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Laidlaw Scholars Research and Leadership Programme – 2025 Cohort

Summer 1 Research Report

The Grass Isn't Greener on the Others' Side: Examining the Economic Integration of
Immigrants in Stockholm through Unequal Access to Public Green Spaces

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Abstract

There are two pivotal problems facing the Swedish and European economy at large: the anticipated influx of climate refugees and an aging labour population. Despite the solution to reinvest in integration efforts, Sweden — following the nationalistic and xenophobic trend observed in many EU nations — is redirecting these funds to promote repatriation. My research seeks to quantify the economic and urban shortcomings of the Swedish integration system, such as access to quality green spaces, as a measure of current integration levels. My research also serves as a proxy for future integration efforts in the anticipated influx of refugees, specifically climate refugees, to Nordic countries. The study cross-analyses economic data from Statistics Sweden with geographical data from a Sentinel-2 satellite. The findings conclude minimal interplay between the two variables, but a substantial and persisting economic disparity between native- and foreign-born residents. Through measuring the geo-economic impacts of a backlogged integration system, this paper seeks to deconstruct the notion that immigrants lead to economic stagnation, rather than the systems that unintentionally fail them; if economically and socially integrated, the impending economic crisis that future waves of immigrants present can instead be viewed as an economic opportunity.

1. Methodology

1.1 NDVI analysis on ArcGIS Online

My research manifests as a two-tiered quantitative analysis. Using ArcGIS, a geographic information software, I have developed a map that compares the NDVI — normalized difference vegetation index, or the health and density of public green spaces — in Stockholm city between the years 2018 and 2022. I exported two NDVI scenes from days in June with less than five percent cloud coverage from Sentinel-2 Living Atlas as a map viewer into ArcGIS Online. Due to the distinct clustering between first-generation immigrants and native-Swedes, I isolated the subsequent NDVI values by district to capture their individual values.

I clipped each layer for the years 2018 and 2022 respectively so that they were within ArcGIS' processing range, creating a polygon layer — a map layer that visualises boundaries such as neighbourhoods or parks — outlining every green space in Stockholm city. I ran the raster analysis function, called “Compute Change”, which compares the NDVI change between the two clipped layers. After which, I color-graded the map; green cells embodied NDVI values that improved, yellow that stayed the same, and red that worsened. I then clipped two districts in my in-depth analysis, Järva and Södermalm, to calculate their individual NDVI levels. I ran the function “Zonal Statistics as Table” on ArcGIS and received a mean NDVI value for both districts. With both NDVI and statistical data, I was able to develop an in-depth picture of the relative geo-economic conditions between the two groups.

1.2 Statistical Analysis in Excel (Statistics Sweden)

The wealth profile was constructed through a robust dataset developed by Statistics Sweden: residents aged 20-66 with income below 60% of the median income, stratified by first-generation immigrants and native-born Swedes, their municipality of residence, and the years 2018 and 2022. Then, a descriptive analysis was completed using dependent variables such as employment rate, education level, housing tenure, and average income.

In Excel, I calculated the average for each variable — separated by both resident status, city district, and year to measure their dependent outcomes — and their 95% confidence interval to create a clustered column bar chart. Bar charts were also completed that depicted the change in each variable for each resident group between 2018 and 2022, but the percentage variation between the years was not statistically significant as most of the internal values remained fairly consistent across the four years. This statistical analysis highlighted a potential disparity in the economic quality of life between these two residence statuses within the same income bracket.

2. Findings and limitations

2.1 Findings

2.1.2 Figures 1-2: Comparison of Employment Rate between resident status (Foreign-born v.s. Native-born) and years (2018 v.s. 2022)

