We asked for workers, but we got labor instead

Modelling labor market effects of migration

Karen Contreras Lisperguer

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Department of Economics

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We asked for workers, but we got labor instead: Modelling labor market effects of migration.
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Summary

The topic of this master’s thesis is the short-run economic outcomes for workers in the receiving country of a migration shock of low-educated people. It was inspired by the so-called Borjas versus Card’ academic debate on the effects of migration, and specially on David Card’s research results, that conclude that a migration shock do not have or have minimal impact on the wages of low-educated local workers. The research question is: Are there alternative mechanisms to David Cards’ research results? My answer to that question is yes. I formalize that answer by presenting two task-based frameworks: Model I and Model II. Model I is a task-based framework, a model with two tasks, and Model II is an extension of Daron Acemoglu and Pascual Restrepo model from their paper “The Race Between Man and Machine: Implications of Technology for Growth, Factor Shares and Unemployment”.

The main result of the models is that, in the short run low-educated immigrants will not compete with locals’ workers given their lack of country specific knowledge. Moreover, if migration increases there will be polarization of wages and jobs. In model I, this is represented for immigrants working only in task x, and lower wages for all the workers performing that task if there is increasing migration, and in Model II, it is represented by immigrants having been assigned low-indexed tasks that correspond to low quality jobs, and local workers in higher indexed tasks. If discrimination is possible, it will reinforce the results of both models. This is undesirable because a poverty circle can be created, keeping immigrants in low quality jobs and increasing the wage gap between immigrants and local workers.

This thesis is divided into sections. Section 1 is the introduction and section 2 presents the method. This is a theoretical work and definitions are at its core, they are presented in sections 3 and 4 together with the academic debate and some theory. Section 5 is motivational to the idea of building models. The models are developed in section 6, the analysis in section 7 and conclusion in section 8.

The main message is that policy will depend on the kind of society we wish to live in. Discrimination should not be a desirable if we want to live in a more equal society without poverty. The good news is that economics, as a field of knowledge, has an important role to play, and that many economists are developing tools, as the task approach, that let us analyze other aspects of production, such as management and organizational aspects. There is hope
we are moving forward to help governments have migration policies that ask for people, and get people to maximize their production function.
Preface

Firstly, I want to thank to my supervisor Halvor Mehlum for saying yes to supervise me. I often heard people talking positively about professor Mehlum at the University of Oslo, and now I understand why. He has a professionalism, intelligence and responsibility I have not seen before, but more than that, he is that kind of supervisor that makes you go beyond your comfort zone, not because he asks you to do so, but because he inspires you to do so. I could have never finishing my master’s thesis without him. Secondly, I want to thank two very special people, my colleague, Mia Brunelle Jønnum, for her unconditional support and advice in the use of the English language, and Professor emeritus, Olav Bjerkholt, because his support and advice was the force that drove me to never give up. Thirdly, to my colleagues at the Department of Literature, Area Studies and European languages, especially Anna Kristine Høyem and Mons A. Vedøy, their support was beyond what I expected. During this journey, I have had contact with many people, and I want to thank those professors who replied to my countless questions without knowing me, Albrecht Glitz from the Humboldt Universität zu Berlin, and David Autor, Daron Acemoglu and Pascual Restrepo from The Massachusetts Institute of Technology. Special mention to Professor Aslan Zorlu, who not only replied to my questions, but he spent time with me at the University of Amsterdam. Three persons, indirectly and without knowing it, set the direction of this master’s thesis. They are Professor Jo Thori Lind, for recommending I read David Card’s paper “The Impact of the Mariel Boatlift on the Miami Labor Market”; Professor David Autor, for sending me an e-mail with the paper “The Race Between Man and Machine: Implications of Technology for Growth, Factor Shares and Employment”; and Jorge Guzman Gutierrez, former diplomat, and Chief Coordinator of the Latin American Crisis Management’s project, who put my first book of economics into my hands and motivated me to study it. Many people have showed me their support during this journey; my professors, my classmates, my friends, and my ex-coworkers at the Department of Economics at UiO, my Norwegian and my Chilean families, and Akilles. In this page I would like to express my deepest thanks all of them.
## Contents

1. Introduction ......................................................................................................................... 1
2. Method ................................................................................................................................. 3
3. Migration ............................................................................................................................... 5
   3.1 Migration today ............................................................................................................... 5
      3.1.1 On labor migration and labor ........................................................ ......................... 7
      3.1.2 Who are the labor immigrants? ............................................................................. 9
      3.1.3 Why migrate? - The decision of migration ......................................................... 10
4. What are the consequences of migration? - On the effects in the host country and an academic discussion ................................................................. 13
   4.1.1 On the effects in the host country ........................................................ ..................... 13
   4.1.2 We asked for workers, but we got people instead ................................................... 13
   4.1.3 An academic discussion: Card versus Borjas ......................................................... 14
   4.1.4 On the debate ........................................................................................................... 15
   4.2 Theory on labor migration ......................................................................................... 17
      4.2.1 Labor supply and demand model ....................................................................... 17
      4.2.2 Theory put to the test ........................................................................................ 21
5. All models are wrong ......................................................................................................... 26
   5.1 An alternative theoretical framework ....................................................................... 27
      5.1.1 Partial equilibrium analysis ................................................................................ 27
      5.1.2 The story of Aki .................................................................................................... 28
6. Models ................................................................................................................................ 31
   6.1 Motivating Evidence ................................................................................................... 32
      6.1.1 Model I: A model of two tasks .......................................................................... 33
      6.1.2 Capital ................................................................................................................... 34
      6.1.3 Technology .......................................................................................................... 34
      6.1.4 Labor ..................................................................................................................... 34
      6.1.5 Human capital ...................................................................................................... 35
      6.1.6 The model ............................................................................................................ 35
      6.1.7 The economic environment ............................................................................... 37
      6.1.8 Step I: The wage setting process ....................................................................... 37
      6.1.9 Step II: Profit maximization ............................................................................... 43
6.2 Model II: An extension of the Ricardian Skill Model ................................................. 48
  6.2.1 Environment .................................................................................................................. 49
  6.2.2 The model ..................................................................................................................... 50
  6.2.3 Allocation of skills to tasks and task to bundles ................................................................. 53
  6.2.4 No arbitrage across skills ................................................................................................. 55
  6.2.5 The wages and inequality ................................................................................................. 55
  6.2.6 Equilibrium in the Static Model ...................................................................................... 56
7 Discussion .............................................................................................................................. 60
8 Conclusion ............................................................................................................................. 64
Bibliography ............................................................................................................................. 66

