New York State Economics Association

Proceedings of the New York State Economics Association Conference

Volume 17

77th Annual Meeting, Oct. 25-26, 2024

Editor: Manimoy Paul

Published: November 2024

77th Annual Meeting NYSEA Proceedings, Volume 17

New York State Economic Association

Founded 1948

Proceedings 2024

Published: October 2024

Table of Contents

Are Betting Markets Efficient? A Check of Pfitzner, Lang, and Rishel (*NYER* 2009), "The Determinants of Scoring in NFL Games and Beating the Over/Under Line"

Gregory Bandura, Kpoti Kitissou, Michael McAvoy, and Philip Sirianni*

ABSTRACT

In this paper we follow Pfitzner, Lang, and Rishel (2009) to predict the total points scored in National Football League(NFL) games during the 2023-2024 season. Where Pfitzner, Lang, and Rishel (2009, 2014) find their model produces winning seasons using their strategy, we find this approach is not successful for the 2023-2024 NFL season.

INTRODUCTION

In recent years, the entertainment industry has grown. Since its legalization in 2018, a recent form of entertainment is legal sports gambling. As technology has lowered the costs of communication and laws have legalized online sports betting, mobile wagering on sports is now possible and has become more accessible and convenient. The legal online gaming market continues to grow and as gamification of sports gambling has developed, younger fans have increasingly been attracted to this growing billion-dollar industry.

We proceed in two parts. The first is to predict the total points scored for week 18, using the statistics from week 17. We estimate an unsuccessful strategy for week 16. We model our approach after Pfitzner, Lang, and Rishel (2009), using similar determinants to predict the total score and then compare our prediction to the over/under betting line. The second is to examine whether the Pfitzner, Lang, and Rishel (2009) approach continues to offer a means to profit in 2023-2024.

APPROACH OF PFITZNER, LANG, AND RISHEL (2009)

Sports gambling is popular and economists have created models to predict game outcomes. Using the NFL, Pfitzner, Lang, and Rishel (2009) identified statistically significant determinants to predict the total points scored by home and away teams in NFL games during the 2005-2006 season. They estimate separate regression for home and away teams using prior information. These game points predictions are updated weekly and compared to the over/under line. Once identifying determinants, they employ a wagering experiment to find a successful betting strategy for weeks 8 through 17. They produce winning results for the season, and note, "The relevant question is, of course, whether these results will hold up in future seasons" (39). Indeed!

In a follow up article for *The Sport Journal*, Pfitzner, Lang, and Rishel (2014) find that their strategy continues to provide a successful season for the 2010-2011 NFL season. There is some evidence that

* Bandura is a graduate of SUNY Oneonta (2024, B.S. Economics). Kitissou, McAvoy, and Sirianni co-advised Bandura during his research project for the Senior Seminar in Economics, the major capstone. Kitissou, McAvoy, and Sirianni are all Department of Economics, SUNY Oneonta, 108 Ravine Parkway, Oneonta, New York 13820.

perhaps the betting market was adjusting. It appears that the differences between their predictions and the over/under becomes smaller between 2005-2006 and 2010-2011. For instance, their predictions that exceeded the over/under by more than seven points (21 games) was successful 55 percent of the time in 2005-2006, but only 50 percent of the time (10 games) in 2010-2011. However, for predictions more than five points compared to the over/under, their strategy is successful 60.5 percent (39 games) in 2005-2006, and 63 percent (27 games) in 2010-2011. Overall, comparing their prediction to the over/under, they are successful 54 percent across 152 games for the 2005-2006 season, and 55.4 percent in 2010-2011. They state that the break even winning strategy must be 52.4 percent successful (2009, 29). The overall winning percentages using this approach are large enough that the bettor should be successful against the book makers.

We observe that if their determinants persist to produce winning results in future seasons, this is evidence that the betting markets have some inefficiencies that can be exploited. If these results are no longer winning in future seasons, then the betting markets have used their information. Book makers have adjusted the over/under and bettors have competed away the winning results, and the market is at least weakly efficient. We also believe that replicating peer reviewed approaches with new information can validate the continued efficacy (or maybe not) of the approach. Replicating scholarship in general can also be a useful student project that is both instructive and interesting.

PREDICTING WEEK 18 IN THE 2023-2024 NFL SEASON

We use similar determinants for total points scored in an NFL game. We predict points scored separately for the home team and the away team in the following equations:

$$TP_{hi} = \beta_0 + \beta_1 Pass_{hi} + \beta_2 Rush_{hi} + \beta_3 D_i + \beta_4 T_{hi} + \varepsilon_{hi}$$

and

$$TP_{vi} = \beta_0 + \beta_1 Pass_{vi} + \beta_2 Rush_{vi} + \beta_3 D_i + \beta_4 T_{vi} + \varepsilon_{vi}$$

Where the subscripts *h* and *v* represent the home and visiting teams, and *i* represents the game. *Pass* is total passing yards. *Rush* is total rushing yards, *D* is a dummy variable for whether the game is played in a dome, and *T* is the total turnovers (interceptions or fumbles).

For a team in game *i*, the passing yards (*Pass*) are the total offensive passing yards and the defensive passing yards allowed. Rushing yards (*Rush)* are similarly the total offensive rushing yards and the defensive rushing yards allowed. Turnovers (*T*) are the offensive turnovers lost and the defensive turnovers gained. There are 11 teams that play their home games under a dome.

Table 1. Summary Statistics for Weeks 1-17 During The 2023-2024 NFL Season

Variable	Observations	Mean	Standard deviation	Minimum	Maximum
Home Team Points	256	23.32	10.27	0	70
Away Team Points	256	20.59	9.58	0	70
Total Pass Yards	512	440.50	111.38	184	790
Total Rush Yards	512	224.35	59.88	86	419
Turnovers	512	2.71	1.51	0	7
Game In Dome	512	0.34	0.47	0	1

In Table 1, we summarize the game statistics for the first 17 weeks of the 2023-2024 NFL season. The 2023-2024 season consisted of 32 teams playing a season of 17 regular season games across 18 weeks. There are a total of 256 games played during the first 17 weeks of the season. These game data are collected from the website Pro-Football Reference (https://www.pro-football-reference.com/). Through weeks 1-17, the home team averaged about 3 points more than away teams, with an average total of 23.3 points. Pfitzner, Lang, and Rishel (2009) similarly record an average total of 22.5 points for the 2005-2006 season. Interestingly, the point-spread wager in most cases with two somewhat equal teams always favors the home team by almost 3 points. The average total passing yards per game is 440.5, average total rushing yards is 224.4, and team have 2.71 turnovers per game.

We show our estimation results in Table 2. Both total passing yards and total rushing yards are statistically significant at the 1 percent level and have a positive relationship with points scored. Neither playing the game in a dome nor turnovers are statistically significant as determinants for points scored.

Table 2. Regression Results

Variable	Away Team Points	Home Team Points
Total Passing Yards	0.042***	0.040***
	(0.005)	(0.005)
Total Rushing Yards	0.056***	0.055***
	(0.009)	(0.009)
Dome	-1.325	0.584
	(1.226)	(1.177)
Turnovers	0.001	0.025
	(0.371)	(0.371)
Constant	-7.317**	-7.175**
	(3.548)	(3.553)
Observations	256	256
R^2	0.258	0.255

Standard errors in parentheses. *** significant at 1% level, ** significant at 5% level, * significant at 10% level

For week 18, we use our estimated models to predict total points for each team and then compare the predicted total points to the over/under wager. We obtain the over/under from BetMGM (https://www.ny.betmgm.com/en/sports), the betting line for every week 18 game. Our strategy is that if the predicted total points exceed the over/under wager, then bet the over. If our predicted total points is less than the over/under, we bet the under. We find that our strategy has a success rate of 44 percent. Our success rate decreases to 29 percent when the predicted total points exceeds the over/under by more than 6. In either case, our strategy has a success rate below 52.5 percent.

REPLICATING THE 2023-2024 NFL SEASON

In this section, we replicate the Pfitzner, Lang, and Rishel (2009, 2014) approach for the 2023-2024 season. As they do, we measure the total points for the home and visiting team for each game. We construct variables as they describe, passing yards (*PY*) and rushing yards (*RY*):

$$PY = PO + PD$$

$$RY = RO + RD$$

Passing yards (*PY*) is the sum of average offense passing yards of team A (*PO*) and the defense passing yards given up by team B (*PD*). Rushing yards (*RY*) is the sum of average offense rushing yards of team A (*RO*) and the defense rushing yards given up by team B (*RD*).

We begin with week 5 game data to find determinants for total points scored by the home team and the visiting team. Pfitnzer, Lang, and Rishel (2009, 2014) include a variable for the prior game points (*PP*) scored by the team, and we include it here. In addition, we include variables for game overtime (OT), net turnovers (*TO*) and days in between games for the team (*Days*). We did not include the *Dome* variable since we did not observe it as a determinant of points in our previous results above. Table 3 shows our estimation results.

None of the estimations are statistically significant. We cannot proceed to use these models to predict points and then seek winning strategies.

Table 3. Regression Results for Total Points Scored, 2023-2024 NFL Season, Weeks 5-18

Variable	Home Team	Home Team	Visitor Team	Visitor Team
Intercept	25.49**	22.41**	41.65**	37.47***
	(12.46)	(11.24)	(12.66)	(12.22)
PY_{hi}	0.0144	0.0195		
	(0.0214)	(0.0208)		
RY_{hi}	0.0453	0.055*		
	(0.0310)	(0.0305)		
PY_{vi}			0.035	0.035
			(0.0226)	(0.0223)
RY_{vi}			-0.0409	-0.043
			(0.0342)	(0.0339)
PP_i	0.1127		0.0436	
	(0.096)		(0.95)	
OT_i	10.0014*		9.7867*	
	(5.2951)		(5.3263)	
TO_i	-0.3888		0.2584	
	(0.5223)		(0.5233)	
$Days_i$	-0.2286		0.8207*	
	(0.4696)		(0.481)	
$Week_i$	0.03504		-0.0242	
	(0.2366)		(0.2365)	
Adjusted R^2	0.021	0.011	0.024	0.009
SEE	13.73	13.18	13.71	13.82
Observations	208	208	208	208
F-statistic	1.64	2.13	1.73	1.95

Standard errors in parentheses. *** significant at 1% level, ** significant at 5% level, * significant at 10% level

CONCLUSION

We had an interest and an idea to put our economic training in the over/under wagers. In one case we found some statistically significant determinants that we used to predict game points scored, and then see that our betting strategy is not successful.

In the other case, we identified some scholarship in our interest, and then sought to replicate its approach. If we replicate the approach by Pfitzner, Lang, and Rishel (2009, 2014), for the 2023-2024 NFL season, we find that their variables are not determinants of total points scored. We removed the dome variable because it was not a determinant in our earlier estimated model, but since we had the information, we could have included it. However, we included other factors, and our model taken together does not describe the variation in total points scored. More seasons of data may be necessary to repeat their result. Another possibility is that the strategy and play in NFL games has changed greatly between the seasons of 2005-2006 (or 2010-2011), and 2023-2024.

It appears that as legalized online sports betting markets become more liquid and active, they may also demonstrating greater efficiency, in at least its weak form.

REFERENCES

Pfitzner, C. B., Steven D. Lang, and Tracy D. Rishel. 2009. "The Determinants of Scoring in NFL Games and Beating the Over/Under Line." *New York Economic Review* 40(1): 28-39.

Pfitzner, C. B., Steven D. Lang, and Tracy D. Rishel. 2014. "Factors Affecting Scoring in NFL Games and Beating the Over/Under Line." *The Sport Journal* 24, ISSN: 1543-9518.

How Does Democracy in Former Colonies Affect Human Development After Independence?

Ossama Elhadary*

ABSTRACT

Using the Human Development Index as the dependent variable, I propose a model of the factors that affect human development in former European colonies. I add the Polity score to my model as a measure of how democratic a former colony is and then demonstrate that there is no relationship between democracy at independence and human development today. Although surprising, this result can be explained by the fact that for the most part ex-colonial powers did not necessarily leave functional democratic institutions behind but instead left fractured and unequal societies where democracies found it hard to thrive and function.

INTRODUCTION

The relationship between democracy and socio-economic development has long been debated, particularly in the context of states emerging from colonial rule. Early modernization theorists suggested that economic development naturally fosters democracy, while later scholarship has questioned whether democracy itself drives development or whether deeper historical and institutional legacies are more decisive. In the case of former colonies, the debate cannot be separated from the institutional frameworks and social hierarchies inherited at independence, which continue to shape developmental trajectories.

The institutional imprint of colonialism is widely regarded as one of the most important factors shaping both democracy and development in post-colonial states. Acemoglu, Johnson, and Robinson (2001) argue that the strategies employed by colonial powers (whether settler-based or extractive) produced fundamentally different institutional outcomes. Settler colonies often saw the establishment of more inclusive political and economic institutions, while extractive colonies were designed for resource exploitation, producing highly centralized and authoritarian state structures that made later democratization difficult.

Administrative styles also mattered. Lange (2009) highlights the distinction between direct and indirect rule: direct colonial rule tended to create formal bureaucracies and legal systems that could, at least in principle, support political participation, while indirect rule reinforced traditional hierarchies and localized power, leaving behind fragmented authority and weak state capacity. These choices had lasting consequences, particularly for how societies managed ethnic, class, and regional divisions after independence. Similarly, scholars note that French and Spanish colonies were often governed through more centralized and authoritarian systems than British ones, producing legacies less conducive to democratic consolidation (Olsson, 2009).

Economic development is frequently cited as a key determinant of democratic survival. Lipset's (1959) classic argument—that higher levels of income, education, and urbanization generate the social conditions necessary for democracy—remains influential. More recent work (Przeworski et al., 2000) shows a strong empirical relationship between wealth and democratic durability, suggesting that economic growth helps stabilize democratic institutions by fostering a middle class that demands accountability.

Yet, development alone does not fully explain democratic outcomes in post-colonial states. Some countries with relatively low-income levels have managed to sustain democratic institutions, while others with far higher development indicators remain authoritarian. This inconsistency underscores the role of non-economic factors, including colonial administrative practices, civil society strength, and religious or cultural influences. For example, Woodberry (2012) shows how Protestant missionary activity during the colonial period—especially in parts of Africa and Asia—fostered education and civic engagement that later supported democratic governance.

A different line of argument emphasizes democracy itself as a catalyst for development. Democracies tend to provide greater political accountability, more inclusive policymaking, and mechanisms for peaceful conflict resolution—qualities especially valuable in multi-ethnic post-colonial states where colonial borders often grouped together disparate groups. Gerring et al. (2005) suggest that although democracies may not always deliver rapid economic growth, they generally achieve better long-term outcomes in areas such as health, education, and poverty reduction.

However, the extent to which democracy independence mattered for subsequent development remains contested. Hariri (2012) points out that states with strong centralized pre-colonial polities (common in parts of the Middle East and North Africa) were less likely to democratize, regardless of post-independence development. More broadly, the argument follows that ex-colonial powers often left fractured societies and extractive institutions rather than functioning democracies, meaning that even where democratic forms were adopted at independence, they frequently lacked the capacity to deliver developmental gains.

THE POLITY SCORE

The Polity score is a widely used measure of regime characteristics, designed to capture the extent to which a political system is democratic or autocratic. It is derived from the Polity IV dataset, which evaluates institutionalized authority patterns and governance structures across countries over time. The score ranges from –10 (full autocracy) to +10 (full democracy), based on six core dimensions of political institutions, including the competitiveness of political participation, the openness and competitiveness of executive recruitment, and constraints on the chief executive. Because it reflects formal institutional features rather than short-term political events, the Polity score has become a central tool in comparative politics and development research, allowing scholars to quantify and compare regime types across diverse historical and regional contexts.

THE DATA

In this research, I compiled data for 104 former colonies from various sources. I also downloaded the

2018 Human Development Index values for all those colonies together with their 2018 population sizes. I also downloaded the 2022 Polity score as well as the historical polity scores of all the former colonies in the sample, and for each colony, I noted the Polity score for that colony when it gained independence. I then calculated the number of years a former colony was colonized, number of years under military rule, and the number of years since independence. For every former colony, I noted the colonizer as England, France, Spain, or other (including mix of colonizers like in the case of the Maldives or Guyana). Table 1 shows the number of former colonies, and the average and median (in parenthesis) of the 2018 HDI value, number of colonization years, number of independence years, number of years under military rule, and population size.

Table 1. Descriptive Statistics per colonizer

	England	France	Spain	Other
Number of Colonies	33	24	17	30
Former Colonies HDI (2018)	.676 (.149)	.543 (.116)	.743 (.066)	0.686 (0.01)
ColonizationYears	113.6 (84.8)	88.1 (54.8)	282 (44.1)	260.2 (146.1)
IndependenceYears	59.1 (14.7)	67.8 (32.5)	194.9 (19.1)	61.6 (34)
MilitaryRuleYears	5.3 (10.6)	10.1 (11.4)	32.7 (17.9)	7.5 (13.1)
Population (in Millions)	30.1 (52.4)	22.2 (24.5)	23.9 (30.6)	72.7 (259)

A dummy variable (Resources) representing a former colony with abundance of resources was also added. This variable takes the value of 1 for Brazil, Brunei, Oman, Qatar, Congo, Angola, Algeria, United Arab Emirates, Iraq, Venezuela and Kuwait, and 0 for all other countries. Table 2 shows the number of former colonies, and the average and median (in parenthesis) of the 2018 HDI value, number of colonization years, number of independence years, number of years under military rule, and population size for low and high-resource countries.

Table 2. Descriptive Statistics for Low and High Resources former colonies

	Low Resources	High Resources
Number of Former Colonies	93	11
Human Development Index	0.647 (0.134)	0.757 (0.098)
ColonizationYears	179 (127)	151.3 (125.8)
IndependenceYears	84 (55.8)	82.7 (58.8)
MilitaryRuleYears	11.4 (16)	12.6 (16)
Population (in Millions)	39.6 (148)	35.1 (61)

I also added a dummy variable (Size) for countries with populations larger than 1 million (there are 22 countries with population smaller than 1 million and 82 with population larger than 1 million). Table 3 shows the number of former colonies, and the average and median (in parenthesis) of the 2018 HDI value, number of colonization years, number of independence years, number of years under military rule, and population size for low and high-population countries.

Table 3. Descriptive Statistics for Low and High Population Former Colonies

	Low Population	High Population
Number of Former Colonies	22	82
Human Development Index	0.716 (0.1)	.644 (0.14)
ColonizationYears	208.1 (110.1)	167.5 (129.9)
IndependenceYears	44.9 (6)	94.5 (58.5)
MilitaryRuleYears	1.6 (4.8)	14.2 (16.8)
Population (in Millions)	.39 (.30)	49.6 (157)

Table 4 presents the mean and standard deviation (SD) of the Polity scores for former colonies at the time of independence grouped by colonizing power England, Spain, France, and "Other" (representing colonizers not in the first three categories).

Table 4. Polity Scores at Independence

	# Colonies	Mean	SD
Other	22	1.1	0.59
England	25	-0.52	7.0
Spain	17	-2.6	3.6
France	24	-4.2	4.1

The data in table 4 suggests that former British colonies exhibit the widest range of political outcomes, spanning from democracy to autocracy, while former French and Spanish colonies tend to be more consistently autocratic. Interestingly, colonies of "other" powers appear to be more democratic and politically stable, as indicated by both the higher mean and low variability. This may reflect differences in colonial governance strategies, institutional legacies, or post-independence trajectories.

