m), ..., l_q(m))/(m+n^0)$ be the per capita GDP in terms of the migrants' quota. The maximum of $y(m)$, denoted by m^{**}, is unique and positive.*

The intuition is as follows. The GDP per capita, $y(m)$, is a continuous function of m because f is a continuous function and, according to Lemma 3, $l_s(m)$ is continuous in m. Let M be the possible number of migrants, which can be arbitrarily large but finite. Since $y(m)$ is continuous on $[0, M]$, a maximum, m^{**}, exists. For any m less than m^{**}, the GDP per capita must increase. This increase occurs as migrants are systematically assigned starting from the industries with the highest relative productivity, and new industries are only activated when their relative productivity begins to align. Consequently, a local maximum cannot occur, where the GDP per capita initially increases, then decreases, and increases again. This is because a decrease in per capita GDP indicates that the addition of more migrants to a particular industry is no longer compensating for the population increase, and thus the per capita GDP declines. If the per capita GDP were to increase again after entering industries with lower relative productivity, it would imply that the population increase is somehow being compensated in these less productive industries, which contradicts the earlier observation that additional migrants did not suffice to boost per capita GDP

in more productive industries. A similar argument can be made to show that for all $m > m^{**}$, per capita GDP decreases.

Finally, given m^{**}, let $\hat{s}$ be the last industry in which some migrants enter, that is, $\hat{s}$ is such that $\bar{m}_{\hat{s}} < m^{**} \leq \bar{m}_{\hat{s}-1}$. Therefore, m^{**} should be the value that solves the following maximization problem, where industries 1 to $\hat{s}-1$ are fixed with their initial number of workers and $l_s(m)$ is given by (12) for all $s \geq \hat{s}$.

$$\underset{\{m\}}{\text{Maximize}} \quad \frac{f(l_1^0, ...l_{\hat{s}-1}^0, l_{\hat{s}}(m), l_q(m))}{n^0 + m} \tag{13}$$

Consequently, the number of new entrants m^{**} that maximizes the per capita GDP is

$$m^{**} = \frac{n^0 \sum_{j=\hat{s}}^{q} \gamma_j - \sum_{j=\hat{s}}^{q} l_j^0}{1 - \sum_{j=\hat{s}}^{q} \gamma_j} \tag{14}$$

In an economy with multiple industries and an initial distribution of workers across them, the number of migrants needed to maximize per capita GDP is lower if workers can be reallocated between industries compared to the case where the initial distribution of workers in each industry is fixed. When workers can be reallocated between industries, the economy can adjust its labor force more efficiently to match the varying marginal productivity of labor across industries. By redistributing workers to the industries where they contribute the most to production, the economy can achieve a higher level of output per worker (per capita GDP) with fewer additional workers. In contrast, if the initial distribution of workers across industries is fixed, some industries may remain under- or overstaffed relative to their optimal levels. To compensate for this inefficiency and maximize per capita GDP, the economy would require more migrants to fill the gaps in labor shortages or to counteract overstaffing inefficiencies. This highlights the importance of labor mobility in improving the efficiency of resource allocation and minimizing the need for additional labor to achieve a given economic goal.

The following lemma provides the conditions under which both migration quotas coincide.

Lemma 5. *Given any economy $(n^0, (\gamma_s)_{s\in Q}, (l_s^0)_{s\in Q})$, if for any industry $s \in \{1, .., q\}$, $n^0\gamma_s - l_s^0 > 0$, then $m^* = m^{**}$.*

Note that Lemma 5 indicates that if $\bar{m}_{\hat{s}} < m^{**} \leq \bar{m}_{\hat{s}-1}$, then $n^0\gamma_s - l_s^0 < 0$ for all $s < \hat{s}$. This indicates that the ability of industries $s < \hat{s}$ to significantly increase their output in proportion to added labor is limited. Adding more workers to those industries is not as effective in boosting production compared to other industries with a higher relative productivity. Given that GDP per capita is a measure of the average output per person, industries that do not fully leverage their labor force can significantly lower the average economic output. This can directly impact per capita

GDP negatively, particularly if such industries employ a significant portion of the labor force but do not contribute proportionally to GDP due to their lower relative productivity.

6 Agents' Preferences over Migration Quotas with a Fixed Initial Distribution of Workers

In this section, we prove that agents' preferences over migration quotas are single-peaked, assuming that migrants are efficiently allocated according to the mechanism described in the previous section and therefore the majority voting equilibrium exists.

Agents' Preferences

We distinguish between nonworkers and workers. Nonworkers care only about per capita GDP, which is interpreted as proxy for resources available for public goods, while workers care only about their wages. We do not explicitly model the labor market. Instead, we assume that wages depend positively on marginal labor productivity. Therefore, a worker's utility depends positively on the marginal productivity of the industry for which they are qualified.

Formally, for a nonworker u, utility is given by $U_u(m) = y(m)$. For a worker in industry s, the utility is given by the wage in her industry, ω_s. Since wages are positively related to the marginal productivity of labor in that industry, without loss of generality, we assume that:

$$U_s(m) = \omega_s(m) = \frac{\partial f(l_1(m), \ldots, l_q(m))}{\partial l_s} = \frac{\gamma_s}{l_s(m)} f(l_1(m), ..., l_q(m)) \tag{15}$$

where $l_s(m)$ is defined by (12).

The next theorem summarizes the main results in this section.

Theorem 1. *The preferences of nonworkers and workers are single-peaked, their preferred migration quotas are m^{**} and $\bar{m}_s$ respectively and therefore the majority voting equilibrium exists.*

Proof. We begin by showing that the preferences of nonworkers are single-peaked with preferred migration quota m^{**}.