Table 1. United Nations. Population division. December 2015. Selected regions and countries. (B) means that the data used to produce the estimates refer to the foreign-born population (United Nations, 2015) ................................................................. 6

Table 2. International immigrant stock by age group in millions and % of the global total. Data source: United Nations (2015) ........................................................................................................... 9

Figure 1: This figure shows the direction of the migration flow in the labor supply and demand model. The left side of the figure is the “poor” country and the right side is the “rich” country. \( W_1 \) is the wage in period 1, as \( W_2 \) for period 2. \( S_1 \) is the labor supply for period 1, as \( S_2 \) is the labor supply for period 2. For simplicity, a perfect inelastic labor supply curve is used. Due to wage differentials, migration takes place .................................................................................. 18

Figure 2: To the left the short-run impact of immigration when immigrants and natives are perfect substitutes and to the right the short-run impact of immigrants when they are perfect complements to natives ........................................................................................................... 19

Figure 3: The long-run impact of immigration when immigrants and natives are perfect substitutes ............................................................................................................................................ 20

Figure 4: An aggregate wage-setting curve in the production of task \( x \). Each point in the line is the sum of all the wages offered to each type of worker at a given skill set (s, h). The blue line shows the extreme case of workers accepting a minimum survival wage, \( w_{minF} \), and they do not have country-specific skills .............................................................................................................................. 42

Figure 5: “The task space” before migration .............................................................................. 54

Figure 6: “The task space” after migration ............................................................................... 54
1 Introduction

The evening that one of my professors recommended I read David Card’s paper “The Impact of the Mariel Boatlift on the Miami Labor Market” (Card, 1990), I started a journey trying to understand Card’s main result: A migration shock has no effect on the wages or unemployment rate of less-skilled native workers². The value of Card’s paper has driven labor economists into a discussion on the effects of migration on the wages of natives. Economists have developed two different schools of thought: one that supports that migration have no or minimal effects on native wages lead by David Card, and another that claim the opposite based on established and well accepted labor market theories represented particularly by George J. Borjas. The debate has concentrated itself in the slope of the labor demand curve, and econometric and research designs.

This debate drove me into trying to get data from Norway in order to reproduce the econometric model proposed by Ethan Lewis that analyzed Card’s result in light of International trade theory². I failed on getting the needed dataset, but that attempt offered me the opportunity to learn on economic of migration, re-evaluate and put a question mark in what I have learned during my studies.

I asked myself the following question: Could there be alternative mechanisms for David Card’s results? My answer is yes. Because there are two features that, the orthodox theory of labor demand and supply does not take into account: 1) Migration is a complex process because it is about people, but in economics, we study people as labor, in other words as a mere quantity, a direct input in a production function. 2) Labor markets are imperfect, in the sense that firms can affect inputs prices. It is therefore that a model that study the relationship between wages and migration from the start point of imperfection in the labor market, and a production function that humanize labor better suits Card’s results. In this spirit, two models

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² The fact that the results of this paper are based on data of a real migration shock, that took place in the Miami labor market between May and September of 1980, a situation that can be called a natural experiment makes this paper very valuable. Its value resides in the fact that in the social sciences it is very difficult and even unethical to perform experiments to test theory because we deal with human subjects. Natural experiment is a study in which the alignment of treatments to subjects is haphazard and possibly random. Such experiments have become increasingly prominent in recent years, and they have been used by scholars in a wide variety of fields to help make causal inferences (Sekhon & Titiunik, 2012)

² Ethan Lewis used the so-called instrumental variables regression approach, using the historic settlement patterns as instrument, when he analyzes Card’s results in light of an open-economy framework, this paper asks whether after the boatlift, Miami increased its production of unskilled-intensive manufactured goods, allowing it to “export” the impact of the boatlift (Lewis, 2004).
are presented in this master’s thesis: **Model I**, which is a simple model of two tasks, and **Model II**, which is an extension of a model proposed by Daron Acemoglu and Pascual Restrepo.