Table 5. Polity Scores in 2022

	# Colonies	Mean	SD
Other	22	3.8	6.4
England	25	1.16	6.4
Spain	17	7.6	3.1
France	24	1.3	5.1

Table 5 shows the Polity score data for the same former colonies in 2022. Comparing the data in tables 4 and 5, one comes to the following conclusions:

- All four colonial groups show an increase in their mean Polity scores, indicating that, on average, former colonies have become more democratic over time—though the extent and consistency of this progress vary significantly.
- Spanish colonies, many in Latin America, had autocratic beginnings but have made significant democratic gains, with relatively uniform improvements across countries. This group shows the most consistent democratic consolidation.

- Despite slight improvements, French colonies remain least democratic on average. The increase in SD suggests more variation now, with some progress, but a persistent democratic deficit in many.
- British colonies started with greater variation in regime type. Some (e.g., India) had democratic frameworks early, while others (e.g., Sudan) were authoritarian. In 2022, there's been modest democratic improvement, but broad divergence remains, reflecting inconsistent democratization.

THE MODEL

Grier (1997) pooled data from 63 former colonies and found that the identity of the colonizing power has a significant and permanent effect on subsequent growth and development and noted that former British colonies perform significantly better on average than their French and Spanish counterparts. He confirmed these results again in Grier (1999) and by creating a time variable that depicted the length of colonization, he confirmed that colonies that were held for longer periods of time on average performed better after independence. In his research, Grier (1999) used the average real GDP as the dependent variable and initial real GDP, Government Consumption, inflation, population growth, and a dummy variable for the colonizer (France, England, and Spain). Initial real GDP and population growth though were not generally found to have a significant impact on average real GDP.

In this paper on the other hand, I use the Human Development Index (HDI) as the dependent variable. The Human Development Index (HDI) is “a summary measure of achievements in three key dimensions of human development: a long and healthy life, access to knowledge and a decent standard of living” (UNDP, 2021). I believe that these indexes provide a better measure of the overall progress a former colony makes after independence since they do not only focus on the economy but also on education and health attainment.

Echoing Block and Evans (2005) assertion that development is largely about institutional transformation, I start with the hypothesis that the variation in the levels of human development observed among former colonies arose from the quality of the institutions established by European colonialists and from the inability of former colonies to fully reclaim their resources from the colonizers after independence. As Muiu (2010) explains, the postcolonial state was "post" in name only as it continued to retain all colonial institutions, and even after independence, colonial powers never ceased to have unfettered access to the resources of the colonies. Because of this, I believe that the longer the independence duration, the more a former colony can break away from those institutions and practices that have hindered its development, and retake control of its resources. Accordingly, I used the number of years a former colony is independent (IndependenceYears) as an independent variable in the regression equation.

Like Grier (1999), I also use the colonization duration (ColonizationYears) as an independent variable hypothesizing that the longer the colonization duration the deeper the roots of the established colonial institutions and policies, and the more difficult it will be to change or dismantle them. I also add a variable representing the length of time a former colony spends under military dictatorships (MilitaryYears) after independence as an exogenous independent variable. This variable will help test the hypothesis that military dictatorship tends to interrupt the improvements made because of independence and sets a former colony on a lower development trajectory.

Hypothesizing that large and small former colonies have different development trajectories, I add a dummy variable (Size) for former colonies with population sizes greater than 1 million inhabitants. Table 6 shows the number of former colonies, population size, the average and standard deviation (in parenthesis) of the 2018 HDI value, colonization, independence, and military rule durations for low and high-population countries. The data clearly shows that for low-population countries, the average HDI is .716 compared to larger countries that have an average HDI of .64.

Table 6. Descriptive Statistics for Low and High Population former colonies

	Low Population	High Population
Number of Former Colonies	22	82
Human Development Index	0.716 (0.1)	.644 (0.14)
ColonizationYears	208.1 (110.1)	167.5 (129.9)
IndependenceYears	44.9 (6)	94.5 (58.5)
MilitaryRuleYears	1.6 (4.8)	14.2 (16.8)
Population (in Millions)	.39 (.30)	49.6 (157)

A dummy variable (Resources) representing a former colony with abundance of resources is also added. This variable takes the value of 1 for Brazil, Brunei, Oman, Qatar, Congo, Angola, Algeria, United Arab Emirates, Iraq, Venezuela, and Kuwait, and 0 for all other countries. Table 7 shows the number of former colonies, and the average and median (in parenthesis) of the 2018 HDI value, number of colonization years, number of independence years, number of years under military rule, and population size for low and high-resource countries.

Table 7. Descriptive Statistics for Low and High Resources former colonies

	Low Resources	High Resources
Number of Former Colonies	93	11
Human Development Index	0.647 (0.134)	0.757 (0.098)
ColonizationYears	179 (127)	151.3 (125.8)
IndependenceYears	84 (55.8)	82.7 (58.8)
MilitaryRuleYears	11.4 (16)	12.6 (16)
Population (in Millions)	39.6 (148)	35.1 (61)

Finally, I add dummy variables for the colonizers: British, French, or Spanish colonies. I use "other" for a mix of colonizers like in the case of the Maldives or Guyana. Table 8 shows the number of former colonies, and the average and median (in parenthesis) of the 2018 HDI value, number of colonization years, number of independence years, number of years under military rule, and population size.

Table 8. Descriptive Statistics per colonizer

	England	France	Spain	Other
Number of Colonies	33	24	17	30
Former Colonies HDI (2018)	.676 (.149)	.543 (.116)	.743 (.066)	0.686 (0.01)
ColonizationYears	113.6 (84.8)	88.1 (54.8)	282 (44.1)	260.2 (146.1)

IndependenceYears	59.1 (14.7)	67.8 (32.5)	194.9 (19.1)	61.6 (34)
MilitaryRuleYears	5.3 (10.6)	10.1 (11.4)	32.7 (17.9)	7.5 (13.1)
Population (in Millions)	30.1 (52.4)	22.2 (24.5)	23.9 (30.6)	72.7 (259)

The model thus can be represented by the following equation with the Human Development Index as the dependent variables.

$$HDI = \alpha + \beta 1 * ColonizationYears + \beta 2 * IndependenceYears + \beta 3 * MilitaryYears + \beta 4 * Size + \beta 5 * Resources + \beta 6 * English + \beta 7 * French + \beta 8 * Spanish + \varepsilon \quad (1)$$

Where ColonizationYears: is the number of years a former colony has been colonized; IndependenceYears: is the number of years since a former colony has gained independence from its former colonizer; MilitaryYears: is the number of years a former colony has been under military rule since gaining independence from its former colonizer; Size: is a dummy variable taking the value of 1 for former colonies with population size; Resources: is a dummy variable taking the value of 1 for former colonies with abundance of resources; English: a dummy variable taking the value of 1 if the former colonizer was England; French: a dummy variable taking the value of 1 if the former colonizer was France; and Spanish: a dummy variable taking the value of 1 if the former colonizer was Spain

The Results - Factors Affecting the Human Development Index:

By running regression equation 1 (see table 9) one notes that the coefficients of both the English and Spanish colonies dummy variables are statistically insignificant and so these two variables are removed from the equation, and I rerun regression equation 2.

Table 9. Regression results with HDI as the Dependent Variable

	Coefficient	t	P
ColoniationYears	.00011	2.05	.043
IndependenceYears	.00041	.9	.368
MilitaryRuleYears	-.0021	-2.3	.024
French	-.088	-2.52	.013
English	-.0051	-.16	.87
Spanish	.067	1.06	.291
Resources	.1212	3.48	.001
Size	-.065	-2.19	.031
Constant	.658	15.77	0
R^2	.43		
Adj R^2	.38		

$$HDI = \alpha + \beta 1 * ColonizationYears + \beta 2 * IndependenceYears + \beta 3 * MilitaryYears + \beta 4 * Size + \beta 5 * Resources + \beta 6 * French + \varepsilon \quad (2)$$

Table 10. Model Regression results after removing English and Spanish

	Coefficient	t	p
ColonizationYears	.00024	2.49	.014
IndependenceYears	.0008	2.88	.005
MilitaryRuleYears	-.00198	-2.24	.028
French	-.0891	-3.27	.001
Resources	.1157	3.38	.001
Size	-.0704	-2.43	.017
Constant	.636	20.89	0
R^2	.42		
Adj R^2	.39		

The results in table 10 show that the colonization and independence durations as well as the resources variable have a positive and statistically significant effect on HDI. French colonization, duration of military rule and colony size on the other hand have a negative and statistically significant effect on HDI.

HUMAN DEVELOPMENT AND DEMOCRACY AT INDEPENDENCE

Now I add the Polity score at independence to equation 2, and I run the new regression equation (equation 3):

$$HDI = \alpha + \beta 1 * ColonizationYears + \beta 2 * IndependenceYears + \beta 3 * MilitaryYears + \beta 4 * Size + \beta 5 * Resources + \beta 6 * French + \beta 7 * PolityAtIndependence + \varepsilon \quad (3)$$

Table 11. Regression Results After Adding the Polity Score at Independence

	Coefficient	t	p
ColonizationYears	.00024	2.19	.029
IndependenceYears	.00089	2.93	.003
MilitaryRuleYears	-.00186	-2.06	.040
French	-.0726	-2.48	.013
Resources	.11587	2.97	.003
Size	-.04668	-2.43	.017
Constant	.59628	13.03	0
PolityAtIndependence	.00092	.37	.709
R^2	.43		
Adj R^2	.40		

The results in table 11 show that democratic attainment at-independence for a former colony (as measured by the Polity score) has no statistically significant impact on the Human Development Index of that former colony.

CONCLUSION

This study sets out to examine whether democracy at independence had a lasting effect on the human development outcomes of former European colonies. Using the Human Development Index as a broad measure of well-being, the analysis reveals that democratic attainment at independence (as measured by the Polity score) has no statistically significant impact on current levels of human development. Instead, factors such as colonial duration, length of independence, years under military rule, Population size, resource endowments, and the identity of the colonizer (specifically French) are more consistent predictors of human development outcomes.

These results suggest that while democracy is often assumed to provide a pathway to development, its effectiveness depends heavily on the quality of institutions and the broader historical context. Most former colonies did not inherit functioning democratic systems at independence but rather extractive or fractured institutions that constrained their capacity to deliver inclusive development. Thus, democracy at independence was often nominal, lacking the institutional depth required to shape long-term development trajectories.

The findings reinforce the importance of colonial legacies in shaping contemporary socio-economic conditions. Prolonged colonial rule entrenched extractive institutions, while French colonialism in particular left behind centralized administrative systems that remain negatively associated with human development. Resource-rich colonies, on the other hand, tend to perform better on HDI, though resource dependence also carries risks of inequality and rentier politics.

REFERENCES

Acemoglu, Daron, Simon Johnson, and James A. Robinson. 2001. "The Colonial Origins of Comparative Development: An Empirical Investigation." *American Economic Review*, 91(5): 1369–1401.

Acemoglu, Daron and James A. Robinson. 2012. *Why Nations Fail: The Origins of Power, Prosperity, and Poverty*. New York: Crown Publishing Group.

Block, Fred and Peter Evans. 2005. "The State and the Economy." In Neil J. Smelser and Richard Swedberg, eds., *The Handbook of Economic Sociology*, 2nd ed., 505–526. Princeton, NJ: Princeton University Press.

Gerring, John, Philip Bond, William T. Barndt, and Carola Moreno. 2005. "Democracy and Economic Growth: A Historical Perspective." *World Politics*, 57(3): 323–364.

Grier, Robin. 1997. "The Effect of Religion on Economic Development: A Cross National Study of 63 Former Colonies." *Kyklos*, 50(1): 47–62.

Grier, Robin. 1999. "Colonial Legacies and Economic Growth." *Public Choice*, 98(3–4): 317–335.

Hariri, Jacob Gerner. 2012. "The Autocratic Legacy of Early Statehood." *American Political Science Review*, 106(3): 471–494.

Lange, Matthew. 2004. "British Colonial Legacies and Political Development." *World Development*, 32(6): 905–922.

Lange, Matthew. 2009. *Lineages of Despotism and Development: British Colonialism and State Power*. Chicago: University of Chicago Press.

Lipset, Seymour Martin. 1959. "Some Social Requisites of Democracy: Economic Development and Political Legitimacy." *American Political Science Review*, 53(1): 69–105.

Muiu, Mueni wa. 2010. "Colonial and Postcolonial State Formations in Africa." *Social Evolution & History*, 9(2): 120–150.

Olsson, Ola. 2009. “On the Democratic Legacy of Colonialism.” *Journal of Comparative Economics*, 37(4): 534–551.

Przeworski, Adam, Michael E. Alvarez, José Antonio Cheibub, and Fernando Limongi. 2000. *Democracy and Development: Political Institutions and Well-Being in the World, 1950–1990*. Cambridge: Cambridge University Press.

Sen, Amartya. 1999. *Development as Freedom*. Oxford: Oxford University Press.

United Nations Development Programme (UNDP). 2021. *Human Development Report 2021/2022*. New York: UNDP.

Woodberry, Robert D. 2012. “The Missionary Roots of Liberal Democracy.” *American Political Science Review*, 106(2): 244–274.

Zakaria, Fareed. 1997. “The Rise of Illiberal Democracy.” *Foreign Affairs*, 76(6): 22–43.

When Zebras Change Their Stripes: Social Cooperation under Dynamic Time Preference

M. Garrett Roth[*]

ABSTRACT

This paper provides a game-theoretic basis for the cleft between societies which display social cooperation and non-corrupt institutions and those that do not. To do so, I introduce variable time preference as a function of wealth, proxied by accumulated payoff, to the repeated prisoner's dilemma game. Through a dynamic contagion process, a unique but unstable ratio of "cooperators" and "defectors" emerges within an arbitrarily large group of randomly paired players. The corresponding prediction is a gradual shift toward a homogenous society of either "cooperative" or "non-cooperative" agents.

INTRODUCTION

Can the enormous economic gulf that exists between the developed and undeveloped world be explained by a single psychological variable? This paper presents a game theoretic model that attempts to do so via the well-establish correlation between individual wealth and time preference (Hausman, 1979; Lawrance, 1991). By treating time preference as an endogenous function of a player's accumulated payoffs, my model explains not only the outcomes but the *dynamic process* by which players change both their actions as well as their actual *types* within the classic illustration of potential social cooperation, the repeated prisoner's dilemma.

I find that jointly cooperative and non-cooperative outcomes are self-reinforcing; from any given initial point, societies either develop (i) an ever-increasing number of members with an ever-increasing preference for delayed gratification and, therefore, ever-increasing economic development or (ii) an ever-increasing number of members with an ever-increasing preference for immediate payoffs and a corresponding hand-to-mouth existence. However, despite this ostensibly grim prognosis, the model's

[*] Department of Accounting, Economics and Finance, Gannon University, 109 University Square, Erie, PA 16541, mgarrettroth@gmail.com. The author wishes to thank Michael Munger for helpful comments on an earlier draft of this paper.

predictions differ sharply from those who regard the cause of poverty as potentially cognitive (for example, Schoon et. al., 2011). Rather, the model underscores the need for commitment devices whereby those who *may* have the capacity to build savings can be assisted in sparking small-scale outbreaks of cooperation and wealth accumulation within an otherwise destitute society.

The relatively recent shift of focus in fostering economic development, from direct subsidy to micro-credit, indicates a paradigmatic reassessment of the root causes of long-term poverty, from a lack of immediate income to the lack of a means for saving and borrowing. A present-oriented society with minimal savings is often perpetuated by the corruption of political institutions and unavailability of formal financial intermediaries (Morduch and Rutherford, 2003). Long-term alleviation of poverty therefore begins with the creation and maintenance of reliable institutions and secure transactions, a two-way relationship between an honest lender/seller and honest borrower/buyer (Serra, 2006). The widespread coordination of individuals choosing between honesty and economic development versus corruption and economic stagnation suggests a game theoretic treatment of the issue as a prisoner's dilemma (MacRae, 1986. Witt (1986), for example, posits the influence of moral standards as a means to assure mutual cooperation in such precarious social circumstances. As a matter of public policy, the goal of many recent development initiatives has been to escape a "mutual defection" outcome through the creation of social capital (Janssens, 2010).

Recent experimental evidence also bears out the pivotal role played by time preference, an individual's level of patience, in both the causes and prospective cures for systemic poverty. More specifically, the difficulty presented by immediate economic concerns makes long-term saving difficult without a means for pre-commitment (Bauer et. al., 2012; Ashraf et. al., 2006; Gugerty, 2007; Ambec and Treich, 2007). Previous models of cooperation within the prisoner's dilemma framework have, however, neglected the empirical link between income and time preference, regarding discount rates as immutable and exogenous (notably, Axelrod, 2006). A purely theoretical contribution of the paper is, therefore, a richer and more realistic treatment of the most critical determinant of optimal strategy, a player's discount factor, in the most basic of repeated games, the prisoner's dilemma.

An *exogenous* treatment of time preference ala Axelrod permanently divides players into tentative "cooperators" and "defectors" which results in a "tit for tat" strategy proving successful on average, even when a small proportion of the population is like-minded (Axelrod, 2006, Ch. 3). The repeated prisoner's dilemma I present in the next section, in contrast, uses payoffs as a surrogate for income which affects time preference and, therefore, individually optimal strategy. Outcomes of mutual cooperation and unilateral defection make the player more future-oriented, while unilateral cooperation and joint defection have the opposite effect. This relationship dissolves the permanent division between prospective cooperators and serial defectors; repeatedly high or low payoffs don't simply change a player's strategy but their actual "type".

The potential results of model described in the next section, of either mutual cooperation or defection in finite rounds, may seem unremarkable in and of themselves. However, as pertains to the problem of fostering social cooperation, they are novel in two respects. First, unlike an exogenous treatment of time preference, players are not only accumulating payoffs, they are continuously updating the relative values of tit-for-tat and "always defect" strategies, which are contingent on their individual discount factor. Thus, repeated rounds of joint cooperation (defection) not only make players very rich (poor), they also make them very patient (impatient). Protracted spells of poverty will, therefore, be more debilitating because of the erosion of time preference as well as income.

The inclusion of pay-off dependant time preference is also novel in that, where player types were initially dissimilar, the model predicts that they will eventually be alike. In other words, when paired with a "cooperator", a "defector" will eventually adopt a cooperative strategy or vice versa. Thus, in sharp contrast to the *ex ante* imposition of strategies, cooperative and non-cooperative behaviors are both potentially "contagious".

To further explore the implications of this contagion process, I expand the context of the game to a large society in the third section of the paper, where individual players engage in interactions with many partners. In order to simplify this macro-analysis, I append the standard repeated prisoner's dilemma with the highly realistic assumption that where one or both players defect, games do not continue for additional rounds. Similar in construction to a prisoner's dilemma with ostracism (Hirschliefer and Rasmusen, 1989), this modification collapses each interaction into a "quasi-repeated game" which may or may not be played into the infinite future. Adding what I term a "grim trigger termination" assumption makes the game simpler to analyze in aggregate than the standard, repeated prisoner's dilemma but also richer in potential outcomes than the one-shot game, as defection is not unambiguously optimal.