Preferences of Nonworkers

Since nonworkers care only about per capita GDP, their preferences over the number of new entrants are represented by

$$U_u(m) = \frac{f(l_1(m), \ldots, l_q(m))}{n^0 + m}, \tag{16}$$

where $l_s(m)$ is defined by (12). Given Lemma 4, their preferences are single-peaked, and their most preferred migration quota is denoted by m^{**}.

We now show that the preferences of workers are single-peaked with preferred migration quota $\bar{m}_s$.

Preferences of workers.

We identify each worker with the industry in which they work.

For any $m \leq \bar{m}_s$, $l_s(m) = l_s^0$. Since $f(l_1(m), ..., l_q(m))$ is increasing in m, we see that marginal productivity is also increasing.

For any $m \geq \bar{m}_s$, let $s' < s$ be the last industry that receives migrants under quota m. We now show that marginal productivity is decreasing. By taking derivatives of $w_s(m)$ we obtain

$$\omega_s'(m) = \frac{-\gamma_s l_s'(m)}{(l_s(m))^2} f(l_1(m), ..., l_q(m)) + \frac{\gamma_s}{l_s(m)} \sum_{j=s'}^{q} \left[\frac{\partial f(l_1(m), ..., l_q(m))}{\partial l_j} l_j'(m) \right] \tag{17}$$

Given that

$$\frac{\partial f(l_1(m), ..., l_q(m))}{\partial l_j} = \gamma_j \frac{f(l_1(m), ..., l_q(m))}{l_j(m)} \tag{18}$$

and

$$\frac{l_j'(m)}{l_j(m)} = \frac{1}{\sum_{k=s'}^{q} l_k^0 + m} \tag{19}$$

equation 17 can be written as

$$\frac{\gamma_s}{l_s(m)} f(l_1(m), ..., l_q(m)) \left[\frac{-1}{\sum_{k=s'}^{q} l_k^0 + m} + \sum_{j=s'}^{q} \frac{\gamma_j}{\sum_{k=s'}^{q} l_k^0 + m} \right] \tag{20}$$

Since $\sum_{j=1}^{q} \gamma_j < 1$ we have that $\omega_s(m)$ is decreasing in m for any $m > \bar{m}_s$. Therefore, the preferences of workers are single-peaked over m, furthermore, their preferred migration quota is $\bar{m}_s$. Therefore, a majority voting equilibrium exists. □

Suppose that m^{**} is strictly less than $\bar{m}_1$. Under this condition, m^{**} will coincide with the outcome of the majority vote if neither the workers in the industries such that $\bar{m}_s < m^{**}$ nor the workers in the industries at $\bar{m}_s > m^{**}$ form a majority on their own. However, if m^{**} exceeds $\bar{m}_1$, then m^{**} will align with the majority voting outcome only if the nonworkers constitute a majority. However, if either group of workers alone constitutes a majority, the equilibrium number of migrants deviates from m^{**}, potentially leading to an excess or a deficit in migrants relative to what would maximize GDP per capita.

We now perform a comparative statics exercise to examine how changes in the structure of the economy affect the preferred migration quota across different industries. To this end, we compare two economies, A and B, which differ marginally in only one parameter, while the identity of the winning coalition remains unchanged. [3]

[3]The comparative statics we perform here refer to marginal changes in each parameter individually, holding all others constant.

Suppose that Economy B differs from Economy A only in having *more non-workers*. First, the preferred migrant quota of workers remains unchanged. Additionally, since non-workers prefer the migration quota that maximizes per capita GDP, and this increases with the number of non-workers, Economy B may achieve a higher migration quota than Economy A.

If economy B differs from economy A in having a larger workforce in industry s' or a lower elasticity in industry s', the impact on migration preferences follows a similar pattern. In both cases, the preferred migration quota remains unchanged for workers in industries $s > s'$, decreases for those in industries $s < s'$, and increases for industry s' itself. The key difference lies in the response of non-workers. When the workforce in industry s' increases, the preferred migration quota of the nonworkers decreases if $s' \geq \hat{s}$ and increases if $s' < \hat{s}$; however, when the elasticity of industry s' decreases, the preferred migration quota of the nonworkers also decreases if $s' \geq \hat{s}$, but remains unchanged when $s' < \hat{s}$.[4] Thus, while both types of structural change lead to similar shifts in industry migration preferences, changes in workforce size can induce stronger effects on nonworker preferences compared to changes in elasticity. Lemmas 6 and 7 in Appendix A.1 formally analyze these changes in preferences.

We now analyze how changes in the structure of an economy influence the majority-voting migration quota. If the majority vote migration quota in economy A exceeds $\bar{m}_{s'}$, then the majority vote migration quota in economy B will be lower. In contrast, if the majority voting migration quota in economy A is lower than or equal to $\bar{m}_{s'}$, then the majority voting migration quota in economy B will be greater than or equal to that in economy A. This relationship holds whether the structural change involves an increase in the number of workers in industry s' or a reduction in its elasticity (see Propositions 1 and 2 in Appendix A.1).

7 Empirical Illustration

This section provides an empirical illustration of the normative results derived from the theoretical framework using data from the U.S. economy. The empirical analysis spans the period 2001–2018 and covers 65 industries.[5] Industry-level employment data are obtained from the Bureau of Labor Statistics (l_s^0), while demographic information on retirees is sourced from the Census Bureau (l_u^0). Together, these variables determine the baseline allocation of workers and nonworkers.

The implementation of the mechanism requires ranking industries according to the ratio γ_s/π_s,

[4] Recall that $\hat{s}$ is the last industry to which migrants are allocated under m^{**}.

