

SOCIAL SCIENCES

The effect of citizenship on the long-term earnings of marginalized immigrants: Quasi-experimental evidence from Switzerland

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We provide evidence that citizenship catalyzes the long-term economic integration of immigrants. Despite the relevance of citizenship policy to immigrant integration, we lack a reliable understanding of the economic consequences of acquiring citizenship. To overcome nonrandom selection into naturalization, we exploit the quasi-random assignment of citizenship in Swiss municipalities that held referendums to decide the outcome of individual naturalization applications. Our data combine individual-level referendum results with detailed social security records from the Swiss authorities. This approach allows us to compare the long-term earnings of otherwise similar immigrants who barely won or lost their referendum. We find that winning Swiss citizenship in the referendum increased annual earnings by an average of approximately 5000 U.S. dollars over the subsequent 15 years. This effect is concentrated among more marginalized immigrants.

INTRODUCTION

Many countries have experienced sharp increases in the size and diversity of their immigrant populations in the last decade, prompting governments to reevaluate their immigration and integration policies to accommodate the new arrivals and facilitate their integration into the host country economy, society, and polity. Much is at stake in this process. Successful integration opens the door for immigrants to economically benefit their host countries and strengthen their civil societies (1). Unsuccessful integration can fuel social conflict and undermine cohesion, given widespread perceptions that immigrants threaten their host country's culture, security, and social safety net (2, 3). At a personal level, marginalization from the host country society and economy imperils immigrants' social, mental, and economic well-being (4, 5).

Central to integration is the issue of immigrants' access to host-country citizenship (6–10). Two viewpoints, which are sometimes referred to as the “catalyst” versus “crown” paradigms, structure debates about citizenship policy (11, 12). The first paradigm holds that citizenship is a catalyst for immigrant integration. Viewed from this perspective, obtaining host-country citizenship promotes the subsequent integration of immigrants, because it inspires them to invest in a future in the host country (11, 13), invigorates their political participation (14), and reduces the discrimination that they face in the local labor market (15, 16). The second viewpoint argues that citizenship is the crowning prize for a successfully completed integration process (9, 17). Viewed from this perspective, the integration requirements for naturalization, such as mandatory language or country-knowledge tests, incentivize immigrants to invest in integration. Once immigrants are awarded citizenship, they have reached the end point of their integration process, so we expect no effects of citizenship itself on subsequent integration (18).

While these viewpoints are not mutually exclusive, they often serve as competing justifications for more liberal or restrictive citizenship policies (11). If naturalization is a catalyst, then access to

citizenship improves immigrants' integration outcomes. If naturalization is a crowning prize, then more restrictive citizenship policies with higher integration requirements are more beneficial, because they motivate immigrants to invest in integration (9, 12).

In this study, we focus on the second of these viewpoints, that naturalization fosters integration. Does gaining citizenship actually improve integration outcomes? If so, then how long does it take for the benefits of citizenship to materialize? In addition, how do the effects vary across immigrant groups? While immigrant integration is a multidimensional concept, which can broadly be defined as the degree to which immigrants acquire “the knowledge and capacity to build a successful, fulfilling life in the host society” (19), we focus specifically on the dimension of economic integration and, in particular, the long-term effects of citizenship on immigrants' wages. While economic integration is not the only important dimension of integration, it is often the focus of prominent integration debates. Economic integration can also serve as a stepping stone for other dimensions of successful integration (19). In related studies, we examine the effects of citizenship on political and social integration outcomes (11, 14).

Several studies focusing on the effects of citizenship on economic integration demonstrate important links between naturalization and immigrants' short-term economic outcomes, such as wages and employment (13, 20–25). Yet, little is known about citizenship's long-term effects, despite their importance for policy. Two challenges stand in the way of estimating long-term effects. First, we must isolate the effect of citizenship from the two-stage selection bias that determines which immigrants apply for and receive citizenship (11, 14). This is challenging because researchers typically cannot control for the myriad of unobserved factors that lead immigrants to apply for citizenship and that lead decision-makers to approve applications (11, 18, 26, 27). Second, data constraints have largely prevented researchers from measuring long-term effects of citizenship. Many studies rely on surveys that typically limit analyses to short-term effects and raise concerns about the accuracy of self-reported earnings (28). In addition, studies that have used register data, while including precise measurements of when immigrants receive citizenship, frequently lack information on whether and when immigrants apply for citizenship, which makes accounting for the two stages of selection bias difficult because one cannot control for the important confounder of the motivation to apply.

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We address these gaps and provide causal evidence on the effects of citizenship on the long-term earnings of immigrants. We leverage a natural experiment in Switzerland, where some municipalities held municipality-wide referendums on the citizenship applications that met the eligibility requirements (including sufficient residency, a clean criminal record, and economic self-sufficiency). Voters received a leaflet containing detailed information about each application, including the applicant's name, origin country, gender, age, length of residency in Switzerland, and language skills, and then cast a secret ballot to approve or reject each application. An example leaflet is shown in fig. S1. Applicants receiving a majority of "yes" votes received Swiss citizenship; rejected applicants kept their permanent residency status and could apply for citizenship again, if they so chose.