The modified, two-person prisoner's dilemma serves as a springboard for investigating the effects of introducing payoff-dependant time preference on society-wide evolutionary dynamics. More specifically, I examine the stability of both homogeneous (all-cooperator and all-defector) and heterogeneous (part tit-for-tat cooperator, part defector) societies. As with empirical investigations by White and Runge (1995), I find a considerable "critical mass" (in this case, of sufficiently patient individuals) is necessary in order to foster cooperation. However, once reached, a cooperative outcome will be self-sustaining and burgeoning. Conversely, a level of cooperators short of this "critical mass", as determined by model parameters, will push the percentage of cooperators to zero. Traditional policy initiatives such as external aid are, therefore, likely to provide the "amplification effect" toward increasingly dictatorial or democratic institutions uncovered by Dutta et. al. (2013) depending on whether the "critical mass" of cooperators has been reached. Further implications of these games, particularly as applied to problem of economic development, are briefly discussed in the final section.

A REPEATED PRISONER'S DILEMMA WITH ENDOGENOUS TIME PREFERENCE

Consider an infinitely repeated version of the simple Prisoner's Dilemma game illustrated in Figure 1, where two players choose between some form of cooperation and defection. Payoffs are generically written as in Gintis (2009), with *R* for "reward" when both players cooperate, *P* for "punishment" when both defect, *T* for "temptation" to the lone defector, and *S* for "sucker" to the lone cooperator.

		Player 2: Cooperate	Player 2: Defect
Player 1	Cooperate	*R,R*	*S,T*
	Defect	*T,S*	*P,P*

FIGURE 1 – THE PRISONER'S DILEMMA

The ordering of payoffs is familiar, with $T > R > P > S$. To rule out the possibility that alternating defection is superior to sustained cooperation, also assume that $S+T < 2R$. While many scenarios are possible, subsequent analysis is uninteresting unless a meaningful difference exists in the effect of various payoffs on a player's rate of time preference. More specifically, let the discount factor of a given player be such that all potential payoffs have a non-zero impact on the player's discount factor, δ. Also, assume that payoffs of *T* and *R* increase δ and that payoffs of *P* and *S* decrease δ, thus

$$\delta(\omega_i + T) \geq \delta(\omega_i + R) > \delta(\omega_i) > \delta(\omega_i + P) \geq \delta(\omega_i + S),$$

where the variable ω_i is a player's initial level of wealth.

Consider the standard problem of Player 1 in whether to defect or cooperate under the assumption that Player 2 has adopted a tit-for-tat strategy. Defecting amounts to the payoff *T* in the current period and *P* in each subsequent period. Sustained cooperation accrues a payoff of *R* into the infinite future. Thus, the decision to cooperate hinges on satisfying the inequality

$$R + \delta R + \delta^2 R + \ldots > T + \delta P + \delta^2 P + \ldots,$$

where δ is the period-specific discount factor of Player 1, which collapses to $\delta(\omega_1) > (T-R)/(T-P)$. Having played the initial game, players will reap their respective payoffs and their relative levels of impatience will adjust accordingly. First, consider the situation where both players choose the same strategy.

Proposition 1: Joint defection in the initial period ensures infinitely sustained mutual defection and an erosion of both players' discount factors to zero.

Proof: Follows immediately from the assumptions that *S+T < 2R* and $\delta(\omega_i) < \delta(\omega_i + P)$. ■

Proposition 2: Joint cooperation in the initial period ensures infinitely sustained cooperation and an increase of both players' discount factors to an arbitrary maximum less than or equal to one.

Proof: Follows immediately from the assumption that $\delta(\omega_i + R) > \delta(\omega_i)$. ■

The case where players choose opposite strategies is less straightforward and naturally depends on the period-specific effects of payoffs on respective values of δ. While many outcomes are possible, the ultimate trajectory of game-play hinges on the absolute difference between *T*, the "temptation" payoff, and *S*, the "sucker" payoff. These possibilities can be formalized as follows:

Proposition 3: Where one player has adopted a tit-for-tat strategy, if $\delta(\omega_i + T)$ is sufficiently greater than $\delta(\omega_i)$ and *T* is sufficiently greater than *S* in absolute value, the endogeneity of δ ensures that mutual cooperation will emerge from dissimilar initial strategies in the repeated prisoner's dilemma game.

Proof: Without loss of generality, assume that Player 1 has defected in the initial round of play and Player 2 had adopted at tit-for-tat strategy. If $\delta(\omega_1 + T)$ is sufficiently greater than $\delta(\omega_1)$, the accumulation of *T* will ensure that $\delta(\omega_1 + T) > (T - R)/(T - P)$. Thus, Player 1 would prefer sustained cooperation in future. However, under the assumption that Player 2 has adopted a tit-for-tat strategy, Player 1 must endure a "sucker" payoff for one period. Sustained cooperation will, therefore, prevail in the third round of play iff $\delta(\omega_1 + T + S) > (T - R)/(T - P)$, which necessarily holds if *T* is sufficiently greater than *S* in absolute value. ■

Proposition 4: If either $\delta(\omega_i + T)$ is sufficiently close to $\delta(\omega_i)$ or *T* is less than *S* in absolute value, the repeated prisoner's dilemma game will eventually result in joint defection into the infinite future.

Proof: Assume, as in the proof of Proposition 3, that Player 1 has defected in the initial round of play and Player 2 had adopted at tit-for-tat strategy. As $\delta(\omega_1 + T) - \delta(\omega_1)$ approaches zero, the possibility that $\delta(\omega_1 + T) > (T - R)/(T - P)$ also approaches zero, given that $\delta(\omega_1) < (T - R)/(T - P)$. Similarly, if $|T| < |S|$, $\omega_1 + T + S$ must be less than ω_1 and, therefore, the inequality $\delta(\omega_1 + T + S) < (T - R)/(T - P)$ must hold. Thus, the adoption of a cooperative strategy by Player 1 can never be rational under either set of circumstances. ■

The inclusion of payoff-dependent time discounting within the repeated prisoner's dilemma framework is most notable in terms of its impact on long-run outcomes. Joint cooperation or defection in the first round of play not only assures that each outcome will continue in perpetuity but also reinforces the initial decision to cooperate or defect by increasing or decreasing both players' discount factors, respectively. Also, while the initial adoption of cooperation is based on the relative values of *T*, *R*, and *P*, the eventual generation of cooperation from initially dissimilar strategies depends on the relative values of *T* and *S*. From any given pair of initial strategies, however, the game will necessarily settle into either joint cooperation or joint defection by the third round of play. Thus, beyond the hypothetical vacuum of an isolated two-player game, the perpetually cooperative and non-cooperative outcomes that emerge are "infectious" in the sense that eventual joint defection (cooperation) makes players more impatient (patient) in all subsequent social interactions. To further develop the implications of this possibility, I now expand my purview to the question of strategic cooperation as pertains to society as a whole.

THE EVOLUTIONARY STABILITY OF COOPERATION

The previous section presents two possible long-run outcomes to a repeated Prisoner's Dilemma where the rate of time preference is based on accumulated payoffs. Though self-reinforcing equilibria of joint defection and joint cooperation are illuminating in and of themselves, a single two-person scenario fails to address the broader societal implications of such isolated interactions. As Propositions 1-4 demonstrate, the game between Players 1 and 2 will eventually drive their rates of time preference to maximum patience or impatience. Such intertemporal modifications of time preference naturally have spillover effects into either player's other social interactions. Thus, inherent in the endogeneity of time preference is a potential "contagion effect" in changing a player's optimal strategy from tit-for-tat to "always defect" or vice versa. Accordingly, this section examines whether, as a matter of evolutionary stability, a society comprised of both impatient "defectors" and patient "cooperators" can feasibly exist.

Because the notion of evolutionary stability requires random pairings of agents, the permanent association assumed in the previous section is no longer directly applicable. However, the basic scenario can be modified to what becomes a "quasi-repeated game". More specifically, I can embed the game's potential trajectories in the initial outcomes by making a "grim trigger" termination assumption, i.e. if one or both players defect, I assume that the game simply ends. If both players cooperate, I assume that the game continues into the infinite future because, as per Proposition 1, such cooperation will be reinforced by bolstering both players' discount factors. Thus, unlike the case of a finitely-repeated prisoner's dilemma, cooperators who suspect they are encountering other cooperators still have an incentive to cooperate in the first round of play.

Figure 2 illustrates the modified game, where $\tilde{R}$ is the utility to sustained cooperation, which is a function of players' current time preferences. Note that unlike the standard prisoner's dilemma, the value of $\tilde{R}$ relative to *T* will necessarily vary amongst players. Cooperators, although patient, are not saps, and therefore prefer to match their opponent's strategy, implying that, for them, $\tilde{R} > T > P > S$. By definition, defectors must view the defection strategy as dominant, thus, for them, $T > \tilde{R} > P > S$.

		Player 2: Cooperate	Player 2: Defect
Player 1	Cooperate	$\tilde{R}_1(\delta_1), \tilde{R}_2(\delta_2)$	*S,T*
	Defect	*T,S*	*P,P*

FIGURE 2 – THE PRISONER'S DILEMMA WITH "GRIM TRIGGER TERMINATION"

Consider a society composed of a percentage, *q*, of cooperators.

Proposition 5: There exists some minimum value of *q* below which cooperation never occurs.

Proof: The payoff to a cooperator of defection and cooperation are, respectively,

$qT + (1-q)P$ and $q\tilde{R} + (1-q)S$. Thus, the net expected benefit of defection is

$$qT + (1-q)P - q\tilde{R} - (1-q)s \,. \qquad (2)$$

By assumption of the payoff ordering for a cooperator, Equation 2 is strictly decreasing in *q*. ■

Lemma to Proposition 5: If the value of *q* is sufficiently low in any given period, it will further decrease to zero within a fixed population after sufficiently many rounds of play.

Proof: Follows from Proposition 5 and the assumption that $\delta(\omega_i + P) < \delta(\omega_i)$. ■

Although Proposition 5 is identical to Proposition 2 in Chapter 3 of Axelrod (2006), the subsequent lemma highlights the distinction between two very different conceptions of evolutionary stability, the circumstantial modification of strategy *as such* versus the modification of strategy due to a change in preferences over the payoffs themselves. In Axelrod's world of exogenous time preference, cooperators and defectors comprise fixed and distinct groups. Thus, when the percentage of cooperators is sufficiently low, cooperators will rationally "mimic" the defector majority. However, this behavior is circumstantial in the sense that cooperators have not changed their "type" but merely (and possibly temporarily) their strategy. To draw some parallel to the most popular illustration of evolutionary stability, the hawk-dove game, Axelrod identifies the circumstances under which doves will *act* like hawks. The adoption of endogenous time preference, in contrast, allows for a true "contagion" process whereby the preferences (and, therefore, strategy) of cooperators may be changed by repeated social interactions. Thus, my analysis identifies the circumstances under which doves will *become* hawks.

Returning to the potential stability of a homogenous society, consider the scenario where a lone defector is introduced to a society entirely comprised of cooperators. As in Section II, the outcome where players choose opposite strategies is contingent on the relative values of *S* and *T*; thus, several scenarios are possible. Without loss of generality, assume that Player 1 is the defector who first encounters a cooperative Player 2.

Proposition 6: If S is sufficiently large in absolute value and T is sufficiently small, a society wholly comprised of cooperators is not evolutionarily stable.

Proof: There must exist some value of *S* which is sufficiently large in absolute terms such that $T > \tilde{R}(\delta_2(\omega_2 + S))$. In addition, as T approaches zero, $\delta(\omega_2 + T)$ approaches $\delta(\omega_2)$, which implies that *q*, the percentage of cooperators, is non-increasing. Thus, where both conditions hold, the value of *q* will never increase and almost always decrease over time. ■

Proposition 7: If *S* is sufficiently small in absolute value and *T* is sufficiently large, a society of cooperators is immune to invasion by a lone defector.

Proof: As the value of *S*, and therefore *P*, approaches zero, $\delta(\omega_1 + S)$ approaches $\delta(\omega_1)$, which implies that *q* is non-decreasing. In addition, there must exist a sufficiently large value of *T* such that $\tilde{R}(\delta_2(\omega_2 + T)) > T$. Thus, where both conditions hold, a lone defector will adapt his preferences to those of the homogenously cooperative society without affecting the preference ordering of others. ■

In tandem, Propositions 6 and 7 demonstrate that the evolutionary stability of an all-cooperator society is heavily contingent on payoff values.

While the invasion of a single mutant creates interesting dynamics, consider the more realistic case of a society comprised of many defectors and many cooperators. For the sake of generality, assume that the change in time preference due to various payoffs is uniform across players and denoted as: $\delta_i(\omega_i + \tilde{R}) - \delta_i(\omega_i) = r$; $\delta_i(\omega_i + S) - \delta_i(\omega_i) = s$; $\delta_i(\omega_i + P) - \delta_i(\omega_i) = p$; and $\delta_i(\omega_i + T) - \delta_i(\omega_i) = t$. Also assume that *S* and *T* are sufficiently small in absolute value such that, where opposite strategies are chosen, players do not necessarily switch types. If time preferences were static, an analysis of "replicator dynamics" amongst a large group of randomly paired agents would require a calculation of the average payoff differential between the strategies of cooperation and defection. The corresponding determinant of stability where game-play actually modifies preferences is that the average discount factor of both sub-groups remains unchanged.

In any given period, the average change in discount factor to a cooperator is $qr + (1-q)s$; the average change to a defector is $qt + (1-q)p$. Setting both equal to zero implies a unique value of *q* which assures the stability of a heterogeneous society, $q^* = \dfrac{p-s}{r+p-s-t}$.

If *q* lies above *q**, the average discount factors of both groups must, on average, increase each period, given that *r* and *t* are positive and that *s* and *p* are negative, implying an ongoing net increase in the number of cooperators. Conversely, if *q* lies below *q**, both groups will collectively become more impatient each period, implying an ongoing net increase in the number of defectors. Just as in the original two-person prisoner's dilemma presented in Section II, society as a whole is pushed toward universal cooperation or universal defection, with a unique, fragile equilibrium where a heterogeneous society is feasible.

DISCUSSION

The models presented in Sections II and III illustrate how societies can separate into two stark categories, those which are overwhelmingly future-oriented and prosperous, where institutions are largely trustworthy, and those which are present-oriented and impoverished, where institutions are largely corrupt. Incorporating time preference as a function of accumulated payoffs rather than a static absolute introduces a new game theoretic possibility: the endogenous modification of a player's strategy for the repeated game as a whole. Thus, unconditional defectors can potentially become tit-for-tat players and vice versa. Because strategies quickly settle to mutual cooperation or defection, the time preferences of both players will be pushed to maximal or minimal levels, respectively.

The prisoner's dilemma with "grim trigger termination" game presented in Section III broadens the scope of potential "contagion effects" (both toward and away from cooperation) from isolated, two-person game-play to society as a whole. The endogenous modification of preferences over payoffs (specifically, the value of the "reward" payoff relative to the "temptation" payoff) implies a unique and highly unstable ratio of cooperative to non-cooperative players where both types will continue indefinitely. Thus, the introduction of an additional cooperator or non-cooperator will eventually result in a society wholly comprised of cooperative or non-cooperative players, respectively. Though superficially similar to the temporary adaptation of strategy to social circumstances (e.g. I, as a tit-for-tat player, defect when confronting a society mostly comprised of defectors), these models predict an adaptation of players' fundamental valuations of cooperation versus defection. Thus, when the number of defectors is sufficiently high, I actually *become* a defector through repeated "punishment" payoffs.

Though necessarily stylized, the models' results provide a gloomy prognosis for the prospects of broad-scale economic development. Where defection in social interactions has eroded players' orientation toward delayed gratification, a small influx of cooperators will be gradually converted into defectors. The converse scenario, whereby a small group of defectors is introduced to a cooperator society may, however, paint an optimistic picture for the economic assimilation of impoverished immigrants into the developed world, insofar as immigrant groups do not voluntarily cut themselves off from the broader society (and insofar as their decision to immigrate does not inherently imply a preference for delayed gratification).

Although the societal dynamics of wealth-based time preference may illustrate the difficulties inherent in broad-based economic development, they nevertheless underscore how targeted development can be encouraged. More specifically, the model suggests that cooperation can be fostered by: (i) bolstering time preference through the accumulation of long-term savings and (ii) increasing the relative value of the "sucker" payoff to diminish the penalties to tentative cooperation.

As discussed more thoroughly in the introduction, current trends in fostering economic development have shifted distinctly toward the opportunity for savings as a means to overcome the immediate pressures of a hand-to-mouth existence, thereby validating an increased emphasis on time preference as the primary catalyst for social cooperation and growth. Concurrently, the concept of pooled savings via informal social groups in the developing world (called "Roscas") as a means to insure against risk both diminishes the severity of a "sucker" payoff and encourages protracted cooperation by increasing the social sanction (and therefore diminishing the payoff) to unilateral defection.

ENDNOTES

1. The developmental game played between the state and the private sector can also be depicted as a prisoner's dilemma (Huff et. al., 2001). Alternatively, Daniel et. al. (2005) present multiple interpretations of the basic cooperation / defection decision (or, to use their preferred language, action versus inaction) as embodied in a prisoner's dilemma payoff structure. Insofar as the primary goal of economic development is to allow for private capital formation, the model presented herein is most closely related to their "selfish game".

2. Naturally, the analysis also applies to a prisoner's dilemma that is repeated each period with some given probability less than one.

3. Note that this is a simplified version of the restriction that the discounted payoff to alternating defection (to the initial defector) is less than that of discounted cooperation for all feasible discount factors. Thus, planning to "eventually resume cooperation" is never rational.

4. This assumption is merely illustrative and serves to rule out the possibility that a player's discount factor has reached its potential maximum or minimum. If, for example, a player's discount factor was zero before the first round of play, a payoff of P could not, by definition, lower it further.

5. One would naturally wonder, however, why an initially cooperative player would choose to repeatedly associate in future with a consistent defector. I accordingly develop a game where their association ends in the third section of the paper.

6. Note that the "sucker" payoff accrued by Player 2 in the first round of play has the potential to lower his discount factor such that he prefers to "always defect" in future. However, if Player 1 cooperates in the second round (where Player 1 knows Player 2 will defect), both will have accumulated payoffs of S and T. Given that Player 2's initial wealth is greater than Player 1's (as evidenced by their initial adoption of tit-for-tat and "always defect" strategies respectively), Player 2's net wealth after two rounds of play must still be greater than Player 1's. Thus, insofar as the functional relationship between wealth and discount factor is not radically different across players, whenever Player 1 finds tit-for-tat preferable to "always defect" in the third round of play, Player 2 must find it preferable as well.

7. The entire question of resuming cooperation is, of course, moot under a "grim trigger" strategy. I therefore restrict my analysis of the category of "potentially cooperative strategies" to tit-for-tat as this is both the simplest and most common variation within that broader category.

8. Alternatively, one could assume that players engage in multiple and infinitely repeated prisoner's dilemmas. However, this scenario is both analytically cumbersome if not intractable and less realistic than the "quasi-repeated game" which I propose, as it assumes that both cooperative and non-cooperative players repeatedly associate with known defectors.