[5] The original dataset comprises 71 industries; however, following Vollrath (2024), we exclude five industries associated with public administration and housing. These industries are excluded due to the difficulty of accurately measuring value added, capital costs, and labor costs. In addition, the housing industry exhibits an unusually high capital cost share, which tends to distort the estimated elasticity. The full list of industries is provided in the Appendix.

which captures each industry's relative contribution to aggregate productivity. Accordingly, the first step consists of estimating the elasticities of aggregate output with respect to labor input in each industry, denoted by γ_s.

7.1 Estimation of Industry Elasticities

This subsection establishes the link between the theoretical model and the data by estimating the marginal contribution of each industry to aggregate output and constructing the empirical ranking that underpins the efficiency analysis developed in the previous sections.

The elasticities γ_s are not directly observable in the standard datasets. To estimate them, we follow the approach of Vollrath (2024) and Baqaee & Farhi (2020), who recover industry-level elasticities from input–output data and factor cost shares. The first step consists of constructing the input matrix Λ, which encodes both the technological use of intermediate inputs and the intensity of primary factors (labor and capital). Each entry λ_{si} represents the cost share of input from industry i in the production of industry s, while λ_{sK} and λ_{sL} denote the cost shares of capital and labor, respectively. Formally,

$$\Lambda = \begin{bmatrix} \lambda_{11} & \lambda_{12} & \cdots & \lambda_{1J} & \lambda_{1K} & \lambda_{1L} \\ \lambda_{21} & \lambda_{22} & \cdots & \lambda_{2J} & \lambda_{2K} & \lambda_{2L} \\ \vdots & \vdots & \ddots & \vdots & \vdots & \vdots \\ \lambda_{J1} & \lambda_{J2} & \cdots & \lambda_{JJ} & \lambda_{JK} & \lambda_{JL} \\ 0 & 0 & \cdots & 0 & 0 & 0 \\ 0 & 0 & \cdots & 0 & 0 & 0 \end{bmatrix}.$$

From this structure, we compute the Leontief inverse $(I - \Lambda)^{-1}$. This matrix captures how shocks propagate through the production network: an increase in labor supply in one industry affects not only its own output but also transmits to other industries through intermediate-input linkages. The elasticity of aggregate output with respect to labor in industry s is then given by

$$\gamma_s = \lambda_{sL} \cdot \sum_{i=1}^{q} \sigma_i \left[(I - \Lambda)^{-1}\right]_{is},$$

where σ_i denotes the value-added share of industry i. Three components determine γ_s: (i) the intensity of direct labor input, λ_{sL}; (ii) the propagation of shocks through the Leontief inverse; and (iii) the aggregate relevance of each industry, as measured by σ_i.

Figure 1 reports the ranking of estimated industry elasticities γ_s in 2001.[6] At the top of the distribution are service-oriented industries such as ambulatory health care services, retail trade,

[6]This process is repeated each year, and the ranking remains stable across periods.

and other personal services. These industries are highly labor-intensive, with a large share of their costs devoted to wages, and contribute significantly to aggregate consumption. Their position at the top of the ranking is consistent with the framework: the direct effect of labor (λ_{sL}) is strong, and demand for their output is widespread throughout the economy.

Close behind are industries that combine moderate labor intensity with strong network effects, such as financial intermediation, broadcasting and telecommunications, motor vehicles and parts, and computer systems design. These industries do not necessarily employ the largest number of workers directly, but their outputs serve as essential inputs into other activities.

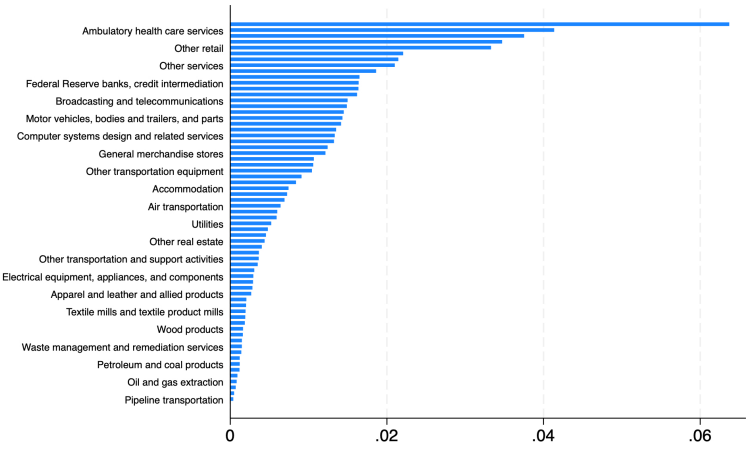


Figure 1: Ranking of industry elasticities γ_s in the US economy in 2001

The middle of the distribution includes industries such as accommodation, air transportation, utilities, and general merchandise stores. Their elasticities reflect a balance between moderate labor shares and more limited spillovers. At the bottom of the distribution are capital-intensive and resource-based industries such as oil and gas extraction, petroleum and coal products, and pipeline transportation. These industries rely heavily on physical capital and natural resources, with labor playing only a minor role in their production processes.

We normalize these elasticities by each industry's employment share (i.e., γ_s/π_s), which ranks industries according to the marginal product of labor. Figure 2 presents the ranking of the industries in 2001 according to this ratio. Industries such as other transportation equipment, financial intermediation, and chemical products exhibit high values of γ_s/π_s, indicating that small increases in employment can generate relatively large gains in GDP per capita. In contrast, industries such as petroleum and coal products or utilities rank much lower, consistent with their capital-intensive structure and limited responsiveness to labor inputs.