The structure of this master’s thesis is as follows; in the ensuing section, I described the method used in this master’s thesis. Section 3 is called Migration, where I firstly give a general overview of migration today. Secondly, in order to set clear boundaries to the definitions behind the models that will be developed in section 6 I define labor migration, labor and I present an overview over the two major questions that economics of migration studies: Who migrates and why do people migrate? In section 4, I concentrate on the third major question that economics of migrations try to answer: What are the effects of migration? I focus only on the effects in the receiving country, especially on native wages. The theory of labor supply and demand is presented just in order to give a background and a set of definitions for the debate on the effects of migration on wages in the receiving country. Then I present the Card versus Borjas debate, and how theory is put to a test. Section 5 called “All models are wrong” is a motivational introduction to the models and the models are finally developed in section 6. The discussion of some of the results from the models takes place in section 7, before presenting the conclusion.
2 Method

This master’s thesis presents two models that study the relationship between wages and migration. It is therefore a theoretical work, and when it comes to method the ones used in theoretical work are the most difficult to describe (Nygaard, 2008). It is therefore that in this section I do not focus on concrete activities I carried out, as I would have to do if it was an experimental work, but on the train of thought for the analysis.

The train of thought for the analysis was firstly to find the fundamental concepts that I needed in the relevant literature and to define them clearly in order to be able to build the foundations of a model.

I actively delimited the relevant literature to literature on labor migration. Specially the one that presents the neoclassical or orthodox model used to explain labor migration, and the one related to empirical researches on the effects of migration on the wages of natives.

In sections 3 and 4, I define the problematic concepts in the context of this master’s thesis. These concepts are migration, labor, labor migration, who the immigrants are, the reasons of migration, and the effects of migration in the receiving country.

Secondly, the models pretend to be alternative mechanisms that explain David Card’s result and that is the reason why I analyze literature in order to present and delimit both the econometrical research designs and the theoretical alternatives that researchers have previously presented as mechanisms behind his results. Those alternatives are presented in section 4.2.

Thirdly, I used actively the inductive approach, in the sense that my point of departure is a problem that needs a solution. The problem is that there is a theoretical gap and that answering the research question of this master’s thesis can help fill a meaningful part of the gap. The theoretical gap exists because there is no model that have as its starting point both that labor markets are imperfect and that workers are not a mere quantity in the production function, but that they are using their skills to performs tasks and those tasks are the ones that produce output.

Finally, in section 5 and 6 I use basic microeconomics principles to build and analyze the models because at the core of them is the concept of the production function.
Now that the method has been presented, let us set the boundaries to fundamental definitions for the model.
3 Migration

Migration is not a new phenomenon. Actually, it is one of the oldest phenomena in the planet, it has existed since the beginnings of humankind, and it plays a crucial role on the shape of societies. Theories on migration and its study have evolved enormously during the past half century, and it is a subject of debate, both at the academic and political level. In the last decade, an increasing migration trend to the Western world has contributed to escalate the political and scientific debate.

3.1 Migration today

In 2015, the word migration appeared daily in the central news of every single newspaper in Europe. Journalists reported the biggest mass movement of people around the world in recent history. A trend of increasing migration flows at pre-crisis level was well-documented using data from 2014 by the OECD in its International migration Outlook 2015, but the so-called European migration crisis doubled some of the numbers in few months. Germany alone registered a total of 441,800 first time asylum seekers, while the total of 1,255,600 was registered in the EU member states (Eurostat Press, 2016). It was a 123% increase from 2014.

In December 2015, there were 244 million of international immigrants in the world as a whole, a 3.3% of the worldwide population as shown in table 1. The worldwide population of immigrants has increased by 0.4% in the last 25 years. As the percentage of the population of

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3 Support for this statement and a review on this history of migration can be found at for example, “A Short History of Migration” (Livi Bacci, 2012) and
4 A good review supporting this statement can be found in Hein de Haas’s paper: “Migration and Development: A theoretical Perspective” (De Haas, 2010)
5 As for example, between 2000 and 2015, positive net migration contributed to a 42% of the total population growth in North America (United Nations, Poulalion Division, 2015).
6 For a complete review on media coverage on migration in 2015 see “Moving Stories”, a 100-page report published by the Ethical Journalism Network (EJN) on December 18th, 2015.
7 Before the so called European migration crisis.
8 It is the name given to the movement of over 1 million migrants, and asylum-seekers, which reached the European Union via the Mediterranean. It has been reported that over 3,700 people died or went missing in 2015 and over 80% of those migrants originates from countries on war or with repressive governments (Human Right Watch, 2016). A dangerous journey that continues in 2016 with 151,104 arrivals reported by March 31st, 2016 (UNHCR, 2016).
9 First time asylum seeker is defined by Eurostat as a person having submitted an application for international protection or having been included in such application as a family member, for the first time. It excludes repeat applicants i.e. persons applying for asylum more than once in one country (Eurostat Press, 2016).
immigrants increases in each country, so does the concern around the economic effects that migration has on the labor market, especially on the wages of natives.

The largest number of international migrants (47 million) resided in the United States of America, equal to about a fifth (19 per cent) of the world’s total. Germany and the Russian Federation hosted the second and third largest numbers of migrants worldwide (12 million each), followed by Saudi Arabia (10 million).

<table>
<thead>
<tr>
<th>International migrant stock as a percentage of the total population (both genders)</th>
</tr>
</thead>
<tbody>
<tr>
<td>World</td>
</tr>
<tr>
<td>Europe</td>
</tr>
<tr>
<td>US (B)</td>
</tr>
<tr>
<td>Norway (B)</td>
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<tr>
<td>Sweden (B)</td>
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<tr>
<td>Netherlands (B)</td>
</tr>
<tr>
<td>UK (B)</td>
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<tr>
<td>Germany (B)</td>
</tr>
<tr>
<td>Spain (B)</td>
</tr>
<tr>
<td>Poland (B)</td>
</tr>
</tbody>
</table>

Table 1. United Nations. Population division. December 2015. Selected regions and countries. (B) means that the data used to produce the estimates refer to the foreign-born population (United Nations, 2015)

The study of mechanisms behind labor migration is extremely relevant today when increasing migration is the hottest topic on the political agenda of Europe and the U.S., and economic theories play a major role in the development of policies that affect the life of millions of people in the search for new opportunities around the world. Increasing migration has called for a critical academic dialogue and further development of the theoretical framework on labor migration.