9. I regard an outcome-contingent repetition of the game to be more plausible than the probabilistic approach of Axelrod (2006), which is analytically identical to an infinitely-played game. The assumption that the "quasi-repeated game" continues with some set probability (when joint cooperation occurs) could be easily embedded within the payoffs without meaningfully changing the results of the model.

10. Note that this preference shuffling does not constitute dynamic inconsistency in the customary sense, as players can not predict a "future self" with a different preference ordering from the "present self".

11. The introduction of a small number of defectors within a large population of cooperators would yield the same results given that defectors were sufficiently unlikely to be paired against each other.

12. In the highly unlikely scenario that all defectors are paired against each other, there will be no change in q. Also note that where the population is sufficiently large, cooperation is still rational for Player 2, even when T, and therefore R, is arbitrarily small in absolute value. If, for example, $T = 2e$ and $R = e$, cooperation is still rational for those with a discount factor greater than 0.5 for all $e > 0$.

13. Idiosyncratic adjustments in time preference as a result of payoffs could yield an infinite number of potential scenarios. However, admitting of this possibility within the formal analysis is tantamount to allowing for different values to payoffs themselves, i.e. different players actually play different games. Given that adjustments in time preference from a single social interaction are likely to be small, I consider the tractable and straightforward yet illustrative case of identical adjustment of discount factor (given the same payoff) across agents.

14. In this circumstance, the number of cooperators who become defectors is necessarily equal to the number of defectors who become cooperators. Thus, stability is trivially ensured.

15. Within the strict confines of the mathematical models, increasing the "temptation" payoff would increase the number of defectors who would be converted to cooperators via the accumulation of a high initial payoff when encountering a tit-for-tat player. However, increasing the value of T would make defection more attractive to all players, thereby proving largely self-defeating. One might also question whether augmenting the "reward" to defection would realistically encourage a reversal of strategy, especially given that defectors are most likely to consume their payoff and thereby find themselves (in the next round of play) with little increase in long-term wealth.

REFERENCES

Ambec, Stefan and Nicolas Treich. 2007. "Roscas as Financial Agreements to Cope with Self-Control Problems." *Journal of Development Economics*. 82: 120-137.

Ashraf, Nava, Dean Karlan and Wesley Yin. 2006. "Tying Odysseus to the Mast: Evidence from a

Commitment Savings Product in the Philippines." *Quarterly Journal of Economics*. 121: 635-672.

Axelrod, Robert. 2006. *The Evolution of Cooperation*. Revised Edition. New York: Basic Books.

Bauer, Michal, Julie Chytilova and Jonathan Morduch. 2012. "Behavioral Foundations of Microcredit: Experimental and Survey Evidence from Rural India." *American Economic Review*. 102: 1118-1139.

Daniel, G., M. Arce and Todd Sandler. 2005. "The Dilemma of the Prisoners' Dilemmas." *Kyklos*. 58: 3-24.

Dutta, Nabamita, Peter T. Leeson and Claudia R. Williamson. 2013. "The Amplification Effect: Foreign Aid's Impact on Political Institutions." *Kyklos*. 66: 208-228.

Gintis, Herbert. 2009. *Game Theory Evolving*. Second Edition. Princeton: Princeton University Press.

Gugerty, Mary Kay. 2007. "You Can't Save Alone: Commitment in Rotating Savings and Credit Associations in Kenya." *Economic Development and Cultural Change*. 55:251-282.

Hausman, Jerry A. 1979. "Individual Discount Rates and the Purchase and Utilization of Energy-Using Durables." *Bell Journal of Economics*. 10:33-54.

Hirschliefer, David and Eric Rasmusen. 1989. "Cooperation in a Repeated Prisoner's Dilemma with Ostracism." *Journal of Economic Behavior and Organization*. 12: 87-106.

Huff, W.G., G. Dewit and C. Oughton. 2001. "Credibility and Reputation Building in the Developmental State: A Model with East Asian Applications." *World Development*. 29: 711-724.

Janssens, Wendy. 2010. "Womens' Empowerment and the Creation of Social Capital in Indian Villages." *World Development*. 38: 974-988.

Lawrance, Emily C. 1991. "Poverty and the Rate of Time Preference: Evidence from Panel Data." *Journal of Political Economy*. 99: 54-77.

MacRae, John. 1982. "Underdevelopment and the Economics of Corruption: A Game Theory Approach." *World Development*. 10: 677-687.

Morduch, Jonathan and Stuart Rutherford. 2003. "Microfinance: Analytical issues for India." in: Priya Basu (ed.), *India's Financial Sector: Issues, Challenges and Policy Options*. New York: Oxford University Press. Accessed 14 Oct. 2013 at: http://www.usfinancialdiaries.org/sites/default/files/publications/microfinance-analytical-issues-for-india.pdf

Schoon, Ingrid, Elizabeth Jones, Helen Cheng and Barbara Maughan. 2011. "Family Hardship, Family Instability, and Cognitive Development." *Journal of Epidemiology & Community Health*. 66: 716-722.

Serra, Danila. 2006. "Empirical Determinants of Corruption: A Sensitivity Analysis." *Public Choice*. 126: 225-256.

White, T. Anderson and C. Ford Runge. 1995. "The Emergence and Evolution of Collective Action: Lessons from Watershed Management in Haiti." *Economic Development*. 23: 1683-1698.

Witt, Ulrich. 1986. "Evolution and Stability of Cooperation without Enforceable Contracts." *Kyklos*. 39: 245-266.

Leaving Home: Regulations, Outward FDI Flows, and Economic Outcomes

Mansokku Lee†

ABSTRACT

This paper examines how changes in outward foreign direct investment (FDI) flows make an impact on the level of employment and the value of output produced in a manufacturing industry. Using the internationally comparable data on minimum wage, FDI, employment, and out production with the application of the linear IV mediation analysis for a sample of developed countries for the period 2010 – 2021, this paper suggests that the overseas relocation of production facilities can lead to a decrease in employment and the value of output produced in home country through a decrease in export and industrial production.

INTRODUCTION

This paper examines the impact of outward foreign direct investment (FDI) flows on a domestic economy in the context of the influences of economic and institutional regulations. Besides globalization and the growth in output production, government regulations, including those in the labor market, can be one of the major drivers of outward FDI flows. Regulatory policies can prompt firms to consider investing in foreign countries or relocating their production facilities overseas to capitalize on lower costs. Recent studies have sought to shed light on the impact of non-economic determinants on FDI, such as democracy, legal origins, political systems, and institutions. Examples include Li et al. (2018), Jadhav and Katti (2012), Sabir et al. (2019), and Arel-Bundock (2017).

Using Fraser Institute's freedom index (Gwartney et al., 2022), Figure 1 illustrates the relationship between outward FDI flows and various regulation-related measures in OECD countries. Outward FDI flows tend to be higher in countries with relatively elevated hourly minimum wages, bureaucracy costs, and combined (central + averaged local government) corporate income tax rates. Additionally, there appears to be a positive correlation between outward FDI flows and the strength of work hour regulations.

A profit-maximizing firm's activities rely on mutual trust in the market mechanism. However, political factors can alter market conditions, and an increase in government regulatory standards—due to influences such as political partisanship and corruption—may constrain business operations, potentially reducing domestic production and investment. This, in turn, could hamper the economy's production capacity. Yet, the impact of outward FDI on a home country's economy remains uncertain. Much of the literature suggests that the effect varies based on factors such as the industrial structure and the size of the economy. To explore these relationships further, we employ panel regression models with various control variables for a more precise empirical analysis.

† School of Business, SUNY-Geneseo, 1 College Circle, Geneseo, NY 1445. Email: leem@geneseo.edu.

MODEL, DATA, AND ESTIMATION

In this paper, we aim to demonstrate how outward FDI flows from the home country to foreign countries affect economic outcomes in both the labor and output markets of the home country. Our baseline empirical analysis involves estimating the following panel data model for changes in economic performance (Y) in country i and year t:

$$Y_{i,t} = \alpha + \beta OFDI_{i,t} + X'_{i,t}\gamma + \phi_t + \eta_i + \upsilon_{i,t}$$

where $Y_{i,t}$ represents the economic outcome (such as employment or output) in country i at time t, and $OFDI_{i,t}$ refers to outward FDI flows. The vector X includes exogenous control variables. We account for time effects with ϕ_t, country specific time-invariant fixed effects with η_i, and random disturbance with $\upsilon_{i,t}$. Based on our data, we hypothesize that an increase in outward FDI flows negatively impacts employment levels and output value in the home country. This is likely due to the reduction in available resources for domestic production and investment as FDI outflows rise.

Challenges in estimating this model arise if there is latent endogeneity. If outward FDI activities indirectly influence economic outcomes through other channels, a simple linear specification may fail to capture these complex dynamics - an underlying mechanism of the effect of domestic firms' overseas FDI on home country. To address this issue, we employ instrumental variable (IV) mediation analysis, as proposed by Dippel et al. (2019, 2020). Consider the following mediation model:

$$\begin{aligned} Z &= \epsilon_Z \\ T &= \beta_Y^Z \cdot Z + \epsilon_T \\ M &= \beta_M^T \cdot T + \epsilon_M \\ Y &= \beta_Y^M \cdot M + \beta_Y^T \cdot T + \epsilon_Y \end{aligned}$$

where Y is the outcome variable, M is the mediator, and the T is treatment variables. Z serves as the instrumental variable. The unobserved error terms ϵ_Z, ϵ_T, ϵ_M, and ϵ_Y are associated with Z, T, M, and Y, respectively.

The mediator M is considered a result of the treatment T, and both T and M jointly influence the final outcome Y. If T is non-random, it needs to be instrumented by Z. When both T and M affect Y, Dippel et al. (2019, 2020) propose a method to use a single instrumental variable (IV) to estimate the causal effect of the intermediate variable (mediator) M on the final outcome Y, without requiring separate instruments for both T and M. To implement this, the first step is to estimate β_Y^Z through an OLS regression of T on Z. Next, β_M^T can be identified using a standard a standard two-stage least squares (2SLS) regression of M on T, where T is instrumented with Z:

$$\begin{aligned} First\,Stage: \quad T &= \beta_T^Z \cdot Z + \epsilon_T \\ Second\,Stage: \quad M &= \beta_M^T \cdot \hat{T} + \epsilon_M \end{aligned}$$

In this context, $\hat{T}$ represents the estimated values of T from the first stage. Here, T is the endogenous variable, and M is the outcome variable. The estimation results for this stage are presented in Table 3-Panel A.

Next, we can estimate β_Y^M and β_Y^T by applying a 2SLS regression to the following equations, where T serves as a conditioning variable, Z is the instrument, M is the endogenous variable, and Y is the dependent variable:

$$\begin{aligned} First\,Stage: \quad \widehat{M} = &\quad \gamma_M^Z \cdot Z + \gamma_M^T \cdot T + \epsilon_M \\ Second\,Stage: \quad Y = &\quad \beta_Y^M \cdot M + \beta_Y^T \cdot T + \epsilon_Y \end{aligned}$$

In this case, $\widehat{M}$ denotes the estimated values of *M* from the first stage. The estimation results for this stage are provided in Table 3-Panel B.

Finally, by substituting the mediation equation into the outcome equation, we can measure the total effect (TE) of the treatment on the outcome. This total effect can be decomposed into direct and indirect effects:

$$\begin{aligned} Y &= \beta_Y^M \cdot M + \beta_Y^T \cdot T + \epsilon_Y \\ &= \beta_Y^M \cdot (\beta_M^T \cdot T + \epsilon_M) + \beta_Y^T \cdot T + \epsilon_Y \\ &= \underbrace{(\beta_Y^M \cdot \beta_M^T + \beta_Y^T)}_{TE} \cdot T + \underbrace{\beta_Y^M \cdot \epsilon_M}_{\eta_Y} + \epsilon_Y \end{aligned}$$

In the above linear specification, the coefficient β_Y^T represents the direct effect of the treatment *T* on the outcome *Y*. The indirect effect of the treatment *T* on the outcome *Y* through the mediator *M* is represented by the coefficient multiplication $\beta_Y^M \cdot \beta_M^T$. The total effect (*TE*) is obtained by summing these two terms:

$$TE = \beta_Y^M \cdot \beta_M^T + \beta_Y^T$$

This indicates that the endogenous treatment variable can influence the outcome variable both directly and indirectly. Our primary focus is on measuring the influence of the indirect effect that is transmitted through the mediator variable. The results of this estimation can be found in Table 3-Panel C. Figure 3 addresses the identification challenges inherent in the instrumental variable (IV) mediation analysis.

In this paper, we focus on the causal relationships among economic variables specifically within the manufacturing industry, rather than examining the entire economy. Given that the changes in outward FDI flows are likely not random events, we use hourly minimum wage as an instrumental variable (IV), which is considered one of the driving forces behind capital flight in a domestic economy. Thus, we define outward FDI flows in the manufacturing industry as the treatment, instrumented by the (logged) hourly minimum wage. Figure 2 panel (a) illustrates the relationship between the logged hourly minimum wage (in 2021 US dollars) and the size of government score, one of the measures of economic freedom. A higher score indicates less government intervention. Panel (b) depicts the relationship between the logged hourly minimum wage and the index of bureaucracy costs, which also reflects regulatory burden risk; higher values indicate greater risk. Both scatterplots demonstrate that minimum wage levels tend to be relatively high in countries with larger bureaucratic systems. This observation supports the notion that using minimum wage data as a numeric IV can effectively capture latent institutional effects.

This instrumental variable (IV) setting is well supported by empirical findings indicating that minimum wage policies significantly affect the manufacturing industry. See Del Carpio et al. (2012) and Alvarez and Fuentes (2018). Additionally, we propose an underlying mechanism in which the effect of outward foreign direct investment (FDI) flows on a home country's economic conditions operates through changes in manufacturing exports, thereby influencing manufacturing employment. Given that the output market is connected to the labor market, we also assume that the effects of FDI abroad can ultimately be transmitted to value-added production activities through changes in industrial production. Table 1 outlines our selected proxies for *T*, *M*, and *Y*. Out of the four econometric specifications proposed in this paper (1 through 4), specifications (1) and (3) use Manufacturing Employment as the proxy for the outcome variable (*Y*). In these specifications, Manufacturing Exports and Industrial

Production serve as proxies for the mediator variable (*M*), respectively. In both cases, Outward FDI Flows is used as the proxy for the treatment variable (*T*). Specifications (2) and (4) utilize Value Added in the Manufacturing sector as the proxy for the outcome variable (*Y*). Similarly, Manufacturing Exports and Industrial Production are employed as proxies for the mediator variable (*M*) in specifications (2) and (4), respectively. Again, Outward FDI Flows serves as the proxy for the treatment variable (*T*) in both specifications.

Table 1. Variables used in regression specifications

	Variable	Used in Specification
Outcome (*Y*)	Manufacturing Employment (% of total employment)	(1) and (3)
	Manufacturing, Value Added (% of GDP)	(2) and (4)
Treatment (*T*)	Outward FDI Flows	(1), (2) , (3), and (4)
Mediator (M)	Manufacturing Exports (% of merchandise exports)	(1) and (2)
	Industrial Production (100 in 2015)	(3) and (4)

The model includes a set of the following covariates: the centralized collective bargaining index, which ranges from 1 to 7, where a value of 1 indicates wages are set by a centralized bargaining process, and a value of 7 indicates wages are determined by each individual company. Additionally, the model accounts for the federal corporate tax rate and the environmental taxes imposed on energy, transportation, pollution, and resources (expressed as a percentage of total taxation). Higher values for these two tax-related variables indicate a greater degree of governmental regulation. The vector of covariates also includes inward FDI flows from foreign countries to the home country. We tested a range of alternative covariates, and our choice of different sets did not alter the statistical significance of the estimates.

The panel dataset covers 26 OECD countries over the period from 2010 to 2020. Results from a series of panel unit-root tests suggest that our dataset is stationary; however, we do not report these results for the sake of parsimony. Details on the variables can be found in Table 2.

Table 2. Descriptive statistics

Variable	Obs	Mean	SD	Min	Max
Manufacturing Employment (% of total employment)	259	14.937	5.29	3.4	27.9
Manufacturing, Value Added (% of GDP)	262	14.019	5.398	4.554	34.651
Outward FDI Flow (billion US $)	262	6.700	20.250	-56.939	121.322
Hourly Minimum Wage (2021 US $)	262	5.992	4.263	0.92	15.2
Manufacturing Exports (% of merchandise exports)	262	64.317	23.848	10.632	93.771
Industrial Production (100 in 2015)	262	99.891	11.497	58.145	127.467
Centralized Collective Bargaining (1 - 7)	262	6.908	1.116	3.534	8.754
Corporate Income Tax (%)	262	23.243	7.162	9.000	44.433
Environmental Tax (% of taxation)	262	7.077	2.436	2.12	13.22
Inward FDI Flow (billion US $)	262	8.750	29.024	-40.929	230.981

EMPIRICAL RESULTS

Table 3 presents baseline regression results. Based on these findings, we compute and report the total, direct, and indirect effects of the treatment on the outcome in Table 4. Specifications (1) through (4) display the empirical results of the linear instrumental variable (IV) mediation analysis using different combinations of *M* and *Y*. The results indicate that changes in outward FDI flows, which may be influenced by variations in minimum wage, significantly affect employment and the value of output produced in the manufacturing industry of the home country. For instance, as shown in specifications (1) and (3), the total effect (TE) estimates that in OECD countries, every $1 billion increase in outward FDI flows results in an average decrease of 0.47 percentage points in manufacturing employment as a share of total employment. Additionally, specifications (2) and (4) indicate that such a change in outward FDI flows leads to a decrease of 0.18 percentage points in manufacturing value added as a percentage of GDP. This can be interpreted as a causal effect under typical IV settings.

Table 3. Baseline IV regression results

Panel A: IV regression of Y on T				
Outcome (Y)	(1)	(2)	(3)	(4)
Treatment (T)	-0.477***	-0.180*	-0.477***	-0.180*
	(0.166)	(0.118)	(0.166)	(0.118)

Panel B: IV regression of M on T				
Mediator (M)	(1)	(2)	(3)	(4)
Treatment (T)	2.512***	2.718***	0.563***	0.572***
	(0.711)	(0.765)	(0.238)	(0.240)

Panel C: IV regression of M on Y, controlling T				
Outcome (Y)	(1)	(2)	(3)	(4)
Treatment (T)	0.034	0.018	-0.032	-0.007
	(0.030)	(0.031)	(0.025)	(0.028)
Mediator (M)	-0.197***	-0.070*	-0.788***	-0.304*
	(0.063)	(0.048)	(0.291)	(0.187)

Note: *(**(***)) represent statistical significance at the 10%(5%(1%)) levels. Robust standard errors in parentheses and the significance of independent variables' coefficients are based on one-tailed tests. A constant term is also estimated, but this study does not report it for parsimony.