This natural experiment allows us to apply two complementary research designs to overcome the double selection bias: a regression discontinuity (RD) design and a difference-in-differences (DD) design. In both designs, we remove the first-stage selection bias, from nonrandom selection into the application process, by restricting the analysis to successful and unsuccessful applicants. In the RD design, which prior research has shown to have high internal validity and the ability to replicate benchmark results from randomized experiments (29), we compare applicants who narrowly won or lost their naturalization referendums to remove the second-stage selection bias. Success in close referendums was largely decided by arbitrary factors, such as current events, other referendums being decided at the same election, or even the weather on the election day. Consequently, applicants who won or lost by just a few votes were similar on confounding characteristics, and comparisons of their postreferendum earnings represent the causal effect of winning citizenship in the referendum. Figure S4 shows that most covariates, including prereferendum earnings outcomes, are fairly balanced among narrow winners and losers, suggesting that in close referendums, citizenship is as good as randomly assigned. For the DD design, we overcome the second-stage selection bias by leveraging the panel dimension of our data and compare the trajectories of pre- and postreferendum outcomes of successful and unsuccessful applicants whose vote margins were within a narrow margin. This allows us to examine whether the earnings trends of winners and losers were similar before the referendum and then diverged afterward.

Our data combine detailed records from referendums and leaflets that we extracted from municipal archives to identify all 4160 immigrants whose naturalization applications were decided in the 46 municipalities that used the secret ballot referendum process between 1970 and 2003 (30). From these records, we observe the number of yes and no votes that each applicant received and the information available to voters from the leaflets when they voted in the referendums, including the applicant's name, birth year, gender, referendum year, and origin country. To measure applicants' economic outcomes, we worked with the Swiss Central Compensation Office (CCO) to match applicants to records of their mandatory contribution to the Swiss pension system [Old Age and Survivors' Insurance (OASI)] on the basis of their name and date of birth. CCO successfully matched 92% of applicants to the OASI data; the match rate was roughly the same among close referendum winners and losers (fig. S2). The deidentified matched dataset that we received from CCO contains only the OASI information, birth year, gender, referendum year, grouped origin country, rounded vote share, and referendum outcome from the archival records. The grouping of immigrants by origin country followed (31) and was conducted before CCO linked the data.

The OASI data allow us to track the earnings of matched applicants before and after their naturalization referendums, as all adults between 18 and 64 (for women) or 65 (for men) years of age who live in Switzerland are required to contribute a fixed percentage of their annual income to the OASI. Our primary outcome is each applicant's annual total earnings from employment, measured in 2015 consumer price index (CPI)-adjusted Swiss Francs (CHF; 1 CHF \approx 1 U.S. dollar). We do not count as earnings income from nonemployment sources such as capital gains, pensions, scholarships, disability, or unemployment benefits. Applicants whose only income in a given year comes from these nonemployment sources remain in the sample—we code them as having zero earnings. Further, we top-code earnings at 200,000 CHF to limit the influence of outliers. We observe earnings from 1981 through 2015. Our matched sample includes $n = 3814$ applicants and a total of $n = 42,160$ annual applicant observations. Details about the measures, sample, design, and statistical analysis can be found in the materials and methods section.

RESULTS

Figure 1 shows the results from applying the RD and the DD designs to the matched dataset. Winning citizenship in the referendum increased the long-term earnings of these immigrants. The top-left panel shows a placebo check for the RD design. We find no discernible difference in the earnings of applicants who just barely won or lost their referendums during the prereferendum period. In contrast, the top-right panel shows that in the postreferendum period, applicants who just barely won achieved higher earnings than those who just barely lost. The bottom-left panel shows that the DD design yields similar results. Focusing on applicants within a 40 to 60% yes vote range, winners' and losers' earnings trends were parallel in the 5 years before the referendum but diverged in the years after. Applicants who became citizens enjoyed sustained earnings growth; applicants who lost experienced stagnation followed by earnings losses (in real terms) 11 to 15 years after their referendums.

The bottom-right panel of Fig. 1 shows point estimates and confidence intervals from both the RD and DD designs for the placebo check on prereferendum earnings and for the short- and long-term effects of winning the citizenship referendum. For the RD design, the estimates are based on standard local linear regressions fitted to applicants who won or lost by ± 10 percentage points. There was no discernible difference in the earnings of referendum winners and losers over the 5 years before the referendum ($P = 0.614$). Winning the referendum increased average annual earnings by 2934 CHF for the 5 years following the referendum ($P = 0.335$) and by 5133 CHF for the period of 6 to 10 years after the referendum ($P = 0.124$). For the combined 10-year period after the referendum, the effect was 3635 CHF ($P = 0.202$). In the subsequent 5 years (11 to 15 years after the referendum), the effect on earnings was 8125 CHF ($P = 0.033$). Estimated over the entire 15-year postreferendum period, the effect of winning citizenship on average annual earnings was 5615 CHF ($P = 0.047$). This amounts to an increase of approximately 13.5% over the average postreferendum earnings of narrowly rejected applicants.