In order to be able to study, analyze or develop any theoretical framework the boundaries of the definitions of fundamental concepts must be clear. It is therefore I will review central definitions in the next sections, and set boundaries to them.

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10 This statement is based on the idea that economics is the most politically influential social science. There is a long list of literature on the topic, but my reference is based MacKenzie, 2007 and Hirschman & Popp, 2014

11 As well written by Karl Ove Moene at Klassekampen (20.02.16): Hysj, dette er hemmelig: “.. Kritikk er viktig. Økonomi trenger det mer enn andre samfunnsfag blant annet fordi noen økonomer har makt og fordi faget i noen sammenhenger har prestisje” (Moene, 2016).
3.1.1 On labor migration and labor

Labor migration is defined as the movement of human beings from one place to another for the purpose of employment. It is called international migration when it is a cross-country movement and internal migration when it takes place within countries borders. There are three major questions, which the study of economic theory of labor migration is concerned about: Who migrates, why do they migrate, and what are the consequences for the sender and receiving countries? (Bodvarsson & Van den Berg, 2013)

These questions have been present in the study of economics since its very beginnings, Adam Smith being the first economist to reference labor migration in his famous work “An Inquiry into the Nature and Causes of the Wealth of Nations” (Smith, 1776) where he wrote:

“...the wages of labour vary more from place to place than the price of provisions. The prices of bread and butcher’s meat are generally the same or very nearly the same through the greater part of the United Kingdom. These and most other things which are sold by retail, the way in which the labouring poor buy all things, are generally fully as cheap or cheaper in great towns than in the remoter parts of the country. ... But the wages of labour in a great town and its neighborhood are frequently a fourth or a fifth part, twenty or five-and twenty per cent higher than at a few miles distance. Eighteen pence a day may be reckoned the common price of labour in London and its neighbourhood. At a few miles distance it falls to eight pence, the usual price of common labour through the greater part of the low country of Scotland, where it varies a good deal less than in England. Such a difference of prices, which it seems is not always sufficient to transport a man from one parish to another, would necessarily occasion so great a transportation of the most bulky commodities, not only from one parish to another, but from one end of the kingdom, almost from one end of the world to the other, as would soon reduce them more nearly to a level. After all that has been said of the levity and inconstancy of human nature, it appears evidently from experience that a man is of all sorts of luggage the most difficult to be transported.” (Smith, 1776).

From Adam Smith’s observations let us rescue two important conclusions: the first one is that the movement of labor is not and should not be analyzed as the same as the movement of goods and the second one is that wage gap is not the only determinant behind the decision of migration.
The first conclusion is certainly very interesting because the impact of migration on the labor market is normally studied using an elementary model of labor supply and demand (Cahuc & Zylberberg, 2004) that analyzes the movement of labor under the same principles as the movement of goods. It looks like Adam Smith’s observation at a certain point lost importance or was just forgotten in the development of the neoclassical approach. Economic theory has developed further since Smith’s times, and it is now rich in theory and empirical studies. There has been a huge development of econometric tools and multidisciplinary perspectives have been taken into account in the study of economics, but still every bachelor student who takes their first course in economics (and perhaps the only one) learns that the basic model of labor demand is the explanation of the effect of migration on wages. It gives this model an enormous influence in the world.

Now let us stop for a second on the concept of labor. When we study the economic behavior of the firms and the labor market, we learn that labor is an input in the production function, a mere quantity that will produce output, but labor is workers, and workers are people. It is people who perform tasks in the firms that consequently will produce goods and services. Labor immigrants are human beings with the same needs and complexity that you have. There is complexity in human relationships, especially the one between workers and firms in the labor market, and this complexity must be reflected in the economic theory of labor.

Many economics have taken this critique very seriously and they have seen the importance in humanizing the study of labor economics, perhaps the best examples are Nobel Prize awarded economists Christopher A. Pissarides, Dale T. Mortensen and Peter A. Diamond who developed the search and matching theory. In Pissarides own words on the matching model “The way I saw it replaces the labor demand analysis”.

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12 As it is explained in the most used textbooks, as just for example in Labor Economics of G. Borjas on page 167.

13 In Paul A. Samuelson’s own words on the influence of being a textbook writer, an educator: “By writing a leading international textbook… You have a great deal of influence, I will not said power, but influence as a communicator. You heard the expression: I do not care who writes a nation’s laws, let’ me write their textbooks”, well there is true on that” (USB, 1998)

14 Cambridge dictionary’s definition of the word labor is workers. The definition of the word worker is someone who works in a particular job or in a particular way (Cambridge University Press, 2016)

15 Taken from a video at Nobel’s perspectives where he explains the basics of the matching model called “Can unemployment be explained by supply and demand?” (UBS, 2010)
In the next pages, whenever I use the words migration or labor migration I will refer only to international labor migration as the cross-country movement of people. Now let us define who are the labor immigrants and why do they migrate.

### 3.1.2 Who are the labor immigrants?

Researches, reports and analysis on labor migration will use different definitions of labor immigrants depending of which groups they want to focus on, sometimes they will refer to those who have registered work as the reason of migration, sometimes to the stock of international immigrant active in the labor force or at working age, etc. It is therefore important when reading literature on the topic to check carefully which definition is being used.