In specification (1), the direct effect estimates a negligible increase of only 0.034 percentage points from a $1 billion increase in outward FDI flows from home to foreign, which is not statistically significant. Conversely, the indirect effect estimates a decrease of approximately 0.5 percentage points (calculated as 2.512 × −0.197) due to changes in manufacturing exports acting as a mediating factor. We assess the total, direct, and indirect effects using alternative proxies to verify the robustness of the model, with results presented in specifications (2) through (4). While the results remain qualitatively similar, the statistical significance is lower in specifications (2) and (4), compared to (1) and (3).

In all four regression specifications, the direct effect of an increase in outward FDI flows is statistically significant. Notably, the indirect effect appears larger than the total effect. For the indirect effect to exceed 100 percent of the total effect, it must be partially offset by the direct effect. This finding suggests that changes in manufacturing exports as a mediator play a crucial role in determining fluctuations in employment within the manufacturing industry.

Table 4 presents the results of two first-stage regressions used to test for weak identification by reporting the corresponding *F*- statistics for the excluded instrument. Given that we employ robust standard errors, we report the Kleibergen and Paap *F*- statistic. According to Stock and Yogo (2005), a commonly accepted rule of thumb is that the *F*- statistic for the excluded instruments in the first-stage regression should be 10 or greater to mitigate potential bias caused by weak identification in IV regression. In all four specifications, the Kleibergen-Paap *F* statistics exceed 10 in both first-stage regressions, allowing us to reject the null hypothesis of weak identification.

Table 4. Linear IV mediation analysis

	(1)	(2)	(3)	(4)
Total Effect	-0.477***	-0.180*	-0.477***	-0.180*
	(0.167)	(0.118)	(0.166)	(0.118)
Direct Effect	0.034	0.018	-0.032	-0.007
	(0.030)	(0.031)	(0.025)	(0.028)
Indirect Effect	-0.495***	-0.190*	-0.444***	-0.174*
	(0.211)	(0.140)	(0.249)	(0.129)
Casual Mediation Effect	103.84%	105.97%	93.12%	96.66%
Kleibergen-Paap F-statistic for excluded instruments in:				
first stage one: (*T* on *Z*)	12.529	12.356	12.529	12.356
first stage two: (*M* on *Z*|*T*)	28.835	33.343	11.118	11.627
Observation	259	262	259	262

Note: *(**(***)) represent statistical significance at the 10%(5%(1%)) levels. Robust standard errors in parentheses and the significance of independent variables' coefficients are based on one-tailed tests.

CONCLUSION

The main determinants of outward FDI flows include factors related to markets, assets, natural resources, and efficiency seeking behavior. Deteriorating business conditions due to government regulatory policies may prompt firms to seek investment and production opportunities abroad. To enhance our understanding of FDI flows as a vital resource for economic growth, it is essential to incorporate the public's awareness of the quality of governance into the literature.

This paper proposes an underlying mechanism through which outward FDI flows, instrumented by minimum wage as a proxy for government regulatory policy, affect both labor and output markets in the home country. Empirical findings indicate that, within the manufacturing industry, an increase in outward FDI flows negatively impacts both labor and output markets indirectly by increasing manufacturing exports and industrial production.

Identifying how shocks—such as changes in minimum wage and the resulting shifts in FDI flows—are transmitted to the economy offers valuable insights into the types of policies that countries should prioritize to stabilize markets and promote growth. Our findings can suggest that an increase in the minimum wage elevates the overall wage level in the economy, prompting firms in the manufacturing sector to relocate their production facilities through offshoring. Consequently, these firms may export halffinished goods (e.g., parts) that are produced labor intensively through automation in the home country to their foreign production sites, where they complete the production process or assemble products using cheaper local labor. This scenario can explain the observed decrease in the employment rate and value added in the manufacturing sector alongside increases in manufacturing exports and industrial production. It also highlight the need for further empirical evidence to support the proposed mechanisms. A deeper investigation into these dynamics could provide a richer understanding of the relationship between minimum wage, outward FDI flows, and their impacts on labor and output markets. As such, this paper suggests these issues as a promising avenue for future research.

APPENDIX

IV MEDIATE ESTIMATION

Dippel et al. (2019) note that Model I represents the standard IV model, which identifies the causal effects of the treatment variable (*T*) on the mediator variable (*M*). Model II is another standard IV model, focusing on identifying the causal effects of T on the outcome variable (*Y*). Meanwhile, Model III introduces the IV mediation model, incorporating an instrumental variable (*Z*) to establish the indirect effects of *T* on *Y* through *M*. Panel A of the paper provides a graphical representation of these models, while Panel B outlines the nonparametric structural equations corresponding to each model. In these equations, the symbol ⊥ denotes statistical independence.

TEST FOR WEAK INSTRUMENT

This paper also applies Montiel Olea and Pflueger (2013)'s robust weak instrument test, designed for pooled-IV regressions with one endogenous regressor under non- *i.i.d.* conditions. The test is an extension of Stock and Yogo (2005)'s weak-identification test but is robust to heteroskedasticity, serial correlation, and clustering whereas Stock and Yogo (2005)'s test relies on the *i.i.d.* assumption.

Table A1. Results of Montiel-Pflueger robust weak instrument test for specification (1)

Effective F statistic:	19.788	
Confidence level:	5%	
Critical values:	TSLS	LIML
% of worst case bias:		
Γ = 5%	37.418	37.418
Γ = 10%	23.109	23.109
Γ = 15%	15.062	15.062
Γ = 20%	12.039	12.039

Note: According to Montiel and Pflueger (2013), IVs are weak when the TSLS or LIML bias is large relative to a benchmark level.

As shown in Table A1, the effective *F* statistic is 19.788 at the 5 percent confidence level. This value exceeds the benchmark critical values (at Γ = 15%) for both Two-Stage Least Squares (TSLS) and Limited Information Maximum Likelihood (LIML) with a single endogenous regressor. Consequently, we reject the null hypothesis of weak instruments in the pooled-IV setting. Thus, we conclude that the instruments are valid, with a bias no greater than 15% of the worst-case bias.

REFERENCES

Alvarez, R., Fuentes, R., 2018. “Minimum Wage and Productivity: Evidence from Chilean Manufacturing Plants.” *Economic Development and Cultural Change,* 67: 193–224.

Arel-Bundock, V., 2017. “The Political Determinants of Foreign Direct Investment: A Firm-Level Analysis.” *International Interactions,* 43: 424–452.

Del Carpio, X.V., Nguyen, H.M., Nguyen, H., Wang, L.C., 2012. “Does The Minimum Wage Affect Employment? Evidence from The Manufacturing Sector in Indonesia.” *World Bank Policy Research Working Paper*.

Dippel, C., Ferrara, A., Heblich, S., 2020. “Causal Mediation Analysis in Instrumental-Variables Regressions.” *The Stata Journal*, 20: 613–626.

Dippel, C., Gold, R., Heblich, S., Pinto, R., 2019. “Mediation Analysis in IV Settings With A Single Instrument.” *Working Paper.*

Gwartney, J., Lawson, R., Hall, J., Murphy, R., 2022. “Economic Freedom of the World.” Fraser Institute .

Jadhav, P., Katti, V., 2012. “Institutional and Political Determinants of Foreign Direct Investment: Evidence from BRICS Economies.” *Poverty & Public Policy*, 4: 49–57.

Li, Q., Owen, E., Mitchell, A., 2018. “Why Do Democracies Attract More or Less Foreign Direct Investment? A Metaregression Analysis.” *International Studies Quarterly*, 62: 494–504.

Montiel Olea, J.L., Pflueger, C., 2013. “A Robust Test for Weak Instruments.” *Journal of Business & Economic Statistics*, 31: 358–369.

Sabir, S., Rafique, A., Abbas, K., 2019. “Institutions and FDI: Evidence from Developed and Developing Countries.” *Financial Innovation*, 5: 1–20.

Stock, J.H., Yogo, M., 2002. “Testing for Weak Instruments in Linear IV Regression” *NBER Working Papers.*

Figure 1: Outward FDI Flows, minimum wage and non-economic conditions

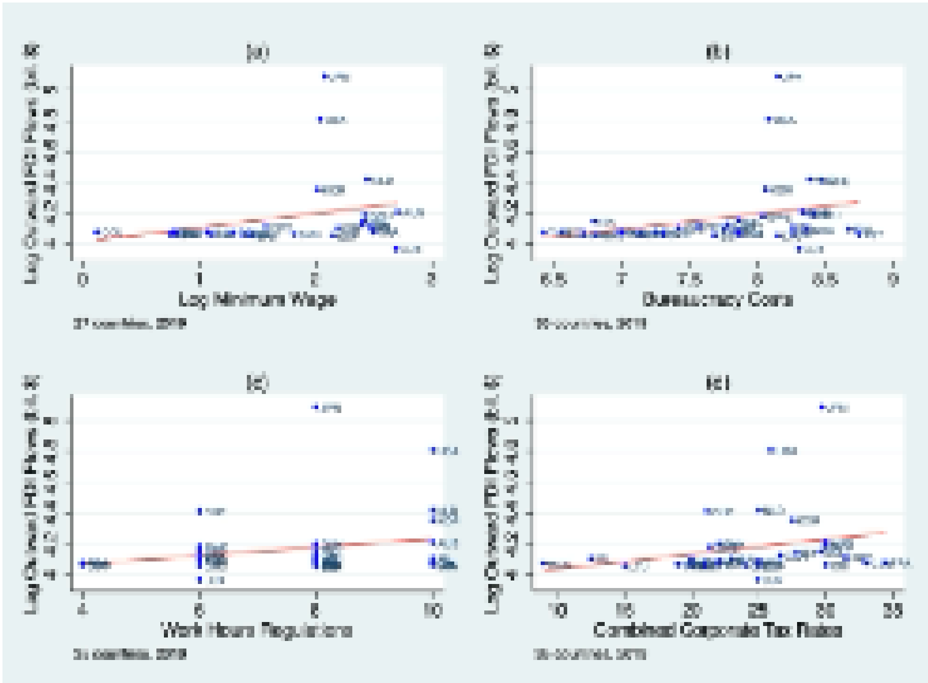


Figure 2: Hourly minimum wage, size of government, and bureaucracy costs

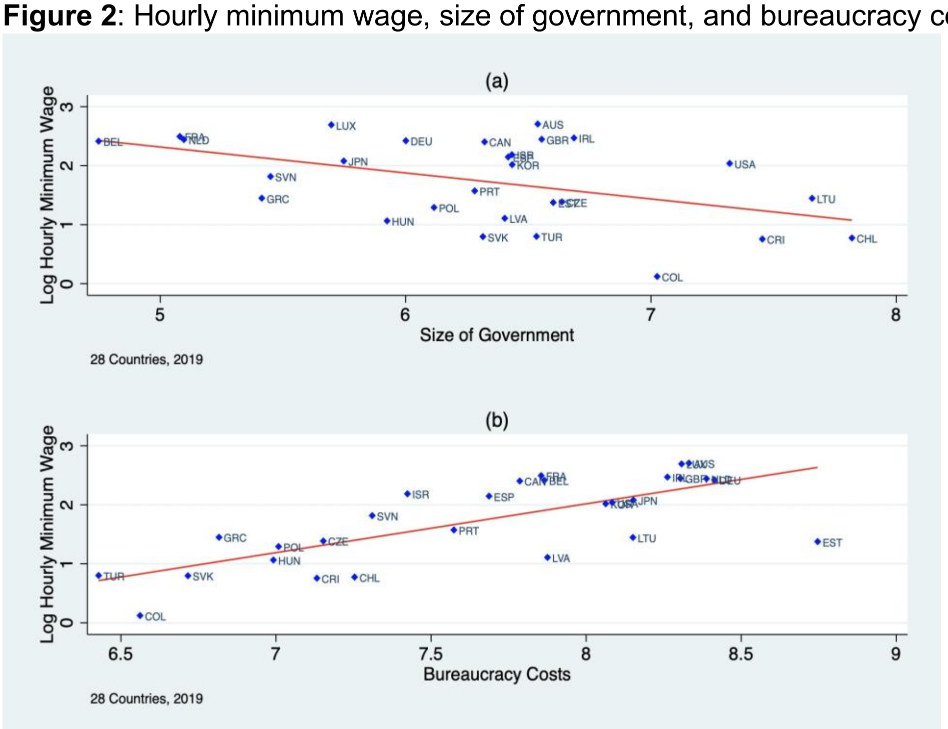
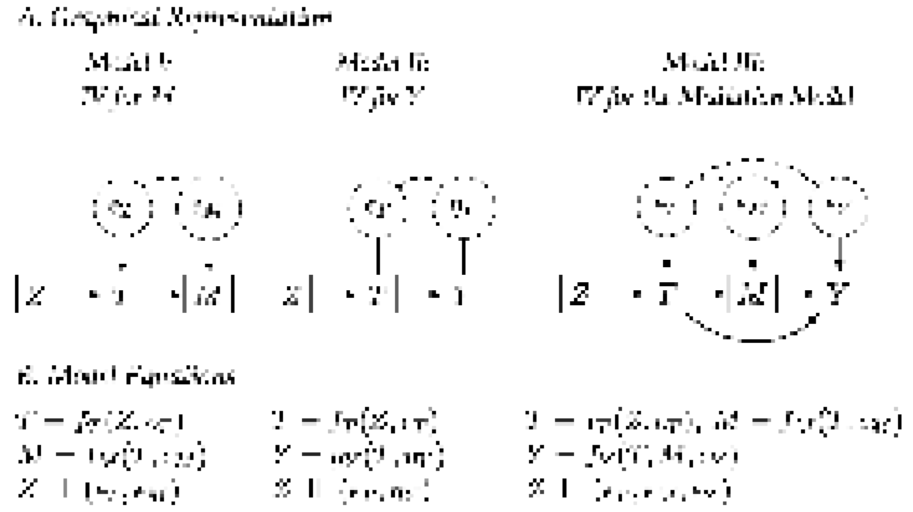


Figure 3: The identification problem of mediation analysis with IV (Source: Dippel et al. (2019))



International Trade by Technology Intensity and the Language Aspect

Lev Vlasenko*

ABSTRACT

Shared language, linguistic distance, and language proximity are significant factors in international trade. As demonstrated in numerous economic models, language has an impact on bilateral trade, serving both as an obstacle and a facilitator of the connection between two trading partners. However, most articles on this subject consider trade homogeneous and measure the influence of language on exports, imports, or total trade flows of all products combined in one indicator, without separating commodities into groups and categories. This article examines the relationship between language proximity and the exports of different groups of commodities, considering their technological intensity, to determine whether the influence of language proximity varies according to the type of product.

INTRODUCTION

Modern trends in international trade increase the importance and role of language. The spread of the Internet and the increasing information component in even the most basic goods lead to the need for translation and localization, thereby increasing transaction costs. Companies spend vast amounts of money on managing infrastructure and on post-sales support for their products, which, depending on the complexity and expense of the translation, both in monetary and time terms, can impose additional restrictions on access to foreign markets. In these conditions, the presence or absence of a common language between two trading partners can be a decisive factor in organizing commercial cooperation.

The cost of translation and its complexity also significantly depend on whether the languages of the two trading partner countries are linguistically close to each other or belong to entirely different language families. The proximity or remoteness of languages is especially relevant for Southeast Asian countries, such as China, Japan, and Korea, due to their distance from Indo-European languages and the unique writing systems used in these countries. Under these conditions, the study of the influence of language on international trade is becoming increasingly important.

The influence of a shared language on bilateral foreign trade has been a long-standing subject of study among economists and linguists. The most influential scholar to establish the connection between language and trade was J. Melitz. In his articles, he proved the influence of the linguistic factor on international trade (J. Melitz, 2008; 2012; 2018). In their research, P. Chiswick & B. Miller (1994, 2005) demonstrated that linguistic diversity and linguistic distance have a significant impact on communication, making them critical indicators of the performance of economic cooperation. Specifically, as a determinant of bilateral trade linguistic distance was examined by W. K. Hutchinson (2005); the question on whether a trade is affected by language was also studied by J. Lohmann (2011). A. Maghssudipour, M. Bellandi & A. Caloffi (2022) utilized the concept of linguistic proximity to analyze different commodity groups of Italian exports and established a strong connection between the proximity of languages and the international trade. According to Kwan Choi (2002), commodities of Chinese origin are additionally hindered by the language factor when facing promotion on the global market, because it is unlikely for Mandarin to become a universal language of trade, while the cost of translation from Chinese is considerably higher than in the case of more closely related languages.

However, despite the apparent interest expressed by scholars and researchers, linguistic distance (or proximity) remains a new subject in economic theory. It requires further research and analysis, especially when considering the impact of language on distinct types of commodities, depending on their technological intensity. Due to its role in the contemporary global economy, the language of the not widely spoken Sino-Tibetan family, along with its unique writing system, makes China a particular focus of such research.

THE PURPOSE OF THE STUDY

The following article aims to prove the connection between the linguistic proximity of two languages and the intensity of bilateral trade. This is achieved by building a gravity model that utilizes linguistic distance as one of the key elements in the analysis and forecasting of bilateral trade, and to determine the extent to which linguistic proximity affects trade in distinct types of commodities, depending on their technological intensity. To achieve this goal, existing theories of the gravitational model of international trade were considered, and the concept of linguistic proximity was defined, with its expediency in being included in the gravitational model justified. Final calculations of the OLS model for linguistic proximity were performed for five commodity groups, depending on technology intensity, and one group by language intensity.

THEORETICAL FRAMEWORK

The gravity model of trade is based on Newton's Law of Universal Gravitation. In its traditional form, the gravity model posits that bilateral trade between two countries is proportional to the size of their economies (usually measured by GDP) and inversely proportional to the distance between them. Originally, W. Isard (1954) introduced the gravity equation of international trade. In more recent studies, it is widespread practice to use a log-log model suitable for subsequent Ordinary Least Squares (OLS) regression:

$$LnT_{ij} = \alpha_0 + \alpha_1 \ln(Y_i) + \alpha_2 \ln(Y_j) + \alpha_3 \ln(D_{ij}) + \alpha_4 DV1 + \alpha_5 DV2 + \alpha_6 DV3 + \cdots + \varepsilon_{ij} \quad (1)$$

Where constant G becomes part of α_0 and DV 1, 2, 3… stands for different dummy variables aimed to describe quality factors, i.e., such determinants of bilateral trade as the common language, cultural similarity, shared colonial past, membership in trade blocs and alliances, etc. All these dummy variables aim to describe the ease or complexity of trading with a particular partner. Each additional dummy theoretically makes the model more dependable; however, it also makes it harder to interpret, as the results become increasingly complex with the addition of each variable. Dummy variables must be meaningful and distinct from one another, as is often the case with linguistic, language, and cultural variables.

Since the introduction of this model, the inclusion of the language factor as a dummy variable has been heavily criticized as an oversimplification. Several attempts have been made to improve the dummy variable by replacing the traditional language dummy variable with an index (Adserà & Pytliková, 2015) or a series of indicators (Melitz & Toubalm, 2014) to assess the relative cheapness or costliness of business communication in international trade.