The DD design estimates are based on standard panel regressions with applicant- and year-fixed effects. The effect estimates were similar to those from the RD design in magnitude, but somewhat more precise. We found no discernible difference in the earnings trends for the 5 years before the referendum ($P = 0.921$), but winning the referendum increased annual earnings by 710 CHF ($P = 0.584$), 3086 CHF

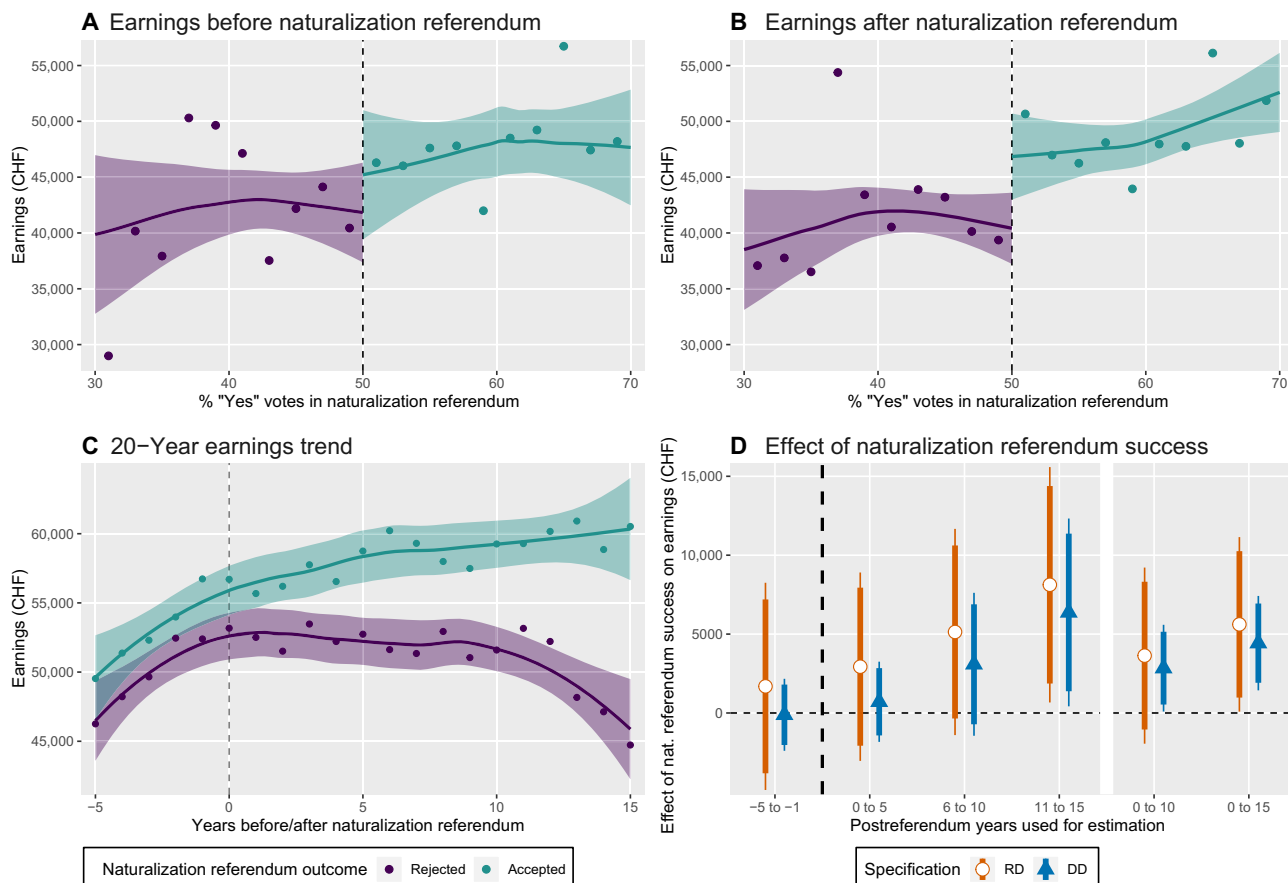


Fig. 1. Winning citizenship in the referendum increases immigrant earnings in the long term. (A) Placebo test shows no significant differences in earnings between immigrants who barely won or lost their citizenship referendum in the last 5 years before the referendum ($n = 1337$). (B) RD estimate shows sizable and significant differences in earnings between immigrants who barely won or lost their citizenship referendum in the years after the referendum ($n = 2262$). (C) The 20-year earnings trends spanning the time period before and after the naturalization referendum shows an increasing earnings gap between immigrants who won or lost their referendum (applicants in 40 to 60% yes-vote range; $n = 10,731$). (A) to (C) show loess smoother and 95% confidence intervals. (D) Point estimates for the RD and DD regressions and 90% (thick line) and 95% (thin line) confidence intervals.