In the literature, immigrants are commonly classified by the reasons they have for migrating: family, asylum and labor, but are not also asylum seekers or immigrants due to family reason entering the labor market? Yes, they are. The reason for migration may not be labor, but most international immigrants are of working age and they will enter the labor market of the host country, as table 2 shows: 72% of the global total of immigrants is at working age.

<table>
<thead>
<tr>
<th>Age group</th>
<th>Total stock</th>
<th>% of the global total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 20</td>
<td>37 million</td>
<td>15%</td>
</tr>
<tr>
<td>20-64</td>
<td>177 millions</td>
<td>72%</td>
</tr>
<tr>
<td>65 or more</td>
<td>30 millions</td>
<td>12%</td>
</tr>
</tbody>
</table>

**Table 2.** International immigrant stock by age group in millions and % of the global total. Data source: United Nations (2015)

Migration due to only labor reasons is not as big as many would believe, one of the determinant factors of labor migration are wage differences between regions and still with higher wage differences and zero legal cost of migration, pure labor migration is not very high. For example, in 2012 the OECD countries registered a notable fall in permanent international labor migration and it accounted for only 36% of the total migration in all the European Economic Area (International migration division OECD, 2014).
The main reason for these low numbers is that the cost of migration can be extremely high. Statistics from the US showed that only 10% of Mexicans and only 30% of Puerto Ricans have moved since World War II. Actually, most people do not move (Borjas G., 2008) (Kennan & Walker, 2011).

For the purpose of this master’s thesis, a labor immigrant is defined as a person at working age at any period of time that was born abroad, without taking into account the reasons the subject had for migrating to the receiving country.

3.1.3 Why migrate? - The decision of migration

There is no “one” single model or theory about the decision of migration, and economists and sociologists tend to disagree. There is a huge amount of literature on the topic, and the most accepted theories can be divided as follow (Bodvarsson & Van den Berg, 2013):

a) The neoclassical approach focuses mainly on wage differentials as the reason for migration:

The work of Adam Smith (Smith, 1776) is considered the starting point for this perspective; it is attributed to him the focus on wage differentials and barriers to migration. Even that he did not explain in his work what the barriers of migrations are or the mechanism behind wage differential as a force for migration. It was John Hicks, 156 years later, that on page 76 of “The theory of wages” (Hicks, 1932) made clear the relationship between wage differentials and migration: “differences in net economic advantages, chiefly differences in wages, are the main causes of migration”.

In 1946, George Zipf influenced by the Ravenstein laws developed “The gravidity model of migration” (Zipf, 1946). He considered distance as a good proxy for migration: The volume

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16 In this paper, they developed an econometric model of optimal sequences of migration decisions focusing on expected income as the main economic influence on migration. They estimated using panel data that the moving cost for the average mover in their sample was about $312,000 (in 2010 dollars). In their sample they considered only white non-Hispanic high-school graduates with no post-secondary education for the US. (Kennan & Walker, 2011)

17 Even that I follow the classification presented in (Bodvarsson & Van den Berg, 2013) I differ from them in some shade, specially respect to Adam Smith. I disagree with their interpretation they give on the work for those two authors.

18 This is not the only possible classification. There are other classifications, that are very interesting as the one that classifies immigrant as suppliers, investors, consumers and producers in their decision of migration as in (Shields & Shields, 1989).

19 Ravenstein laws model by Ravenstein (1889). He built seven laws on migration based on British census data.
for migration is higher the greater are the populations of the origin and destination communities. Another model that has in its core the wage differentials is “The business cycle model” (Jerome, 1926), in which migration fluctuations are based on business cycles.

b) *The standard modern theory of migration differences three major reasons: Human capital, consumer behavior and household production.*

In the Human capital approach, people migrate to invest in human capital. They are different models based on this reason, and the most knowns are the ones in Becker, 1975 and Sjaastad, 1962. It has been extensive used to study internal migration by economist, and it presents the decision of migration as a one-time investment. The Consumer approach sees the decision of migration as a consumption decision, and migration will take place if it can increase the immigrant consumption of amenities and public goods (Greenwood 1997, Rosen 1974 and Tiebout, 1956). In the Household production approach, the decision of migration is seen as a decision of the household as a productive unit. If the immigrant is a producer of their own household goods and services, migration can change costs of production and income, as in Shields and Shields 1989, Lancaster 1996 and Willis 1973.

Extensions have been developed from the three mentioned theories. One of the most popular is the work of George Borjas who has presented not one but three models, starting with an extension of the model at Sjaastad 1962 (Borjas, 1987,1991) and then two mathematical approaches. Other important extensions have also been developed as an answer to characteristics that cannot be explained by Sjaastad’s model. These extensions are the role of past migrations (Yap 1977, Hugo 1981, Taylor 1986, Massey and Garcia España 1987 and Lundborg 1991), immigration as a life cycle investment decision (Polacheck and Horvath 1977), and expected income hypothesis (Todaro 1969, 1976 and Harris and Todaro 1970). Extensions of Borjas model have been made by Hatton and Williamson (2005, 2010) and in Clark, Hatton and Williamson (2007).

c) *The family approach focus in the family or household as the decision-making unit.*

It has been presented from two different points of view. On one hand, some authors see the decision of migration as a conflict of interest. Their models recognize that this decision can enhance the welfare of some family members but reduces others members’ welfare, as in

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20 There are many surveys of literature as for example Massey and Garcia España 1987
Polanchek and Horwvath 1977, and Mincer 1978. On the other hand, some authors see it as a portfolio decision: They focus on looking at the decision of sending a family member abroad as diversification of the risk of the family investment, as in Stark and Levhari 1982, Stark 1984 and Katz and Stark 1986.