Among the latest developments in the field of comparative linguistics is the calculation of values for relatedness (genetic or linguistic proximity) between 550 languages by Vincent Beaufils (eLinguistics). The index is measured from 0 (same language) to 100 (languages completely unrelated), and the results are proposed to be separated into the following groups:

Table 1. Linguistic (genetic) proximity values

Degree of Linguistic Proximity	The relation between languages	Description
0	Same language	Most of the population of the two countries speak the same language.
1-30	Highly related languages	Protolanguage (common "ancestor") between several centuries and approximately 2000 years.
30-50	Related languages	Protolanguage approx. between 2000 and 4000 years.
50-70	Remotely related languages	Protolanguage approx. between 4000 and 6000 years. Chance interference increases with values above 60-62.
70-78	Very remotely related languages	Protolanguage approx. older than 6,000 years - but with a high potential for interference due to chance resemblance.
78-100	No recognizable relationship	The few resemblances measured are more likely to be due to chance than to common origin.

Source: (eLinguistics)

This indicator allows for the easy perception of relatedness through simple quantification. It can be included alongside other similar indices as an independent variable in a gravity model of international trade. It was used by a group of researchers from the University of Florence to estimate the impact of linguistic proximity between Italian and other languages on exports (Maghssudipour, Bellandi, & Caloffi, 2022). There is also a question of the influence of language on different types of commodities, depending on the cost of localization into other languages. The assumption is that language will be more influential in the case of trade in technology-intensive products than in the trade of raw materials (Melitz, 2008). In this study, we analyze the impact of linguistic proximity on five different commodity groups separated by the technology intensity into: 1) Raw Material Intensive Goods (RMIG); 2) Labor-Intensive Goods (LIG); 3) Capital-Intensive Goods (CIG); 3) Easy-to-Imitate Research-Intensive Goods (EIRG); 4) Difficult-to-Imitate Research-Intensive Goods (DIRG). This technological classification was previously proposed and used by G. Erlat and H. Erlat (2008) and is described in the Appendix. We also added one more group of commodities that are Language Intensive Goods (LAG) and include: Printed books, newspapers, pictures etc. (Harmonized System (HS) code 49); Electrical, electronic equipment, including computer software and movies (HS 85); Toys, games, sports requisites, including videogames (HS 95).

The formula used for OLS regression is:

$$LnT_{ij} = \alpha_0 + \alpha_1 \ln(Y_{it}) + \alpha_2 \ln\left(Y_{jt}\right) + \alpha_3 \ln\left(D_{ij}\right) + \alpha_4 L_{ijt} + \varepsilon_{ijt} \quad (2)$$

Where T_{ij} – is the turnover of trade (sum of export and import) between country i and j (note that in this article *i* stands for China); t – is a year of data unitized in each example (from 2004 to 2018); Y_i, Y_j – is the Gross Domestic Product; D_{ij} – is the distance (in kilometers) between China and the specific trade partner (measured to the geographic center of the country); L_{ijt} – is the language (genetic) proximity (measured from 0 to 100); ε – is an error term.

DATA SOURCES

In this article, 198 countries, administrative regions, territories, and dependencies were analyzed over a timespan from 2004 to 2018 (later years were excluded to avoid the influence of the COVID-19 pandemic and the Russo-Ukrainian war). Data on GDP was obtained from the World Bank; the International Trade Centre provided data on trade in commodities; and data on languages and the number of speakers were obtained from the 26th edition of Ethnologue, the world's most comprehensive catalogue of languages. To analyze the results, we utilize the method developed by Dr. Selim Raihan at the Capacity Building Workshop on Introduction to Gravity Modelling (Raihan, 2016).

ANALYSIS OF RESULTS

According to research by Jacques Melitz, a language must share at least 4% of speakers in two countries to be considered statistically significant in measuring its influence on international trade. In 2014, Melitz identified 42 of such influential languages (24 official and/or common spoken languages shared by most of the population and 18 often spoken languages shared by at least 4% of the population) (Melitz & Toubal, 2014). Using the latest data provided by Ethnologue we were able to identify 83 influential languages, most important among them: English (38 countries with majority of population using English, 79 with English-speaking population of more than 4%); French (15 countries with majority of French speakers, 45 with more than 4%); Spanish (22/12); Arabic (15/10); Russian (10/14), and German (6/17). Chinese language is used only in the People's Republic of China (PRC) along with the special economic regions (SAR) of Hong Kong, Macao, and Taiwan as the language of the majority, and in Singapore (48.16% of population) and Malaysia (10.7%) as a language of a significant minority. Detailed analysis of linguistic proximity (see Figure 1) allowed to establish that only eight countries are very remotely or remotely related linguistically to Mandarin Chinese, specifically: 1) Lao People's Democratic Republic (Lao, linguistic proximity of 77.4 to Mandarin Chinese); 2) Albania (Albanian Tosk, 77.3); 3) Japan (Japanese, 76.8); 4) Myanmar (Burmese, 76.7); 5) Thailand (Thai, 75.5); 6) Ethiopia (Amrahic, 73.5); 7) Bhutan (Burmese, 76.7); 8) Malta (Maltese, 67.5). All other countries have no recognizable language relation with China, with an index variation ranging from 78 to 100.

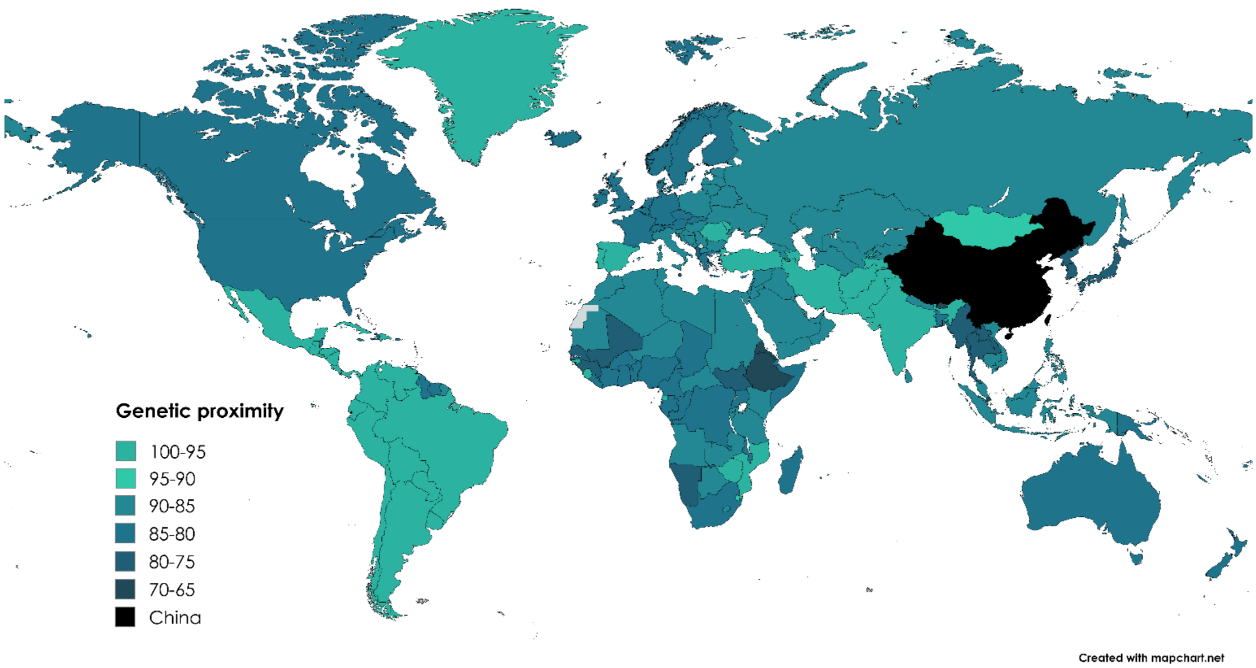


Figure 1 – Linguistic proximity to Mandarin Chinese

Source: eLinguistics, 2024; Author’s calculations

According to the analysis results, linguistic proximity (Table 2) hurts bilateral trade, affecting the total volume of trade and all seven analyzed commodity groups. This impact is significantly lower than that of geographic distance. However, this can be attributed to the fact that Mandarin Chinese has little linguistic proximity with the languages of China’s trade partners.

Thus, other things being equal, we find that the volume of trade between the two countries is higher when their official languages are more closely related. These results hold for all examined categories but yield a higher negative impact on trade on Difficult-to-Imitate Research-Intensive Goods (OLS coefficient of Linguistic Proximity is -0.022823) and Language-Intensive Goods (-0.023749), and the lowest impact on Raw Material Intensive Goods (-0.006134). This supports the hypothesis that language in international trade is a significant factor, depending on the type of good, and will be particularly influential when it comes to technology or information-intensive goods. In contrast, its impact on trade in raw materials will be negligible.

Table 2. Result of the estimation of the proposed gravity model

Commodity group	OLS coefficient				R-squared
	GDP_j	GDP_y	Distance	Linguistic proximity	
Total trade	0.989655	0.544403	-0.427958	-0.015686	0.817490
Raw Material Intensive Goods (RMIG)	0.969872	0.637793	-0.510962	-0.006134	0.643713
Labor-Intensive Goods (LIG)	1.025920	0.507340	-0.436706	-0.013953	0.784661
Capital-Intensive Goods (CIG)	0.985178	0.652205	-0.325885	-0.012530	0.782028
Easy-to-Imitate Research-Intensive Goods (EIRG)	1.228685	0.419558	-0.406718	-0.014639	0.825751
Difficult-to-Imitate Research-Intensive Goods (DIRG)	1.035416	0.605578	-0.473435	-0.022823	0.818857
Language Intensive Goods (LAG)	1.134301	0.594285	-0.512585	-0.023749	0.848447

Source: Author's calculations

CONCLUSION

This article examines the impact of the language factor (linguistic distance) on bilateral trade, utilizing a set of four indicators designed to depict the linguistic distance or proximity between China and its 198 partners (countries, territories, and dependencies, as listed in the International Trade Center's data). The goal of this study was to propose a new approach to measuring linguistic distance or proximity based on the linguistic (genetic) proximity index introduced by Vincent Beaufils.

To further address the research question, the enhanced gravity model was estimated using a panel dataset constructed from trade flows, GDP, and distance data from China and 198 source countries, spanning the period from 2001 to 2018. According to the gravity model estimation results, bilateral trade flows between China and its partners are influenced by the size of the economy (measured by GDP), as well as geographical and linguistic distance. Linguistic proximity has a significant negative impact on Research-Intensive Goods and Language-Intensive Goods, whereas its effect on Raw Material-Intensive Goods is negligible. This demonstrates that the methodology presented in this study for measuring linguistic distance is plausible and may be further examined in subsequent studies with other countries and languages.

REFERENCES

Adserà, A. and Pytliková, M. (2015), The Role of Language in Shaping International Migration. Econ J, 125: F49-F81. doi:10.1111/ecoj.12231

Amir Maghssudipour & Marco Bellandi & Annalisa Caloffi, 2023. "The role of language in international trade and the "made in Italy"," Economia e Politica Industriale: Journal of Industrial and

Business Economics, Springer; Associazione Amici di Economia e Politica Industriale, vol. 50(3), pages 677-702, September.

Chiswick, B., & Miller, P. (1994). Language Choice among Immigrants in a Multi-Lingual Destination. Journal of Population Economics, 7(2). – pp. 119-131.

Chiswick, B., & Miller, P. (2005). Linguistic Distance: A Quantitative Measure of the Distance Between English and Other Languages, Journal of Multilingual and Multicultural Development, 26:1. – pp. 1-11. doi: 10.1080/14790710508668395

Choi, E. Kwan (2002). "Trade and the adoption of a universal language," International Review of Economics & Finance, Elsevier, vol. 11(3). – pp. 265-275.

CIA Factbook - The World Factbook. Official website. Retrieved March, 2020, from https://www.cia.gov/library/publications/the-world-factbook/

Confucius Institute Headquarters (Hanban). Official web-site. Retrieved March, 2020, from http://english.hanban.org/

EF Education First. Official web-site. English Proficiency Index. Retrieved March, 2020, from http://www.ef.edu/epi/

Fasih, F. (2018). Language as a Driver of Migration and Trade using the Gravity Model: A Comparative Analysis. Reprosentralen, Universitetet i Oslo.

Ferro, M. J., & Ribeiro, S. (2016). The role of language in international trade: How does language affect the choice of foreign trading partners? In S. Neves de Jesus, & P. Pinto (Eds.), Proceedings of the International Congress on Interdisciplinarity in Social and Human Sciences. – pp. 608-621.

Gil, J. (2017) Soft Power and the Worldwide Promotion of Chinese Language Learning: The Confucius Institute Project. Multilingual Matters.

Hartig, F. (2016). Chinese Public diplomacy: The rise of the Confucius Institute. London: Routledge.

Hutchinson, William K., (2005). “Linguistic Distance” as a Determinant of Bilateral Trade, Southern Economic Journal, 72, issue.

International Trade Center. Official web-site. Retrieved March, 2020, from http://www.trademap.org

Isard, W. (May 1954). “Location Theory and Trade Theory: Short-Run Analysis”. Quarterly Journal of Economics. 68 (2). – pp. 305–320. doi: 10.2307/1884452

Isphording, I.E. and Otten, S. (2013). The Costs of Babylon. Review of International Economics, 21. – pp. 354-369. doi:10.1111/roie.12041

Lohmann, J. (2011). Do language barriers affect trade?, Economics Letters, 110, issue 2. – pp. 159-162.

Melitz, J (2008), “Language and foreign trade”, European Economic Review 52: 667-699.

Melitz, J (2018), “English as a lingua franca: Facts, benefits and costs”, The World Economy 41(7): 1750-1774.

Melitz, J and F Toubal (2014), “Native language, spoken language, translation and foreign trade”, Journal of International Economics 93: 351-363.

Poston, D. L., & Wong, J. H. (2016). The Chinese diaspora: The current distribution of the overseas Chinese population. Chinese Journal of Sociology, 2(3), 348–373. https://doi.org/10.1177/2057150X16655077

Raihan, R (2006). The OLS Estimation of a basic gravity model. ARTNeT-GIZ Workshop on Introduction to Gravity Modelling for Trade Policy Analysis. Ulaanbaatar, Mongolia. Retrieved March 19, 2020, from https://www.unescap.org/sites/default/files/Day1_S3_Gravity_estimation_applyingOLS_0.pdf

Tinbergen, J. (1962) “Shaping the World Economy: An Analysis of World Trade Flows,” New York Twentieth Century Fund, Vol. 5, No. 1. – pp. 27-30.

Weidenbaum. M.L. & Hughes. S. (1996). The bamboo network: How expatriate Chinese entrepreneurs are creating a new economic superpower in Asia. New York: Martin Kessler Books.

World Bank. Official web-site. Retrieved March, 2020, from http://www.worldbank.org.

APPENDIX

THE FIVE-WAY CLASSIFICATION OF COMMODITIES BY TECHNOLOGY INTENSITY

Raw Material Intensive Goods (RMIG)

SITC 0 Food and Live Animals

SITC 2 Crude Material, Inedible, Except Fuels (excluding 26)

SITC 3 Mineral Fuels, Lubricants and Related Materials (excluding 35)

SITC 4 Animal and Vegetable Oils, Fats and Waxes

SITC 56 Fertilizers (Other Than Those of Group 272)

Labor-Intensive Goods (LIG)

SITC 26 Textile Fibres (Other Than Wool Tops and Other Combed Wool) and Their Wastes (Not Manufactured Into Yarn or Fabric)

SITC 6 Manufactured Goods Classified Chiefly by Material (excluding 62, 67, 68)

SITC 8 Miscellaneous Manufactured Articles (excluding 88, 87)

Capital-Intensive Goods (CIG)

SITC 1 Beverages and Tobacco

SITC 35 Electric Current SITC 53 Dyeing, Tanning and Colouring Materials

SITC 55 Essential Oils and Resinoids and Perfume Materials; Toilet, Polishing and Cleansing Preparations

SITC 62 Rubber Manufactures, n.e.s.

SITC 67 Iron and Steel

SITC 68 Non-Ferrous Metals

SITC 78 Road Vehicles (Including Air-Cushion Vehicles)

Easy-to-Imitate Research-Intensive Goods (EIRG)

SITC 51 Organic Chemicals

SITC 52 Inorganic Chemicals

SITC 54 Medicinal and Pharmaceutical Products

SITC 58 Plastics in Non-Primary Forms

SITC 59 Chemical Materials and Products, n.e.s.

SITC 75 Office Machines and Automatic Data-Processing Machines

SITC 76 Telecommunications and Sound-Recording and Reproducing Apparatus and Equipment

Difficult-to-Imitate Research-Intensive Goods (DIRG)

SITC 57 Plastics in Primary Forms

SITC 7 Machinery and Transport Equipment (excluding 75, 76, 78)

SITC 87 Professional, Scientific and Controlling Instruments and Apparatus, n.e.s.

SITC 88 Photographic Apparatus, Equipment and Supplies and Optical Goods, n.e.s.; Watches and Clocks

Refugees, Amenities, and the Skill Premium

Elif Basaran‡

ABSTRACT

This paper examines how native migration and regional welfare respond to large immigrant inflows, focusing on Turkiye's substantial inflow of Syrian refugees after 2011. Using reduced form evidence, I show that refugee arrivals increased rents, altered local labor markets, and induced native outmigration, particularly among high skilled workers, amid deteriorating amenities. I develop a dynamic spatial general equilibrium model where amenities evolve endogenously and shape migration through estimated skill specific preferences. The model highlights amenity decline as a central driver of native flight and rising skill premiums, and shows how refugee reallocation and targeted subsidies can reduce regional inequality.

1 - INTRODUCTION

Global refugee flows have surged over the past decade, with an estimated 1.2% of the world's population now forcibly displaced. These large population movements pose complex economic challenges for host countries, influencing labor market dynamics, housing availability, and patterns of internal migration. While much of the existing literature has focused on wage and employment effects, a growing concern is the strain such inflows place on local amenities, which may deteriorate as a result of increased demand and limited fiscal capacity. In this context, native migration responses are shaped not only by labor market competition but also by changes in the quality of place-based amenities. Importantly, these responses are heterogeneous, as relocation patterns differ across skill groups, with high- and low-skilled natives facing distinct trade-offs in the presence of refugee inflows. Understanding how refugee inflows affect both local amenity provision and skill-specific migration decisions is therefore critical for evaluating the broader spatial and economic impacts of forced migration.

This paper examines the case of Turkiye, which experienced a large and rapid influx of Syrian refugees following the 2011 Syrian Civil War. Under an open-door policy, refugee numbers rose from roughly 10,000 in 2011 to 2.5 million by 2016 and nearly 4 million by 2021, with most settling in southeastern border provinces. As refugees arrived, high-skilled natives disproportionately migrated out of these regions, coinciding with a rising skill premium in those regions that they left. I document these patterns using administrative data from Turkish Statistical Institute (TurkStat) and examine the effects of the influx on local labor markets, housing rents, and native mobility. A central question becomes: What drives natives to avoid immigrant-concentrated areas? Understanding the drivers of high-skilled outmigration is crucial, as I will later provide evidence that this outmigration causes rising skill premiums and, in turn, growing inequality between different skill groups. Identifying the mechanisms behind native avoidance of refugee-concentrated areas would inform policy efforts to mitigate these disparities and promote more equitable regional outcomes of wages, rents, and amenities in Turkiye.

