

Supplement to “Immigration Lottery Design: Engineered and Coincidental Consequences of H-1B Reforms”

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Abstract

This file contains three online appendices. Appendix A contains proofs of all results in the paper. Appendix B documents the visa allocation rules using the Federal Register. Appendix C provides formal definitions of the comparisons of visa allocation rules.

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A Appendix: Proofs

A.1 Proof of Theorem 1

Proof. Fix a visa allocation problem $E \in \mathcal{E}$ and $\pi \in \Pi$. Let $\pi_u = \pi_r = \pi$. Let $\mu^{ef} = \varphi^{ef}(E)$ be the outcome of the Exemptions-First visa allocation rule, $\mu^{oa} = \varphi^{oa}(E)$ be the outcome of the Over-and-Above visa allocation rule, and matching $\mu \in \mathcal{M}$ be any matching that complies with the statute. That is, μ is any non-wasteful matching that accommodates reservation policy and respects priorities.

For any $k \leq q$, let $J_G(k)$ denote the set of general-category applicants and $J_R(k)$ denote the set of reserved-category applicants among k highest π -priority applicants. Hence, $|J_G(k)|$ denotes the number of general-category applicants, and $|J_R(k)|$ denotes the number of reserved-category applicants among k highest π -priority applicants. By definition, for any $k \leq q$,

$$|J_G(k)| + |J_R(k)| = k.$$

Consider the q_u highest π -priority applicants. Of these applicants, $|J_G(q_u)|$ are from the general-category and $|J_R(q_u)|$ are from the reserved-category.

We first relate the set of applicants $\mu^{oa}(I_G)$ and $\mu(I_G)$. Since μ is non-wasteful and respects priorities,

$$|\mu(I_G)| \geq |J_G(q_u)|. \tag{1}$$

Since general-category applicants receive $|J_G(q_u)|$ unreserved and 0 reserved slots under μ^{oa} ,

$$|\mu^{oa}(I_G)| = |J_G(q_u)|. \tag{2}$$

Equation (1) and equation (2) imply $|\mu^{oa}(I_G)| \leq |\mu(I_G)|$, which in turn implies

$$\mu^{oa}(I_G) \subseteq \mu(I_G), \tag{3}$$

since both matching μ and matching μ^{oa} respect priorities.

We next relate the set of applicants $\mu(I_R)$ and $\mu^{oa}(I_R)$. Equation (1) implies

$$|\mu(I_R)| \leq q - |J_G(q_u)| = q - (q_u - |J_R(q_u)|) = q_r + |J_R(q_u)|. \quad (4)$$

Since reserved-category applicants receive $|J_R(q_u)|$ unreserved slots and q_r reserved slots under matching μ^{oa} ,

$$|\mu^{oa}(I_R)| = q_r + |J_R(q_u)|. \quad (5)$$

Equation (4) and equation (5) imply $|\mu(I_R)| \leq |\mu^{oa}(I_R)|$, which in turn implies

$$\mu(I_R) \subseteq \mu^{oa}(I_R), \quad (6)$$

since both matching μ and matching μ^{oa} respect priorities.

Next consider the q highest π -priority applicants. Of these applicants, $|J_G(q)|$ are from the general-category and $|J_R(q)|$ are from the reserved-category.

Claim: $|\mu(I_R)| \geq \max\{q_r, |J_R(q)|\}$.

Proof of the Claim: Since matching μ is non-wasteful and it accommodates reservation policy,

$$|\mu(I_R)| \geq q_r. \quad (7)$$

Consider an applicant $i \in I_R$ who is one of the q highest π -priority applicants. Towards a contradiction, suppose $\mu(i) = \emptyset$. Since matching μ is non-wasteful, it accommodates reservation policy and respects priorities, all q_r reserved slots must be awarded to reserved-category applicants who have higher π -priority than applicant i . But since all q_u unreserved slots are also exhausted by non-wastefulness, at least one of the applicants who receive an unreserved slot must have lower π -priority than applicant i , for otherwise applicant i would not be one of the q highest π -priority applicants. This contradicts

matching μ respecting priorities (for unreserved slots), yielding the desired contradiction.

