A Barrier for Progress

An interdisciplinary analysis of Mexican migration

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A Barrier for Progress

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CONTENTS

A BARRIER FOR PROGRESS.....I

FOREWORD 3

INTRODUCTION..... 5

CHAPTER 1 HISTORY OF MIGRATION 13

CHAPTER 2 ECONOMICAL ANALYSIS 31

CHAPTER 3 BUILDING A MODEL..... 51

CHAPTER 4 INTEGRATING INSIGHTS 79

DISCUSSION..... 93

BIBLIOGRAPHY..... 97

APPENDIX A FACTOR TABLES.....101

Foreword

"Every part must open with a quote."
—Thom Smetsers

AT THE ONSET OF THIS PROJECT WE WERE excited about the ridiculous idea of a physical wall being built on the United States-Mexican border. How did Trump think this would solve the problems forthflowing from migration? And how would such a wall be realised in the first place? We noticed that we were in the grasp of a common case of 'What if...?' and decided to pursue this idea as our research topic.

Along the way, we learnt not only how migration is influenced by factors of various natures, but also how our three disciplines have different methodologies and expertise. We discovered our mutual dispositions towards certain data, our wildly

varied assumptions, and noticed everyone involved had brought his own share to the table. This work is a result of not just some gathered insights, but an integration of collected theories, evidence and methods. We did our best not to put up a wall around the topic, but openly state the facts as we've discovered them.

We would like to thank our disciplinary supervisors E. Swart (history), J. Swart (economics) and F. Dignum (artificial intelligence) for their literary suggestions and support.

We must also include our personal project supervisor M. van Goch in this list for her overseeing our progress and insightful remarks.

* * *

After an extensive research on the feasibility and effects of Trump's wall, we can personally confirm some things are not as simple as they initially seem. But you'll discover that for yourself.

Happy reading,

Jelmer, Thom and Wessel.

INTRODUCTION

"I will build a great wall – and nobody builds walls better than me, believe me – and I'll build them very inexpensively. I will build a great, great wall on our southern border, and I will make Mexico pay for that wall. Mark my words."
—Donald Trump

THE MIGRATION FLOWS FROM MEXICO TO THE United States have been a frequently discussed topic and due to presidential candidate Donald Trump and his controversial statements, it's back in the spotlight. One of his latest ideas, a wall on the border, is his solution to the migration flow and the problems it encompasses. But this solution only takes the accessibility to the U.S. into account. Is this a realistic assumption, or are there more factors at play? What brings Mexicans to pack

their belongings and migrate to the land that Trump will "make great again"?

Trump published his positions, amongst which a piece called 'Pay for the wall'. He compels Mexico to pay for a wall that costs around $5-10 billion, along with intensified border control and trade restrictions. Trump seems to think that migration is a matter of sentiment in the United States. Common stories involve Mexicans profiting from the U.S. economy and sending remittances back to their families, taking jobs from under ordinary American noses along the way. The fact is that Mexico has inherent problems as a country by depending on the United States for remittances (World Bank, 2016). Gaining insight in the current situation allows us to form theories on the underlying principles of migration flow. With these theories and factors we can start to predict the effects of different factors changing migration and we can consider the wall's influence on migrationary patterns.

We discuss the formation of the flow and discover the hidden mechanics behind migration. These factors are used to evaluate and form theories of migration, which results in a model that is able to simulate migration flows. Our research is focussed on the Mexican perspective, thus we ask:

What will the impact on Mexican migration be when a wall is introduced at the Mexico-United States border?

By answering this question, we show the significance and application of theories of migration. The resulting model and interpretations can be used for further research or policy-making. Not only do we get to understand the predictability of migration flows, but we will also identify universal properties of migration decisions.

The proposed strategy for researching this topic is not straightforward, as the posed question can't be answered by a single discipline. We will have to apply more fields of study to address the inquiry. Repko (2012) describes an interdisciplinary research framework that is suited for this kind of problem. We will follow the steps prescribed by this framework, starting with a justification for this interdisciplinary approach. The next step is to analyse the problem from a disciplinary perspective.

We slightly deviate from Repko's plan here by starting the integrative phase prematurely, because our disciplines need each other's support in the form of theories and datasets to create a coherent report. In this way, our research can be said to be inherently integrative. We continuously build on previous knowledge throughout the disciplinary chapters until we naturally reach the peak of the integrative phase in our more comprehensive understanding. Here, we combine our gained insight into a more complete view on the migration flow between Mexico and the United States and attempt to formulate an answer to the research question.

The need for an interdisciplinary approach becomes clear after a close look at Trump's statement. Trump reduces the system of migration to a simple answer ("just build a wall"). We are not as daring. We see migration as a complex system with many factors, fine-tunings and interactions. Previous studies showed that there are socio-cultural factors that play a role in the Mexican migration flow which can be researched from a historical perspective, but that there are economical factors as well (de Haas, 2010). Seeing the system as a random process with emergent behaviour also doesn't give complete insight. The unsolved problem of migration is not about just economical reasons, or just cultural reasons, and can therefore not be wholly understood by only one discipline. The need for an interdisciplinary approach is apparent, which brings us to our choice of disciplines.

* * *

The study of history can provide us the socio-cultural background and a theoretical network of migration. Ever since the Declaration of Independence the United States has struggled with global migration flows. Many immigration acts have restricted or re-enforced the inflow of Mexican migrants in the past. While Trump's idea of a wall is a new concept, the motives and ideas it represents are a

recurring theme in America's history. By exploring economic and political events from the past that helped shape the current migration flows can provide new understandings about the impact of a new immigration policy like the hypothetical wall of Trump.

If one should formulate the purpose of history, it is aiming to highlight all the perspectives on a certain historic event or development. History has always been written by the victors, and it's the historian's duty to not follow that history, but to also take into the account the perspectives of the underdog. In the case of our thesis, the focus shouldn't be too much on that of America. Certainly, one could approach the issue from America's perspective by addressing the issue of America's identity and the question of what gives an American his identity with the increasing hispanicisation in the southern states of the U.S., but we choose to approach it from the perspective of Mexico. By exploring Mexico's history and analyzing different secondary sources we managed to develop a more comprehensive understanding of the true causes of Mexican migration to the U.S..

Evaluating the economic theories behind migration gives a clear perspective on the causes and reasons why people leave their homes and try to enhance opportunities in a more challenging environment. No single theory is extended enough to fully comprehend all the aspects of the force of migration and what is

clear from the start is that not all the theories discussed by economists end at the border of the discipline of economics. These theories also pass that border and enter in the domain of the social studies. We evaluate and discuss these theories and afterwards distill some factors from these perspectives that will suit our purpose and will explain migration from the perspective of the economist. These causes will most of all be long term in time frame in contradiction with the short term time-frame and sudden shiftings of the historical trends.

What is more, the economist is also able to measure these variables and to attach a strength to the factors in correlation with the trend of migration. These variables explain the national changes per year and are therefore not directed at the individual rational actor. Instead, it takes, by case of an example, the average income of Mexicans into regard and shows the effect this has on migration. What happens to migration to the United States when the average income increases? After examining the data a linear model is proposed and this model has to be tested to some criteria before the hypothesis can be further explored.

From an artificial intelligence perspective, discovering the underlying principles of making migration decisions can be seen as an experiment. There are several groups that each represent a population of potential migrants. Every group can be considered as

an imaginative country where all of the inhabitants are influenced to either travel or stay home. You control these factors and analyse the resulting migrations. A physical limitation of this kind of experiment is that migration often involves large numbers of people. Imagine that you have to monitor all Mexicans and take note of their travels, not just once, but multiple times. In the other iterations of the experiment, you need to change the influence of the factors by limiting access to knowledge about them (your imaginative country has no television to see what American cities are like) or by informing the participants more, or by eliminating any differences (all participants could have an equal salary).

This proposal should sound absurd and unfeasible, yet the data we could gather from such experiments is appealing. Precisely these kinds of experiments are suited for virtual implementations. A large group of people is represented and stored in merely some bytes. It could be argued that these virtual agents are not conscious, or otherwise similar to humans or something we would ascribe moral rules to, thus it is probably not immoral to micromanage the agents as it would be for real people. Instead of having to convince a government, radically different legislations can be instantiated by a mouseclick. What is not possible to conduct in real life, can be simulated in virtual worlds.

The chapter on artificial intelligence explains how to turn data into a simulation from which causal factors can be extracted.

We will use Mexican and American population data to build an agents-based model to mimic the current scenario. A statistical analysis of this model will prove its usefulness as a predictive system.

After understanding the current migration flow, we use the model to simulate the wall-scenario, which is interpreted with the integrated insights we gained. Be aware that our available disciplines, time and expertise are limited and clearly insufficient to solve the problem as a whole. Increasing these resources will lead to significantly greater insight. As an exploratory research with the unique combination of three disciplines, however, the results will prove fascinating and might arouse interest in comparable research techniques.

* * *

Now that we have laid the foundation we can, disciplinary brick by disciplinary brick, start building towards a wall.

CHAPTER 1
History of Migration

written from the perspective of history

by Wessel Verkerk

"All you had to do coming from Mexico, if you were a Mexican citizen, was to report at the immigration office on the American side [and] give your name, the place of your birth, and where you were going to."

—Cleafas Calleros

THE WORDS FROM THE MEXICAN IMMIGRANT Cleofas Calleros show how easy it was for Mexicans in the early twentieth century to enter the United States (Takaki, 2008). The migrants only had to cross the Rio Grande and they were in the land of opportunity, free to determine their own future.

However, the ease with which the border could be crossed changed over the course of the twentieth century and is still changing now. Numerous economic and political events have both promoted and limited Mexican migration to the U.S. This chapter covers the history of the Mexican migration to the U.S. and digs into the context in which the migration came into being and the underlying factors that contributed to the Mexican migration to the U.S.. 1876 is taken as a starting point, marking the beginning of the reign of Porfirio Díaz and the first investments of the U.S. in the Mexican rail system.

These events mark the beginning of the imperialist attitude that the U.S. took against Mexico (Fernandez & González, 2002). The imperialist attitude of the U.S. against Mexico is part of a theory mentioned by Gilberto G. González and Rául Fernandez, both members of the department of Chicano/Latino Studies, School of Social Sciences, at the University of California in their article Empire and the Origins of Twentieth-Century Migration from Mexico to the United States (Fernandez & González, 2002). According to this theory, the multiple factors that caused the Mexican migration to the U.S. are all generated by American imperialism, the overarching factor for the Mexican migration (Fernandez & González, 2002). This theory is applied in this chapter in the study of the history of the Mexican migration to the U.S.

Studying the history of Mexican migration to the U.S. can supply helpful insights in the problem of the Mexican migration flow. By exploring the underlying factors for the Mexican migration flow one can determine the real problem and figure out if the implementation of a wall on the border is a solution to the problem of migration. Hence the central question of this chapter:

Which socio-cultural and political factors contributed to the migration flow from Mexico into the U.S.?

The first two sections will cover the history of the Mexican migration to the U.S. until 1964. The year marks the turning point in America's outlook to position immigration as a matter of national security rather than labour regulation. The third section covers the history of Mexican migration to the U.S. since 1964, diving deeper in the restrictionist acts and operations deterring the migration influx of Mexicans. The final part will put the historical events into perspective by relating it to Trump's wall and envisioning the possible effects of the wall, which relates this chapter to the central question of this thesis.

THE TUMULTUOUS NINETEENTH CENTURY OF MEXICO

At the end of the eighteenth century, Mexico endured many problems limiting its leaders in its development as a nation within the modern world (Henderson, 2011). A dominant Catholic Church that deterred any toleration of competing belief systems; the rugged geography of Mexico that made transportation and communication difficult; a decade lasting bloody war for independence from 1810 to 1821 which resulted in a stagnation of the Mexican population: all of these factors contributed to the Mexican struggle of becoming a modern nation (Henderson, 2011). Mexico's weakness stimulated the U.S. to take aggressive action. The Texan independence from Mexico in 1836 resulted in the annexation of Texas by the U.S. just ten years later. This expansion of U.S. territory spawned an open war between Mexico and the U.S. The still unstable Mexico couldn't compete with the might of the U.S. nation and the Mexican-American War ended in 1848 with the Treaty of Guadalupe Hidalgo. In the treaty it was agreed that the United States would pay the modest amount of 15 million dollars in exchange for more than half of Mexico's territory (Henderson, 2011).