Having estimated industry-level elasticities γ_s and the corresponding ratios γ_s/π_s, we can

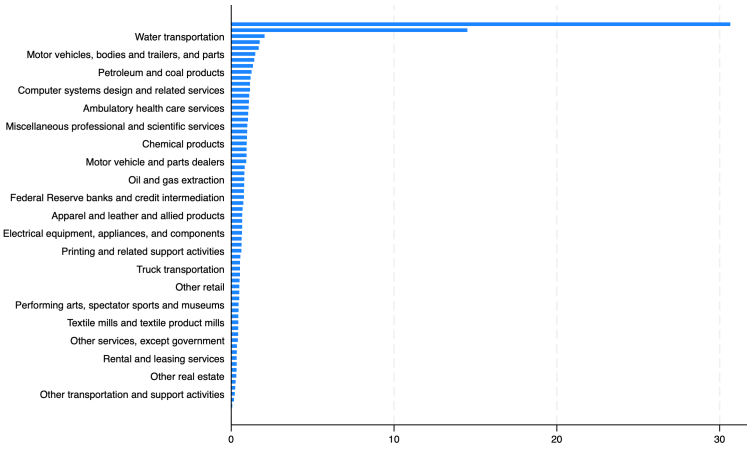


Figure 2: Ranking of industry ratio γ_s/π_s in the U.S. economy, 2001.

implement the allocation mechanism developed in the theoretical section. These objects allow us to compute the industry-specific thresholds $\bar{m}_s$, which determine when an industry becomes active and starts receiving migrant workers. Based on these thresholds, we obtain the optimal allocation m^{**}, which jointly determines the aggregate migrant quota and its industry composition that maximizes GDP per capita. This, in turn, allows us to quantify the resulting gains in GDP per capita.

Figure 3 illustrates the relationship between efficient migrant allocations and the resulting growth in GDP per capita relative to the no-migration baseline (i.e., $\frac{y(m)-y(0)}{y(0)}$). The horizontal axis represents the migrant quota (m), while the vertical axis shows the percentage change in GDP per capita relative to its initial level. Each point along the curve corresponds to the maximum attainable growth for a given migrant quota, as the allocation is determined by our mechanism.

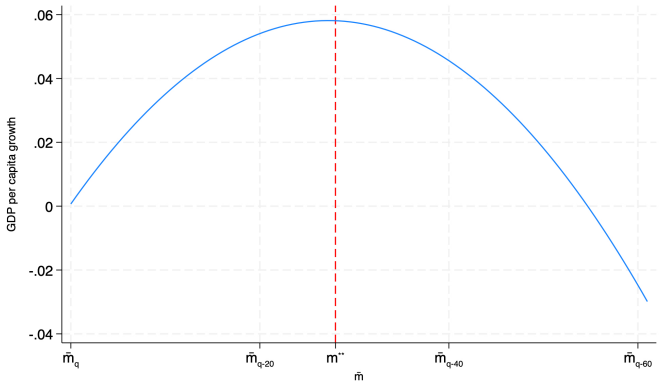


Figure 3: Combinations of Migration quotas and GDP Per Capita Growth in 2001

7.2 Quantifying the Gains from Efficient Migrant Allocation

After implementing the mechanism for the U.S. economy, we conduct several exercises to assess how actual economic performance compares with the outcomes predicted by our framework. To this end, we collect data on annual GDP per capita growth from the World Bank, actual migrant inflows from the U.S. Census Bureau, and work visa issuances from the Bureau of Consular Affairs.

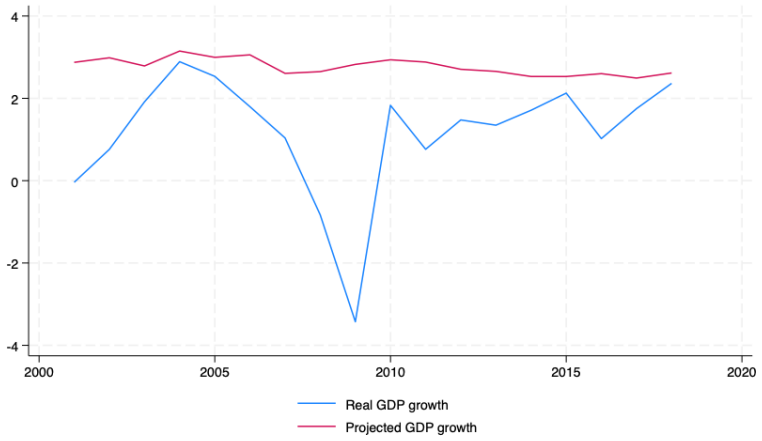


Figure 4: Projected vs. real GDP growth with migration quota fixed at full migration inflows, 2001–2018.

Given the observed migration inflows, we compute the GDP per capita growth if this migration inflow were selected and allocated according to our mechanism. Figure 4 illustrates the results. The orange line depicts the counterfactual GDP per capita growth that would have occurred if all migrants had been workers allocated according to our mechanism, while the blue line shows actual GDP per capita growth. The figure suggests that, in a typical year, an efficient allocation of migrants could have generated potential GDP per capita growth of around 3%, conditional on the initial conditions of that year. This value can be interpreted as an upper bound on the growth achievable through efficient migrant allocation. Although similar growth rates were observed in several years, the actual trajectory diverged notably during the periods surrounding the financial crisis.