Hence, $\mu(i) \neq \emptyset$, and thus

$$|\mu(I_R)| \geq |J_R(q)|. \quad (8)$$

Equations (7) and (8) imply

$$|\mu(I_R)| \geq \max\{q_r, |J_R(q)|\},$$

completing the proof of the Claim. \diamond

Observe that

$$|\mu^{ef}(I_R)| = \max\{q_r, |J_R(q)|\} \quad \text{and} \quad |\mu^{ef}(I_G)| = q - \max\{q_r, |J_R(q)|\}. \quad (9)$$

Therefore, the first part of equation (9) and the Claim imply $|\mu^{ef}(I_R)| \leq |\mu(I_R)|$, which in turn implies

$$\mu^{ef}(I_R) \subseteq \mu(I_R), \quad (10)$$

since both matching μ and matching μ^{ef} respect priorities.

Finally, observe that the Claim further establishes

$$|\mu(I_G)| \leq q - \max\{q_r, |J_R(q)|\}. \quad (11)$$

Equation (11) and the second part of equation (9) imply $|\mu(I_G)| \leq |\mu^{ef}(I_G)|$, which in turn implies

$$\mu(I_G) \subseteq \mu^{ef}(I_G), \quad (12)$$

since both matching μ and matching μ^{ef} respect priorities.

Together, relations (3), (6), (10), and (12) complete the proof of the theorem. \blacksquare

A.2 Proof of Theorem 2

Proof. Fix a visa allocation problem $E \in \mathcal{E}$ and any pair of priority orders $\pi, \pi^* \in \Pi$. Assuming $\pi_u = \pi_r = \pi$, let $\mu^{ef} = \varphi^{ef}(E)$ be the outcome of the Exemptions-First visa allocation rule. Assuming $\pi_u = \pi$ and $\pi_r = \pi^*$, let $\mu^{ru} = \varphi^{ru}(E)$ be the outcome of the Reserved-Initiated visa allocation rule.

Let J_R^* be the set of q_r highest π^* -priority reserved-category applicants, and J_R be the set of q_r highest π -priority reserved-category applicants. We have

$$\mu_r^{ru}(I) = J_R^* \text{ and } \mu_r^{ef}(I) = J_R.$$

Let S^* be the set of q_u highest π -priority applicants in $I \setminus J_R^*$ and S be the set of q_u highest π -priority applicants in $I \setminus J_R$. Define

$$\begin{aligned} S_R^* &= S^* \cap I_R, & S_G^* &= S^* \cap I_G, \text{ and} \\ S_R &= S \cap I_R, & S_G &= S \cap I_G. \end{aligned}$$

Observe that

$$\begin{aligned} \mu^{ru}(I_R) &= J_R^* \cup S_R^*, & \mu^{ru}(I_G) &= S_G^*, \\ \mu^{ef}(I_R) &= J_R \cup S_R, & \mu^{ef}(I_G) &= S_G. \end{aligned}$$

Let $g \in S_G^*$. That is, applicant g is one of the general-category recipients of an unreserved slot under matching μ^{ru} . By construction of the set S_G^* ,

$$|\{i \in I \setminus J_R^* : i \pi g\}| < q_u,$$

for otherwise applicant g would not be assigned one of the unreserved slots in μ^{ru} .

Since $|J_R \setminus J_R^*| = |J_R^* \setminus J_R|$ and

$$j \pi j^* \quad \text{for all } j \in J_R \setminus J_R^* \text{ and } j^* \in J_R^* \setminus J_R,$$

we must have

$$|\{i \in I \setminus J_R : i \pi g\}| < q_u,$$

which in turn implies $g \in S_G$. Therefore, $S_G^* \subseteq S_G$, and hence

$$\mu^{ru}(I_G) \subseteq \mu^{ef}(I_G), \tag{13}$$

showing the second desired relation.

Recall that we have $|J_R^*| = |J_R| = q_r$. Therefore the relation (13), together with the non-wastefulness of matchings μ^{ru} and μ^{M-G} imply

$$|\mu^{ef}(I_R)| \leq |\mu^{ru}(I_R)|, \tag{14}$$

showing the first desired relation and completing the proof. ■

A.3 Proof of Theorem 3

Proof. Fix a visa allocation problem $E \in \mathcal{E}$ and any pair of priority orders $\pi, \pi^* \in \Pi$. Let $\pi_u = \pi$ and $\pi_r = \pi^*$. Let $\mu^{ru} = \varphi^{ru}(E)$ be the outcome of the Reserved-Initiated visa allocation rule, and $\mu^{ur} = \varphi^{ur}(E)$ be the outcome of the Unreserved-Initiated visa allocation rule. Let $\mu \in \mathcal{M}$ be any matching that complies with the statute. That is, μ is any non-wasteful matching that accommodates reservation policy and respects priorities.