In this master’s thesis, the main reasons presented by the neoclassical approach, the standard modern theory and the family approach are considered complementary of each other, as pull and push factors of migration, following sociology theory (Lee, 1966, Çelik & Notten, 2014, among others). Sjaastad’s work has been extremely important because he introduced the concept of human capital investment. Since I will argue in section 7 that the decision of migration is not a one-time investment and against complete wage convergence, I distance myself somewhat from it. Sjaastad’s model implies complete wage convergence between source and destination (Bodvarsson & Van den Berg, 2013).

I also distance myself from models that present themselves as the only real reason of explaining why migrations happen. Due to the complexity of the phenomena, I consider the existence of “one” true reason as implausible.
4 What are the consequences of migration? - On the effects in the host country and an academic discussion

In the center of the study of migration are the economic effects for the sender and the receiving countries. I will only focus on the effects in the receiving countries because whether the immigrant inflows negatively affect native labor markets outcomes remains a controversial issue for both politicians and academics.

4.1.1 On the effects in the host country

When people migrate, the effects in the receiving country will be economic, political and cultural in character, such as language, music, health, commercial practices, policies, gender, racial issues, intermarriages, prices, wages, etc. Researchers in the social sciences study the nature, the size, the social impact and the mechanisms behind all these different effects. In the context of this master’s thesis, the economic effects are the one been studied.

How does migration affect the labor market’s outcomes for natives? This is the main question that economists try to answer in the study of migration. There are diverse channels by which migration can affect the labor market, but the most studied channel is through wages. Researchers normally concentrate their efforts on finding out if native’s wages change with migration and the literature is rich in papers that intend to answer this question. The importance of this question lies with the social frictions developed between natives and immigrants when migration takes place. Since, in the presence of increasing migration, frictions will emerge.

4.1.2 We asked for workers, but we got people instead

Are the mentioned frictions important? Let us answer this question with an example. The Swiss writer Max Frisch made famous the phrase “we asked for workers. We got people instead”2122. It refers to how ironically the Swiss government encouraged the arrival of guest

workers in the 60’s, especially Italian workers. The government assigned them different types of work permits, some forbidding them to switch jobs, ranging from the "frontaliere" permit given to Italians living near the Swiss border to the "C" permit granting the same status of a Swiss citizen minus the political rights (swissinfo.ch , 2004). At the same time, the frictions with the natives increased at the point that an “anti-italians party” was created in 1963. The Italian workers that the Swiss wanted so much as an input in their production were at the same time a problem for the society.\(^{23}\)

Italian immigrants migrated to Switzerland because they needed work, and they arrived with a package of human capital that was different from the average Swiss worker. It meant an increase in the variety of the human capital that was available to perform tasks in the production processes, but it created frictions in society and in the labor market. Immigrants take with them their families, culture and customs, they become consumers in the receiving countries and part of their societies. When labor increase, it is not only an increase in the number of an input in a production function, it is an increase in the number of human beings with a different cultural background, values, language and understanding of the world, who will interact with natives. \textit{When the labor stock increases due to a positive migration shock, the frictions in the labor market increases as well.} With this in mind, let us move on into an academic debate full of frictions.

\subsection*{4.1.3 An academic discussion: Card versus Borjas}

We have seen now, how migration increases frictions in the receiving country, but what does it mean? Are there negative labor market outcomes for native workers? Do the wages of native workers depreciate? There is no one unique answer to these questions.

In searching for literature about the effects of migration in the labor markets, whenever I met with or talked to researchers in the field of Economics of Migration, I regularly got the same

\begin{flushleft}
\footnotesize
\textit{interviews and documents of Italian seasonal workers in Switzerland. I focus on the difficult relation between Swiss and immigrants, full of prejudices and a fear. It is not a theory, just documentation. A documentary, directed by Alexander J. Seiler, with the same name was produced in 1964 (CINEMAN)\(^{22}\)}

\textit{Max R. Frisch was a Swiss playwright and novelist, known for his use of irony and focus on problems of identity, individuality, morality and political commitment. (Bourgoi & Byers, 1998)\(^{23}\)}

\textit{This problem is ironically well showed in the Swiss short film: “Die Schweizermacher (The Swissmakers)”1979. It is a problem that must be fixed by the government by means of integration: converting immigrants into Swiss people.}
\end{flushleft}
questions: Skill cell correlation approach or spatial correlation approach?, Area studies or skill-group studies? Moreover, whom do you really agree with: Borjas or Card?

This happened because there is an ongoing academic debate in this field on the effects of migration on the wages of natives in the receiving countries. This debate has divided researchers into two groups: One group that agree with professor George Borjas, which finds that migration has a negative significant effect on the wages of native workers, and the other group that agree with professor David Card, which supports that migration have no or minimal effects on native wages\textsuperscript{24}\textsuperscript{25}.

Sometimes this debate have been so heated that it looks like Borjas and Card have been part of an ugly divorce after being best friends, and that it is more a personal discussion than an academic one. It has become public knowledge, and some of the major magazines and newspapers in the U.S., for example “The New York Times”, have published articles on their academic discussion.

Now, let us move on into understanding the reasons behind it.