Figure 5 presents a lower bound on the potential GDP per capita growth implied by our mechanism. In this conservative scenario, only migrants holding a work visa are classified as active workers, while all others are treated as nonworkers. Under this assumption, the potential gains in GDP per capita decrease by about 25% on average, from 2.8% to 2.1%. In some years, however, actual growth exceeds the projected level, suggesting that the economy may have absorbed migration more efficiently than implied by the conservative benchmark or experienced demand and



Figure 5: Projected vs. real GDP growth with migration quota fixed at the number of visas issued, 2001–2018.

productivity effects not captured by the model.

Figure 6 estimates the number of migrants required to account for the observed GDP per capita growth under the implementation of our mechanism. The figure includes only the years with positive growth in real GDP per capita, excluding the years 2001, 2008, and 2009.[7] The results indicate that applying the mechanism would require a migration quota lower than the actual migration flow. Compared with the actual number of work visas issued, the mechanism implies a smaller number of migrants in most years, except during periods of strong GDP per capita growth (2004–2005 and 2018). In those years, the economy performed sufficiently efficiently that the observed level of migration was close to that predicted by our mechanism.

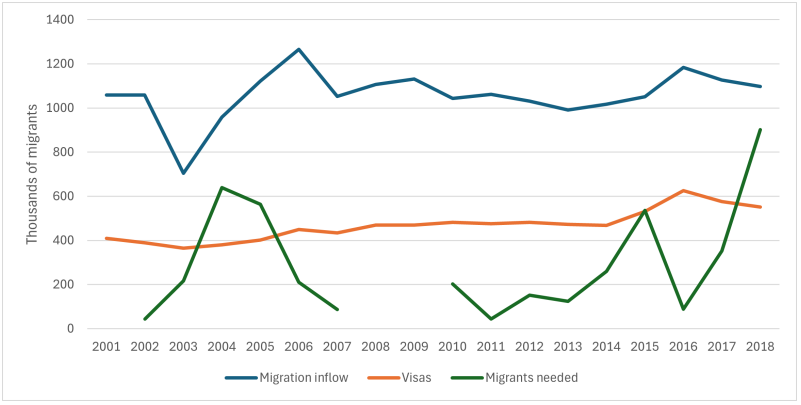


Figure 6: Minimum number of migrants required to reach the observed GDP per capita growth. Period: 2001–2018.

[7]Crisis years (e.g., 2001, 2008–09) mainly reflect shocks outside the model; including them would misattribute these shocks to labor and distort the implied worker needs.

Migrant inflows bring not only workers but also nonworkers. To account for this compositional aspect, we extend the baseline analysis by incorporating alternative demographic scenarios. Figure 7 builds on Figure 6 by considering two cases. In the first, workers constitute 95 percent of total migrants, while the remaining 5 percent are nonworkers. In the second, the share of workers is further reduced to 90 percent.

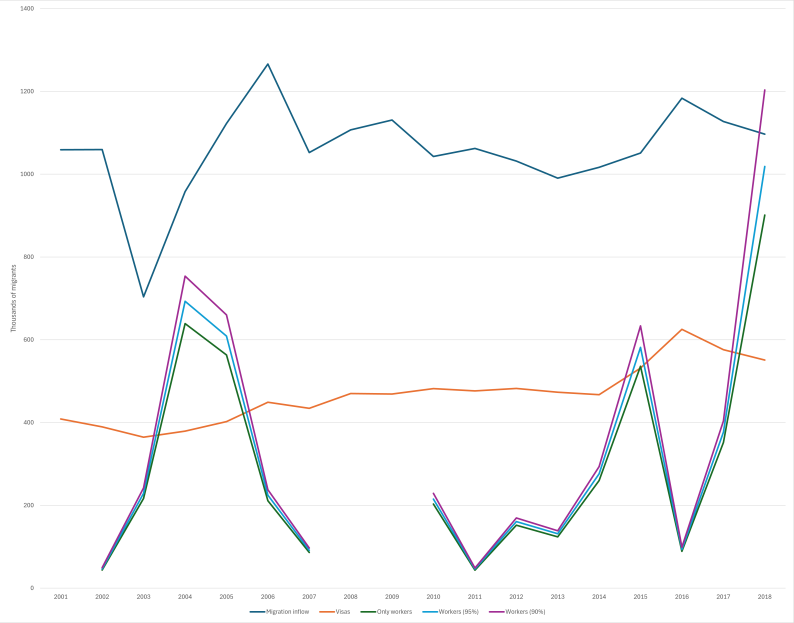


Figure 7: Migrants required to sustain GDP per capita growth under alternative demographic assumptions.

The results suggest that in years when the number of migrants required to sustain actual growth was relatively small, the inclusion of nonworkers exerts only a limited influence on the migrant inflow needed to match the observed level of GDP per capita. By contrast, in years when the required inflow was substantially larger (for instance, 2004, 2015, or 2018), the presence of nonworkers considerably amplifies the number of migrants necessary to achieve the observed growth in GDP per capita.[8] This pattern is consistent with the idea that the demographic composition of migration flows becomes quantitatively more relevant during periods of stronger economic expansion.

[8]In relative terms, during years of high GDP per capita growth, the required migration inflow would need to increase by approximately 13–35 percent to achieve the same GDP per capita growth when including 5–10 percent nonworkers. In contrast, during years of low GDP per capita growth, the adjustment would range only between 5 and 12 percent.

8 Conclusion

This paper studies how migration policy can be designed to increase GDP per capita when labor is imperfectly allocated across industries and political constraints matter. We develop a tractable framework in which migrants can be selected by skills and assigned across industries to maximize GDP per capita. The key object is an industry ranking based on marginal labor productivity, which delivers a simple allocation rule: for any migration quota, migrants should be directed first to the industries with the highest marginal returns, and additional industries become active only when marginal productivities are equalized.