The Syrian refugee influx began in 2011 with Turkiye's open-door policy, which was later institutionalized through the temporary protection policy granting access to healthcare, education, and legal employment. At its peak, Turkiye hosted nearly 4 million Syrians, more than any other country. Most initially settled in southeastern provinces such as Sanliurfa, Gaziantep, Hatay, Kilis, and Mardin, where the government concentrated refugee camps and infrastructure. This pattern was not driven by formal mobility restrictions but by the economic infeasibility of moving to more distant provinces. While the immigrant mobility expanded over time, early settlement patterns shaped geographic concentration for years. These border regions became the frontline of the humanitarian response, facing substantial pressure on services, housing, and labor markets. Refugees, largely low-skilled, entered sectors like agriculture, construction, and textiles, often with limited legal protections. Although Turkiye's policy approach was initially praised, rising social tensions and economic pressures have fueled public debate over repatriation. Despite government programs to encourage

‡ †Pennsylvania State University, Department of Economics

return, most refugees remain due to safety risks in Syria, and the Southeast continues to be a focal point of humanitarian and policy challenges.

My paper builds most directly on the labor market literature, while also contributing new evidence on amenities. A large and growing body of research has examined the economic consequences of refugee inflows on labor markets, including Card (1990), Ruiz and Vargas-Silva (2015), Del Carpio and Wagner (2015), Akgunduz et al. (2015), Stave and Hillesund (2015), Ceritoglu et al. (2017), Borjas and (2020 (2017), Clemens and Hunt (2017), and Peri and Yasenov (2019). Additional work points to effects on firms by Akgunduz et al. (2018) and Altındag et al. (2020). There are also studies by Tumen (2018), and Rozo and Vargas (2020) focusing on education, as well as Ibanez et al. (2021) on health. In this paper, I construct an amenity index that encompasses not only education and health, but also environment, crime, and culture.

The housing market plays a central role in this paper, as existing housing supply constraints in Turkiye shape how regions adjust to refugee inflows. This is consistent with its broader importance as a key margin of adjustment in the migration literature. Saiz (2003) and Saiz (2007) show that immigration can raise local rents, an effect that persists even when natives are mobile Saiz and Wachter (2011). Housing supply constraints, highlighted by Gonzalez and Ortega (2013), are especially relevant for Turkiye, and Rozo and Sviatschi (2021) show that inelastic housing supply amplifies rent increases in refugee-hosting areas. I extend this literature by incorporating amenity deterioration alongside housing supply constraints, where the two jointly determine native migration responses.

My paper examines how refugee immigration affects native mobility and wages across different skill groups. In analyzing native mobility, it relates to studies such as Card (2001), Peri and Sparber (2011), Mocetti and Porello (2010), and Wozniak and Murray (2012). Regarding wage disparities, it connects to work by Bakens et al. (2012), and Ottaviano and Peri (2006). A further strand of the literature distinguishes impacts by native skill level, including Borjas (2003), Manacorda et al. (2012), Ottaviano and Peri (2012), and Caiumi and Peri (2024). While my paper aligns with this line of work by differentiating households by skill, it departs from prior studies that largely highlight complementarities between natives and immigrants. Much of this literature finds that immigration can generate positive outcomes when skill differences between groups are large. In contrast, the refugee inflow to Turkiye was predominantly low-skilled and concentrated in regions already populated by low-skilled natives, making this composition central to wage divergence between native skill groups.

Regional amenities constitute a central component of this paper's framework, as I model their evolution over time as a determinant of natives' reallocation decisions. Prior work, such as Roback (1982), shows that local wage differentials are largely explained by amenities, and Accetturo et al. (2014) demonstrate that amenities, even when treated as exogenous, shape location choices. Building on this, Diamond (2016) incorporates amenities into household utility and allows them to evolve endogenously with the skill composition of residents, thereby influencing location preferences across groups. Related studies such as Bayer et al. (2004), Bayer et al. (2007), Card et al. (2008), and Guerrieri et al. (2013) examine how regional amenities change in response to resident composition. The novelty of my paper is to allow for endogenous amenity evolution within a spatial general equilibrium framework, where amenity taste parameters differ by household type, capturing heterogeneous amenity preferences. This framework enables me to quantify how refugee-induced changes in amenities and labor markets jointly shape natives' dynamic migration decisions.

This paper introduces a novel dimension by examining all these effects discussed within a dynamic framework, where households make intertemporal migration decisions based on anticipated changes in wages, rents, and amenities. I develop a dynamic spatial general equilibrium model with regionally distinct labor markets. Households make forward-looking migration choices, following the framework of Caliendo et al. (2019), and I model skill-specific mobility patterns in line with Caliendo et al. (2023). As an extension to my baseline model, I incorporate a subsidy channel where amenities respond not only to the existing population but also to government transfers to regions, one source being increased tax revenues. My model also enables counterfactual exercises, such as refugee reallocation and targeted subsidies, to assess their potential to mitigate regional disparities and shifts in economic outcomes.

2 - THE MIGRANTS

In this section, I begin by documenting the spatial and temporal distribution of Syrian refugees. Then using individual-level microdata, I summarize the demographic characteristics of the migrants. Figure 1 below presents the cumulative number of Syrian refugees in Turkiye using data from the refugee survey by AFAD. The red line represents the number of refugees residing in the Southeast region, while the green line represents the total number for all of Turkiye. The figures, expressed in millions, reveal that approximately two-thirds of the Syrian refugee population has settled in the Southeast. In terms of refugee shares relative to the total population, by 2016, refugees accounted for 3% of Turkiye's total population and 11% of the Southeast. The Southeast region, shaded in dark blue on the map in Figure 2, is the area most affected by the refugee influx.

Figure 1. Influx of Syrian Refugees

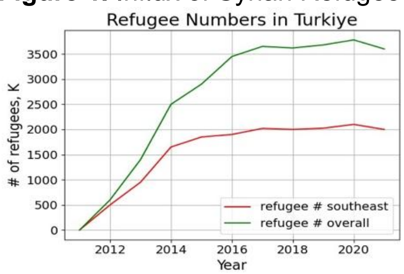


Figure 2. Map of Turkiye

According to the AFAD survey data, 91.6% of Syrian refugees had a high school degree or below, and only 8.4% held a university degree or higher. Due to this distribution of educational attainment, together with the existing language barriers, as Syrians speak Arabic rather than Turkish, I classify all refugees as low-skilled later in my model for analytical simplicity. Finally, it is important to note that, under Turkiye's temporary protection policy, refugees are permitted to obtain work authorization, therefore can enter the formal labor force as natives. However, an important distinction is that refugees face significantly higher internal migration costs within Turkiye once they enter the country. Therefore, as discussed in more detail in Section 4, my model assumes infinite migration costs for Syrians within Turkiye.

3 - PATTERNS OF TURKISH RESPONSES

3.1 - Effect of Refugee Influx on Annual Incomes

For the empirical analysis, I use an Income and Living Conditions Survey from the Turkish Statistical Institute (TurkStat), which is a representative repeated cross-sectional dataset spanning from 2006 to 2019. The data provide rich individual-level information, including demographic characteristics; economic indicators such as occupation and monthly income; and housing conditions such as rents, dwelling size, number of rooms, and heating systems

I begin by estimating the effect of the refugee influx on natives' annual incomes by using the following specification, where the unit of observation is a household *i* in region *r* at time *t*, and H_{irt} denotes household-level controls. The variable $syrian\_share_{rt}$ is computed by the total number of refugees in region r at time t, divided by the total population of region r at time t, for a total of 26 NUTS-2 (Nomenclature of Territorial Units for Statistics) regions:

$$ln\_income_{irt} = \beta_0 + \beta_1 syrian\_share_{rt} + \beta_2 H_{irt} + \lambda_t + v_r + \varepsilon_{rt}$$

Table 1 presents the coefficients for the variable $syrian\ share_{rt}$, controlling for $H_{irt} = \{age_{irt}, age\ squared_{irt}, household\ size_{irt}\}$, where age refers to the age of the household head. The first column reports the estimates for low-skilled natives and the second for high-skilled natives. The coefficient on the Syrian share variable is negative and statistically significant for low-skilled workers, indicating that an increase in the local refugee share is associated with a decline in their income. For high-skilled workers, the estimated coefficient is smaller in magnitude and statistically insignificant. These findings suggest that the refugee influx has had an adverse impact on the earnings of low-skilled natives, consistent with the findings of Card (2001) as well as theoretical expectations of increased competition in lower-wage labor markets.

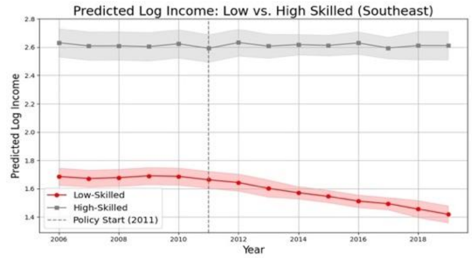
Figure 3. Income Plot

Table 1. Effect of Influx on Annual Incomes

	low-skill income	high-skill income
syrian share	-0.008***	-0.003
	(0.002)	(0.003)
Observations	86,296	18,872
R^2	0.135	0.186

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$



This result is also displayed in Figure 3, with a slight modification in the regression specification, where the variable of interest becomes $syrian\_share_{rt} \times 1_{\{year=t\}}$. Therefore, the plot presents a coefficient for each year both pre- and post-policy date of 2011, in order to display the trend across time.

3.2 - Effect of Refugee Influx on Rents in the Southeast (details in full paper)

$ln\ annualrent_{irt} = \beta_0 + \beta_1 syrian\ share_{rt} + \beta_2 H_{irt} + \beta_3 X_{rt} + \lambda_t + v_r + \varepsilon_{rt}$

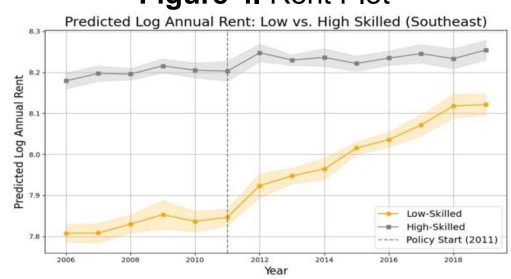
Table 2. Effect of Influx on House Rents

	ls owner	ls tenant	hs owner	hs tenant
syrian share	0.008***	0.011***	0.001	0.020**
	(0.001)	(0.003)	(0.008)	(0.010)
Observations	88,606	37,120	15,364	11,923
R^2	0.436	0.385	0.389	0.470

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure 4. Rent Plot



3.3 - Effect of Refugee Influx on High-Skilled Migration from the Southeast (details in full paper)

$ln\ \_flow_{ct} = \beta_0 + \beta_1 syrian\ share_{ct} + \beta_2 X_{ct} + \lambda_t + v_c + \varepsilon_{ct}$

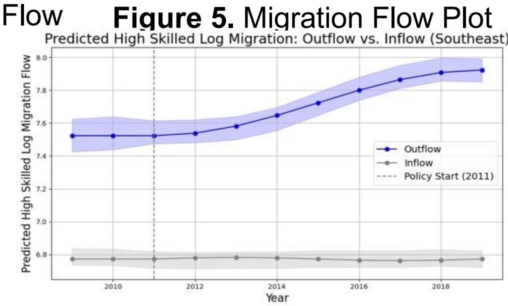
Table 3. Effect of Influx on High-Skilled Migration Flow

	ls inflow	ls outflow	hs inflow	hs outflow
syrian share	-0.004	0.002	0.636	1.040***
	(0.003)	(0.003)	(1.050)	(0.362)
Observations	121	121	137	137
R^2	0.956	0.932	0.378	0.663

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure 5. Migration Flow Plot



3.4 - Principal Component Analysis (PCA) for Amenities

Before presenting the reduced-form analysis of how the refugee influx affected local amenities, I describe how I construct regional amenity indices using Principal Component Analysis (available upon request).

3.5 - Effect of Refugee Influx on Amenities

After constructing the amenity index, I now examine the effect of the refugee influx on regional amenities. I use the amenity index as the dependent variable and Syrian refugee number as the main explanatory variable. However, a key endogeneity concern arises in this context. The refugees might systematically be selecting into regions with initially worse amenities due to those regions being more affordable. Also, they neither have enough knowledge nor easy access to these publicly provided goods before coming into Turkiye. Therefore, this could cause a bias for the estimates of the effect of refugee inflows on amenity outcomes. To address this concern, I construct the following specification:

$S_{rt} = (\frac{1}{T_r})^{\beta_1}(\pi_{r0} S_t)^{\beta_2}$.

Here, S_{rt} represents the predicted number of Syrians in region *r* at time *t*. Intuitively, this variable captures the idea that refugee inflows are more likely to be concentrated in regions closer to the Syrian border and those that had a larger initial share of refugees. Since the instrument depends only on geography and initial settlement patterns, it satisfies the exclusion restriction by being unrelated to current amenities, while remaining correlated with actual refugee shares. The idea behind π_0 being exogenous is that the government determined the initial locations of refugee camps, so refugees' own location preferences did not influence where they first settled. However, π_0 affects later settlements, as newly arriving refugees in subsequent years tend to locate near already-settled Syrians.

I estimate a two-stage least squares (2SLS) model. In the first stage, I regress the log of actual refugee numbers in a region on the log of inverse distance to the border and the log of the inital refugee share scaled by the total number of refugee population (Table 4). In the second stage, I use the predicted refugee number $\widehat{S_{rt}}$ to estimate the effect on the log of the regional amenity index (Table 5).

Table 4. Stage 1

$$ln(S_{rt}) = \beta_0 + \beta_1 ln\left(\frac{1}{T_r}\right) + \beta_2 ln(\pi_{r0} S_t) + \lambda_t + \nu_d$$

	ln_syrian_num
ln_dist_inv	0.081**
	(0.035)
ln_fracxsyrian_tot	0.952***
	(0.011)
Observations	442
R^2	0.998

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5. Stage 2

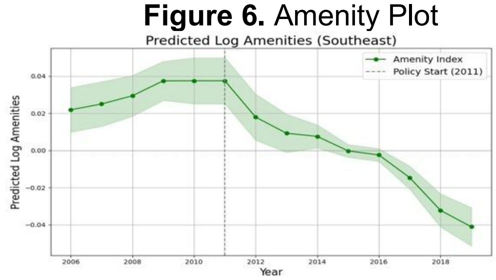
$$ln(b_{rt}) = \alpha_0 + \alpha_1 ln(\hat{S}_{rt}) + \lambda_t + \nu_d$$

	ln_amenity_endo_idx
ln_syrian_num_hat	-0.025***
	(0.006)
Observations	312
R^2	0.949

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure 6. Amenity Plot



The results from both stages are presented in Tables 7 and 8. The first-stage estimates confirm that refugee distribution is strongly predicted by distance to the border and the initial settlement pattern.

In the second stage, I find a statistically significant negative effect of refugee exposure on regional amenities. This suggests that refugee inflows are associated with a deterioration in non-tradable public goods, i.e. amenities.

Finally, in Figure 10, I again follow the structure I used for the three empirical findings I presented earlier, this time for amenities. In the plot below, we observe the predicted amenity index deteriorating over time post-policy, where the variable of interest is $syrian\_share_{rt} \times 1_{\{year=t\}}$.

4 - A DYNAMIC STRUCTURAL MODEL

Environment

I consider an economy composed of *N* distinct regions, indexed by *i* and *j*. Each region hosts a segmented labor market that separately accommodates three groups: high-skilled natives, low-skilled natives, and refugees. A continuum of firms operates competitively in each region, producing a final good using labor inputs. Firms employ a nested CES production technology, where substitution occurs first between low-skilled natives and refugees, and then between low-skilled and high-skilled workers. Following Eaton and Kortum (2002), productivity draws follow a Fr´echet distribution with dispersion parameter ψ.

Time proceeds in discrete intervals, denoted by $t = 0,1,2,...$. All households have perfect foresight, but only Turkish households migrate, choosing locations dynamically based on beginning-of-period labor supplies in each region and anticipated future migration patterns. Households face mobility frictions in the form of interregional moving costs and individual shocks that influence relocation choices. The household location choice problem shares structural features and underlying mechanisms with the framework developed in Caliendo et al. (2019). I begin by outlining the dynamic optimization problem households face when choosing where to locate, taking the evolution of real wages across space and time as given. Subsequently, I describe the static equilibrium that determines wages and prices in each region, conditional on local labor supply.

Consumer Preferences

At time t = 0, each region i is populated by a mass $L^i_{s,0}$ of households belonging to type s. Each household supplies one unit of labor inelastically and earns the prevailing competitive wage $w_{s,t}^i$. The per-period utility of a type s worker living in region i at time t is a function of three components: consumption of goods ($C_{s,t}^i$), housing services ($H_{s,t}^i$), and local amenities (b^i_t). The utility function takes the following form, where the parameter η_s captures the heterogeneity in households' preferences towards regional amenities.

$$U^i_{s,t} = \left(b^i_t\right)^{\eta_s} \left(\frac{C^i_{s,t}}{\lambda}\right)^{\lambda} \left(\frac{H^i_{s,t}}{1-\lambda}\right)^{1-\lambda}, \quad 0 < \lambda < 1, \; s = \{h, \ell, t\} \tag{1}$$

Building on Diamond (2016), I assume that the per capita local amenities in region i at time t decline with the presence of low-skilled workers (both natives and refugees) and improve with a larger share of high-skilled natives. Therefore, I model amenities as an endogenous outcome that depends on the ratio of high-skilled to low-skilled labor in each region. The elasticity of amenity supply is denoted by ϕ. I also refer to it as the congestion parameter in the model, as it captures how much the increase in refugees per region over time, i.e. the congestion, impacts amenities. Finally, ζ_t^i captures the exogenous component of the amenity level b^i_t.

$$b^i_t = \left(\frac{L^i_{h,t}}{L^i_{\ell,t} + L^i_{r,t}}\right)^{\phi} \cdot \zeta^i_t \tag{2}$$

The household's decision-making problem is dynamic. Households are forward-looking and discount future utility at a constant rate $\beta \geq 0$, and their migration choices involve spatial mobility costs.

Following standard assumptions in the literature, I assume that relocation costs $m^{i,j}_s \geq 0$ are additive, time-invariant, and vary by household type s as well as origin-destination pair (i,j); these costs are measured in utility terms. Each household also experiences an idiosyncratic preference shock $\varepsilon^j_{s,t}$ for each potential destination, introducing randomness into their location choices.

The sequence of household decisions unfolds as follows. At the start of each period, households observe prevailing economic conditions across all regions along with their own shock realizations. Those already residing in a region participate in the local labor market and earn the corresponding wage. An important thing is to note that, in the model, only the natives may relocate across regions, while refugees are assumed to remain in their initial location after arriving from Syria. This reflects Turkiye's temporary protection policy, which provides very limited internal mobility for Syrians. To move, a refugee must secure a job offer in another region, file a formal request, and wait for official approval, which is a process that is both bureaucratically and financially burdensome. The lack of funds further constrains their mobility, so refugees do not make dynamic migration decisions in the model and instead choose only their goods and housing consumption within the region where they reside. This is implemented by assigning them infinite migration costs ($m^{i,j}_r = \infty$).