Let J_G denote the set of general-category applicants and J_R denote the set of reserved-

category applicants among q_u highest π -priority applicants. By definition,

$$|J_G| + |J_R| = q_u. \quad (15)$$

We first relate the set of applicants $\mu^{ur}(I_G)$ and $\mu(I_G)$. Since μ is non-wasteful and it respects priorities,

$$|\mu(I_G)| \geq |J_G|. \quad (16)$$

Since general-category applicants receive $|J_G|$ unreserved and 0 reserved slots under μ^{ur} ,

$$|\mu^{ur}(I_G)| = |J_G|. \quad (17)$$

Equation (16) and equation (17) imply $|\mu^{ur}(I_G)| \leq |\mu(I_G)|$, which in turn implies

$$\mu^{ur}(I_G) \subseteq \mu(I_G), \quad (18)$$

since both matching μ and matching μ^{ur} respect priorities.

We next relate the set of applicants $\mu(I_R)$ and $\mu^{ur}(I_R)$. Equation (16) and equation (15) imply

$$|\mu(I_R)| \leq q - |J_G| = q - (q_u - |J_R|) = q_r + |J_R|. \quad (19)$$

Since reserved-category applicants receive $|J_R|$ unreserved slots and q_r reserved slots under matching μ^{ur} ,

$$|\mu^{ur}(I_R)| = q_r + |J_R|. \quad (20)$$

Equation (19) and equation (20) imply

$$|\mu(I_R)| \leq |\mu^{ur}(I_R)|. \quad (21)$$

We finally show that

$$\mu(I_G) \subseteq \mu^{ru}(I_G) \quad \text{and} \quad |\mu^{ru}(I_R)| \leq |\mu(I_R)|.$$

Let J_R^* be the set of q_r highest π^* -priority reserved category applicants. By construction

$$|J_R^*| = q_r \tag{22}$$

and

$$\mu^{ru}(i) = r \quad \text{for any } i \in J_R^*. \tag{23}$$

Let S^* be the set of q_u highest π -priority applicants in $I \setminus J_R^*$. By construction,

$$|S^*| = q_u. \tag{24}$$

Define $S_R^* = S^* \cap I_R$ and $S_G^* = S^* \cap I_G$. Observe that $\mu^{ru}(I) = J_R^* \cup S^*$. Here,

$$\mu^{ru}(I_R) = J_R^* \cup S_R^* \quad \text{and} \quad \mu^{ru}(I_G) = S_G^*. \tag{25}$$

Claim: $\mu(I_G) \setminus S_G^* = \emptyset$.

Proof of the Claim: Suppose that there exists an applicant $g \in \mu(I_G) \setminus S_G^*$. Since $g \notin \mu^{ru}(I_G)$ by relation (25), we must have

$$i \pi g \quad \text{for any } i \in S^*,$$

for otherwise matching μ^{ru} would fail to respect priorities. Therefore,

$$S^* \subset \mu(I), \tag{26}$$

since matching μ respects priorities as well. Moreover, since matching μ respects priorities and accommodates reserve policy,

$$J_R^* \subset \mu(I)$$

by construction of the set of applicants J_R^* . Hence,

$$S^* \cup J_R^* \cup \{g\} \subset \mu(I).$$

But since $|S^*| = q_u$ by equation (24) and $|J_R^*| = q_r$ by equation (22),

$$S^* \cap J_R^* = \emptyset \text{ and } g \notin (S^* \cup J_R^*) \implies |S^* \cup J_R^* \cup \{g\}| = q_u + q_r + 1.$$

Hence, we have a contradiction as

$$|\mu(I)| \geq q_u + q_r + 1 = q + 1.$$

This proves the claim. \diamond

As a result,

$$\mu(I_G) \subseteq S_G^* = \mu^{ru}(I_G). \tag{27}$$

Since μ is non-wasteful,

$$|\mu(I_R)| = \min\{q - |\mu(I_G)|, |I_R|\}.$$

If $|\mu(I_R)| = |I_R|$, then all reserved-category applicants in μ are matched under μ and

$$|\mu^{ru}(I_R)| \leq |\mu(I_R)|.$$

Otherwise,

$$|\mu(I_R)| = q - |\mu(I_G)| \geq q - |\mu^{ru}(I_G)| = |\mu^{ru}(I_R)|,$$

where the inequality follows from relation (27). In either case,

$$|\mu^{ru}(I_R)| \leq |\mu(I_R)|. \quad (28)$$

Equations (18), (21), (27), and (28) complete the proof. ■

B Appendix: Documentation of Visa Allocation Rules

This appendix contains excerpts from the Federal Register, the official journal of the federal government of the United States, related to H-1B allocation.