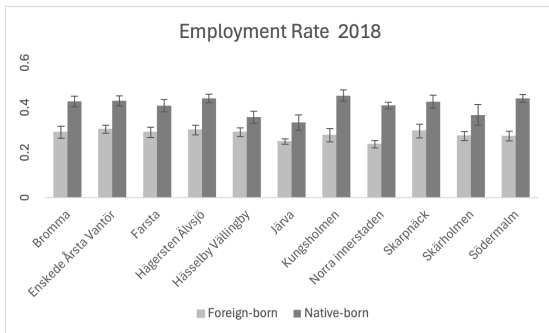


Fig. 1. Employment rate of Stockholm city residents, 2018

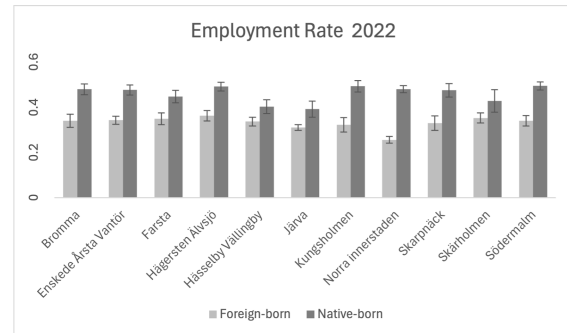


Fig. 2. Employment rate of Stockholm city residents, 2022

Figure 1 and 2 illustrate the respective employment rates of foreign-born and native-born residents below 60% median income for Stockholm city between the years 2018 and 2022. Notably, the employment gap between resident status has remained fairly stable.

In 2018, the average employment rate for foreign-born residents was roughly 28% and native-born was around 41%, resulting in a 13% employment gap. In 2022, the employment rate for foreign born residents grew about 5% to 33% while native-born residents also grew about 5% to 46%, maintaining a 13% employment rate differential. Thus, we can assume that employment rates, on average, have remained consistent at roughly a 13% employment gap.

2.1.3 Figures 3-4: Comparison of Education Level between resident status (Foreign-born v.s. Native-born) and years (2018 v.s. 2022)

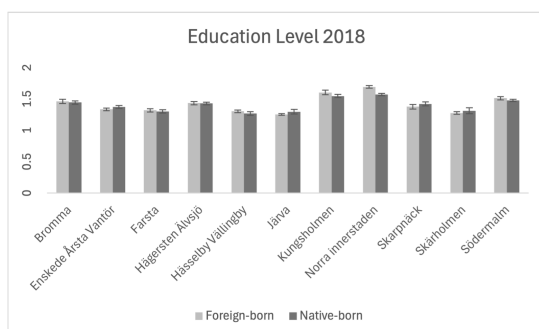


Fig. 3. Education level of Stockholm city residents, 2018

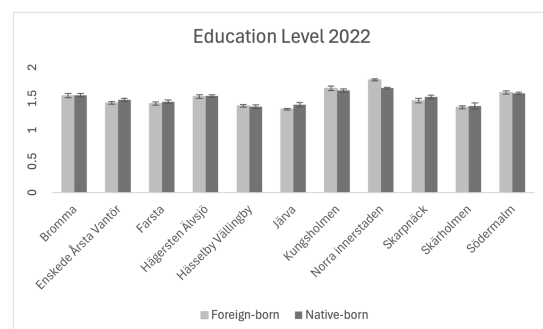


Fig. 4. Education level of Stockholm city residents, 2022

Figure 3 and 4 illustrate the education levels and underwent ordinal encoding, or the process of converting categorical variables into numerical. In this case, primary and secondary education

were assigned the numerical value 1 and post-secondary education was assigned the value 2. In 2018, foreign-born residents achieved an average education level of 1.42 whilst native-born residents achieved an average education level of 1.41.

In 2022, both resident groups increased by about .1 to 1.50. Thus, education levels, on the whole, are essentially equal. It is important to note that the city districts with a higher concentration of foreign-born residents such as Farsta and Järva were on the lower range — around 1.3 — whilst city districts with a higher concentration of native-born residents such as Norra Innterstaden and Södermalm are on the higher end of the scale, around 1.57 and 1.48 respectively.

2.1.4 Figures 5-6: Comparison of Housing Tenure between resident status (Foreign-born v.s. Native-born) and years (2018 v.s. 2022)