When the U.S. convinced the Mexican government to give up an additional piece of land of 30,000 square miles, the 2000 mile border

between the U.S. and Mexico which we know today was established.

The latter half of the nineteenth century was one of great turmoil for Mexico. Between 1858 and 1861 a civil war broke out between the country's liberals and conservatives. The young liberal political elite was appalled by Mexico's tragic defeat in the war against the U.S. and felt that things had to change (Henderson, 2011). After three years of fighting the liberals managed to triumph over the conservatives, their greatest opponent being the Roman Catholic Church. However, it took until 1876 before Mexico could set its first steps towards economic and political development. It was Porfirio Díaz, an astute military leader and liberal politician, who took power in Mexico. Under Porfirio's rule the country saw substantial changes which would have great impact on Mexican migration to the United States in the years to come.

The thirty-five year rule of Díaz became known as the Porfiriato period in Mexican history. Under Díaz' rule, Mexico saw improvements in public safety, public health, mining, industry, foreign trade, and national finances due to increased tax revenues (Henderson, 2011). One of the most important developments concerning Mexican migration to the U.S. during this period were the advances in railroad production in Mexico. With the help of foreign investments from the U.S. thousands of miles of railroads were constructed and connected the Mexican interior with existing rail systems north of the border. This advancement in infrastructure

made large scale migration to the U.S. possible (Durand, Massey, & Zenteno, Mexican Immigration to the United States: Continuities and Changes, 2001). However, the positive developments under Díaz rule came at a cost. Díaz' favouritism toward foreigners at the expense of Mexicans caused popular rage and poverty (Henderson, 2011). Growing political and social unrest resulted in a violent national revolution that commenced in November 1910. Migration increased significantly during the Mexican Revolution, due to states becoming more accessible with the new rail systems.

It seems as though one can already detect a long term factor for migration to the U.S. here. The many problems that Mexico endured in its history, contributing to its frailty as a nation, are a constant factor in Mexican migration to the U.S.. The U.S., or *El Norte* as it was known to the Mexicans, was the land of opportunity (Takaki, 2008). The great contrast between the neighbouring countries could be perceived as both a push and pull factor. On the one hand, the political, social and economic turmoil in Mexico pushes Mexicans to migrate to the United States. On the other hand, the American prosperity and shortage of labour pulls the Mexicans to the United States. This classification of push and pull factors is commonly used in the studies on migration. Yet, in the case of Mexico and the United States, to see the push and pull factors as two distinct components is to create a "false dichotomy" according to González and Fernandez (2002). According to them, all

the factors contributing to the Mexican migration to the United States can be attributed to American imperialism over Mexico which started with Díaz' acceptance of United States aid in constructing new railroads, also described by the American writer John Kenneth Turner in *Barbarous Mexico*, his first-hand account of the last years of the reign of Porfirio Diaz (Turner, 1910):

> *The partnership of Díaz and American capital has wrecked Mexico as a national entity. The United States government, as long as it represents American capital will have a deciding voice in Mexican affairs.*

MEXICAN MIGRANTS: THE NEW LABOUR FORCE OF THE UNITED STATES

American economic influence on Mexico became evident with the American Panic of 1907. The demand for Mexican copper, silver, gold, zinc and other metals plummeted as a result of the financial crisis in the United States, which resulted an economic depression in Mexico in 1907-1908 (Cahill, 1998). This financial crisis, and the political and social tensions that had developed under Díaz' somewhat harsh rule, resulted in the Mexican Revolution in 1910. The years that followed were marked by revolutionary violence and economic stagnation.

The revolution, followed by a civil war, induced thousands of Mexicans to move north to the United States. As a reporter noted in 1914 (Takaki, 2008):

> *When questioned, many of them will tell you that they fled from Mexico to escape starvation. In a great number of instances the refugees have friends or relatives in this country who have told them of the wealth and prosperity of the wonderful Estados Unidos.*

Here, one can see how political and economic instability caused a tremendous pull to the north and how Mexicans already residing in the United States operated as social pull factors for Mexican migrants. By telling their relatives about the numerous opportunities in the prosperous *Estados Unidos*, just one person coming there led to the migration of dozens of families from his or her village (Takaki, 2008). This social pull factor is an example of the cumulative causation theory, according to which Mexicans still residing in Mexico are drawn by the information about the United States they get from migrant relatives. This theory will be further explained in the second chapter of this thesis.

Awaiting the resurgence of peace in their home country during Mexican Revolution, Mexican migrants tried to make the best of their stay in the United States. However, the waiting took years and years and the Mexican population in the Southwest grew from an estimated 375,000 to 1,160,000 between 1900 and 1930

(Takaki, 2008). One of the main reasons why many Mexican migrants were able to find refuge in the United States was the vast demand for simple agrarian and industrial jobs that had emerged from the First World War industry. Industrialists in the United States were cut off from their traditional sources of labour from Southern and Eastern Europe, which shifted their focus to labour from Mexico (Durand, Massey, & Zenteno, 2001). Although many of the immigrants were rural workers in Mexico, in the U.S. they became urban industrial workers to help keep the war industry going (Takaki, 2008). The imperialist attitude of the U.S. is well reflected here. When experiencing a deficiency in labour, they just amended their immigration policies to attract cheap labour from their southern neighbour.

Different U.S. policies heavily restricted Asian migration to the United States (Takaki, 2008). The Immigration Act of 1924 for example limited the annual number of immigrants by setting quota to two percent of the number of people from that country who were already living in the United States in 1890. Even though the Act was aimed at maintaining the American homogeneity, the quota didn't apply to Latin American countries. Many American landlords and farmers in the Southern States took advantage of this exception and hired Mexican labourers for the jobs that white Americans didn't want to do. Another advantage of the Mexican migrants relative to other minority migrants was the fact that they were waived from the

restrictions of the Immigration Act of 1917. The act of 1917 consisted of the implementation of head taxes, contracted labour and literacy requirements. The waiver that was allowed by the Commissioner General of Immigration with the approval of the Secretary of Labour established two important precedents. First, the practice was triggered whereby immigration laws were loosened up when it became desirable to import Mexican workers; second, their restrictive qualities were called upon when it was deemed necessary to exclude Mexicans from immigrating in order to conserve labour for white Americans (Cárdenas, 1975).

The exclusion of Mexicans from immigrating came to the forefront in 1929 with the dawning of the Great Depression that eventually convinced Mexican migrants not to move north. With unemployment in the U.S. rising to 25 percent the demand for Mexican labour plummeted with a massive deportation as a result. Over 400,000 Mexican citizens were deported from the United States between 1929 and 1937 (Hoffman, 1974), and between 1930 and 1940, the number of Mexican nationals enumerated in the U.S. Census actually fell (Durand, Massey, & Zenteno, 2001). The deportations following the Great Depression are a good reflection of how American imperialism serves as the overarching factor of Mexican migration. As mentioned before, the U.S. government kept on trying to regulate the flow of migrants in order to meet their economic needs. In times of war they welcomed Mexicans as cheap

labourers to help contribute to the war industry, however, in times of economic recession they deported hundreds of thousands of Mexicans in order to restore employment under the white American labourers.

With the depression ebbing away in the late thirties, the Second World War was already looming on the horizon. After the attack on Pearl Harbor in 1941 the United States spawned a huge war industry to battle the enemy forces lead by Germany and Japan. With the war industry also came the return in demand for agricultural and industrial labour (Takaki, 2008). As an answer to the new demand in labour the governments of Mexico and the United States came with a bilateral agreement which resulted in the so-called Bracero Program. Labourers would be recruited by the Mexican government and then sent to camps on the U.S. side of the border where employment, wages and transportation to job sites were arranged by the U.S. government (Massey & Reichert, 1980). Under the treaty, Mexicans were granted renewable six-month visas to work for approved agricultural growers, located mostly in the southwestern United States (Durand, Massey, & Zenteno, 2001).

Although it began as a temporary wartime measure, the program was successively extended by the U.S. Congress and did not end until 1964 (Durand & Massey, 1992). During the twenty-two years that the program lasted, some 4.6 million braceros entered the United States (Durand & Massey, 1992). However, in the end the

program was considered an economic success but a social disaster, with many braceros not receiving any of the promised rights and payments. On top of that, the Bracero Program also failed to curtail illegal immigration to the United States. From 1942 to 1964, official statistics indicate, nearly five million Mexicans were apprehended and deported from the United States (Durand & Massey, 1992).

The Bracero Program spawned massive illegal immigration because the program was limited to young male Mexican labourers who were fit to work. Disappointed by these limits, many Mexicans made the decision to cross the border without authorisation of the Mexican government (Hernández, 2006). The influx of illegal immigrants were favored over the braceros since they were illegal aliens so American employers didn't have to deal with certain rights that the braceros had (Hernández, 2006). To halt the flow of illegal immigrants the American government launched Operation Wetback in 1954. With increased Border Patrol personnel concentrated in the U.S.-Mexico border region and improved equipment ranging from buses to planes, the "Operation Wetback" model allowed the Border Patrol to boost the number of annual apprehensions (Hernández, 2006). Despite the more than a million apprehensions of illegal immigrants, Operation Wetback was a short-term success (Ngai, 2004). Even though the Border Patrol had already existed since 1924, Operation Wetback was the first event that set off the intensification of the Border Patrol's actions.

MIGRATION: A THREAT FOR NATIONAL SECURITY

Operation Wetback would lead to a major turn in the history of Mexican migration into the United States. After 1964, the immigration policy of the U.S. turned into a loose-fitting combination of limited legality and expansive tolerance (Fernández-Kelly & Massey, 2007). In 1965, a new Immigration Act was signed in which immigration from the Western Hemisphere was limited for the first time. The years following the Immigration Act of 1965 would see a contradictory attitude of America towards Mexican migration. Different policies were implemented by the U.S. with respect to Mexico, moving towards a greater integration in markets for capital, goods and services while trying to maintain on a separation in labour markets (Fernández-Kelly & Massey, 2007).

The limitations that were implemented with the Immigration Act of 1965 were further tightened with the acceptance by President Ford of the amendments to the Immigration & Nationality Act of 1965 in 1976 (Fragomen, 1977). The total amount of immigrants from the Western Hemisphere that would be accepted was 120,000, with a limitation per country of only 20,000 (Fragomen, 1977). With Mexico being the only country on the Western Hemisphere exceeding the limit extensively, the guest

worker program in the United States based on legal braceros changed into a worker program based on undocumented labour (Fernández-Kelly & Massey, 2007). Undocumented labour was monitored by the Immigration and Naturalization Service (INS), being responsible for most of the apprehensions of illegal immigrants crossing the Mexican-American border (Kassoudji, 1992).

However, with the undocumented labour still rising in the U.S., government officials weren't satisfied with the amendments on the Immigration & Nationality Act of 1976 and insisted on further measures. In 1986 the Reagan administration came with a reaction: The Immigration Control & Reform Act. On the one hand, the act offered legalisation to all undocumented migrants who had entered the United States prior to the first of January 1982. It also provided a special amnesty for the migrants who had worked for ninety days in agriculture during the year preceding 1 May 1986 (Durand & Massey, 1992). On the other hand however, the act made the hiring of undocumented workers by U.S. employers punishable by law and it massively increased the funding for the U.S. Border Patrol (Fernández-Kelly & Massey, 2007).

The intensification of the U.S. Border Patrol alas didn't result in fewer Mexican migrants trying to cross the border. The danger of being apprehended which should have resulted in deterring the flow of Mexican migration proved to have an opposite

effect. Accounts of migrants who had been apprehended numerous times proved the determination of the migrants. The determination of the migrants is also stressed in Takaki's *A Different Mirror*, with accounts of migrants having died in hot deserts with their bodies rotting in desolate canyons, forced by the border patrol to find alternate routes (Takaki, 2008).