\subsection{4.1.4 On the debate}

The debate was primarily developed in the US because when it comes to migration, the US is the country that has been studied the most, simply because there is a lot of data\textsuperscript{26}. As a mere example, data on the number of legal immigrants has been available since the 1820s\textsuperscript{27}.

\textsuperscript{24} George Borjas was born in Havana, Cuba and migrated to the United States in 1962. He is a professor in economics at Harvard Kennedy School. He has written more than 125 articles and books, including \textit{Friends or Strangers: The impact of immigrants on the U.S. economy} and \textit{Labor Economics}, both are used to teach bachelor students all over the world\textsuperscript{26}. His works appear frequently in major magazines and newspapers including editorials in the New York Times and Le Monde. His research on the economic effect of migration has had a central role in migration policy during the last decades and Business Week and The Wall Street Journal have called him “America’s leading immigration economist”.

\textsuperscript{25} David Card is a Canadian professor of economics born in 1956. He migrated as a student to the US and is currently a Professor of Economics at the University of California, Berkeley and Director of the labor studies programs at the National Bureau of Economic Research in USA (University of Carlifornia, Berkeley, 2014). He is a productive writer with more than one hundred articles and has been awarded a series of very important prizes in the field of econometrics and labor economics. He has been awarded with the American Economic Association’s John Bates Clark Prize (1995), the IZA Labor Economics Award (2006) and the Frisch Medal by the Econometric Society (2007).

\textsuperscript{26} I mean “a lot of data” as big in size, and not as “big data”, since the term “big data” means big, fast and variety data.

\textsuperscript{27} For a complete overview of statistical data on immigration for the US in the 1800s see the “The Statistical review of immigration 1820-1910” (US Congress , 1911)
Data copiousness and accumulation have given a good basis for researches to develop their work. Studies about migration have flourished especially after the development of microdata sets during the 1970s and 1980s (Greenwood M., 2004). This academic debate exists mainly because most “cross-city studies” find little evidence of a sizable adverse impact on the earnings of natives, while other empirical researches give the opposite results.\(^{28}\)

The common start of all these research papers is that they try to give an answer to the following question: How are changes in the skill mix of local labor supply absorbed by the economy? Researchers have different approaches to answering this question:

Labor economists confront this question arguing that the main channel of adjustment is the changes in factor prices, as in Ottaviano and Peri 2011, Card 2001, Borjas 2003, Dustman et al 2005, etc.

Trade economists argue that the main channel of adjustment is through changes in the output mix, the production units that use the more abundant factor grows faster, as in Rybczynski 1955 or empirically in Quispe-Agnoli and Zacodny 2002, and Lewis 2004.

The study considered the start point of this debate is David Card’s famous paper “The Impact of the Mariel Boatlift on the Miami Labor Market”. In this paper, he analyzed the impact of a migration shock on the Miami labor market when Cuban immigrants accounted for increasing the labor force of Miami by 7% (Card, 1990). He found no effect on native’s wages. Other analyses that he had published always give us the following conclusion: a migration shock had no or minimal effects on native wages.\(^{29}\) George Borjas’s work on similar cases gave the opposite result, and in 2015/2016, he re-examined the Mariel Boatlift case: According to him, the migration shock depreciated native’s wages of the least educated Miamians by a 10 to 30 percent (Borjas G., 2016). These contradictory research results are at the core of the discussion on how econometric research design can be the reason behind the results.\(^{30}\) In order to have a clear understanding of the central concepts of disagreement I present in the next section a short review of the theory on labor supply and demand before pointing out the


\(^{29}\) He found no negative wage’s effect for low-skilled natives in the US in his paper called: Is the new migration really so bad? (Card, 2005).

\(^{30}\) Econometric research design refers to how economists choose the explanatory variables in econometric models (Stock & Watson, 2015).
main arguments in this conflict, *for the mean time I can say that they disagree specially on the elasticity of the labor demand.*

### 4.2 Theory on labor migration

At the core of this debate is the model of labor supply and demand. It is therefore that in this section I introduce the model and its basic concepts.

#### 4.2.1 Labor supply and demand model

The labor supply and demand model is the one used to study the effects of labor migration. This is a model under perfect competition assuming that both inputs and good prices are given, there is full information and the markets can clear each other. Let first us see what the short run looks like:

On the supply side, optimizing agents maximizes a utility function with two arguments, income and leisure, subject to a full-income constraint. The agents will supply labor so the marginal rate of substitution of consumption for leisure equals the wage rate; hence, the individual labor supply is a function of the wage rate. If we focus on migration, this intuition is in accordance with the neoclassical theories on the reasons of migration, if there are wage differentials between two countries the agent should offer his labor in the country with the highest wage and this action requires migration.

On the demand side, profit-maximizing firms have a product function with two arguments, capital and labor, subject to a cost constraint. Since we are looking to the short run, capital is kept constant, so we have a macro production function $Z=\mathbf{F}(L, K) \equiv Z=\mathbf{F}(L)$. The firms will demand labor up to the point that the value of the marginal product of labor equals the wage. The demand of labor tells us the willingness of the firms to hire workers, and this willingness derives from the consumers’ consumption behavior.