($P = 0.182$), and 6372 CHF ($P = 0.036$) for the 0- to 5-year, 6- to 10-year, and 11- to 15-year periods following the referendum. Across the first 10 years after the referendum, the effect of referendum success on annual earnings amounted to 2841 CHF ($P = 0.043$). Over the entire 15-year postreferendum period, the effect of referendum success on annual earnings was 4426 CHF ($P = 0.004$).

Our finding that the effect of winning the referendum grows over time echoes earlier studies' findings (21, 25) and points to naturalization allowing applicants to attain higher wages in the long term. When comparing our estimates to those from studies in other countries, we should keep in mind that many contextual factors such as the origin and skill composition of the immigrant population, labor market conditions, and legal barriers to host-country citizenship may moderate the returns to naturalization. Our estimate for Switzerland (years 1981–2015) is in the range reported by previous studies that have estimated the effect of naturalization over a 15-year postnaturalization period to be an approximately 7.4% wage increase in Germany (1975–2004) and a 38.1% increase in the United States (1979–91) (21, 25). For Germany, Steinhardt (25) uses a linear growth model to estimate the annual wage growth caused by naturalization to be 0.49% for each postnaturalization year. Using the same model, Bratsberg *et al.* (21) get a corresponding estimate of 2.54% for the United States. To make the estimates compa-

rable across studies, we multiply the annual wage growth reported for Germany and the United States by 15 postnaturalization years.

Several checks support the robustness of the results including changes to the inflation adjustment (fig. S5 and tables S7 and S8), excluding applicants with self-employment earnings (tables S9 and S10) or with zero earnings through their pre- and postreferendum periods (tables S17 and S18), including earnings measured after retirement age (tables S19 and S20), changing the regression specifications (tables S11 to S16), and varying the bandwidths for the estimation samples (figs. S6 and S7).

Our designs identify the effect of winning citizenship in the naturalization referendum, i.e., an intention-to-treat effect. Because some applicants who lost their referendum subsequently reapplied and obtained citizenship at a later date, our estimates are distinct from the effect of obtaining citizenship. For the subset of applicants who obtain Swiss citizenship if and only if they pass their first referendum, we could estimate the effect of citizenship, i.e., a local average treatment effect (LATE), if we made additional assumptions—notably, an exclusion restriction—and obtained a reliable measure of when and if rejected applicants naturalize so that we could compute a compliance ratio. Note that under these assumptions, the LATE would be strictly larger than the intention-to-treat effect that we report here (32); hence, our results can be viewed

as a lower bound on the effect of citizenship. In the Supplementary Materials, we provide approximations to the LATE by leveraging data from a targeted survey of close referendum winners and losers and the CCO's indicator for naturalization, which is unfortunately not updated regularly, to measure whether and when rejected applicants naturalized. Given the measurement errors of these variables, we caution against overinterpreting these somewhat speculative approximations of the LATE and instead prefer the conservative intention-to-treat effects.

What mechanisms explain the sizable long-term effect of winning the citizenship referendum on earnings? One possibility is that the earnings differences do not represent a positive effect of citizenship but rather a negative effect of alienation felt by rejected applicants. Several points cast doubt on this explanation. Losing the referendum did not affect unsuccessful applicants' permanent residency status, and they faced no new restrictions to labor market access or the security of their residence in Switzerland. Consistent with this, rejected applicants' pre- and postreferendum earnings are relatively similar (Fig. 1, A and B), and we observe rejected applicants throughout the postreferendum period at similar rates as accepted applicants (fig. S8). This suggests that losing the referendum did not make them more likely to leave Switzerland. In addition, the difference in the earnings trend between accepted and rejected applicants grows rather gradually throughout the postreferendum period, and there is no discontinuous effect in the immediate aftermath of the referendum when an alienation effect would be expected to be strongest.

Another possible mechanism is that naturalization confers a sense of security that allows for greater risk taking in the labor market and that this eventually leads to higher earnings. We also view this explanation as unlikely. All applicants, regardless of referendum outcome, had permanent residency in Switzerland and equal access to the Swiss social security system. It is therefore unclear why citizenship would incentivize greater risk taking. Empirically, one implication of greater risk-taking behavior on the part of successful applicants is that they would use unemployment benefits at higher rates, as they become more selective during job searches or take time away from the labor market to gain additional skills. To test this argument, we can use the RDD and DD designs to estimate the effect of winning the referendum on unemployment frequency. Tables S25 and S26 show the results. Across all specifications, we find no evidence that referendum success affected unemployment frequency. This suggests that referendum winners are not more likely to rely on unemployment benefits, contrary to the risk-taking argument. At the same time, this null result also implies that the benefits of passing the referendum for earnings, which are coded zero for unemployment spells, are not driven by a reduction in unemployment risk for winners. Part of this might be due to the fact that unemployment is rather rare in our sample. Applicants' average unemployment duration is only 0.38 months per year.