Operation Blockade and Gatekeeper in 1993 and 1994 were other attempts by U.S. officials to bring to a halt the undocumented migration into the U.S.. The two operations were aimed at intercepting illegal immigrants crossing the Mexican-American border at the two busiest crossing points by increasing resources (Fernández-Kelly & Massey, 2007). However, driven by their determination to find a better life in the land of opportunity channeled the undocumented flows to remote and more hazardous regions (Fernández-Kelly & Massey, 2007). The undocumented immigrants have kept coming to the U.S. because they know that the American employers are willing to hire them, despite the criminalisation of hiring illegal immigrants that was caused by the implementation of the IRCA (Takaki, 2008).

Contrary to America's many attempts to halt the influx of Mexican migrants was the increase in trade between the United States and Mexico. U.S. investments which were first focused on railroads and mining shifted towards industrial manufacturing. By 1975 the investments of the United States were largely focused on

Mexico City, which then accounted for 50 percent of the total manufacturing production of the country (Fernandez & González, 2002). Moreover, Mexico became more dependent on foreign loans and the foreign debt grew at an annual rate of 23 percent, reaching 11 billion dollar by 1972 (Fernandez & González, 2002).

Despite Mexico's economic instability, commercial transactions between the U.S. and Mexico grew by a factor of eight from 1986 to 2003, reaching 235 billion dollar (Fernández-Kelly & Massey, 2007). This increase in economic activity and capital investments was primarily caused by the agreement on the North American Free Trade Agreement in 1994 (Fernández-Kelly & Massey, 2007). This agreement between Mexico, Canada and the United-States enabled the latter two to invest in Mexico and to take advantage of Mexico's cheap wages (Fernandez & González, 2002). Furthermore, the agreement also denied other economic powers, like Europe and Japan, the advantage of operating in and exporting from Mexico (Fernandez & González, 2002). With NAFTA, the U.S. sealed its firm grip on Mexico's economy. An unexpected effect of the agreement was that the free trade destabilised the Mexican economy and led to increases in unemployment (Takaki, 2008). NAFTA surprisingly also caused an increase of Mexican migration towards the U.S.. The government-subsidised corn grown in Iowa and shipped to Mexico bankrupted 1.5 million Mexican farmers, forcing them to move north, even across the border (Takaki, 2008).

If the theory of González and Fernandez concerning American imperialism is applied to the NAFTA, one can see how it is yet another example of how American imperialism caused Mexican migration.

CONCLUSION

From a historical perspective it is apparent that the problem of Mexican migration isn't simply just a one-sided problem. Ever since the Treaty of Guadalupe Hidalgo in 1848 the U.S. has been interfering with Mexico's economic and political situation. As stressed by Fernandez and González, the migration isn't a simple division of push and pull factors. The Mexican-American war, the immigration acts, the Bracero Program and NAFTA can all be considered attempts by the United States to get a grip on Mexico to foster its own economic position. It's the imperialist attitude of the United States towards Mexico that can be considered as the underlying factor for Mexico's economic and political instability. The instability causes the migration of Mexicans to the north of the border.

As this chapter points out, many immigration laws and amendments have been implemented and changed to resolve a problem not caused by illegal aliens or undocumented labourers, but by the United States itself. The wall that Trump wants to build to

stop Mexican migration might put a halt to the migration flow temporarily, but it won't solve the structural economic and political problems which afflict the Mexican population. The illegal alien, that is the Mexican immigrant, has always been a labour unit for the United States whenever the country needed it. The changing of immigration laws and the carrying out of different operations only functioned as a on and off button, flicking it the way that suited the United States best. So when Trump states that Mexico is totally dependent on the United States as a release valve for its own poverty, I only have this to say: Trump, know your history.

CHAPTER 2
Economical Analysis

written from the perspective of economics

by Thom Smetsers

"The world is more interconnected than ever before. And it's becoming more connected every day. Building walls won't change that."
—Barack Obama

OBAMA, THE CURRENT PRESIDENT OF THE United States advocates a contradictory view to Trump, the Republican presidential candidate, concerning the Mexico-United States border. This chapter is about what economically affects migration between Mexico and the United States and will examine the groundwork that is already done in

economics, by considering specifically the different theories, perspectives and reasons for Mexico-United States migration. This serves to enlighten the question:

To what extent do economic factors of development explain the changes in migration flow?

On the one hand the problem can be seen from the perspective of the United States, where the sentiment exists that Mexicans are undesirable and therefore do not belong in the United States. On the other hand from the perspective of Mexico, which fails to develop sufficiently to become a developed country partly due to the immigration of their best and brightest. This last perspective will be evaluated in this chapter, due to the academic scope on Mexico existent in the literature.

The contribution of this chapter is the introduction and examination of the theoretical and empirical economic work that exists concerning migration and specifically the Mexican-United States migration. Further, this chapter derives concepts of independent variables from this work and introduces an own dataset containing those concepts, but with data from the Mexican Migration Project and the World DataBank.

The first section will give the theoretical groundwork by explaining academic work, theories and assumptions of migration.

The second section expands on the theoretical literature by discussing different empirical articles. The third section dives into a self-made dataset, discusses the source of the data and will include a short introduction of the independent variables. The fourth section constructs the model and tests it. The fifth section expands on the results of the regression. Section six draws the conclusions.

THEORY AND LITERATURE REVIEW

Massey *et al*. (1993) describe different theoretical frameworks which try to explain international migration: neoclassical theory, new economics of migration theory, dual (segmented) labor market theory, and cumulative causation theory (Massey *et al*., 1993). De Haas (2010) also describes theories of migration. Some theories overlap with the frameworks from Massey (1993) and others elaborate on it or they are completely different, such as the migrant syndrome theory and the livelihood approach theory. De Haas further states that the literature lacks a broad theoretical framework and that the researchers are unable to put the specific debate on migration in a broader perspective (de Haas, 2010).

There has been heated academic debate about the impact of migration on the development in migrant sending countries (de Haas, 2010). This discussion existed between "migration optimists" and "migration pessimists" and reflects deeper deviations in social

theories. The debate is swinging hence and forth between the two ultimates before the 1960s and after the 1960s. But middle ground was also reached in the late 1980s and 1990s due to more pluralistic theories of migration (de Haas, 2010).

The micro neo-classical migration theory and the dual labor market theory are examples of optimistic views on migration before the 1960s. The micro theory of the neoclassical economics looks at individuals rather than places. Rational actors decide to migrate because they will enhance their positive net return (Massey *et al.*, 1993). The wages will be higher in the receiving country, in other words they are maximising their utility as an individual. Standard neoclassical theory sees migration as a mechanism to reach optimal allocation of production factors to benefit both sending and receiving countries (de Haas, 2010). Due to the free movement of labor, scarcity is enhanced in the sending countries and the wages will therefore increase. This process is ongoing until supply and demand are on the optimal level. The dual labor market theory turns away from the individual and regards the demands of modern industrial societies (Massey *et al.*, 1993). The dual labor theory is in outline the same as the macro neo-classical migration theory. Immigration stems from the demand of societies and from the pull factors that exist in highly developed countries. In other words, it's caused by the geographical differences in the supply and demand of labor.

From the late 1960s onward this discourse was perceived in a more negative manner. Empirical studies and the implementation of policies lead to this pessimistic view (de Haas, 2010). This view manifested in the cumulative causation theory and the "Migrant Syndrome". The theory of cumulative causation[1] comprises every act of migration that changes the decision-making process of migration and makes additional movements more likely to occur (Massey *et al.*, 1993). The leap most migrants have to make when migrating to the United States will therefore be easier and safer, due to the acquired knowledge and information, about immigrating to the United States. In other words the cost of migration declines (Fussel & Massey, 2004). This process of cumulative causation is relatively strong in the rural areas of Mexico (Fussel & Massey, 2004). Families are close in villages and even a single leaving member has a great impact on the already small population. This effect is less noticeable in the urban areas of Mexico. Here surfaces the pessimistic view of the trend. This leads to a drain of the talented population and causes the phenomenon known as "brain drain". This is the first step that leads to the Migrant Syndrome: it increases inequality in Mexico, contributes to conspicuous

[1] "The primary mechanism underlying cumulative causation is the accumulation of social capital, by which members of a community gain migration-related knowledge and resources through family members and friends who have already traveled to the United States." (Fussel & Massey, 2004).

consumption and provokes consumerist, non-productive and remittance-dependent attitudes (de Haas, 2010). When linking this with the concept of deprivation, an interesting phenomenon is noted. Relative deprivation plays an important role in Mexico-United States migration (Oded and Taylor, 1989). It can both cause migration and be a result of migration. On the one hand households are relatively deprived and send someone abroad who will forward remittances. On the other hand the remittances will result in deprivation of the rest of the environment. To use the term deprivation in this chapter without misunderstanding, a definition follows. Deprivation[2] is the damaging lack of benefits considered to be basic necessities in a society. No further explaining is necessary of this concept. But how to evaluate deprivation?

Since the 1980s and 1990s pluralistic views such as the new economics of migration and the migration as a household livelihood strategy take the stage in the academic debate. The new economics of migration theory[3] states that decisions to migrate are not made by

[2] "We can roughly say that [a person] is relatively deprived of X when (i) he does not have X, (ii) he sees some other person or persons (possibly including himself at some previous or future time) as having X (whether or not that is or will be in fact the case), (iii) he wants X, and (iv) he sees it as feasible that he should have X." (Oded & Taylor, 1989)

[3] "[M]igration decisions are not made by isolated individual actors, but by larger units of related people- typically families or households-in which people act collectively not only to maximise expected income, but also to minimise risks and to loosen constraints associated with a variety of market failures, apart from those in the labor market into account that migration decisions are not made by individual actors." (Douglas *et al.*, 1993)

individual actors, but by families or households to maximise income and minimise risks (Douglas *et al.*, 1993). Oded and Taylor (1989) describe that international migration decisions get affected by relative and absolute income considerations. The article concludes that the improvement of absolute income plays a major part in the decision making process of a household. Furthermore, it states that the successful and intelligent household member who has a competitive advantage over the others will migrate (Oded & Taylor, 1989). These capable individuals are most inclined to migrate to geographical locations with more opportunities that suit their level. While remittances are ignored in the neoclassical theory, in the new economics of migration theory it is one of the most essential motives to migrate (de Haas, 2010). The livelihood approach[4] has major parallels with the new economics of migration theory, but more specific in perspective.

After reviewing some theories of migration it becomes clear that to explain Mexico-United States migration, a specific perspective is needed. In the discussed articles and different perspectives certain economic factors emerge that can contribute to or deduct from the amount of migration that occurs, like income (wages), deprivation (inequality), cumulative causation, education,

[4] "A strategic or deliberate choice of a combination of activities by households and their individual members to maintain, secure and improve their livelihood." (de Haas, 2010)

remittances and the brain drain concept. The next part of this chapter examines a few empirical literature articles and how they model migration.

EMPIRICAL LITERATURE

George J. Borjas is an American economist who specialises in immigration issues. Borjas' negative-selection hypothesis is that in poor countries the individuals with the strongest incentive to migrate to rich countries are those with relatively low skill levels. (Chiquiar, 2002) Borjas studies gained a lot of support and critique (Pedersen *et al.*, 2004). This negative-selection hypothesis is empirically rejected by Chiquiar (2002). Chiquiar states that the more educated are more likely to migrate than the less educated. This leads to an unequal wage distribution in Mexico due to the immigration of the upper middle class and lower higher class (Chiquiar, 2002). Wage is for these an important factor when considering migration.

Furthermore, David Karemera, Victor Oguledo and Bobby Davis specified a gravity model derived from the system of demand and supply and try to incorporate political, economic and demographical factors to explain immigration flows to North America, like income, inflation rate and unemployment (Karemera, Iwuagwu Oguledo, & Davis, 2000).

Lastly, Pedersen *et al.*, (2004) tested an empirical model that consisted of three independent variables, which can show us how to approach an empirical model. Independent variable *S* consisted of characteristics that affects an individual's utility of living in a country. For example, an individual would like to move to another country when many relatives live there. Independent variable *D* reflected the time-fixed costs and psychological and social costs of moving to another country. *X* consisted of the push and pull factors of the source and destination country. In short how this article divided its independent variables (Pedersen *et al.*, 2004). Moreover, Pedersen describes short, apart from the empirical model, the ignorance of welfare magnets (social security) as an indicator of migration. (Pedersen *et al.*, 2004) This is another way of looking at it.