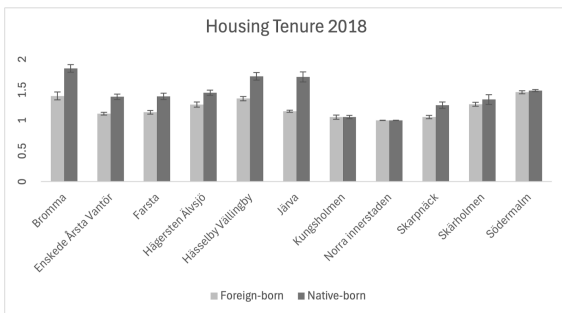


Fig. 5. Housing Tenure of Stockholm city residents, 2018

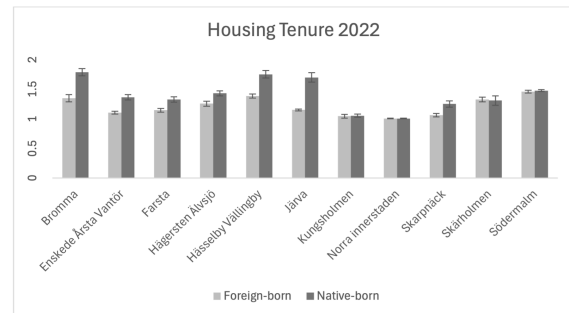


Fig. 6. Housing Tenure of Stockholm city residents, 2022

Figure 5 and 6, similar to education level, underwent ordinal coding. The three housing tenures were assigned a numerical value: rented dwelling was assigned a value of 1, tenant-owned dwelling 2, and owner-occupied dwelling 3.

In 2018, the average housing tenure for foreign-born residents is 1.206 with a .214 (15.1%) disparity in relation to native-born residents which was 1.42. In 2022, the housing tenure for foreign-born residents increased by .003 (0.25%) to 1.209 whilst native-born residents actually decreased by .0171 (1.2%) to 1.4029, narrowing the gap slightly, from about .21 to .19 (15.1% to 13.8%).

2.1.5 Figures 7-8: Comparison of Income Level between resident status (Foreign-born v.s. Native-born) and years (2018 v.s. 2022)

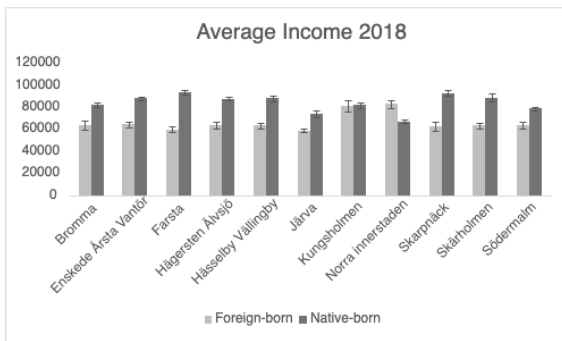


Fig. 7. Average Income of Stockholm city residents, 2018

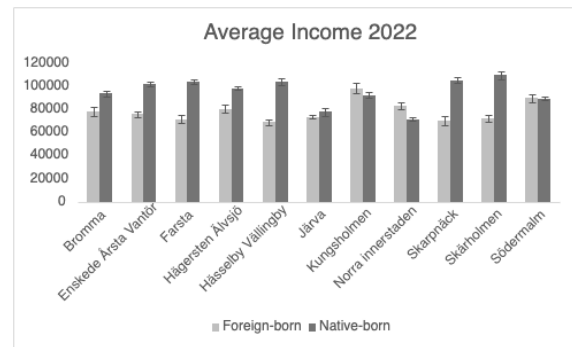


Fig. 8. Average Income of Stockholm city residents, 2022

Figure 7 and 8 illustrate the average income of residents that are below 60% of median income. The average income for foreign-born residents in 2018 is about 66,233 SEK and native-born residents earned approximately 84,029 SEK, resulting in a 17,796 SEK or a 21.2% disparity. Foreign-born residents' income in 2022 increased by 12,638 to 78,871 SEK and native-born residents increased by 11,784 to 95,813 SEK, with a reduced disparity of 16,942 SEK or 17.7%. Foreign-born incomes grew about 19% whilst native-born incomes grew about 14%, resulting in a 5% gap between growth rates and a 854 SEK or 3.5% decrease in their disparity.

2.2.1 In-depth Economic analysis: Järva v.s. Södermalm, the districts with the highest concentration of foreign-born and native-born residents in Stockholm city, respectively

Table 2.3: Percent differential of the four dependent variable values between foreign-born residents in Järva and native-swedish residents in Södermalm and the years (2018 and 2022)

<i>Sum of Percent Differential (%)</i>	<i>Year</i>	
Variable	2018	2022
Education level	22.81	25.24
Employment rate	19.18	18.46
Housing tenure	33.91	32.89
Average Income	25.68	17.64

The two districts Järva and Södermalm were chosen with direct intent; Järva is the district with the highest concentration of foreign-born residents and Södermalm is the district with the highest concentration of native-born residents. The percent differentials were then calculated between the two resident statuses to track the disparity of the four dependent variables over time (2018 and 2022).