B.1 2005 Federal Register, Vol. 70, No. 86, May 5

“The H-1B Visa Reform Act of 2004 was enacted after the start of FY 2005 and after the receipt of all petitions necessary to reach the existing 65,000 H-1B cap for FY 2005. The amendment [...] authorizing the cap exemption of 20,000 H-1B nonimmigrant aliens with U.S. master’s or higher degrees, did not become effective until March 8, 2005. Congress did not specify any procedures for implementation or dictate the manner in which USCIS should allocate H-1B numbers made available pursuant to the new exemption. Congress specifically did not require USCIS to ‘reopen’ its review of the H-1B petitions already received and re-characterize the petitions that would have qualified for the next exemption had it been in effect at the time the petitions were received. Thus, in order to give full effect to the newly created exemption, it is reasonable to do so only going forward only, applying the exemption to up to 20,000 petitions seeking work start dates during FY 2005.” (Page 23777).

“[...], for FY 2005, USCIS has determined that the only appropriate way to implement the H-1B Visa Reform Act of 2004 is to apply the 20,000 exemptions prospectively.” (Page 23777).

“For FY 2006 and future fiscal years, USCIS will accept and adjudicate properly filled H-1B petitions on a first-in, first-out basis and will track those H-1B petitions that qualify for the U.S. master’s or higher degree exemption under the H-1B Visa Reform Act of 2004 as cases are received and adjudicated. [...] Similarly, H-1B nonimmigrant aliens that are exempt under the H-1B Visa Reform Act of 2004 will not be counted towards the fiscal year numerical limit of 65,000. USCIS will continue to exempt such aliens until USCIS has allocated all 20,000 H-1B exemption numbers authorized [...] Thereafter, any H-1B petition granted for an H-1B nonimmigrant alien who has earned a U.S. master’s or higher degree, unless otherwise exempt, will be counted against the fiscal year numerical limitations.” (Page 23777)

B.2 2008 Federal Register, Vol. 73, No. 57, March 24

“In order to ensure that the 65,000 and 20,000 caps are not exceeded, USCIS monitors the number of H-1B petitions it receives. The first day on which petitions may file H-1B petitions can be as early as six month ahead of the employment start date. Therefore, a petition requesting an employment start date of October 1, the first day of the next fiscal year, may file the H-1B petition as early as April 1 of the current fiscal year. When the USCIS determines, based on the number of H-1B petitions it has received, that the applicable cap will be reached, it announces to the public the final day on which it will accept such petitions for adjudication in that fiscal year. USCIS refers to this day as the “final receipt date.” USCIS then randomly selects the number of petitions necessary to reach the cap from the petitions received on the final receipt date.” (Page 15390)

“However, because demand for other H categories has not been as great as for the H-1B classification, USCIS has only had to apply the random selection procedures to H-1B petitions subject to the overall 65,000 cap or the 20,000 cap on master’s degree exemption.” (Page 15391)

“On Monday, April 2, 2007, the first available filing day for fiscal year (FY) 2008, USCIS received H-1B petitions totaling nearly twice the 65,000 cap. This was the first time since the random selection process regulations were promulgated that USCIS received more petitions than available cap numbers on the first available filing day. [...] The high volume of filings scheduled for delivery on April 2 caused logistical problems for overnight couriers and on the two USCIS service centers where filings could be made. Using the petitions received on April 2, and April 3, USCIS conducted the random selection process and thereafter rejected all petitions that were not randomly selected.” (Page 15391)

“Just as with the 65,000 cap, the 20,000 cap on the master’s degree exemptions has been exhausted earlier and earlier for each fiscal year since the cap exemption was added to the law. For FY 2006, the 20,000 cap was reached on January 17, 2006. For FY 2007, the cap was reached on July 26, 2006, less than four months after petition filings began on April 1, 2006. For FY 2008, the cap was reached on May 4, 2007, just over one month after petition filings began on April 2, 2007. For each of these fiscal years, USCIS announced a final receipt date and conducted the random selection process.” (Page 15391)