Many different possibilities are open to us for the empirical examination of migration due to the degree of interconnection migration has with life. Income (wage) seems an important indicator and the variables from the gravity model are also clear indicators on national level. The neglectance of a concept like the welfare magnets makes it challenging to add to the model in this chapter.

DATABASE

From the short theoretical and empirical overview of the literature independent variables can be distilled. But not everything can be taken into account due to missing information. Earlier we discussed, for example, remittances. There is simply not enough information to conclude it in the model.

The most important source we used for the model in this chapter is the Mexican Migration Project. This project was created in 1982 by an interdisciplinary team of researchers to examine the interconnected and difficult occurrence of Mexican-United States migration. Information is on national level and has a timeframe from 1965 until 2013. Further information is extracted from the world databank, which gives all sort of information about Mexico on national level. While trying to get information from 1965 until 2013, it fast became apparent that the information in the world bank is lacking and there are huge gaps.

The dataset we made has 49 observations starting in 1965 and has 8 independent variables. Most independent variables are relatively easy to link directly to the literature, like inflation, income, unemployment, education and cumulative causation. The next three need to be explained to grasp the connection. First, deprivation as described talks about the difference in situation of households and is therefore easy to link to inequality. Moreover, in the empirical literature social security came forward. But, instead of security we

look at crime and safety. The second independent variable therefore looks at drug crime and the third independent variable on safety.

Table 1. Definition of variables.

Variables	Description	Source
Years	Sample of the years 1965-2013.	-
Immigration	Legal immigrants admitted from Mexico.	(1)
Inflation	Mexican inflation rate.	(1)
Income	Mexican minimum wage (nominal pesos).	(1)
Unemployment	Mexican unemployment rate.	(1)
Education	Gross enrolment ratio tertiary education.	(2)
Cumulative Causation	Mexicans admitted as relatives of U.S. citizen.	(1)
Deprivation	Gini-coefficient 0-100.	(2)
Drug Crime	Amount of smugglers located in Mexico.	(1)
Safety	Intentional homicides per 100,000 people.	(2)

Source: (1) Mexican Migration Project. (2) World Bank

MODEL OF MEXICO-UNITED STATES MIGRATION

Cohen and Kim describe four ways to model migration: linear regression models, gravity models, Markov chain models, and matrix population models (Cohen & Kim, 2010). Karemera *et al.* use a gravity model in their research whereas this chapter will use a linear regression model to explain the factors correlating with the amount of migration to the United States from Mexico (Karemera, 2000). The multivariate model below must be tested first for non stationarity, unit root and cointegration. After that the OLS-rules have to be considered. When everything is alright, we can move on to the regression and matching analyses.

Multivariate analyse

$$\mathrm{Y_i} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \varepsilon_i$$

where:

$Y_i = Migration\ flow$
$X_1 = Inflation\ rate$
$X_2 = Income$
$X_3 = Unemployment$
$X_4 = Education$
$X_5 = Cumulative\ causation$
$X_6 = Deprivation$
$X_7 = Drug\ crime$
$X_8 = Safety$

Dickey-Fuller test - testing for nonstationarity or unit root test and cointegration

Hypothesis: H_0: Variable is not stationary or has unit root

H_1: stationary

Table 2. A Dickey-Fuller test shows a stationary and significant result.

Variable	Test Statistic	1% Critical value	5% Critical value	10% Critical value
Immigration	-3.144	-3.594	-2.936*	-2.602*
Inflation	-2.105	-3.594	-2.936	-2.602
Income	-2.068	-3.594	-2.936	-2.602
Unemployment	-2.340	-3.594	-2.936	-2.602
Education	-4.205	-3.594*	-2.936*	-2.602*
Cumulative causation	-1.761	-3.594	-2.936	-2.602
Deprivation	-8.394	-3.594*	-2.936*	-2.602*
Drug crime	-2.518	-3.594	-2.936	-2.602
Safety	-0.772	-3.594	-2.936	-2.602

**stationary for the indicated critical value*

The test statistic is less than than the critical value and therefore the null-hypothesis can be rejected. What means that the model is stationary. What is more surfaces when examining the *p*-value,

which is less than 0.05. This again states that the model is stationary and is significant. But when examining the independent variables they seem to be technically unit roots. Therefore the residuals have to be tested for cointegration.

TESTING FOR COINTEGRATION

Cointegration: H_0: No cointegration among the variables

H_1: There is cointegration

Table 3. A cointegration test shows a conintegration of the variables.

Rank	Trace statistic	5% critical value
0	326.54	192.89
1	213.02	156.00
2	138.45	124.24
3	88.11*	94.15

When the trace statistic is less than the the critical value, we can accept the null hypothesis. For the rank 'zero' and 'one' the null hypothesis is rejected. The value of the trace statistic is finally less than the critical value at the rank 'two'. What means that the model has two cointegration and that means cointegration of the four variables.

ORDINARY LEAST SQUARES PARAMETERS

1. Population model is linear in parameters (and the error term is additive).
2. Error term has a zero population mean.
3. All independent variables are uncorrelated with the error term:
4. No perfect (multi)collinearity between independent variables (and no variable is a constant)
5. No serial correlation: errors are not correlated with each other across different observations,
6. No heteroskedasticity: error term has constant variance (where is a constant).
7. This means we assume that the error term is normally distributed, with a mean of zero (cf. assumption 2) and a constant variance.

The first and second conditions are met by assumption, because we assume that the population model is linear and that our error term has a mean of zero. The third assumption is an interesting one, as it is a condition of overestimation bias. As we have an r-squared that is not 1 it leads to overestimating, because the model is not completely

explained by the independent variables. In the fourth assumption, after testing for multicollinearity, it becomes clear that multicollinearity does not exist in the five different combinations of the model. The fifth assumption can be tested with the dwatson command. The value is close to two, so their is no serial correlation. This means we assume that the error terms are not correlated across different observations. The sixth or heteroskedasticity assumption has to be met to interpret the coefficients and observe a relation. We can test for this using the command 'estat hettest' after running the regression. There is heteroskedasticity and this can be fixed with the 'robust' command. The last assumption is connected with the sixth one.

RESULTS OF THE REGRESSION

Table 4. The resulting regression values for all variables.

Independent variables	Model 1	Model 2	Model 3	Model 4	Model 5
Inflation	-1891.30**	-2122.30***	-1865.28**	-1870.74**	-1608.41*
Income	36.49***	35.25***	35.16***	38.80***	39.39***
Unemployment	5.41	–	–	–	-5.40**
Education	-6.35	-5.39	–	-7.86*	–
Cumulative causation	0.56	0.39	–	0.83***	–
Deprivation	3.92	–	–	2.95	3.04
Drug crime	6.65*	4.81	6.56***	–	–
Safety	-1.85	–	-4.53*	–	-8.38**

*Significant level of 10%, **Significant level of 5%, ***Significant level of 1%

What we have done in this chapter is model the eight independent variables. What became apparent is that the variables lack significance when they are all put together. That is why we tried to look for a combination that shows us the independent variable in a significant manner, even though this only occurs once.

What is clear from the start is that the independent variable inflation and income both are significant. That is than also the reason why they return in every combination. Income has an overall positive effect and inflation rate a negative effect. The rest of the independent variables were only under certain circumstances

significant with a 10%, 5% or 1% significance level. In these circumstances we saw that unemployment, education and safety have a negative effect. While cumulative causation and drug crime have a positive effect. It is not possible to say something about deprivation, because no combination resulted in a significant outcome.

In some circumstances certain variables are significant and in other they are not. But important is that this model considers the different variables and shows the positive or negative effects, when possible. So, we can better understand the effect of the economic factors.

CONCLUSION

From the theoretical perspective of economics we can say that the migration issue has many facets and one individual theory will therefore not be sufficient to comprehend the interconnected problem of migration. As theories can not explain the complete picture, so are independent variables only focused on a certain situation of cause and effect. What we can see is the trend of migration theories and the effect of the independent variables on migration.

The limitations of this part are the following. First of all, due to lack in information available about migration and its factors, the dataset does not contain all the variables consistent with the

literature, such as remittances, factors of the brain drain concept etc. Second, the model lacks in certain circumstances significance for most of the independent variables. This makes it difficult to see which correlation they have on immigration.

Future study can move on from the theory of migration to examine the current situation in terms of development in Mexico. Followed by examining the political and economic structure of Mexico and the actions needed to make it less reliable on migration.

CHAPTER 3
Building a model

written from the perspective of artificial intelligence

by Jelmer van Nuss

"Prediction is very difficult, especially if it's about the future."
—Nils Bohr

THE BEHAVIOUR OF ANIMALS IS INTRIGUING TO humankind, which has led to the study of behavioural patterns by the field of artificial intelligence. This research resulted in successful models of animal behaviour. These models led to a better understanding of interesting phenomena, such as emergence in bird formations (Reynolds, 1987) and ant-colony optimisation (Dorigo, 1992). Human migration is another example

of an action performed by a peculiar animal: we humans made up for 40 million migrations in the global population from 2005 to 2010[5] (Abel & Sander, 2014). Immigrants all over the world have sent back a total of 601 billion dollars to their countries of origin in 2015 (World Bank, 2016). With migration having such an impact demographically and economically, no wonder several efforts are made to model this drifting behaviour, with various success (Willekens, 2013).

The goal of this section is an analytic model of migration. We question

What kind of model based on which migration theories is best for simulating migration flow centered in Mexico?

The answer will be a factor profile that states the contribution of each factor to the migration decisions that Mexicans make.

MIGRATION FLOW IN A NETWORK

Migration can be approached in varying levels of abstraction. As it is unfeasible to pinpoint all migrants down to their coordinates, we use the level of state-to-state migration. All citizens in a state are

[5] An overview of the global migration flows is available as an astute visualisation on: **http://www.global-migration.info/**

stacked together as being in that state, regardless of exact location. This level of abstraction is easy to work with: it is both intuitive to grasp the idea and results, and there is plenty of migration data available on this level (MMP154, EMIF Norte[6]).

We construct a graph to reach a workable abstraction of the migration flow. A graph shows what is connected and how things flow. First, we decide on the type of origin and destination locations. We use states as the location types. For example, a migrant might be currently located at Coahuila, Mexico and moves to Texas, U.S.. Each of these states is called a *node* in our graph.

The migrant is moving from Coahuila to Texas through a migration route between the two states. We call such a route an *edge*. As a simplification, we don't discern between mode of transport. Walking, driving or flying all serve as a migration route. It is only possible to move from one node to another whenever there is an edge between the two. Also notice that a direction is implied in the definition of the route. This *directed graph* allows one-way trips, as well as a back-and-forth connection. We simply create two edges in opposite direction if migration is possible in both ways.

[6] Statistics are available on
http://www.colef.mx/emif/eng/tabuladosnte.php

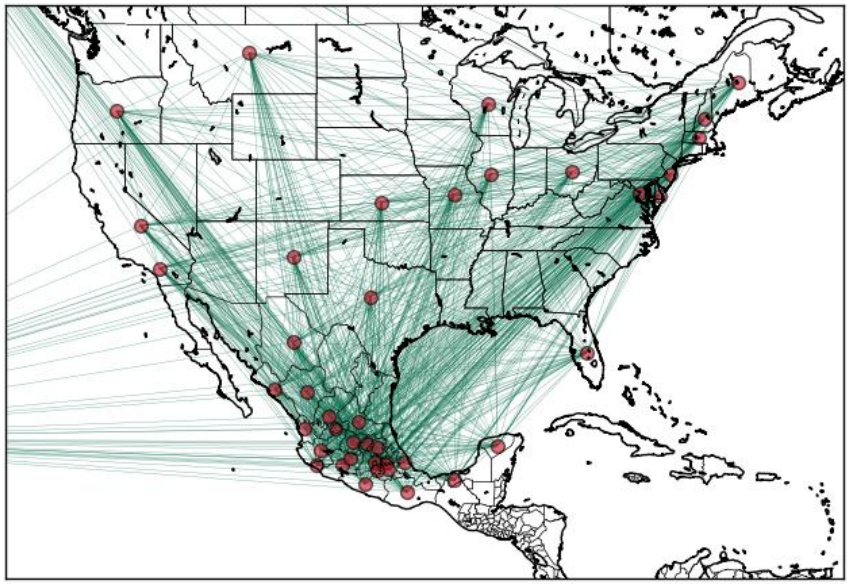

Figure 1. A map of Mexico and the U.S. showing all involved states (red dots) and their connections (green lines). The lines to the top-left corner and to the left side are connected to Alaska and Hawaii, which are not shown in the figure.