The gap in education level, Primary and Secondary education and Post-secondary education, increased marginally between the two years (2.43%). This narrow increase indicates a stable yet substantial inequality in higher-level education between native Swedes and foreign-born residents. The gap between the rest of the variables — employment rate, housing tenure, and average income — decreased. The disparity between education levels increased from 22.81% to 25.24%. In 2018, the education level of foreign-born residents in Järva was about 1.25 and approximately 1.48 for native-born residents in Södermalm. The education level gap between resident statuses was roughly 0.23. In 2022, the average increased by 0.08 to about 1.33 for foreign-born residents in Järva and increased by 0.11 to roughly 1.59. The new education level gap between resident statuses increased to 0.26 in 2022, or a 2.43% increase within the ordinally encoded range.

The gap between employment rate decreased slightly from 19.18% to 18.46%. In 2018, the employment rate of residents aged 20-66 below 60% of median income for foreign-born residents in Järva was roughly 25% and 44% for native-born residents in Södermalm. Both employment rates increased by approximately 6% in the year 2022, with Järva's foreign population reaching 31% and Södermalm's Swedish population reaching 50%.

The gap between types of housing tenure maintained fairly steady, fluctuating within a range close to 0.34 (33.91% to 32.89%). Järva's foreign-born population remained mostly stable

at 1.15. The housing tenure for Södermalm's native-born population decreased slightly from 1.49 to 1.48. The majority of the raw data of all residents below 60% of median income oscillate between rented and tenant-owned dwellings — 56% and 36% respectively — with roughly 8% of residents in this income bracket owning their dwelling.

The disparity in average income decreased by 8.04%, (25.68% versus 17.64%) between Järva and Södermalm from 2018 and 2022. Average income for a foreign-born resident in 2018 in Järva was around 58,798.97 SEK and 79,117.69 SEK for native-born residents in Södermalm. In 2022, Järva's foreign-born residents' income jumped by about 25% to 73,927.74 SEK and by 13% in Södermalm to 89,763.39 SEK. It should be noted that income increased by almost double in Järva than in Södermalm; income-growth disparity can perhaps be attributed to income catch-up growth, or the economic phenomena that lower-income or developing groups have the capacity to grow faster than already developed or higher-income groups.