“USCIS believes that the trend of exhausting the 20,000 cap on master’s degree exemptions at an earlier date will continue. Should both 20,000 and 65,000 caps be reached on the same day that numbers become available (e.g., April 1 of the preceding fiscal year) no regulatory mechanism is in place to facilitate administration of the 20,000 cap in relation to the 65,000 cap.” (Page 15391)

“This problem would be exacerbated were the 20,000 cap to be reached prior to or at the same time as the 65,000 cap, since all petitions not selected random selection process for the 20,000 cap would be considered twice—at the time of the random selection for the 20,000 cap and, thereafter, for the 65,000 cap.” (Page 15391)

“This rule provides that USCIS will include petitions filed on all of those first five business days in the random selection process if USCIS receives a sufficient number of

petitions to reach the applicable numerical limit (including limits on exemptions) on any one of the five business days on which USCIS may accept petitions. [...] This rule also provides that, if both the 65,000 and 20,000 caps are reached within the first five business days available for filing H-1B petitions for a given fiscal year, USCIS must first conduct the random selection process for petitions subject to the 20,000 cap on master's degree exemptions before it may begin the random selection process of petitions to be counted towards the 65,000 cap. After conducting the random selection for petitions subject to the 20,000 cap, USCIS then must add any non-selected petitions to the pool of petitions subject to the 65,000 cap and conduct the random selection process for this combined group of petitions. Therefore, those petitions that otherwise would be eligible for the master's degree exemption that are not selected in the first random selection will have another opportunity to be selected for an H-1B number in the second random selection process. This rule also clarifies that those petitions not selected in either random selection will be rejected." (Page 15392)

B.3 2019 Federal Register, Vol. 84, No. 2, January 31

"The statute is ambiguous as to the precise manner by which beneficiaries with a master's or higher degree from a U.S. institution of higher education must be counted toward the numerical allocations. The statute states that the 65,000 numerical limitation does not apply until 20,000 qualifying beneficiaries are exempted, but is otherwise silent as to whether they must be exempted prior to, concurrently with, or subsequent to the 65,000 numerical limitation being counted and/or reached, or some combination thereof. This ambiguity was recognized by DHS when it initially determined how the exemption should be administered." (Page 895)

"DHS believes this approach is most consistent with the overall statutory framework as it counts all petitions filed by cap-subject petitioners until the numerical limitation

is reached, and otherwise precludes additional petitions, allows for an additional 20,000 petitions.” (Page 895)

“DHS believes that administering the numerically limited cap exemption in a way that does not reduce the odds of selection for beneficiaries with a U.S. advanced degree under the regular cap is most appropriate and maximizes the overall odds of selection for such beneficiaries under the numerical allocations.” (Page 895)

“DHS also disagrees that the statute requires that initial H-1B visas be allocated to petitions in the order received.” (Page 896)

“While DHS agrees that Congress has not limited the H-1B classification to the ‘best and brightest’ foreign nationals, nothing in the statute or legislative history precludes DHS from administering the cap allocation in a way that increases the odds of selection for beneficiaries with a master’s or higher degree from a U.S. institution of higher education.” (Page 896)

“Rather, this final rule simply creates a registration process to streamline the existing H-1B cap selection process, and reverses the order in which submissions are counted toward the H-1B numerical allocations, but does not change the overall number of foreign workers that may be hired under existing statutory authority.” (Page 897)

“Reversing the cap selection order is expected to result in a greater number of beneficiaries with master’s or higher degrees from U.S. institutions of higher education being selected under the numerical allocations and is in line with the executive order’s directive to ‘help ensure that H-1B visas are awarded to the most-skilled or highest-paid petition beneficiaries.’ Furthermore, master’s or higher degree holders still maintain their own selection pool.” (Page 912)

“It was clearly Congress’s intent to prioritize such workers by creating a 20,000 cap exemption only for them.” (Page 912)

“DHS is not able to increase the H-1B cap allocations, as the cap allocations are statutory and set by Congress.” (Page 913)