Every state has a population as a dynamical property. Whenever an inhabitant leaves, the population size is reduced, and whenever a new one arrives, the population size is increased. The volume of this inflow and outflow of people is what we are interested in. It will not only be helpful in deciding projected population sizes, but it will also determine the size of migration. This last part is important to know, as a migration flow that is too large brings about its own logistical problems.

MIGRATION DATA

Real migration data from the Mexican Migration Project (MMP) is used to model the current flows. The MMP was started in 1982 to gain an understanding of the migration flows between Mexico and the United States. It is a collaborative research project based at the Princeton University and the University of Guadalajara. We use the October 2015 project (MMP154) where 154 communities with a total of 25,658 households were interviewed. The database contains several files describing the lives of about 160,000 Mexican people.

The file PERS contains general demographic and migratory information on each member of a surveyed household. This information is used to initialise and evaluate the migration model. The states of all Mexican households interviewed are indexed and stored in codebook Appendix A[7]. All American states are available in Appendix C[8]. To reduce complexity, only the American states that show up in the interview data are used in the model[9].

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7 **http://mmp.opr.princeton.edu/databases/pdf%20codebooks/Appendix%20A%20-%20Sample%20Information%20(MMP154).pdf**

8 **http://mmp.opr.princeton.edu/databases/pdf%20codebooks/Appendix%20C%20-%20States%20(MMP154).pdf**

9 The following states are included: Aguascalientes, Baja California Norte, Chihuahua, Colima, Durango, Guanajuato, Guerrero, Hidalgo, Jalisco, Mexico, Michoacán, Morelos, Nayarit, Nuevo, Oaxaca, Puebla, Querétaro, San Luis Potosí, Sinaloa, Tabasco, Tlaxcala, Veracruz, Yucatán, Zacatecas, Alaska, California, Delaware, Florida, Hawaii, Illinois, Kansas, Maine, Massachusetts,

CREATING A MIGRATION MODEL

The goal of this section is to create a model that is able to simulate migration flows. We build an artificial society based on the network described above. All nodes represent states where citizens live and migrate freely. The citizens act fully rational and use complete information of the world to support their behaviour. This is a fairly basic agent-based model, but it is possible to extend the model to include other theories or restrict agent-knowledge to make the model more realistic.

Several other attempts at modelling migration flows were quite successful. Kniveton *et al*. (2011) used an agent-based model to predict migration flows for Burkina Faso. The model uses the consequences of environmental change and rainfall as main motivators of migration. Agents are assumed to behave according to the theory of planned behaviour. In this model, agents are represented as having internal properties and beliefs that are affected by external motivators. Every simulated year, all the agents have to make a migration decision. They can either stay at their current location, or move to another zone.

The model is primarily economically based and includes static social information. We will use this framework as a basis for

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Missouri, Montana, New Hampshire, New Jersey, New Mexico, Ohio, Oregon, Texas, Washington and Wisconsin.

our model, but rule out social interactions between agents for now, as we have neither enough supporting data, nor the expertise and time to research these factors applied to our Mexico-United States case study.

Social networks and social influence in agent-based models have been researched by Barbosa Filho, Neto & Fusco (2011). They added a social layer where agents could transfer their experiences to other agents that are in their social network. The agents had incomplete information about the world: they could only see their direct environments and had to rely on the knowledge of relatives to understand the world around them. This is a more intuitive and realistic approach to modelling decision-making: you as a Guanajuatan would be ignorant about the career opportunities in Florida, unless a family member migrated to Florida and wrote letters back home.

To initialise the model, we need to distribute agents in the designated zones. The distribution is based on the MMP data and uses factors that are available in the data set. There are three categories of factors in the model: citizen factors, state factors and migration route factors.

There are internal factors of an agent: age, gender, years of education, salary, health, amount of U.S. migrations, amount of domestic migrations and total months of U.S. experience. These

factors we call agent factors a_i for $i = 1 \dots 8$. Next are differences between states: the difference in Mexican population size, the metropolitan category, hectares of irrigated land[10], amount of factories[11], annual amount of committed crimes per 10,000 citizens[12], amount of schools[13], amount of hospitals[14], the average salary of the destination state compared to the current state, and the difference in average health. These factors we call node factors n_j for $j = 1 \dots 9$. The route factors are the distance of a route, the accessibility, the amount of Mexican apprehensions, the amount of line watch hours,

[10] Mexican irrigation figures are taken from the COMMUN file, U.S. irrigation numbers are taken from **https://www.agcensus.usda.gov/Publications/2012/Full_Report/Volume_1,_Chapter_2_U.S._State_Level/st99_2_010_010.pdf** under *Irrigated land* and converted from acres to hectares.

[11] Mexican factory figures are taken from the COMMUN file, U.S. factory counts are from **http://www2.census.gov/econ/susb/data/2013/state_naicssector_2013.xlsx** selecting the business type *Manufacturing*.

[12] Mexican crime figures are taken from the COMMUN file, U.S. crime counts are from **https://www.fbi.gov/about-us/cjis/ucr/crime-in-the-u.s/2015/preliminary-semiannual-uniform-crime-report-januaryjune-2015/tables/table-4/table_4_january_to_june_2015_offenses_reported_to_law_enforcement_by_state_by_city_100-000_and_over_in_population/view** under *Violent crime*.

[13] Mexican school figures are taken from the COMMUN file, U.S. school counts are from **https://nces.ed.gov/pubs2007/overview04/tables/table_2.asp** under *Total number of schools having membership*.

[14] Mexican hospital figures are taken from the COMMUN file, U.S. hospital counts are from **https://www.ahd.com/state_statistics.html** under *Number Hospitals*.

and the trade balance between Mexico and the U.S.. These factors we call edge factors e_k for $k = 1 \ldots 5$.

At the start of a simulation, there are 1500 agents distributed equally over the Mexican states, and 1 in each state of the U.S. that is involved in the model. The agents are citizens of Mexican descent, thus the recorded population size of a state is in reality the number of Mexicans in that state. The amount of fellow Mexicans can influence the migration decision: a birds-of-a-feather-flock-together principle called cumulative causation is suggested in the earlier sections on history and economics.

Citizens have internal factors that need to be initialised with random values. Citizen ages are generated with a gamma distribution, following Barbosa Filho *et al.* (2011). This distribution is calibrated with the age distribution from the interview data[15]

$$age_i \sim \Gamma(\alpha, \lambda)$$

where $\alpha = \frac{\mu^2}{\sigma^2}$ and $\lambda = \frac{\sigma^2}{\mu}$, and μ, σ^2 represent the mean and variance respectively. The corresponding values are $\alpha \approx 2.649$ and $\lambda \approx 0.090$.

Gender is generated by a random selection between the choices $Male = 1$ and $Female = -1$. These values are distributed according to the observed genders, with a percentage of 49.4% males

[15] There are 162,293 unique persons. After filtering out deceased (code 8888, 1324 occurrences) and unknown (code 9999, 258 occurrences) data, there are 160,711 ages left.

and 50.6% females.

The amount of years of education is generated via an exponential distribution (Barbosa Filho, Neto, & Fusco, 2011) based on the MMP data[16]

$$education\ years_i \sim \text{Exp}(\lambda)$$

with $\lambda \approx 0.159$.

As people can only study if they are born, we take the minimum of the age and education years.

The salary of citizens in USD is generated in a similar way to education via an exponential distribution

$$salary_i \sim \text{Exp}(\lambda)$$

with $\lambda \approx 0.0000107$.

The health of a citizen at age 14 can take on any of the values $Poor = 1$ (0.3%), $Regular = 2$ (2.9%), $Good = 3$ (60.6%) and $Excellent = 4$ (36.3%)[17].

The amount of migration experiences is set to zero.

The model is run for an amount of years. In our training phase, we start the simulation in 1960 and end it in 2000. This should be long enough to make claims about the accuracy, and there is plenty of

[16] As with age, there are 162,293 unique persons. After filtering out unknown data (code 9999, 429 occurrences), there are 160,282 examples left.

[17] There are 37,164 answers on the health question. After filtering out the unknown data (code 8888 and code 9999, 25,060 occurrences), there are 12,104 health-types left. This question was introduced in community #115.

data for this era. Choosing a timestep of a year is acceptable for the approximation of migration flow as it is easier to compute than smaller timesteps, and the MMP dataset records in years. Every year in the simulation involves the same three steps. First, all properties of the model and the citizens are updated. Then, all citizens make a migration decision based on their knowledge and influence of others. Lastly, the migrations are performed and migratory data is updated.

In the update-phase, the model progresses by a year, while citizens age, become more educated, regress their salary and health to the state's mean, and gain more experience of living in the United States.

After the properties of the model and of the citizens are updated, all citizens have to make their migration decision. A citizen can stay at its current location, or migrate to another state, either in Mexico or in the U.S.. We denote a possible migration route as *Origin-Destination*. Staying at a location is implemented as a migration from one state to the same state, for example *Oaxaca-Oaxaca*. Making a migration decision now comes down to ranking all possible routes from the citizen's current location (including to the current location itself) and choosing the option with the highest score.

The score of a migration route depends on the multitude of factors defined earlier. The agent factors a_i for $i = 1 \dots 8$, state

factors n_j for $j = 1 \dots 9$ and route factors e_k for $k = 1 \dots 5$ are all taken into account when calculating the migration score.

A first definition of a route score takes these factors as arguments and returns the sum of the factors:

$$migration\ score(a_1, \dots, a_8, n_1, \dots, n_9, e_1, \dots, e_5) = a_1 + \dots + a_8 + n_1 + \dots + n_9 + e_1 + \dots + e_5$$

Example of migration score calculation (1)

Consider a citizen in Oaxaca with the following factors who is considering travelling to Puebla.

Note that factors e_3, e_4 and e_5 are ignored, as it is a within-country migration.

Factor	Value	Description	Factor	Value	Description	Factor	Value	Description
a_1	27	Age	n_1	-10	Population size	e_1	258	Distance
a_2	1	Gender	n_2	-1	Metropolitan category	e_2	1	Accessibility
a_3	8	Education years	n_3	5630	Hectares irrigated land	e_3	0	Mexican apprehensions
a_4	22614	Salary	n_4	5321	Factories	e_4	0	Line watch hours
a_5	3	Health	n_5	7	Crimes	e_5	0	Trade balance

a_6	3	U.S. migrations	n_6	-145	Schools
a_7	1	Domestic migrations	n_7	1	Hospitals
a_8	12	U.S. experience	n_8	316	Average salary
			n_9	1	Average health

Plugging in these values in our migration function, we get

$$
\begin{aligned}
&migration\ score(a_1, \ldots, a_8, n_1, \ldots, n_9, e_1, \ldots, e_5) \\
&= 27 + 1 + 8 + 22614 + 3 + 3 + 1 + 12 - 10 - 1 + 5630 \\
&\quad +5321 + 7 - 145 + 1 + 316 + 1 + 258 + 1 + 0 + 0 + 0 \\
&= 34048
\end{aligned}
$$

A flaw of this approach is that the factors are not in proportion with each other. Salary with a range of 0-20000, for example, is about 200 times greater than age with a range of 0-100. In this way, aging by two years contributes equally to the migration score as getting a raise of $1. This does not seem right. We would like all factors to be in the 0-1 range, where 0 means no attribution to migration score at all, and 1 means full attribution. Reducing a range to a 0-1 interval is called normalisation.

These factors are probably not equally important in deciding where to travel. We need parameters to change the influence of each factor. This covers another flaw of the first definition: we can now assign negative values to the parameters, which makes it less interesting to migrate when the corresponding factors increase. This seems to be the case for distance, as the further away a state is, the less likely it is for a citizen to migrate there.