2.2.2 NDVI: Järva v.s. Södermalm

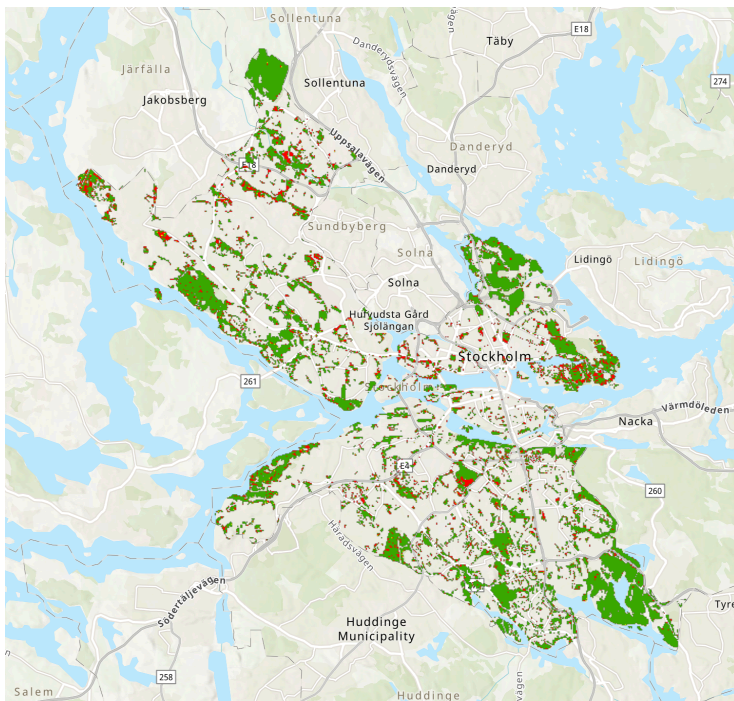


Fig. 9. Color-graded NDVI map of Stockholm City Districts

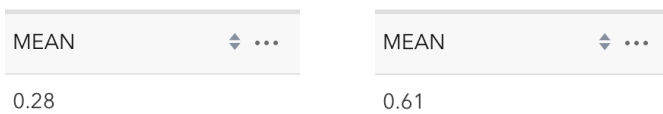


Figure 12 and 13. Mean NDVI values from Södermalm and Järva, ArcGIS online

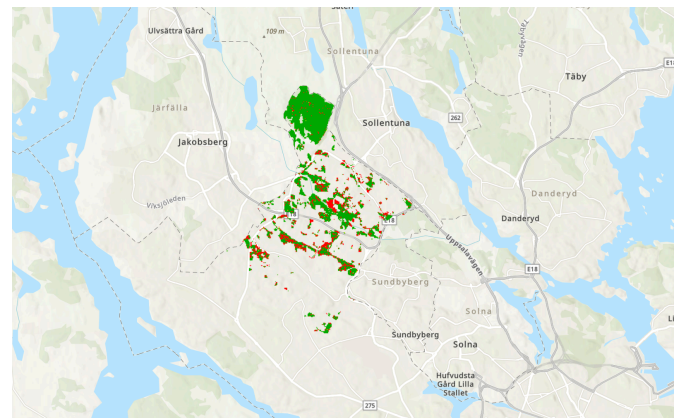


Fig. 10. Color-graded NDVI map of Järva

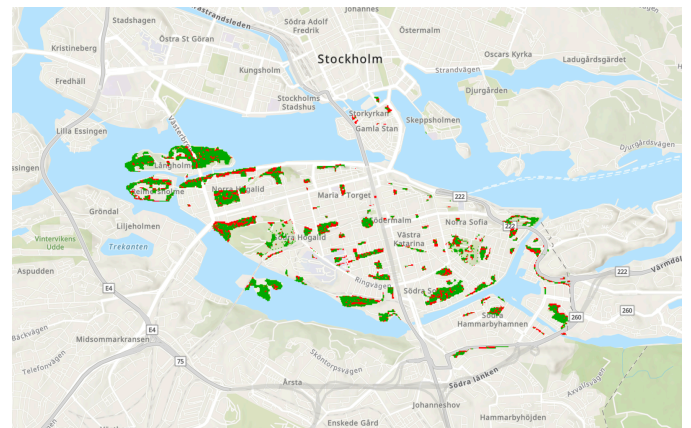


Fig. 11. Color-graded NDVI map of Södermalm

NDVI values can range from -1.0 to 1.0. Negative values are usually attributed to water mass, lower values such as 0.2 to 0.4 represent minimal shrubbery, and higher NDVI values close to 1.0 are likely in lush areas of green space such as rainforests.

After running “Zonal Statistics as Table” on each district, Södermalm received a mean of 0.28 and Järva a mean of 0.61. Both values, whilst low, are to be expected in a dense city environment such as Stockholm. Although Järva is the area with the highest concentration of foreign-born residents, its respective NDVI value was over twice as high as for Södermalm, the district with the highest concentration of native-born residents.

This disparity can perhaps be attributed to the fact that Järva is located in the outskirts of the city and Södermalm is located in the city center; the difference in NDVI values is likely of geographical significance, as suburban housing in outer districts with a commuting culture is often cheaper compared to more central districts like Södermalm.

2.3 Discussion

The findings of the study reveal little correlation between NDVI value and economic status. While wealth disparity between foreign-born residents in Järva and native-born residents in Södermalm cannot be ignored, the NDVI in Järva suggests a larger quantity of healthy green space than in Södermalm. This result challenges my initial hypothesis that integration shortcomings would extend to quality green spaces; it also confronts larger notions of urban inequality coupled to economic and residency-based discrimination.