The model highlights two central results. First, in the frictionless benchmark, the optimal migration quota depends on the aggregate labor elasticity and on the share of nonworkers in the population. Second, when initial workers are immobile across industries, the optimal migrant allocation has a threshold structure: only a subset of industries receives migrants for any given quota, and this set expands as the quota increases. Building on these normative results, we characterize agents' preferences over migration quotas. Nonworkers favor the quota that maximizes GDP per capita, while workers prefer quotas that increase wages in their own industry, leading to single-peaked preferences and a well-defined majority-voting equilibrium. The voting equilibrium does not generally coincide with the GDP-per-capita-maximizing quota, although we provide conditions under which the two coincide.

We then implement the mechanism using U.S. data for 2001–2018 across 65 industries. The empirical ranking combines each industry's labor cost share with its position in the input–output network. Using this ranking, we quantify the potential gains from reallocating migrant inflows across industries. The counterfactual exercises suggest that, outside periods of particularly strong aggregate performance, the observed allocation of migrants could have delivered substantially higher GDP per capita growth under the efficient assignment implied by our mechanism. Moreover, when we restrict active migrants to work-visa holders, the implied gains are smaller, while allowing for nonworking companions increases the inflow required to replicate observed growth.

Several caveats and extensions are worth highlighting. Our framework abstracts from adjustment frictions within industries, endogenous capital accumulation, and potential effects of migration on innovation, demand, and public finances. Incorporating these channels would be a natural next step and would allow the model to speak to a broader set of policy questions. Nonetheless, the main contribution of the paper is to provide a transparent and operational mapping from industry-level data to normative and political-economy predictions about migration quotas and composition. This mapping can help policymakers evaluate how alternative migration policies trade off economic efficiency and political feasibility, and how these trade-offs evolve with structural change.

Appendix A

Appendix A.1 Lemmas and Proofs

Lemma 3. $l_s(m)$ is continuous for all m

Proof. To prove the continuity of $l_s(m)$ let us see first that for all $t < s$,

$$\lim_{m \to \bar{m}_{t-1}^-} l_s(m) = \lim_{m \to \bar{m}_{t-1}^+} l_s(m). \tag{21}$$

Since

$$\lim_{m \to \bar{m}_{t-1}^-} l_s(m) = \frac{\gamma_s}{\sum_{j=t-1}^q \gamma_j} \left(\sum_{j=t-1}^q l_j^0 + \bar{m}_{t-1} \right),$$

and

$$\lim_{m \to \bar{m}_{t-1}^+} l_s(m) = \frac{\gamma_s}{\sum_{j=t}^q \gamma_j} \left(\sum_{j=t}^q l_j^0 + \bar{m}_{t-1} \right).$$

To prove (21) is equivalent to prove that

$$\frac{\gamma_s}{\sum_{j=t-1}^q \gamma_j} \left(\sum_{j=t-1}^q l_j^0 + \bar{m}_{t-1} \right) = \frac{\gamma_s}{\sum_{j=t}^q \gamma_j} \left(\sum_{j=t}^q l_j^0 + \bar{m}_{t-1} \right) \tag{22}$$

From (11), we know that

$$\bar{m}_{t-1} = l_{t-1}^0 \frac{\sum_{j=t-1}^q \gamma_j}{\gamma_{t-1}} - \sum_{j=t-1}^q l_j^0.$$

Substituting $\bar{m}_{t-1}$ into the left-hand side and the right-hand side of (22), we obtain in both cases $l_{t-1}^0(\gamma_s/\gamma_{t-1})$. Finally, let us see that, for $t = s$

$$l_s^0 = \lim_{m \to \bar{m}_s^+} l_s(m) \tag{23}$$

Since

$$\lim_{m \to \bar{m}_s^+} l_s(m) = \frac{\gamma_s}{\sum_{j=s}^q \gamma_j} \left(\sum_{j=s}^q l_j^0 + \bar{m}_s \right),$$

and

$$\bar{m}_s = l_s^0 \frac{\sum_{j=s}^q \gamma_j}{\gamma_s} - \sum_{j=s}^q l_j^0,$$

it follows that (23) holds. □

Lemma 4. The maximum of $y(m)$, denoted by m^{**}, is unique and positive.

Proof. Note first that per capita GDP, $y(m) = f(l_1(m), ..., l_q(m))/(n^0+m)$, is a continuous function of m because f is a continuous function and, by Lemma 3, $l_s(m)$ is continuous in m. Let M be the possible number of migrants, which can be arbitrarily large but finite. Since $y(m)$ is continuous on $[0, M]$, a maximum exists. Let m^{**} be a maximum of $y(m)$. Let us first see that $m^{**} > 0$. To show this, it is enough to demonstrate that:

$$\frac{\partial}{\partial m}\left(\frac{f(l_1^0, .., l_{q-1}^0, l_q^0 + m)}{n^0 + m}\right)_{m=0} > 0,$$

which is equivalent to showing that

$$\frac{f(l_1^0, \ldots, l_q^0)}{l_q^0 (n^0)^2}(n^0\gamma_q - l_q^0) > 0.$$

But recall that we have assumed in Section 3 that the economy needs new entrants to maximize per capita GDP when the reallocation of initial workers where possible, that is, assumption A.0. holds, which implies that $(n^0\gamma_q - l_q^0) > 0$. Because if $n^0\gamma_q - l_q^0 \leq 0$, rearranging terms, $n^0\gamma_q/l^0\pi_q \leq 1$ and by (7), $n^0\gamma_s/l^0\pi_s \leq 1 \forall s \in Q$. This contradicts $n^0 \sum_{s=1}^{q} \gamma_s - l^0 > 0$.