We need a parameter for each factor. Starting with the internal agent factors a_i, we define α_i as being the parameter modifying them. For the interstate differences n_j, we have β_j. The route factors e_k are influenced by the parameters γ_k. In the new definition of the migration score, we multiply the factors by their parameters:

$$\begin{aligned} &migration\ score(a_1, \dots, a_8, n_1, \dots, n_9, e_1, \dots, e_5) \\ &\qquad = \alpha_1 \times a_1 + \cdots + \alpha_8 \times a_8 + \beta_1 \times n_1 + \cdots \\ &\qquad + \beta_9 \times n_9 + \gamma_1 \times e_1 + \cdots + \gamma_5 \times e_5 \end{aligned}$$

Example of migration score calculation (2)

Consider the same citizen from example 1 with the following randomly initialised parameters.

Parameter	Value	Parameter	Value	Parameter	Value
α_1	85.176	β_1	-2.782	γ_1	-84.981
α_2	81.067	β_2	-92.109	γ_2	76.580
α_3	32.289	β_3	-83.315	γ_3	-33.922
α_4	-28.450	β_4	-41.659	γ_4	-74.300
α_5	-68.625	β_5	-18.236	γ_5	84.286
α_6	-5.126	β_6	-77.171		
α_7	93.318	β_7	-71.861		
α_8	-79.096	β_8	-91.113		
		β_9	-45.958		

Plugging in these values in our migration function, we get

$$
\begin{aligned}
&migration\ score(a_1, \ldots, a_8, n_1, \ldots, n_9, e_1, \ldots, e_5) \\
&= 85.176 \times 0.27 + 81.067 \times 1 + 32.289 \times 0.4 - 28.450 \times 0.452 \\
&\ -68.625 \times 0.75 - 5.126 \times 0.3 + 93.318 \times 0.05 - 79.096 \times 0.2 \\
&\ -2.782 \times -0.05 - 92.109 \times -0.25 + 83.315 \times 0.563
\end{aligned}
$$

□

$$
\begin{aligned}
&+41.659 \times 0.531 - 18.236 \times 0.64 - 77.171 \times -0.407 \\
&-71.861 \times 0.12 - 91.113 \times 0.006 - 45.958 \times 0.25 \\
&-84.981 \times 0.086 + 76.580 \times 1 - 33.922 \times 0 - 74.300 \times 0 \\
&+84.286 \times 0 \\
&\approx 200.50
\end{aligned}
$$

Staying home for this Oaxacan citizen would get the score

$$
\begin{aligned}
&migration\ score(a_1, \dots, a_8, n_1, \dots, n_9, e_1, \dots, e_5) \\
&= 85.176 \times 0.27 + 81.067 \times 1 + 32.289 \times 0.4 - 28.450 \times 0.452 \\
&\quad -68.625 \times 0.75 - 5.126 \times 0.3 + 93.318 \times 0.05 - 79.096 \times 0.2 \\
&\approx 39.96
\end{aligned}
$$

Note that the differences between the states can be dropped, as they will all be zero by definition. The distance and intercountry variables are zero as well, because staying in a state means travelling a distance of zero within the same country.

The citizen would thus deem travelling to Puebla more valuable than staying in Oaxaca.

The combination of parameters $(\alpha_1, \ldots, \alpha_8, \beta_1, \ldots, \beta_9, \gamma_1, \ldots, \gamma_5)$ forms a *factor profile*. These factor profiles are of key importance in the rest of this section. They are the basis of how citizens act and they can be used to extract the importance of every factor in making a migration decision.

TRAINING THE MIGRATION MODEL

The model is now able to simulate the migration flow in a timespan given a factor profile. We want to find a factor profile which simulation best represents the real migratory data. Finding such a profile is called an optimisation problem. The factor profile is optimised in an evolutionary manner with a genetic algorithm. These algorithms are based on the theory of natural selection in biology. This theory dictates that specimens are selected and produce offspring to best fit the environment. How well an individual fits is measured with a fitness score. In our case, the specimens are the factor profiles and the environment stimulates specimens that are good representations of the observed data. As we're interested in finding a factor profile that closely resembles the observed migration patterns, we let a few factor profiles evolve and then we pick the fittest individual. Fitness is defined as having a minimal difference in months of experience living in the U.S. per person for the total model after the run is completed. The average

months of experience per year is compared with the real data[18]. The difference is the error measure of the model and is calculated by the root-mean-square-error (RMSE).

The definition of the fitness score then is:

$$fitness\ score(s, r) = -1 \times error\ measure(s, r)$$

with s and r is the the average amount of U.S. experience of respectively the simulation and real data.

The error is multiplied by minus one, as it must be minimised, thus negative error must be optimised, which is the fitness score.

The error measure is defined as:

$$error\ measure(s, r) = \sqrt{\frac{\sum_{t=1}^{n}(s_t - r_t)^2}{n}}$$

where n is the amount of years simulated, and s_t and r_t is the average amount of U.S. experience in year t of respectively the simulation and the real data.

[18] The average months of experience living in the U.S. is a non-decreasing function. The population in the model remains the same throughout the simulation, and experience can only be added.

Example of fitness score calculation

Consider a simulation between 2000 and 2005.

Year	Simulated experience	Real experience
2001	0.089	0.117
2002	0.196	0.217
2003	0.295	0.292
2004	0.374	0.358
2005	0.398	0.403

Plugging in these values in our migration function, we get

$$fitness\ score(s,r) = -1 \times \sqrt{\frac{\sum_{t=1}^{n} s_t - r_t\ ^2}{n}}$$

$$= -1 \times \sqrt{\frac{0.089 - 0.117\ ^2 + 0.196 - 0.217\ ^2 + 0.295 - 0.292\ ^2 + 0.374 - 0.358\ ^2 + 0.398 - 0.403\ ^2}{5}}$$

$$= -1 \times 0.000702 = -0.000702$$

The resulting factor profile is thus the best approximation of the real data. We can use this factor profile to initialise new simulations, and it forms the basis for running a simulation to predict the migration flow in future years.

Before continuing with the genetic algorithm optimisation, it is necessary to justify this approach. We've seen that a factor profile consists of many parameters that need to be tuned. In turn, each of these parameters has many settings[19]. This causes the search space, all the different possible factor profiles, to be gigantic (Calvez & Hutzler, 2006). In fact, there will be

$$\#\ of\ parameters \times \#\ of\ settings\ per\ parameter$$
$$= 2220000 = 440000 \text{ factor profiles}^{20}.$$

We can assume that most of these profiles have to be checked to find a fitting profile, because of the chaotic nature of agent-based models (Calvez & Hutzler, 2006). A small change in a parameter setting can lead to radical modifications of the dynamics of the system. As a result of this chaotic nature, the solution space, all the factor profiles that result in a close fit to the observed data, is small. There are only so many profiles that have a good fit. So is it feasible

[19] A setting is a real value between -100 and 100. In this example, the values are discretised to make an intuitive argument. In reality, the dimensionality problem is even worse, as there are infinitely many real values in this interval. Good luck trying to check all of them.

[20] Again, there are infinitely many factor profiles, as a number of parameters multiplied by infinite settings per parameter equals infinite factor profiles.

to check the whole search space? If it took a generous five minutes to perform one simulation and evaluation, we would need $5\ minutes\ per\ factor\ profile \times 440000\ factor\ profiles = 2200000\ minutes$ to find the best factor profile. As this is more than four years, it is clearly impractical to use this brute force approach.

Now, a genetic algorithm initially consists of a population of $P = 20$ different and randomly instantiated factor profiles. For each profile, all parameters i, j, k are given values between -100 and 100 at random. We evolve the factor profiles for $N = 30$ cycles. Every cycle, or *generation*, all the factor profiles in the population are used to run a simulation. Then their fitness is compared and the strongest individuals are selected to reproduce. The individuals keep creating offspring until the new child population is of the original size Pagain. The parent generation is now discarded and we look at the newly generated population. A property of this algorithm is that the population size P remains constant between each cycle. In the final cycle, we only select the strongest overall individual and use it as our optimised factor profile.

The parent selection is a weighted spinning wheel with size 3. The selected parents produce offspring via crossover. For each parameter slot in the factor profile, the corresponding parameter from a random parent is copied. This could in theory result in an

exact copy of a parent when only that individual's parameters are selected[21], but in practice it will generate a blend of all parents.

After a child is generated, it has a chance to be mutated to bring variety in the population. Every parameter in the factor profile has a 5% chance of being mutated (mutation chance = 0.05), and when this happens, the value is randomly increased or decreased by 10% (mutation rate = 0.10).

When the training phase is completed, we take the best factor profile as being the most representative of the real life scenario. The best factor profile turned out to be the one found in generation 20 with a score of -1.640. The parameters are shown in the table below.

[21] The chance of this happening is related to the amount of selected parents (3) and the amount of parameters in a factor profile (22). For the first parameter, there is a ⅓ chance of selecting parent *X*. For the next parameter, the chance of selecting *X* again is once more ⅓. The chance of having selected parent *X*'s first and second parameter is $\frac{1}{3} \times \frac{1}{3} = \frac{1}{9}$. This process can be repeated for any arbitrary amount of parameters N, where the chance of all parameters being from the same parent is $(\frac{1}{3})^N$. For 22 parameters in a factor profile, this is $(\frac{1}{3})^{22} = 0.0000000000319$.

Table 5. The parameter values of the factor profile that was found to be the most effective.

Parameter	Value	Parameter	Value	Parameter	Value
α_1	47.865	β_1	-46.597	γ_1	-54.219
α_2	33.163	β_2	57.397	γ_2	-82.963
α_3	-7.278	β_3	-40.947	γ_3	-89.429
α_4	-27.959	β_4	96.122	γ_4	-28.646
α_5	81.005	β_5	33.351	γ_5	46.430
α_6	-13.570	β_6	-62.314		
α_7	103.984	β_7	56.343		
α_8	4.135	β_8	31.646		
		β_9	-6.035		

The parameters of this factor profile are extracted and show the level of importance of each factor. The larger a coefficient (disregarding the sign) is, the more important it is in determining a migration decision. We note the high scores of domestic migration experience, the amount of factories, the Mexican apprehensions at the border and health of the migrants.

SIMULATION AND CONSTRAINTS

The approximation of a good factor profile as found above is now used in a test run between 1960 and 2000. The amount of U.S. and domestic migrations are shown in Figure 2, compared with the observed data. The total months of U.S. experience is shown in Figure 3, compared with the observed data.

Note that these runs can differ wildly, especially for the later years, as the factors are intertwined delicately and small changes in their underlying structure may result in dramatically different outcomes. The simulations are here to give a sketch of the situation, not an indisputable proof.

The U.S. migrations are fairly representative of the observed data. The domestic migrations are hugely overestimated because of a flaw in how domestic migrations are simulated. It is almost always more efficient to travel within your own country, rather than staying at home. This is caused by dropping the interstate and route factors and setting them to zero, making it very unlikely to surpass the domestic destinations in migration value. Setting these factors to an average setting value of 50 in these non-travel scenarios (thus making it more difficult to travel) did not result in a better U.S. migration approximator.

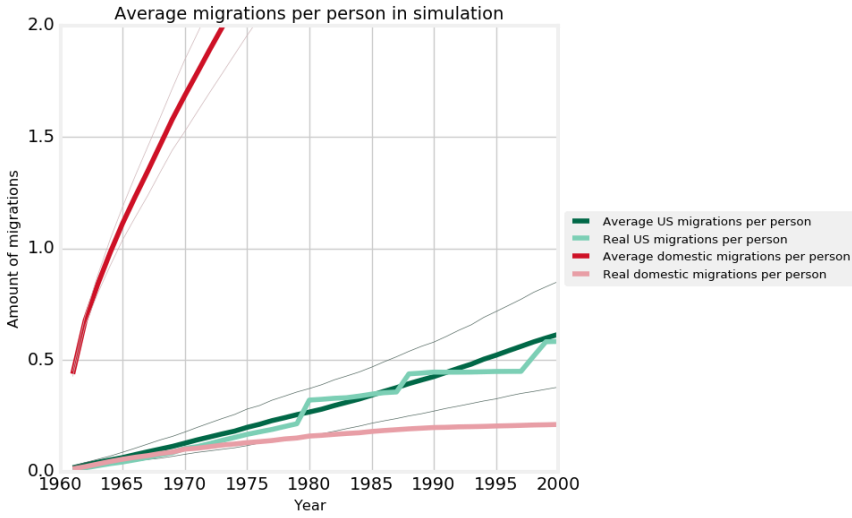

Figure 2. The cumulative average migration per person during the simulation. The green lines represent the U.S. migrations, the red lines represent the domestic migrations.