However, it is important to note that Stockholm, a city widely acknowledged as ideal in terms of equitable welfare and quality of life, should not be inflated as a case against urban inequality in other cities. For example, lower-income housing in a city centered around manufacturing, such as Detroit, is more centrally located whilst suburbs and outer areas are reserved for higher-income residents. As much of Stockholm revolves around white-collar industries, it could be compelling to evaluate my original hypothesis in a manufacturing-oriented setting where the outcome might be reversed. Thus, quality of green spaces are likely not a part of the integration effort and is more likely attributed to a higher density of gray space in the city center, which is often financially inaccessible below a certain income group.

The more apparent shortcomings in integration efforts can be found in areas of economic inclusion, such as average income and employment rate. In order, the largest disparities between the two populations in all districts were average income, housing tenure, followed closely by employment rate, and education level. This ordering could illustrate the positive effects of policies such as education subsidies as well as free Swedish lessons offered by the state to all immigrants to aid in integration. These data might also underline a lack of follow-through by integration departments from opportunity to success within the system; structural barriers such as hiring discrimination and the interplay between proximity to career networks and affordable housing might be the reasoning behind these ever-present gaps between the two resident groups.

The persisting imbalance between foreign-born and native-born residents in Stockholm speaks to an international pattern of insufficient economic integration. Addressing barriers to career mobility, such as practical limitations and networking opportunities, could incite a positive feedback loop. Higher-income jobs directly impacts average incomes, in turn creating more opportunities for foreign-born residents to pursue higher-education and better housing opportunities; if immigrants are not financially driven into districts like Järva but possess the economic freedom to live in more central districts, there could be greater social interactions between the two groups.

These data therefore advocate for a different, equally complicated issue to that of access to public goods. Inadequate economic integration manifests as spatial and social isolation between native-born Swedes and foreign-born immigrants, perpetuating xenophobic rhetoric and anxiety towards the “other”. It also manifests as a material discrimination in Swedish spaces, whether it be apartment listings in Södermalm or office spaces in central Stockholm. The shortcoming in sophisticated integration is not that of unequal access to green space, but likely of social alienation. The Swedish government cannot devote its resources in the same way to Stockholm’s social framework as it does to free Swedish lessons, but indirectly, through promoting an increasingly heterogeneous Stockholm, both in the workspace and in the home.

2.4 Limitations

This study contains some notable limitations. Firstly, it is difficult to isolate and therefore develop an indicator of integration shortcomings such as unequal access to public green spaces as housing is not completely segregated; both foreign-born residents and native-Swedes live in each district and could thus be exposed to lower NDVI levels.

Due to the limited granularity of the data it is impossible to measure a certain resident’s relative proximity to both high and low NDVI outcomes; the dataset did not evaluate the factors across different ethnic or age groups. A breakdown across age groups and ethnic lines may find more significant factors facing integration such as systemic racism and ageism. The study only compared two time periods of relatively short duration between them due to budget constraints. Additional research comparing more time periods may better elucidate trends in the evaluated factors.

Additionally, there could be confounding factors contributing to lower NDVI levels such as amount of green versus gray space which is not relevant to the objective of the study. The study did not overlay the macroeconomic conditions during the period evaluated which may have significant impact on employment, income levels and housing tenure. Furthermore, the study was conducted within a 6-week period and its analytical depth is limited to that window.

3. Navigating interfaces and Acceptance

The challenges presented by the research were twofold: logistical problems in navigating unfamiliar interfaces like ArcGIS and complicated Excel analysis as well as the psychological challenge that accompanied it, accepting conditions outside my control, such as the delay in data delivery or limited access to a larger dataset.

3.1 ArcGIS challenges

I was unfamiliar with ArcGIS, a powerful platform with a substantial array of operations and functionality with an accompanying learning curve. My initial plan was to import .tiff files from Google Earth Engine into ArcGIS and then compare the NDVI between the relative years, 2018 and 2022. My computer model, however, was incompatible with ArcGIS Pro, the interface required to accomplish this task; It took significant time to navigate this issue due to the coded language of the programme. My issues with the program also included hours of troubleshooting the function's parameters and capabilities.

3.2 Data Analysis challenges

My dialogue with Statistics Sweden was extensive, involving 9 months of tailoring my parameters and variables to ensure my dataset was feasible given the time and budget constraints while still maintaining the integrity of the research objective. My original proposal included 10 years of analysis, which was significantly over budget. I had narrowed it down to 5 years, but due to the granularity of the data, the processing time was about 5 weeks. I instead ordered only two years of data, 2018 and 2022, running a cross-sectional analysis instead of longitudinal. This shortened the processing time to two weeks and brought my dataset within budget.