Alternatively, citizenship may lead to higher earnings by reducing the discrimination that immigrants face in the labor market. In Switzerland, employers and employment websites typically expect job applicants to report their citizenship, making citizenship status a visible criterion that can factor into the screening of applications. Statistical discrimination (33, 34) occurs when employers assume that non-naturalized immigrants are, in general, lower skilled and less likely to remain in Switzerland and then are less likely to hire, promote, or invest in specific non-naturalized immigrants based on these assumptions. Acquiring citizenship, because it is costly and requires meeting criteria regarding residency, economic self-sufficiency, and language skill,

sends employers a signal of successful integration and commitment to permanent settlement in Switzerland (35). Alternatively, discrimination against immigrants may be "taste based" (36), i.e., driven by employers' prejudice and animus against particular origin groups.

If citizenship improves earnings by reducing discrimination in the labor market, then we would expect citizenship to be more beneficial to immigrants belonging to groups most often subjected to discrimination. Consistent with this mechanism, we find that when replicating our analyses for different origin groups, the earnings gains from winning the citizenship referendum are concentrated among immigrants from Turkey and Yugoslavia, whom previous research has identified as two of the most marginalized immigrant groups in Switzerland in the period we study (31). Specifically, winning the referendum increased these immigrants' annual earnings by 10,624 CHF ($P = 0.003$; RD design), while there is no discernible effect for immigrants from other countries ($P = 0.957$; RD design).

Immigrants at the lower quantiles of the earnings distribution, who primarily work in low-skill jobs, comprise another group with a higher likelihood of facing discrimination in the labor market (37). Figure 2 shows the effect of winning the citizenship referendum at three different quantiles—25th, 50th, and 75th—of the earnings distribution. We find that the gains in earnings from winning citizenship are largest at the 25th percentile of the earnings distributions. Quantile DD regressions, reported in table S23, indicate that the annual earnings boost from naturalization is stronger at the 25th percentile (2344 CHF, $P = 0.002$ for 0 to 10 years after the referendum and 3234 CHF, $P = 0.001$ for 0 to 15 years) than at the median (1310 CHF, $P = 0.013$ for 0 to 10 years and 1704 CHF, $P = 0.004$ for 0 to 15 years) and at the 75th percentile (283 CHF, $P = 0.572$ for 0 to 10 years and 733 CHF, $P = 0.211$ for 0 to 15 years). These results are consistent with the discrimination mechanism, suggesting that winning the citizenship referendum is most beneficial for immigrants with lower earnings.

Besides earnings and unemployment, the Supplementary Materials explore the impact of winning citizenship in the referendum on two additional labor market outcomes: disability risks and early retirement. Tables S27 to S29 present the results. We find no impact on retirement behavior across model specifications, and only weak evidence for a small effect on disability benefits: according to our DD model, winning the referendum decreases the probability of receiving disability benefits 11 to 15 years later by one percentage point ($P = 0.08$).

DISCUSSION

We provide evidence that winning citizenship in the referendum improves immigrants' earnings over the long term. Leveraging a quasi-experiment that compares similar immigrants who were divided by just a few votes at the time of their naturalization referendum, we found that those who barely won Swiss citizenship had higher earnings up to 15 years later compared to those who barely lost their referendum. This finding provides evidence that citizenship catalyzes immigrants' long-term economic success, at least in the context of naturalization referendums in Switzerland. In addition, we find evidence that winning the citizenship referendum particularly benefitted more marginalized groups, i.e., immigrants from Turkey and Yugoslavia, and those with lower earnings. These findings support the argument that citizenship can alleviate some of the labor-market discrimination that impedes immigrant integration. Because of our design, our findings cannot speak to benefits of naturalization for irregular immigrants or immigrants who do not meet citizenship requirements.