Formally, the value function for a type s worker residing in location i at time t reflects their earnings, utility, and expectations over future outcomes, while incorporating the migration costs $m^{i,j}_s$, the idiosyncratic preference shocks $\varepsilon^j_{s,t}$, the dispersion parameter v, and the discount factor β.

$$v^i_{s,t} = log(U^i_{s,t}) + max_{j=\{1,\ldots,N\}} \left\{ \beta E[v^j_{s,t+1}] - m^{i,j}_s + \nu \varepsilon^j_{s,t} \right\} \tag{3}$$

In this expression, $v_{s,t}^i$ represents the expected lifetime utility of a type s household residing in region i at time t, where the expectation is taken over future realizations of the idiosyncratic shock. The parameter v scales the variance of the idiosyncratic shocks. Households evaluate their current utility and consider all possible destinations, ultimately choosing the location that maximizes their expected future utility net of migration costs and random taste shocks.

To simplify aggregation across heterogeneous households, I assume that the idiosyncratic preference shocks ε are independently and identically distributed over time and follow a Type I Extreme Value distribution with zero mean. This structure enables closed-form expressions for expected values, facilitating tractable computation of household location decisions.

I let $V_{s,t}^{i} = E[v_{s,t}^{i}]$ denote the expected lifetime utility of a representative type s household currently residing in region i, where the expectation is taken over the preference shocks. Under this assumption, the expected utility satisfies the following expression:

$$V_{s,t}^{i} = log(U_{s,t}^{i}) + \nu log\left(\sum_{j=1}^{N} exp\left(\beta V_{s,t+1}^{j} - m_{s}^{i,j}\right)^{\frac{1}{\nu}}\right), \quad i,j = \{1,...,N\} \qquad (4)$$

Equation (4) captures the idea that the value of living in a given region reflects both current-period utility and the expected gains from relocating in the future, i.e. the option value of migrating to another region in the next period. The term $V^{i}_{s,t}$ is interpreted either as the expected lifetime utility before the realization of the preference shocks or as the average utility level across type-s households in region i.

Under the assumption that idiosyncratic shocks follow an i.i.d. T1EV distribution, we can derive a closed-form analytical expression for migration flows between regions. Let $\mu^{i,j}_{s,t}$ denote the fraction of type s households relocating from region i to j, where the case $i = j$ represents those who choose to stay. Then, following standard derivations in the literature, the migration share is given by:

$$\mu_{s,t}^{i,j} = \frac{exp\left(\beta V_{s,t+1}^{j} - m_{s}^{i,j}\right)^{\frac{1}{\nu}}}{\sum_{k=1}^{N} exp\left(\beta V_{s,t+1}^{j} - m_{s}^{i,j}\right)^{\frac{1}{\nu}}}, \quad s = \{h, \ell\},\ i,j = \{1,...,N\} \qquad (5)$$

The expression in equation (5) reflects the intuitive result that regions offering higher expected utility, net of migration costs, will attract a larger share of movers. The parameter $1/\nu$ captures the responsiveness of migration flows to differences in expected value across destinations, effectively serving as migration elasticity. As noted earlier, the refugees are assumed to face prohibitively high migration costs within Turkiye ($m^{i,j}_{r} = \infty$), making their migration shares undefined under this formulation. Therefore, I accordingly set $\mu^{i,j}_{r,t} = 0$ for all $i \neq j$.

Equation (5) plays a central role in the model, as it fully determines how the spatial distribution of labor evolves over time. Specifically, the law of motion for labor of type s in region i is given by:

$$L_{s,t+1}^{i} = \sum_{j=1}^{N} \mu_{s,t}^{j,i} L_{s,t}^{j}, \quad s = \{h, \ell\},\ i,j = \{1,...,N\} \qquad (6)$$

This equilibrium condition describes how native high- and low-skilled workers are reallocated across regions over time. In contrast, the distribution of refugee labor is treated as exogenous and does not evolve through the migration mechanism outlined above. Given the timing structure of the model, the labor supply in each region at time t is entirely determined by relocation decisions made in the previous period. With labor supply in hand, we now turn to the static side of the model and introduce the production environment that determines equilibrium wages through labor market clearing at each point in time.

Production

Output in region i at time t is generated using high-skilled native labor ($L^{i}_{h,t}$), low-skilled native labor ($L^{i}_{\ell,t}$), and refugee labor ($L^{i}_{r,t}$), according to a Nested Constant Elasticity of Substitution (CES) production function.
(Details available upon request.)

5 - RESULTS

5.1 - Baseline

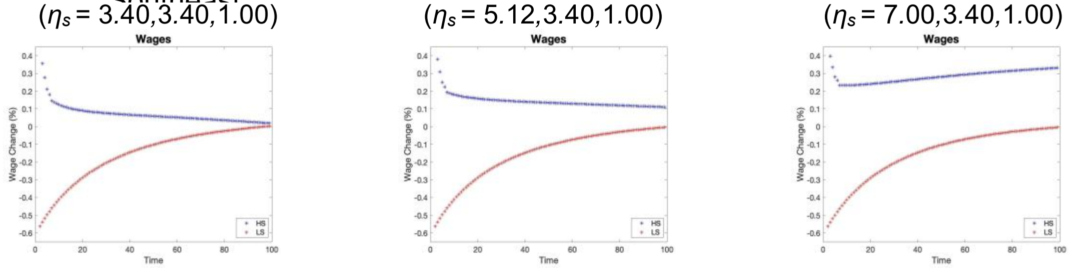
The model yields reduction in low-skilled natives' incomes under all amenity taste parameter specifications presented below. This finding of the model aligns with the earlier reduced form findings. Regarding the high-skilled, a rise in incomes is observed. However, it is lower in magnitude compared to the decrease in incomes of low-skilled. The figures below display time in years as the horizontal axis and the wage effects (%) as the vertical axis. My model simulations are set to t = 100, i.e. 100 years, assuming infinitely lived households. The wage effects (%) are measured via using the value of the economic outcome *y*, with the shock of the refugee influx (*yRefShock*) and without the shock (*yNoShock*). Therefore, the y-axis variable *yDiff* follows:

$$yDiff = \frac{yRefShock - yNoShock}{yNoShock} \cdot 100\%.$$

Below, the observed outcome *y* refers to wages for high-skilled natives shown by the blue line, and wages for low-skilled natives shown by the red line. These values are averages across the Southeast region. The sudden initial negative change in low-skilled wages in all scenarios slowly disappear as the change (%) goes back to zero in the long-run. However, the smaller sized sudden change, i.e. an increase, for high-skilled wages does not go back to zero even in the long run, which can be seen on the middle and rightmost plots of Figure 7. When high-skilled households value amenities more than the low-skilled ($\eta_h = 5.12 > \eta_\ell = 3.40$, and $\eta_h = 7.00 > \eta_\ell = 3.40$), the high-skilled natives observe a permanent increase in their wages in the long-run, causing increased inequality between different skill groups.

Figure 7. Effect of Refugees on Natives' Wage Evolution in the Southeast

($\eta_s = 3.40, 3.40, 1.00$) ($\eta_s = 5.12, 3.40, 1.00$) ($\eta_s = 7.00, 3.40, 1.00$)



Although the production function allows for substitution between high- and low-skilled labor ($\rho = 0.75$), the degree of substitutability is limited. Moreover, amenity deterioration drives highskilled outmigration, reducing their local supply and raising their marginal productivity. This general equilibrium effect outweighs the weak substitution pressure, resulting in an increase in high-skilled wages in refugee-concentrated regions.

The non-monotonic pattern in high-skilled wages arises from general equilibrium adjustments in response to refugee-induced shocks. Initially, deteriorating amenities trigger high-skilled out-migration from the Southeast, shrinking the local high-skilled labor supply and raising wages. Over time, as the labor market rebalances and amenities partially recover due to lower congestion, the wage gains diminish, generating a non-monotonic adjustment path.

The baseline value $\eta_h = 5.12$ is estimated from the data using nonlinear least squares based on observed out-migration patterns. I use $\eta_h = 3.40$ as a lower bound, matching the estimated value for low-skilled households (leftmost plot), and $\eta_h = 7.00$ as an upper bound to test a scenario where high-skilled natives are even more responsive to amenity deterioration (rightmost plot). These alternative values help assess the robustness of the model's implications under varying degrees of amenity sensitivity. The leftmost plot of Figure 11 shows that the income gap created in the short run closes in the long run if the worker types were to have identical preferences in terms of their amenity tastes. However, as mentioned earlier, the other two figures show that this the gap remains even in the long-run, under differentiated taste parameters. The gap widens with higher taste parameters for high-skilled labor. The larger the η_h, the sharper the utility decline of high-skilled workers, even with small amenity deteriorations. This leads to more aggressive out-migration of the high-skilled and thus greater income disparity between the two skill groups who stay in the Southeast.

5.2 - Counterfactual: Reallocation of Refugees into Regions

(Available upon request)

6 - EXTENSION: TAX REVENUES

(Available upon request)

7 - CONCLUSION

Over the past decade, the skill wage premium in Turkiye, specifically in the Southeast, has shown a significant upward trend. This paper investigates one of the underlying drivers of this trend by linking it to the Syrian refugee influx that began after 2011. The analysis shows that the widening wage gap between high- and low-skilled workers in the Southeast can be attributed in large part to the outmigration of high-skilled natives from that region. The central question addressed is why native workers tend to relocate away from areas with high refugee concentrations.

The model presented identifies two key mechanisms behind this native outflow. The first is a congestion channel, captured in the baseline model, where increased population pressure reduces the quality of amenities. The second is a fiscal channel, introduced in the extension, where the arrival of non-taxpaying refugees reduces per capita public spending and further deteriorates local amenities.

The key finding is that concentrating refugee inflows in the Southeast exacerbates congestion, which in turn deteriorates local amenities and intensifies native outmigration. This congestion effect drives up the skill wage premium as high-skilled workers leave and low-skilled workers remain. I examine various counterfactual policy scenarios that alleviate this dynamic (available in the full paper). These counterfactuals demonstrate that wage inequality in the Southeast can be significantly mitigated through either redistribution of refugee settlement or enhanced fiscal support.

These findings underscore the importance of designing more balanced and inclusive refugee policies, where inclusiveness entails either a more equitable geographic distribution of refugees across regions or enhanced fiscal support for shared amenities. In the case of Turkiye, where refugees were initially settled in one of the country's most underdeveloped regions, the economic consequences have been more severe. Policies that either distribute refugee populations more evenly or provide sufficient financial support to high-intake regions can allow the country to meet its humanitarian obligations without undermining its existing economic structure.

Future research could also extend this analysis by incorporating additional shocks such as the COVID-19 pandemic, the 2023 earthquake that caused the death of approximately 50,000 people in the Southeast, and the fall of the Assad regime in 2025, which could lead to refugee repatriation. Integrating these shocks into the model and evaluating their separate effects would offer important insights for designing proactive and context-sensitive refugee policies in Turkiye and other developing countries with comparable institutional and infrastructural settings.

ENDNOTES

[*] I am indebted to my advisor, James Tybout, and my committee members, Bradley Setzler and Ewout Verriest, for their invaluable advice, guidance, and encouragement. I am also grateful to Jonathan Eaton, Fernando Parro, Kala Krishna, Jingting Fan, Stephen Yeaple, Ruilin Zhou, Kai-Jie Wu, Maria Jose Carreras, and Omer Koru for generously sharing their time and insights during the development of my research and for their mentorship. I further thank all the seminar and brownbag participants at Penn State for their constructive comments on my work. Lastly, I thank my classmates, friends, and family for their continued care and support. All errors are mine.

[*] AFAD: Disaster and Emergency Management Authority of Turkiye

[*] Full tables for incomes, rents, migration, and amenities are in Appendix (available upon request).

[*] We do observe Syrian refugee migration to other regions of Turkiye, after they arrive at Southeast, only in more recent years. However, for the time frame of my study, it is plausible to assume no further migration of refugees within Turkiye after they settle into the Southeast.

[*] The taste parameter for refugees is set to $\eta_r = 1.00$ in all specifications, as their amenity preferences affect only their current-period utility and do not influence relocation, due to them facing large migration costs ($m^{i,j}_r = \infty$).

REFERENCES

Accetturo, A., Manaresi, F., Mocetti, S., and Olivieri, E. (2014). Don't Stand so Close to Me: The Urban Impact of Immigration. *Regional Science and Urban Economics*, 45:45–56.

Akgunduz, Y., Berg, M., and Hassink, W. (2018). The Impact of the Syrian Refugee Crisis on Firm Entry and Performance in Turkey. *World Bank Economic Review*, 32:19–40.

Akgunduz, Y. E., van den Berg, M., and Hassink, W. (2015). The Impact of Refugee Crises on Host Labor Markets: The Case of the Syrian Refugee Crisis in Turkey. IZA Discussion Papers 8841, Institute of Labor Economics (IZA).

Altındag, O., Bakıs, O., and Rozo, S. V. (2020). Blessing or Burden? Impacts of Refugees on Businesses and the Informal Economy. *Journal of Development Economics*, 146:102490.

Bakens, J., Mulder, P., and Nijkamp, P. (2012). Economic Impacts of Cultural Diversity in the Netherlands: Productivity, Utility, and Sorting. Tinbergen Institute Discussion Papers 12-024/3, Tinbergen Institute.

Bayer, P., Ferreira, F., and McMillan, R. (2007). A Unified Framework for Measuring Preferences for Schools and Neighborhoods. *Journal of Political Economy*, 115(4):588–638.

Bayer, P., McMillan, R., and Rueben, K. (2004). An Equilibrium Model of Sorting in an Urban Housing Market. NBER Working Papers 10865, National Bureau of Economic Research, Inc.

Borjas, G. J. (2003). The Labor Demand Curve is Downward Sloping: Reexamining the Impact of Immigration on the Labor Market. *The Quarterly Journal of Economics*, 118(4):1335–1374.

Borjas, G. J. and Monras, J. (2017). The Labour Market Consequences of Refugee Supply Shocks. *Economic Policy*, 32(91):361–413.

Caiumi, A. and Peri, G. (2024). Immigration's Effect on US Wages and Employment Redux. NBER Working Papers 32389, National Bureau of Economic Research, Inc.

Caliendo, L., Dvorkin, M., and Parro, F. (2019). Trade and Labor Market Dynamics: General Equilibrium Analysis of the China Trade Shock. *Econometrica*, 87(3):741–835.

Caliendo, L., Opromolla, L. D., Parro, F., and Sforza, A. (2023). Labor Supply Shocks and Capital Accumulation: The Short- and Long-Run Effects of the Refugee Crisis in Europe. *AEA Papers and Proceedings*, 113:577–84.

Caliendo, L., Parro, F., Opromolla, L., and Sforza, A. (2021). Goods and Factor Market Integration: A Quantitative Assessment of the EU Enlargement. *Journal of Political Economy*, 129(12):3491–3545.

Card, D. (1990). The Impact of the Mariel Boatlift on the Miami Labor Market. *ILR Review*, 43(2):245–257.

Card, D. (2001). Immigrant Inflows, Native Outflows, and the Local Labor Market Impacts of Higher Immigration. *Journal of Labor Economics*, 19(1):22–64.

Card, D., Mas, A., and Rothstein, J. (2008). Tipping and the Dynamics of Segregation. *The Quarterly Journal of Economics*, 123(1):177–218.

Ceritoglu, E., Yunculer, H. B. G., Torun, H., and Tumen, S. (2017). The Impact of Syrian Refugees on Natives' Labor Market Outcomes in Turkey: Evidence from a Quasi-Experimental Design. *IZA Journal of Labor Policy*, 6(1):1–28.

Clemens, M. and Hunt, J. (2017). The Labor Market Effects of Refugee Waves: Reconciling Conflicting Results. Working Papers 455, Center for Global Development.

Del Carpio, X. V. and Wagner, M. C. (2015). The impact of Syrian refugees on the Turkish Labor Market. Policy Research Working Paper Series 7402, The World Bank.

Diamond, R. (2016). The Determinants and Welfare Implications of US Workers' Diverging Location Choices by Skill: 1980-2000. *American Economic Review*, 106(3):479–524.

Eaton, J. and Kortum, S. (2002). Technology, Geography, and Trade. *Econometrica*, 70(5):1741–1779.

Gonzalez, L. and Ortega, F. (2013). Immigration and Housing Booms: Evidence from Spain. *Journal of Regional Science*, 53(1):37–59.

Guerrieri, V., Hartley, D., and Hurst, E. (2013). Endogenous Gentrification and Housing Price Dynamics. *Journal of Public Economics*, 100:45–60.

Ibanez, A. M., Rozo, S. V., and Urbina, M. J. (2021). Forced Migration and the Spread of Infectious Diseases. *Journal of Health Economics*, 79:102491.

Manacorda, M., Manning, A., and Wadsworth, J. (2012). The Impact Of Immigration On The Structure Of Wages: Theory And Evidence From Britain. *Journal of the European Economic Association*, 10(1):120–151.

Mocetti, S. and Porello, C. (2010). How Does Immigration Affect Native Internal Mobility? New Evidence from Italy. *Regional Science and Urban Economics*, 40(6):427–439.

Ottaviano, G. I. and Peri, G. (2006). Rethinking the Gains from Immigration: Theory and Evidence from the U.S. Knowledge, Technology, Human Capital Working Papers 12073, Fondazione Eni Enrico Mattei (FEEM).

Ottaviano, G. I. P. and Peri, G. (2012). Rethinking the Effect of Immigration on Wages. *Journal of the European Economic Association*, 10(1):152–197.

Peri, G. and Sparber, C. (2011). Highly Educated Immigrants and Native Occupational Choice. *Industrial Relations: A Journal of Economy and Society*, 50(3):385–411.

Peri, G. and Yasenov, V. (2019). The Labor Market Effects of a Refugee Wave: Synthetic Control Method Meets the Mariel Boatlift. *Journal of Human Resources*, 54(2):267–309.

Roback, J. (1982). Wages, Rents, and the Quality of Life. *Journal of Political Economy*, 90(6):1257–1278.

Rozo, S. and Vargas, J. F. (2020). The Effect of Venezuelan Migration on Educational Outcomes in Colombia.

Rozo, S. V. and Sviatschi, M. (2021). Is a Refugee Crisis a Housing Crisis? Only if Housing Supply is Unresponsive. *Journal of Development Economics*, 148:102563.

Ruiz, I. and Vargas-Silva, C. (2015). The Labor Market Impacts of Forced Migration. *American Economic Review*, 105(5):581–86.

Saiz, A. (2003). Room in the Kitchen for the Melting Pot: Immigration and Rental Prices. *The Review of Economics and Statistics*, 85(3):502–521.

Saiz, A. (2007). Immigration and Housing Rents in American Cities. *Journal of Urban Economics*, 61(2):345–371.

Saiz, A. and Wachter, S. (2011). Immigration and the Neighborhood. *American Economic Journal: Economic Policy*, 3(2):169–88.

Stave, S. E. and Hillesund, S. (2015). Impact of Syrian Refugees on the Jordanian Labour Market. Report Fafo-report 2015:16, International Labour Organization, Geneva. Also published by Fafo Institute for Applied International Studies, Norway.

Tumen, S. (2018). The Impact of Low-Skill Refugees on Youth Education. HiCN Working Papers 283, Households in Conflict Network.

Wozniak, A. and Murray, T. J. (2012). Timing is Everything: Short-Run Population Impacts of Immigration in US Cities. *Journal of Urban Economics*, 72(1):60–78.