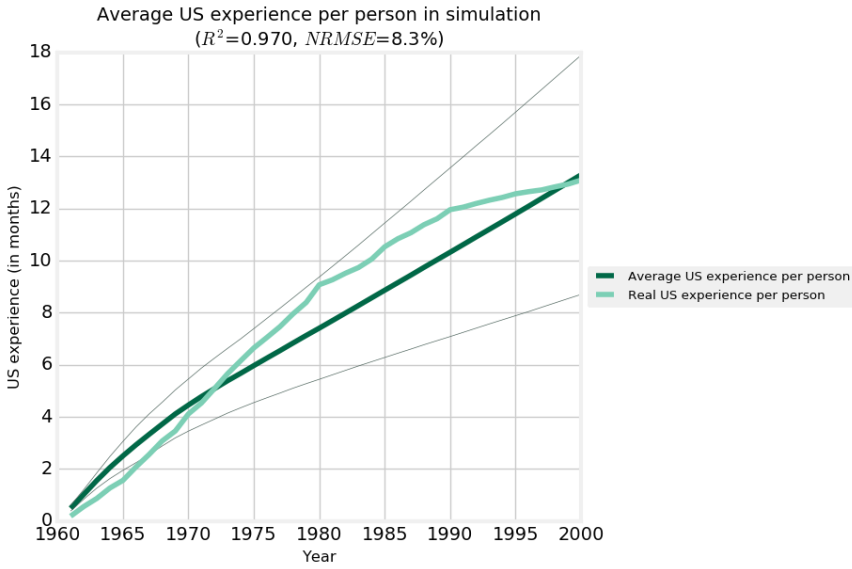

Figure 3. The cumulative average U.S. experience per person during the simulation. The results are averaged over 20 runs and the standard deviation limits are drawn. An NRMSE of 8.3% is found.

CONCLUSION

By simulating the migration flow between Mexico and the United States from 1960 until 2000, we gained an insight in the factors that play a role in making the decision to migrate. These factors are summarised in the ranked list in APPENDIX A Factor Tables. We learnt that the most influential factors are migration experiences, the amount of factories, Mexican apprehensions and health of the migrant.

An agent-based model optimised with a genetic algorithm is quite effective at simulating migration flows, but the generalisability to other case studies has to be proven. It is fair to assume that adding or deleting some factors will result in yet another modelling of migration flows that is perhaps as effective, or even more effective. An important component of human life that we failed to model here is the influence of social interaction and knowledge sharing, which turned out to be useful in other experiments (Filho, Neto & Fusco, 2011).

The model produces several remarkable artefacts, such as a negative influence of schools, whereas intuitively this seems to bring more opportunities and thus should positively influence migration, or the positive influence of crimes. Perhaps this perfectly illustrates how two things can be correlated but not causatively related. Higher crime rates does not necessarily cause more migrations, but perhaps

it just so happens to be that the two appear in the same parts of history. Or intuitively, it makes more sense if the causation was reversed: an increase in migration causes crimes to be intensified. Nonetheless, when the crime figures are known, the model can handle the data to simulate flows, regardless of the direction, if at all, of causation.

The initial distribution of citizens is questionable, as the population of Mexico is clearly not spread uniformly. The distribution of people within Mexico is probably not of importance, as the population sizes will balance out amongst themselves over the years as Mexican states have comparable figures, but the distribution of Mexicans in the U.S. is more problematic. A solution to this would be to use percentages of the population that is Mexican as a way of distributing Mexicans across the United States. This would add more citizens to U.S. states, who are most likely going to remain in those states and contribute to the computational cost. We sacrificed this point of accuracy in favour of speed.

The algorithm was only run with 1500 agents in total per run, which accounts for about 30 citizens per state. The impact of a single migration decision is now greater than it should be. Given enough time, a total amount of agents of 15,000 would place about 300 citizens in each state, which makes a single decision less important.

A last statement worth mentioning, and already mentioned throughout this section, is that a genetic algorithm produces an approximation of the true solution, and might not be directly applicable to reality. Still, the relations between the given factors are made clearer and can help us better understand the reasons why Mexicans migrate.

CHAPTER 4
Integrating insights

"Without economic growth and job creation in Mexico, we won't be able to confront the migratory phenomenon."
—Andrés Manuel López Obrador

THE PREVIOUS CHAPTERS PROVIDED INSIGHT IN the methodologies and theories of the involved disciplines. The conclusions of these chapters are still just the stepping stones to the holistic conclusion. In the following chapter, we will attempt to integrate our insights in a more all-embracing answer.

FINDING THE UNCOMMON GROUND

The disciplinary chapters approached the problem of migration in different ways. These parts comply with perspective taking, where we all three see the problem from a certain point of view. So, we take on a certain role and we reflect on the advantages and limitations of the disciplinary writings. After combining these limitations and advantages we take an interdisciplinary position on the matter.

We do not limit our perspective to only those standard views we described per discipline (Repko, 2012). The first chapter in historical perspective examined major, short term trends such as a revolution or amendments on immigration acts. The second part looked at the nation from an economic macro-perspective and takes long term trends for granted. Together they lay the context by connecting the material to the fabric of time (Repko, 2012). The third part has a less locked perspective and implemented actors, which don't behave like real humans. These actors act by some implemented rules, such as rationality.

Carefully balancing the implementation of a holistic view will be an important part of the integrative phase. Where holistic thinking is the capability to information and perspectives from different disciplines relate to each other and to the main question (Repko, 2012). This holistic view will come to light when we place

the factors on a spectrum. But before this can be done, we need to explore concepts and assumptions like rationality. While these assumptions sometimes conflict, they also overlap in other ways. An analysis of these assumptions results in common terminology like rationality, migration and push-pull factors.

COMMON GROUND BY CONCEPTUALISATION

This part describes the different definitions and discusses the distinction in definitions that exist and help create a standard for each concept. Examples of definitions are migration, a wall, individuals as rational actors, push/pull factors and households.

Migration is movement inspired by socio-economic reasons. All disciplines used the term with different interpretations. Migration in the discipline of economics can be looked at as the reallocation of an individual to another place for economic reasons, like income considerations. In its simplest form, artificial intelligence refers to migration as the movement of agents. In this specific case, a migration has a state of origin and a state of destination between which an agent travels. The motivation for the relocation depends on several factors that could be expanded or shrunk without affecting any theories within its field. Thus, to

redefine this concept we can say that migration is the movement of agents due to certain considerations.

The second concept is a *wall* which can be implemented physically, as migration restrictions or as a trade restriction. From a historical perspective, the wall is seen as an act or policy, economics as a constraint hindering migration and artificial intelligence sees the wall as an abstract concept that affects the already defined factors. The accessibility of U.S. states will drop, the border security in terms of line watch hours will increase and more Mexicans will be apprehended. We redefine the term as a physical or abstract concept which will change migration by hampering the availability of a choice, but will not change the reasons that exist for migration.

Our simulation model uses *rational actors* to represent Mexican migrants. A rational agent always makes the best choice according to its logic, given some information about the situation (Russell & Norvig, 2003). A potential migrant is given all the information about the world and decides which state is the most attractive. The migrant has infallible logic and never lets emotions interfere with the decision-making process (unless emotions are incorporated in the rational logic). This is an assumption existent in many economic theories. When this assumption does not hold it will be impossible to predict something. Historic letters often exaggerate about the opportunities in America, and these letters can result in behaviour that is not best for an individual. But the

definition keeps holding the same meaning in the different disciplines.

In terms of the simulation model, we use a slightly deformed notion of *push and pull factors*. Essentially, all included factors have either a push or a pull effect on migrants, but these are hidden in the migration decision-making process.These push and pull factors are incentives to get away from a place and to go to another. A pull factor from an economic perspective can be a better income level or better employability figures. The inhibitory or excitatory response corresponds with the sign of the factor's parameter. A negative sign means the migration score of this route is reduced because of this factor, while a positive sign means migration has become more likely.

The Mexican Migration Project used in the chapters on economics and artificial intelligence defines relationships between the interviewed people in terms of *households*. It is possible to reconstruct these family dynamics and social interactions in an agent-based model, but this is not done due to a time-constraint in our project. The model employs solitary beings that are only indirectly influenced by their fellow citizens by having access to the population size and average health of a state. There is no agent-to-agent communication in the model. In economics households are also seen as one rational decisionmaker. The household decides to send the individual who is best equipped to immigrate to the United States. This is in contrast with the historical view with communication within a family. Households are then redefined as intensive interaction between

family members who make no individual decisions, but make it in consideration with the household.

PLACING FACTORS ON A SPECTRUM AND ANALYSING 'PREDICTABILITY'

We concluded every disciplinary chapter with a ranking of factors that influenced migration flows between Mexico and the United States. Some remarkable patterns are the high scores of education, income and border control factors. We also noticed that the factors, despite sometimes being opposites, lie on spectrums of time and scale. The collective insight that follows expands on these vaguely hinted spectrums.

The transformation technique as described by Repko (2012) allows us to combine the insights from all disciplines into an integrated piece. A transformation is made by taking two opposite ends and defining a spectrum between the two. Our case study is suited for two transformations.

The first gives us a scale of influence level, or as a rather unfortunate, but more intuitive and easy to use term, a *scale of scales*. The most zoomed-in scale is that of individuals, and includes all factors that extend no further than one human body. Someone's gender is personal, it's insensible to look at the influence of the

gender of a group on migration. On the other hand, for the person itself, its gender might cause it to migrate or not.

At the other end, there are national, or even international, factors that are an abstract summary of all events on the lower scales. The United States has instantiated several migration legislations, which were high-level decisions. The legislations imposed equal consequences on the groups in the scales below. Our mid-level consists of regional factors, while the second level are individual factors influenced by regional events, and the fourth level are regional factors influenced by national events.

The second transformation results in a *scale of timeframes*. A certain factor can be persistent throughout multiple generations: its influence is unaltered in a long-term timeframe. An example of a long-term factor is a citizen's age. Human aging is a constant process and it is unlikely to change in the near future. The influence of age on migration is also constant: older people have more difficulties migrating than younger migrants, this is true in the past, present and future.

Other factors are short-lived: they are defined by their ease of change and rapid fluctuations in influence. These factors often appear as random events and are per definition difficult to predict. The Mexican Revolution is such an event that has influenced the migration flows, but which effects wore off in a short-term timeframe.

All other factors fall somewhere on the spectrum between these opposite ends. Notice the pattern that appears in the interval. As a generalised rule of thumb, most of the long-term factors are those inherent to human nature, they represent the laws of nature, while the short-term effects are the results of a chaotic process in a great system. The factors in between are those with underlying principles based on the rigid rules of nature, but with changes in implementation due to the influence of the system it serves.

Another phrasing will make the scale more applicable for the following discussion on predictability. The long-term factors can be seen as constant, while the short-term factors are variable. This rephrasing more openly shows the difficulties in predicting variable factors. If we are to predict the future scenario with Trump's wall, or even just a future population projection with no restrictions in place, we would like to see a higher correlation between the migration flows and the constant factors than with the variable factors. This property is desired, because the certainty of our prediction goes up with the ratio of constant versus variable factors. This means that when we rank the influence of the majority of the constant factors higher than that of the variable ones, we essentially claim that migrationary patterns are predictable. We use predictability as the certainty with which predictions can be made. Figure 4 shows a plot of the two spectrums with green and red areas defining the high predictability and low predictability areas respectively.