“Under the current process, when the number of cap-subject petitions filed with USCIS during the first five days that such petitions may be filed exceeds the numerical limits, a certain number of petitions projected as needed to meet the 20,000 advanced degree exemption are randomly selected first from the 55,900 advanced degree petitions eligible for the advanced degree exemption. Of the remaining 172,918 petitions, 35,900 (21 percent) of H-1B beneficiaries with master’s degree or higher from a U.S. institution of higher education remain in the pool to be selected in the 65,000 regular cap limit. Then, USCIS randomly selects a certain number of petitions projected as needed to meet the 65,000 regular cap limit from the remaining pool, which includes H-1B beneficiaries with bachelor’s degrees and beneficiaries with a master’s or higher degree from a U.S. institution of higher education not selected under the advanced degree exemption. DHS estimates that an additional 13,495 petitions otherwise eligible for the advanced degree exemption but not selected under the advanced degree exemption would be randomly selected in the regular cap. Therefore, USCIS currently selects an estimated total of 33,495 petitions filed for beneficiaries with a master’s or higher degree from a U.S. institution of higher education, which accounts for 17 percent of 192,918 Form I-129 petitions.” (Page 928)

“Under the new change to the H-1B cap-subject selection process, those seeking to file an H-1B cap-subject petition will have to submit an electronic registration for each beneficiary, unless the registration requirement is suspended. Only those with selected registrations will be eligible to file an H-1B cap-subject petition during an associated filing period for that fiscal year. As previously stated, DHS continues to assume 192,918 registrations will be received annually. Under the new selection process, when registration is required, USCIS would first select a certain number of registrations projected as needed

to meet the 65,000 regular cap limit from the 192,918 registrations. All 55,900 H-1B beneficiaries with a master’s or higher degree from a U.S. institution of higher education (29 percent) will therefore be included in the pool for selection. DHS estimates that up to 18,825 advanced degree registrations that could be selected during the selection for the regular cap.” (Page 928)

“Next, USCIS will select a certain number of registrations projected to meet the 20,000 advanced degree exemption from the remaining pool of 37,065 advanced degree registrations. In total, USCIS is likely to select an estimated 38,835 registrations for petitioners seeking to file H-1B petitions under the advanced degree exemption. These registrations account for 20 percent of the 192,918 registrations. Therefore, DHS estimates USCIS could accept up to 5,340 (or 16 percent) more H-1B cap-subject petitions annually for beneficiaries with a master’s or higher degree from a U.S. institution of higher education.” (Page 929)

C Comparisons Between Visa Allocation Rules

This section provides precise definitions for our comparisons of visa allocation rules. Given two visa allocation rules φ and ψ , we say

- rule φ is **more favorable for the reserved-category applicants** than rule ψ if, for any $E \in \mathcal{E}$, $\mu = \varphi(E)$, and $\nu = \psi(E)$,

$$|\mu(I_R)| \geq |\nu(I_R)|.$$

Similarly,

- rule φ is **less favorable for the reserved-category applicants** than rule ψ if,

for any $E \in \mathcal{E}$, $\mu = \varphi(E)$, and $\nu = \psi(E)$,

$$|\mu(I_R)| \leq |\nu(I_R)|;$$

- rule φ is **more favorable for the general-category applicants** than rule ψ if, for any $E \in \mathcal{E}$, $\mu = \varphi(E)$, and $\nu = \psi(E)$,

$$|\mu(I_G)| \geq |\nu(I_G)|;$$

- rule φ is **less favorable for the general-category applicants** than rule ψ if, for any $E \in \mathcal{E}$, $\mu = \varphi(E)$, and $\nu = \psi(E)$,

$$|\mu(I_G)| \leq |\nu(I_G)|.$$

A visa allocation rule φ that complies with the statute is

- **reserved-category-maximal** if, for any problem $E \in \mathcal{E}$ and rule ψ that complies with the statute, rule φ is more favorable for the reserved-category applicants than rule ψ ;
- **reserved-category-minimal** if, for any problem $E \in \mathcal{E}$ and rule ψ that complies with the statute, rule φ is less favorable for the reserved-category applicants than rule ψ ;
- **general-category-maximal** if, for any problem $E \in \mathcal{E}$ and rule ψ that complies with the statute, rule φ is more favorable for the general-category applicants than rule ψ ;
- **general-category-minimal** if, for any problem $E \in \mathcal{E}$ and rule ψ that complies with the statute, rule φ is less favorable for the general-category applicants than rule ψ ;

rule ψ .