Secondly, let us show that the GDP per capita, $y(m)$, is differentiable relative to m.

For any industry s and for any $m \in (\bar{m}_s, \bar{m}_{s-1})$, $y(m)$ is differentiable because $f(l_1, ..., l_q)$ is differentiable by assumption and $l_s(m)$ is linear in any $m \in (\bar{m}_s, \bar{m}_{s-1})$.

Note that the derivative of $y(m)$ for any $m \in (\bar{m}_s, \bar{m}_{s-1})$ is given by

$$y'(m) = \frac{-1}{(n^0+m)^2} f(m) + \frac{1}{n^0+m} f'(m).$$

Or equivalently,

$$y'(m) = \frac{f(m)}{(n^0+m)^2}\Big[-1 + g(m)\Big] \tag{24}$$

where

$$g(m) = \frac{\sum_{j=s}^{q} \gamma_j}{\sum_{j=s}^{q} l_j^0 + m}(n^0 + m)$$

We now show that $y(m)$ is also differentiable at the extremes of each of the intervals. That is

$$lim_{m \to \bar{m}_{s-1}^-} y'(m) = lim_{m \to \bar{m}_{s-1}^+} y'(m)$$

Since by assumption $f(l_1, ..., l_q)$ is continuous and by Lemma 3, $l_s(m)$ is also continuous, $f(m)$ is continuous. Then $f(m)/(n^0+m)^2$ is continuous. Therefore, the continuity of $y'(m)$ depends on the continuity of $g(m)$. That is,

$$g(\bar{m}_{s-1}^-) = g(\bar{m}_{s-1}^+) \tag{25}$$

Or equivalently,

$$\frac{\sum_{j=s}^{q}\gamma_j}{\sum_{j=s}^{q}l_j^0+\bar{m}_{s-1}}(n^0+\bar{m}_{s-1})=\frac{\sum_{j=s-1}^{q}\gamma_j}{\sum_{j=s-1}^{q}l_j^0+\bar{m}_{s-1}}(n^0+\bar{m}_{s-1})$$

Rearranging terms,

$$\gamma_{s-1}\sum_{s}^{q}l_j^0+\gamma_{s-1}\bar{m}_{s-1}=l_{s-1}^0\sum_{s}^{q}\gamma_j$$

Given that

$$\bar{m}_{s-1}=\frac{l_{s-1}^0\sum_{s-1}^{q}\gamma_j}{\gamma_{s-1}}-\sum_{s-1}^{q}l_j^0$$

(25) holds.

We now show that the maximum per capita GDP, m^{**}, is unique and increases below m^{**} and decreases above m^{**}. Note that if $m'\in(\bar{m}_{s'},\bar{m}_{s'-1}]$ is a maximum or a minimum, the active industries are from s' to q and therefore $-1+g(m')=0$. At m', we have that

$$y''(m')=\frac{\partial\frac{f(m')}{(n^0+m')^2}}{\partial m}[-1+g(m')]+\frac{f(m')}{(n^0+m')^2}[g'(m')]$$

Since $-1+g(m')=0$ and $g'(m)<0$, we have that and $y''(m')<0$. Therefore, any such m' is a maximum. Finally, since $y(m)$ is differentiable in m, the maximum is unique.

□

Lemma 5 Given any economy $(n^0,(\gamma_s)_{s\in Q},(l_s^0)_{s\in Q})$, $m^*\leq m^{**}$. If for any industry $s\in\{1,..,q\}$, $n^0\gamma_s-l_s^0>0$, then $m^*=m^{**}$.

Proof. Let $(n^0,(\gamma_s)_{s\in Q},(l_s^0)_{s\in Q})$ be an economy such that for any industry $s\in\{1,..,q\}$, $n^0\gamma_s-l_s^0>0$. We first show that $m^*\geq\bar{m}_1$. Note that $m^*-\bar{m}_1$ is given by

$$\frac{n^0\sum_{j=1}^{q}\gamma_j-\sum_{j=1}^{q}l_j^0}{1-\sum_{j=1}^{q}\gamma_s}-l_1^0\frac{\sum_{j=1}^{q}\gamma_j}{\gamma_1}+\sum_{j=1}^{q}l_j^0$$

Rearranging terms

$$\frac{1}{\gamma_1}\frac{\sum_{s=1}^{q}\gamma_s}{1-\sum_{j=1}^{q}\gamma_s}\left[n^0\gamma_1-\gamma_1\sum_{j=1}^{q}l_j^0-l_1(1-\sum_{j=1}^{q}\gamma_j)\right]$$

Equivalently

$$\frac{1}{\gamma_1}\frac{\sum_{s=1}^{q}\gamma_s}{1-\sum_{j=1}^{q}\gamma_s}\left[n^0\gamma_1-l_1-\sum_{j=1}^{q}(\gamma_1l_j^0-l_1^0\gamma_j)\right]\tag{26}$$

Since $\gamma_1/l_1^0\leq\gamma_j/l_j^0$ then $(\gamma_1l_j^0-l_1^0\gamma_j)\leq0$ and the expression in (26) is positive. Since the maximum

GDP per capita is unique, we have $m^* = m^{**}$.