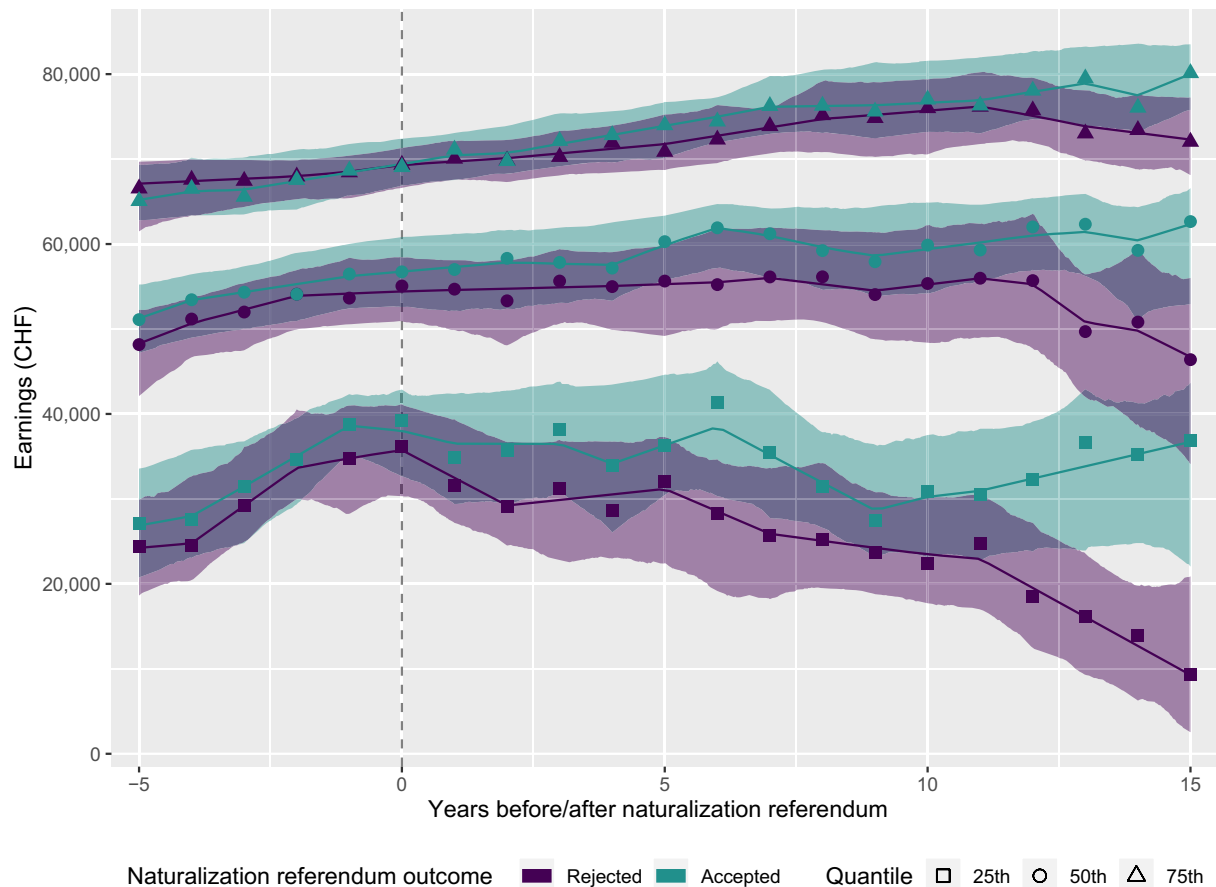


Fig. 2. Effect of winning citizenship in the referendum is largest for lower earning quantiles. Comparing immigrants who barely won or lost their citizenship referendum at the 25th, 50th, and 75th earnings percentile, point estimates and 95% confidence intervals show that the relative and absolute effect of winning citizenship in the referendum is largest for immigrants with lower earnings ($n = 10,731$).

How should we consider the external validity of our findings? One way to judge the external validity is to examine how the 46 ballot box municipalities that are the focus of this study differ from other Swiss municipalities. Table S32 compares the ballot box municipalities to all other Swiss municipalities across a range of characteristics that potentially affect immigrant integration, including population size, share of foreign-born residents, naturalization rate, proportion of the labor force working in the primary, secondary, and tertiary sectors, unemployment rates for Swiss and foreigners, and vote shares for the populist right-wing Swiss People's Party across the study period. While we find that ballot box municipalities are somewhat larger than the other municipalities, they otherwise resemble the rest of Switzerland. Although our results are roughly consistent with other studies that have documented economic benefits of naturalization, external validity beyond Switzerland is much harder to assess given the many cross-country differences that may moderate the effects of citizenship. Future research with similar quasi-experimental designs and register data from other contexts is needed to better evaluate the long-term effects of citizenship in other labor markets.

At a time when governments around the world are striving to design policies that facilitate the integration of large and diverse immigrant populations, our study shows that, at least in our context, awarding host-country citizenship can create lasting economic returns. These returns not only benefit immigrants themselves; they also can strengthen host

communities by increasing tax revenues and lowering welfare spending. While our study advances understandings of the causal effects of citizenship, more work is necessary to identify its benefits in other contexts and to evaluate the impact of lowering barriers to citizenship, such as lengthy residency requirements, high naturalization fees, or lack of information (38, 39). Also, our findings here can only speak to the effect of citizenship given the current citizenship regulations. More work is needed to determine the optimal level of citizenship requirements that would maximize the catalytic effects of naturalization and maximize the integration returns (11, 14).