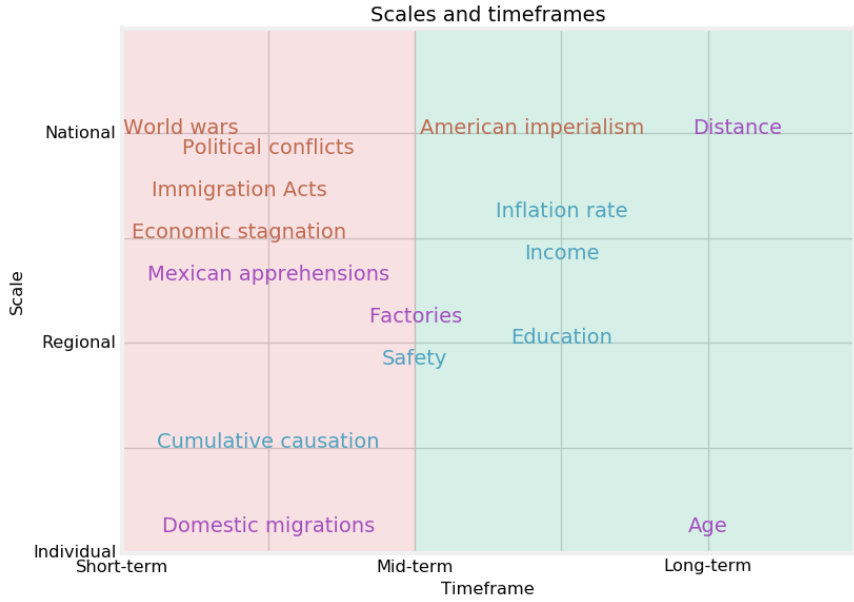

Figure 4. The most important disciplinary factors are placed along the timeframe and scale axes. Orange represents the factors found in the historical chapter, blue those in the economical chapter, and purple those in the chapter on artificial intelligence.

The scales are prepared for the classification of the ranked factors we concluded our disciplinary chapters with. Each factor was placed on both the influence level scale and the timeframe scale. A table of disciplinary factors can be found in APPENDIX A Factor Tables.

Several patterns between the influences can be noted here. All disciplines consider the influence of flow control in the form of border patrol or Immigration Acts. We combine our findings in five redefined concepts which emerge from the common ground and

place them on both scales. The highly predictable factors are opportunities, education and income. Opportunities relate to employment figures and the American attitude toward Mexican immigrants. The attitude is a national concept and usually lasts long, as it is rooted in the American culture. Both education and income are regional factors that are influenced by national decisions in legislations.

Two highly unpredictable factors are social influence and flow control. While the concept of cumulative causation always applies, the manifestation changes quickly. A single story of a relative can change the attitude towards migration, and another story can undo the effects as rapidly. Social influence differs between individuals, but is influenced by the community around the person. Flow control is a recurring theme in America's history. It involves national decisions and strengthening of border patrol, but like social influence, the situation can reverse in the blink of an eye. It usually takes a few years before an Act is cancelled or its effects wear out.

This analysis is represented in Figure 5, making the relation between the factors more easily understood. The factors are specified in detail in the combined table in APPENDIX A Factor Tables.

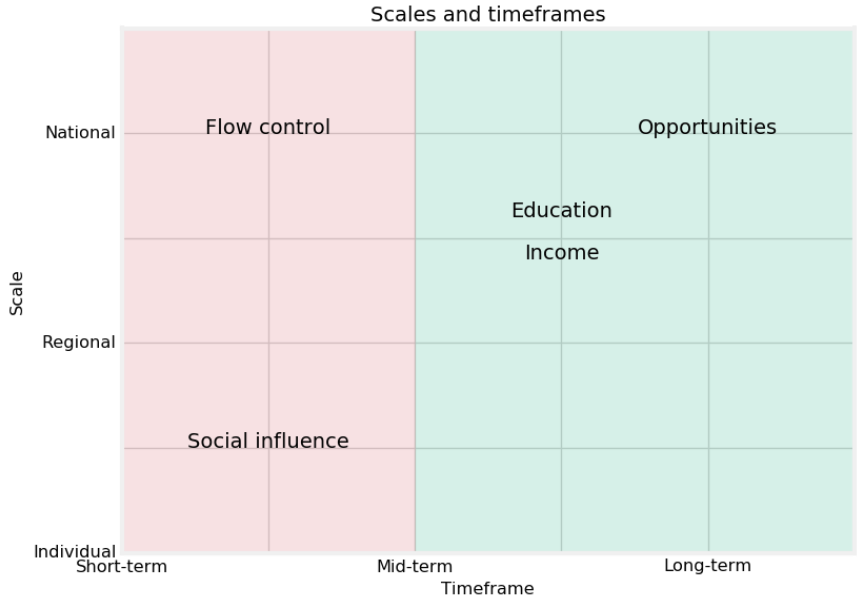

Figure 5. A revised understanding of the situation based on redefined concepts placed on the same scale as above.

MORE COMPREHENSIVE UNDERSTANDING

The next step after combining the disciplines and forming the common ground is the realisation of the more comprehensive understanding. Or in other words, to turn our understanding into something larger than the sum of its parts.

Most of the distilled factors are structural issues that operate on a long-term timeframe. Education and income are stable in both their degree of influence and values. These factors lean towards a high predictability of migrationary patterns.

Another significant element is the control of migration flow. Who may cross the border of Mexico and the United states and who may not? The United States made several attempts at flow control via Immigration Acts that resulted in an intensification of border control in the form of increased line watch hours and appointed border officers, as well as higher apprehension counts. The nature of such effects is short-term, because the sentiments on the topic vary wildly among generations. These variations in flow control make migration flows less predictable.

All in all, a large portion of the reasons for migration can be accounted for by constant factors, but another indispensible part is explained by variable factors. Migration is thus not as predictable as we would like, but attempts at modelling future flows are not impossible either. A caution should be applied when making a prediction, however, as the variable factors reduce the accuracy. The last sections will create a more comprehensive understanding of the wall and its effects on Mexican migration.

PLACING THE WALL ON THE SPECTRUM AND DECIDING ON IMPORTANT FACTORS

At last we return to our original motivation for this research: in what way will Trump's wall affect Mexican migration? The wall can be seen as a combination of factors influencing migration that will change. The influence of these factors are now known, after our disciplinary research and integrative analysis. What remains to be done is deciding which factors represent the wall and how these factors are adjusted. We can then deduce the effects of the wall on Mexican migration.

In Trump's position on the wall he proposes a rule that makes it more difficult for illegal workers to send back money to their home country, thus destroying the only security in Mexico, as there is no social safety net provided by the state.

Trump says the situation calls for trade tariffs that will influence the trade balance in the U.S.' favour and redirect most of the economy and jobs back to the Americans. This decreases the amount of opportunities for the Mexicans and their income will reduce similarly. The Trump Administration promises to cancel visas of Mexicans and send them back to their fatherland. Assuming the worst case where all migrants have to go back, the share of the Mexican population in U.S. cities drops to zero. The effect of

cumulative causation wanes as there are no family members to reunite with or friends who can share their experience of living in the United States. Trump also wishes visa fees and a regulation on the payment. This goes with increased border patrol.

The wall is most of all a flow control factor, and is therefore classified as a short-term cause. Migration will certainly be affected by a wall in the coming years, but it is difficult to say how the wall will influence migration flows on a scale of decades or longer. We suggest that a long-term prediction made while taking a wall into account should be considered with skepticism.

EVALUATING THE EFFECTS ON MEXICO

Placing a wall on the border is most likely going to result in a halt in short-term migration due to several political effects and impracticalities of travel. This effect will decline after a few years, as was the case with other migration restricting acts in the past, after which either the wall has been torn down, or migrants have found a way to cope with the barrier. Many other factors we've found to be influential in making migration decisions are not addressed by a wall. These often personal socio-economic reasons are of a long-term nature and represent the structural problems in Mexico. In order to have a predictable and lasting effect, a solution should address these problems instead.

Discussion

In the discussion there is room to elaborate on what we have learned, reflect on what steps we omitted or compressed and reconsider one's own biases (Repko, 2012). So, in other words what are the answers we got, conclusions we made, what are the shortcomings of our research and how does this pave the way for future research?

Our most valuable lesson is that migration is a complex subject with many different perspectives, theories and causes. Not a single one of these will cover the whole topic on its own and therefore it is difficult to pinpoint what precisely causes migration. And without truly understanding the roots of migration, how can you pose a wall as a solution? If one thing is certain, it's that the present underdevelopment in Mexico will remain unchanged when a wall as a short-term flow control factor is built.

The first limitation of our research, is the many-sided problem allows for various approaches and that it is impractical to account for all possible ways of looking at it. We noted the importance of social interactions during our research, but we lacked the expertise from a social science to walk this path. A further limitation was the difficulty for the disciplines economics and artificial intelligence to find the right statistical information. Migration and foremost illegal migration is an undocumented process. But in order to work with the data, the information has to be documented. This reduces the predictability power of our work. Our historian came to a similar conclusion as it is a common saying in the field that past events may never be used to predict the future; you can merely try to understand the relations between factors. A last point is the questionable precision of the performance rankings of the variables. This is caused mostly by our different understandings of terms. Take for example an United States regulation with unknown data about the influence of this regulation on education. This variable matters according to our interpretation, but which form of education is implied here, and how we can guess the influence, is uncertain.

This research focussed mostly on the perspective of Mexico, mainly in the analysis of causes for migration, and occasionally on both Mexico and the U.S. when discussing the border solutions such as a wall. An unaddressed part of this problem is to look at the

influence of both Mexican policies and development in Mexican regions regarding migration. Although we were unable to produce a definitive plan to tackle all problems regarding Mexican-U.S. migration (and rightfully so), we have discovered that some effects are short-lasting, and building a wall turns out to be a perfect example. To truly solve the problem is to solve it at its roots. We suggest to consider a more structural solution to help Mexico develop and take away the reasons for excessive immigration to the United States.

* * *

An opening statement of this piece was that controlling Mexican migration is not as simple as Trump thought.

Here we conclude our proof.

□

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APPENDIX A
Factor Tables

Table 6. The more comprehensive factors contributing to Mexican migration.

Factor	Description	Scale	Timeframe
Education	Percentage enrolled in education and the type of education completed.	🧍🧍🧍🧍	🕒🕒🕒🕒
Income	Salary of migrants compared to the inflation rate.	🧍🧍🧍🧍	🕒🕒🕒🕒
Social influence	Experience sharing through networks and family-related travel.	🧍🧍	🕒🕒
Flow control	Control of migration flows: opening or intensifying border patrol.	🧍🧍🧍🧍🧍	🕒🕒
Opportunities	Employability and places to work, as well as cultural advantages.	🧍🧍🧍🧍🧍	🕒🕒🕒🕒🕒

Table 7. The factors contributing to Mexican migration according to historical research.

Factor	Description	Scale	Timeframe
Political conflicts Mexico	Economic, political and social turmoil in Mexico causing great terror for the Mexican population (Mexican Revolution & Cristero War)		
American economic stagnation	The immense American financial crisis causing mass unemployment under Americans and the deportation of numerous Mexicans residing in the U.S.. (Great Depression & Mexican Repatriation)		
World wars	The first global war causing an economic boost for the U.S. and providing job opportunities for Mexicans. (American war industry & Bracero Program)		
Immigration acts & amendments	Different acts and amendments, implemented by the U.S. government, limiting and stimulating Mexican migration to the U.S.. (1917, 1924, 1986)		
American imperialism	America's own induced influence in Mexico's economy and politics. (NAFTA & U.S. financed railroad system)		

Table 8. The factors contributing to Mexican migration according to economical research.

Factor	Description	Scale	Timeframe
Inflation rate	Mexican inflation rate.		
Income	Mexican minimum wage (nominal pesos).		
Safety	Intentional homicides per 100,000 people.		
Education	Gross enrolment ratio in tertiary education.		
Cumulative causation	Mexicans admitted as relatives of U.S. citizens.		

Table 9. The factors contributing to Mexican migration according to artificial intelligence research.

Factor	Description	Scale	Timeframe
Domestic migrations	Amount of previous migrations inside Mexico.		
Factories	Total amount of factories in the state.		
Mexican apprehensions	Total amount of Mexicans caught at the border in a given year.		
Age	The age of a citizen in years.		
Distance	The distance in kilometers between the centers of two states. A center is usually the largest or most important city in a state.