3.3 Accepting what I cannot control

The principal challenge was accepting the barriers to progress — delayed timeline, budget constraints, and complicated interfaces — that were beyond control. The research required a competent grasp of two interfaces that were difficult to navigate. Through hours of trial and error, I learned that leadership does not always translate to control and competency in every aspect of one's project. Leadership is instead rooted in the ability to excel in the areas you can control and adaptability in the areas you cannot.

4. Reconciliation & achievement

4.1 Leadership style

I lead best when I am motivated by an outcome that has the potential to contribute to tangible societal progress. At the same time, I value the collaborative aspects of the process, knowing that it is through collaboration that well-balanced leaders are created. My perspective of leadership has evolved; it is not only about successfully executing plans, inspiring others, and bringing change. I believe that leadership exists in moments of failure. At first, I did not feel I had the intellectual fortitude to achieve my goal; the more I learned about both platforms, the less I felt I knew. In actuality, my struggle was an indicator of growth.

4.1.2 Personal Development

My research affirmed my working style to be one adverse to procrastination. This task-oriented work ethic, however, can be both a virtue and an obstacle. My eagerness to confront problems as soon as I face them has the potential to lead to impulsive decisionmaking. Throughout the troubleshooting stage with both platforms, ArcGIS and Excel, I have discovered the value of being able to take a step back, evaluate alternatives, and work through a plan to move forward. Most importantly, I have learned not to let the small failures in work speak to a larger personal failure; true success is only born out of failure, for with failure there is both struggle and the overcoming of struggle, paving the way to growth.

The invaluable acceptance of the inevitability of challenges, obstacles, and the requirement to remain flexible and adaptable is integral to the identity of a leader. My style of leadership is one of constant revision, of embracing setbacks to refine the process and hopefully strengthen the outcome. I am not compatible with a practically dominant leadership style. I find the most potent moments of leadership exist in small instances; it is a thousand small encounters with failure rather than the mountain that is the result.

5. Acknowledgements and Declarations

5.1 Laidlaw and the Esri community

I am grateful for the support of Laidlaw, the Esri Community, and my supervisor. Kate Ivanchenko, the employability officer of Laidlaw at Trinity College Dublin, facilitated the managerial and practical workarounds with an attentiveness that supported the more tedious aspects of my project.

After hours of troubleshooting with ArcGIS, I reached out to Esri support – the geographic information and research institute's support network – where I was put in contact with Kiaran Ratcliffe and Guenter Doerffel. Mr. Ratcliffe and Mr. Doerffel shared numerous resources, met with me to explain how I could achieve my goals, and dedicated their time and knowledge generously.

5.2 Trinity Supervisor

My supervisor, professor Davide Romelli was integral to the success of the project. He strengthened my proposal, guided me through the application process, and advised my interactions with deadlines, budgets, and data analysis. What I valued most, however, was his unwavering support. Before I received the scholarship, professor Romelli invested his time and expertise into my application. He treated me as a peer and regarded my ambition with consideration, despite my position as an undergraduate researcher. I am deeply grateful to the confidence he instilled in my project, my goals, and my identity as a leader.

5.3 Declaration

5.3.1 Funding

The study was supported by the Laidlaw Scholars Research and Leadership Programme.

5.3.2 Competing interests' declaration

Both Author and Supervisor declare no competing interests as a result of the production of data nor findings of the research.

6. Forward-focused goals

6.1 Upcoming goals in research

My upcoming goals are rooted in the desire to raise awareness and confront stigma around the shortcomings in the economic integration of immigrants, especially in the face of the anticipated influx of climate refugees. Moreover, it is imperative to quantify the priority of issues, such as shortcomings in housing versus education, so that local governments can effectively divert resources.

6.2 Upcoming personal leadership goals

This project affirmed my passion for immigration policy; I am fascinated by the intersectionality of macroeconomics and public policy. With the newfound confidence in my ability to overcome a variety of challenges, I have developed a security in my identity as a leader and my capacity to create change.