□

Lemma 6. *Economy B differs from economy A in that the number of workers in industry s' is greater. Then:*

1. *The preferred migration quota for workers in any industry $s > s'$ remains unchanged.*
2. *The preferred migration quota decreases for any industry $s < s'$.*
3. *The preferred migration quota increases for the industry s'.*
4. *The preferred migration quota for non-workers decreases if $s' \geq \hat{s}$ and increases if $s' < \hat{s}$.*

Proof. We analyze the impact of an increase in the number of workers in industry s' on the preferred migration quotas. The function $\bar{m}_s$ defines the preferred industry-specific migration quota, which depends on the initial allocation of labor l_s^0 and the industry productivity coefficients γ_j.

From the structure of $\bar{m}_s$, we observe that industries $s > s'$ do not experience a direct shift in their migration preferences, as the increase in $l_{s'}^0$ does not affect $\bar{m}_s$. Therefore, their preferred migration quota remains unchanged.

For workers in industries $s < s'$, their preferred migration quota decreases since $\bar{m}_s$ decreases in $l_{s'}^0$. In contrast, for workers in industry s', their preferred migration quota increases as $\bar{m}_s$ increases in $l_{s'}^0$.

Finally, the impact on the preferred migration quota for non-workers (the quota that maximizes GDP per capita) depends on whether the industry s' is active or inactive. If $s' \geq \hat{s}$ (i.e., an active industry), the increase in labor in industry s' lowers the migration quota required to maximize per capita GDP, causing m^{**} to decrease. In contrast, if $s' < \hat{s}$ (a non-active industry), the change leads to an increase in m^{**}. □

Lemma 7. *Economy B differs from economy A in that the elasticity of industry s' is lower. Then:*

1. *The preferred migration quota for workers in any industry $s > s'$ remains unchanged.*
2. *The preferred migration quota decreases for any industry $s < s'$.*
3. *The preferred migration quota increases for industry s'.*
4. *The preferred migration quota for non-workers decreases if $s' \geq \hat{s}$ and remains unchanged if $s' < \hat{s}$.*

Proof. We analyze the impact of a change in the elasticity $\gamma_{s'}$ of industry s' on the preferred migration quotas. The function $\bar{m}_s$ defines the industry-specific preferred migration quota, which depends on the initial allocation of labor l_s^0 and the industry productivity coefficients γ_j.

From the structure of $\bar{m}_s$, we observe that industries $s > s'$ do not experience a direct shift in their migration preferences, as the change in $\gamma_{s'}$ does not affect $\bar{m}_s$ for these industries. Therefore, their preferred migration quota remains unchanged.

For workers in industries $s < s'$, a reduction in $\gamma_{s'}$ decreases their preferred migration quota, since $\bar{m}_s$ is positively related to $\gamma_{s'}$. In contrast, for workers in the industry s', a decrease in $\gamma_{s'}$ leads to a higher preferred migration quota as $\bar{m}_s$ decreases in $\gamma_{s'}$.

Finally, the impact on the preferred migration quota for non-workers (the quota that maximizes GDP per capita) depends on whether the industry s' is active or inactive. If $s' \geq \hat{s}$ (i.e., an active industry), the decrease in elasticity lowers the migration quota required to maximize per capita GDP. In contrast, if $s' < \hat{s}$ (a non-active industry), the change does not affect m^{**}. □

Proposition 1. *Economy B differs from Economy A in that the number of workers in industry s' is higher. If the majority-voting migration quota in Economy A exceeds $\bar{m}_{s'}$, then the majority-voting migration quota in Economy B will be lower. Conversely, if the majority-voting migration quota in Economy A is lower than or equal to $\bar{m}_{s'}$, then the majority-voting migration quota in Economy B will be greater than or equal to that in Economy A.*

Proof. We analyze the effects of an increase in the number of workers in industry s' on the migration quota by majority voting. The equilibrium migration quota is determined by the voting preferences of different groups, including workers across industries and non-workers.

From Lemma 6, we know that an increase in the number of workers in industry s' affects industry migration preferences differently depending on whether s' is an active or a non-active industry.

1. If the majority voting migration quota in economy A is greater than $\bar{m}_{s'}$, then the increase in labor in industry s' lowers the demand for additional migration in that industry, shifting the majority voting preference toward a lower migration quota in economy B. This occurs because industries with decreasing preferred quotas exert downward pressure on the majority voting equilibrium.

2. Conversely, if the majority voting migration quota in economy A is lower or equal to $\bar{m}_{s'}$, the majority voting migration quota in economy B is as high as in economy A since only workers in industries $s \leq s'$ are affected.

□

Proposition 2. *Economy B differs from economy A in that the elasticity of industry s' is lower. If the majority voting migration quota in economy A exceeds $\bar{m}_{s'}$, economy B will have a lower*

majority voting migration quota. In contrast, if the majority voting migration quota in economy A is lower than or equal to $\bar{m}_{s'}$, the quota of economy B will not exceed that of economy A.

Proof. We analyze how a reduction in the elasticity $\gamma_{s'}$ affects the migration quota of the majority voting. The equilibrium migration quota is determined by the collective preferences of workers and non-workers across different industries.

From Lemma 7, we know that a decrease in $\gamma_{s'}$ influences industry migration preferences differently depending on whether s' is active or non-active.

1. If the majority voting migration quota in economy A is greater than $\bar{m}_{s'}$, then the reduction in $\gamma_{s'}$ decreases the demand for additional migration in industries of lower ranking, shifting the majority vote preference to a lower migration quota in economy B. This downward adjustment occurs because the relative decline in industry preferences constrains the majority voting equilibrium.

2. Conversely, if the majority voting migration quota in economy A is lower or equal to $\bar{m}_{s'}$, then the decrease in $\gamma_{s'}$ does not significantly reduce the incentive for additional migration, and may even increase it. Consequently, the majority voting migration quota in economy B remains at least as high as in economy A. □

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