MATERIALS AND METHODS

Institutional background

Standard Swiss practice is for citizenship applications to be decided at the municipal level, with procedures for resolving applications varying across municipalities (30, 31). Immigrants seeking Swiss citizenship apply with their municipality of residence. We based our study on the set of municipalities, which we call the ballot box municipalities, that decided naturalization requests with secret-ballot referendums (31). In the ballot box municipalities, immigrants seeking naturalization submitted an application to local authorities, who then checked whether the applicant met the formal requirements. Eligible applicants then had their requests voted on by the citizen population. Shortly before the

naturalization referendums, resident citizens received official leaflets with detailed information about each applicant, which voters could use to inform their decision to approve or reject each application. See fig. S1 for an example leaflet.

Applicants receiving a majority of yes votes were granted Swiss citizenship. Applicants who did not win majority support could re-apply again, although the length of the application process meant that they typically would not have another referendum for some years. See (11, 14, 31) for more details about the process.

Data

We based our sample on data collected by Hainmueller and Hangartner (31). They retrieved records of referendums and leaflet information from municipal archives for all immigrants whose naturalization applications were put to public vote in all 46 ballot box municipalities between 1970 and 2003, when the Swiss Supreme Court struck down the procedure as unconstitutional (30). In total, our sample from the municipal archives contains $n = 4160$ applicants.

From the voting leaflets, we observed a set of prereferendum covariates. Because this is the same information available to naturalization referendum voters, it is effectively the set of covariates that determined whether applicants did or did not receive citizenship at their referendum. This set included, among others, applicants' birth year, gender, referendum year, and origin country. We then connected the leaflet measures to the percentage of yes votes received in referendums. To add measures of pre- and postreferendum economic outcomes to the sample, we worked with the Swiss CCO (Zentrale Ausgleichsstelle) to match applicants to records of their mandatory contributions to the Swiss pension system (OASI, Alters- und Hinterlassenenversicherung) from 1981 through 2015 on the basis of their name and date of birth.

CCO successfully matched 92% of applicants to the OASI data, corresponding to $n = 3814$ applicants and $n = 42,160$ annual applicant observations. The match rate is balanced between close referendum winners and losers (fig. S2) and is similar across values of the covariates in the matched dataset (table S1). The deidentified matched dataset that we received from CCO contains only the OASI information, birth year, gender, referendum year, grouped origin country, rounded referendum vote share, and referendum outcome from the archival records. To ensure data anonymity, we had to group immigrants by origin country before CCO linked the datasets. For this, we followed the grouping of Hainmueller and Hangartner (31). The data that we received from the CCO also include an indicator that allows us to measure whether (and when) initially unsuccessful applicants eventually obtained Swiss citizenship, but as we discuss below, this variable is not systematically updated and is, therefore, affected by measurement error.

Statistical analysis

In our RD approach, we estimate effects by fitting linear regressions specified as

$$Y_i = \delta_t + \beta_1 \text{ above } 50\% + \beta_2 \text{ margin} + \beta_3 \text{ above } 50\% \times \text{margin} + [\text{covariates}] + \epsilon_i$$

where i indexes applicants, Y is one of our outcome variables, δ_t represents fixed effects for referendum year, β_1 is the effect of winning the naturalization referendum, [covariates] is our battery of covariates (grouped origin, female, and a series of binary variables for referendum age), and ϵ is an idiosyncratic error term. We fit these regressions to all

applicants who were observed at least once after their referendum within a $\pm 10\%$ vote share margin, following the method for calculating optimal bandwidths introduced in (40).

A key feature of this design is the assumption that applicants could not manipulate their referendum vote share. Figure S3 shows that the density of applications is fairly smooth at the threshold, confirming that applicants could not manipulate their vote shares. Because of the rounding procedure applied to the vote shares, a formal McCrary density test is not feasible in our context. However, we can compare the density of applicants at the 50% threshold. Among the applicants falling into the 49.5 to 50.5% range, 52% were accepted and 48% were rejected. A two-sided exact binomial test of equality of proportions shows no indication of sorting ($n = 69$, two-sided $P = 0.81$). This test follows the spirit of the sorting test for RD designs with discrete running variables presented in (41), which the rounding structure of our running variable does not permit us to implement exactly. As referenced above, we also provide covariate balance tests for our RD design in fig. S4.

Another important feature of our design is that our running variable “margin” has been rounded to the nearest integer. As shown in (42), naive RD estimation with a rounded running variable can bias treatment effect estimates when the relationship between the running variable and the outcome has a steep slope or is nonlinear near the threshold, and, further, $\beta_3 = 0$ is a sufficient condition for ruling out rounding bias. Our estimates (see table S6) do not allow us to reject the hypothesis that $\beta_3 = 0$, leading us to the conclusion that rounding bias is not affecting our estimates. Note, however, that our estimates of the returns to winning the referendum are only marginally smaller with the correction proposed in (42).

For our DD approach, we estimate effects with linear regressions specified as

$$Y_{it} = \alpha_i + \delta_t + \beta \text{ above } 50\%_i \times \mathbf{1}(\text{calendar year} \geq \text{referendum year})_{it} + \epsilon_{it}$$

where i indexes applicants, t indexes calendar years, α_i is an applicant fixed effect, δ_t is a year fixed effect, β is the effect of winning the naturalization referendum, $\mathbf{1}(\text{calendar year} \geq \text{referendum year})$ is an indicator function that takes on the value of 1 the year of an applicant's referendum and all subsequent years and that takes on the value of 0 for all prereferendum years, and ϵ_{it} is an idiosyncratic error term. To account for errors that are correlated within applicants over time, we cluster SEs by applicant.

The standard identifying assumption for a DD design—commonly called “parallel trends”—states that there are no time-varying variables that confound the relationship between treatment and potential outcomes, i.e., between referendum success and postreferendum earnings. While this assumption may be implausible across the full range of referendum vote shares, or in contexts that compare citizenship applications decided under more opaque procedures, it is plausible when focusing on close referendums, where applicants are relatively similar apart from their levels of referendum support. For this reason, we restricted the sample for our DD models to those applicants with referendum vote shares within a $\pm 10\%$ bandwidth around the threshold—the same restriction that we applied for our RD models.

We further restricted the sample to applicants whom we observed at least once 5 years or more before their referendum, once in the 5 years immediately before their referendum, and once after their referendum. Because the DD effect is based on comparisons of earnings before and

after referendums, these restrictions ensure that only applicants who can contribute to estimating the effect of winning a referendum are included. In addition, the restriction that applicants be observed at least once 5 years or more before their referendum is made so that we have statistical power to estimate the prereferendum trends in earnings. This is necessary for evaluating the plausibility of the parallel trends assumption (see prereferendum period in the bottom-left panel of Fig. 1).

For our main analyses, we fitted six versions of our DD model. First, we fitted a placebo model that tests the assumption of no time-varying confounding. To do this, we restricted the sample only to observations in the final 5 years before an applicant's referendum and then consider treatment uptake, i.e., the beginning of the postreferendum year period, to have occurred in the final two prereferendum years. The remaining five models all include the 5 years immediately before applicants' referendums (and code treatment normally) and cover the following post-referendum year ranges: 0 to 5, 6 to 10, 11 to 15, 0 to 10, and 0 to 15. Additional analyses, unless otherwise specified, use the full set of pre- and postreferendum years.

SUPPLEMENTARY MATERIALS

Supplementary material for this article is available at <http://advances.sciencemag.org/cgi/content/full/5/12/eaay1610/DC1>

Section S1. Additional information on Materials and Methods

Section S2. Descriptive statistics

Section S3. Supplementary Text

Fig. S1. Sample leaflet sent out to voters.

Fig. S2. Match rate for archival and OASI data in close referendums.

Fig. S3. Frequency of referendum vote shares.

Fig. S4. Covariate balance for RD design.

Fig. S5. Regression estimates without CPI adjustment to earnings (CHF).

Fig. S6. Robustness of DD results to alternative bandwidths.

Fig. S7. Robustness of RD results to alternative bandwidths.

Fig. S8. RD plot for postreferendum attrition.

Table S1. Match rate for archival and OASI data across covariates.

Table S2. Variable definitions.

Table S3. Descriptive statistics for RD sample.

Table S4. Descriptive statistics for DD sample.

Table S5. Effect of referendum success on earnings, DD design.

Table S6. Effect of referendum success on earnings, RD design.

Table S7. DD results without CPI adjustments to earnings (CHF).

Table S8. RD results without CPI adjustment to earnings (CHF).

Table S9. DD results without applicants with self-employment earnings.

Table S10. RD results without applicants with self-employment earnings.

Table S11. DD results with years since referendum and year fixed effects.

Table S12. RD results without covariates.

Table S13. RD results with difference-in-means specification.

Table S14. RD results with difference-in-means specification and without covariates.

Table S15. RD results with unrealistic referendum age values recoded.

Table S16. RD results excluding applicants with unrealistic referendum age values.

Table S17. DD results excluding applicants with zero earnings in all years.

Table S18. RD results excluding applicants with zero earnings in all years.

Table S19. DD results including observations after retirement age.

Table S20. RD design results including earnings after retirement age.

Table S21. Effects of referendum success for applicants from marginalized origin countries.

Table S22. Effects of referendum success by gender.

Table S23. Effect of referendum success on earnings by earnings quantile, DD design.

Table S24. Effect of referendum success on postreferendum attrition, RD design.

Table S25. Effect of referendum success on unemployment, DD design.

Table S26. Effect of referendum success on unemployment, RD design.

Table S27. Effect of referendum success on receiving disability benefits, DD design.

Table S28. Effect of referendum success on receiving disability benefits, RD design.

Table S29. Effect of referendum success on early retirement.

Table S30. Effect of referendum success on citizenship according to CCO records.

Table S31. Effect of referendum success on citizenship according to survey responses.

Table S32. Characteristics of ballot box municipalities.

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