Figure 1 shows us two countries, one “poor” (p) and other “rich” (r) in two periods of times: before migration (1) and after migration (2), in the presence of wage differential in period 1 the agents will move from the “poor” country to the “rich” one. There is one type of labor (L), and the macro production functions are given by $Z^R=\mathbf{h}(L_R)$ for the rich country and $Z^P=\mathbf{f}(L_P)$
for the poor country. The profit maximizing behavior of the firms determines the wage structure. This will give us the F.O.C.:

Rich country: \( p^R h_L = w^R \), Poor country: \( p^F f_L = w^F \), \( L^S = L^D \) in both countries

\[ D = p^R f_L \]

\[ D = p^F h_L \]

**Figure 1:** This figure shows the direction of the migration flow in the labor supply and demand model. The left side of the figure is the “poor” country and the right side is the “rich” country. \( W_1 \) is the wage in period 1, as \( W_2 \) for period 2. \( S_1 \) is the labor supply for period 1, as \( S_2 \) is the labor supply for period 2. For simplicity, a perfect inelastic labor supply curve is used. Due to wage differentials, migration takes place.

In the presence of migration, the characteristics of the production function and the immigrants will determine its effects in the receiving country. Let us examine this assumption.

The basic intuition behind this assumption is that before migration the economy is at an equilibrium for natives workers (\( E_{n0} \)), the effect for natives workers will depend on if the immigrants are substitutes or complements as inputs in the production function.

There is one overruling concept behind this assumption: the elasticity of labor demand. It measures the responsiveness of employment in the industry to changes in the wage rate, and in the short run is defined as the percentage change in short-run employment (\( E \)) resulting from a 1 percentage change in the wage(\( W \)):

\[
\text{Elasticity of labor demand} = \frac{\Delta E/E}{\Delta w/w} = \eta
\]

Labor demand is elastic if its absolute value is greater than one and inelastic if it is less than one. Given that the short-run demand curve for labor is downward sloping, it must be the case that the elasticity is negative. This concept is essential to this analysis because it tells us what will happen in the case of a positive migration shock.
The intuition is as follows: If we assume that natives and immigrants are perfect substitutes in production, as long as the demand curve is downward sloping, and technology and capital are fixed, an increase of labor due to migration will move the economy down the demand curve, reducing the wage of native workers (Borjas G. J., 2010).

As shown to the left in figure 2, firms will maximize profits by hiring more labor up to $E_{t1}$ when the wage is $W_1$. This model predicts that immigrants will “take” some jobs from the natives by reducing the market wage and convincing them to not work. Reducing the employment of native workers from $E_{n0}$ to $E_{n1}$.

The second option is that immigrants and natives are complements as shown to the right in figure 2. They are not competing in the same labor market. Then immigration makes natives more productive and the demand curve for natives move up increasing natives wages.

![Figure 2: To the left the short-run impact of immigration when immigrants and natives are perfect substitutes and to the right the short-run impact of immigrants when they are perfect complements to natives.](image)

In the long run, both technology and capital are not fixed, and firms will maximize profits by choosing both how many workers they will hire and how much they will invest in equipment and new technology. Shift in the demand curve will depend on the underlying technologies.

*Therefore, we can say that the characteristics of the production function are the ones that will determine the impact of migration on native wages.*

If immigrants are perfect substitutes on labor, the long run effects of migration can be described as in *figure 3*. The two groups compete in the same labor market, first the wage will fall from $W_0$ to $W_1$, and over time, because capital expands, it will increase. If we have an
underlying production function with constant returns to scale, the economy will move back to its initial wage level $W_0$.

![Figure 3: The long-run impact of immigration when immigrants and natives are perfect substitutes.](image)

To summarize, there are three essential assumptions in this model: firstly, the labor demand curve is downward sloping, secondly, in the short-run effect of migration depends on natives and immigrants being supplements or complements in production, in other words if they are or are not competing in the same labor market. Finally, in the long run effects depends essentially on the underlying technology, in other words in the production function.

One question that is reasonable to ask is the following: Are natives and immigrants getting the same wage for the work they perform? If there are differences, we say that there is a wage gap.

**The wage gap**

Economic theory tells us that the laws of supply and demand, as presented in the previous section, are the ones that determine the structure of wages in the labor market (Borjas G. J., 2010). The existence of wage inequality is considering reflecting two essential features of the labor market:

1) The productivity differences among workers are the reason for the wage gap. The greater the difference, the greater is the wage inequality.

2) The returns to skill will vary across labor markets and over time, the greater the rewards for skills, the greater the wage gap.
Researches have shown that an immigrant gets a lower wage than natives do at the moment they enter the receiving country, even though it will grow over time, some groups will never reach wage parity with natives (Anderson, 2015).

In the context of this master’s thesis, the wage gap means the difference between the real wages of two workers that are equal in their general skills set, except by migratory status.

Now that the main concepts of the labor supply and demand model have been presented, let us move on and see how the academic debate has put this theory to a test.

4.2.2 Theory put to the test

The previous simple and short overview of the theory of labor supply and demand will help to a better understanding of the academic conflict, since as mentioned in section 4.1.3 the elasticity of the labor demand curve is at the center of it. In addition, the concept of inputs being complements or supplements of each other in production is essential to understanding the research results.

Theory must be testable

In the social sciences, we use the scientific method to make sure our attempts to explain how the world works result in valid knowledge (Scholten, 2015). Opinions, beliefs, casual observation and informal logic do not create knowledge. They are too subjective and too susceptible to error.

The scientific method can be explained by using six essential principles, which can be summarized as follows. Theory must be empirically testable, meaning that in order to be considered knowledge, any theory or model must be testable, and the empirical research must be replicable, in the sense that we should be able to replicate consistently the original study and objective because this must allow others to repeat without need for the original researcher. A research study must be transparent, meaning that information is available, in such a way that a research experiment could be replicated by anyone. This means that researchers need to share publicly what assumptions were made, how concepts were defined,

31 This is an extreme simplification of the scientific method in order to make clear the basic principles that should be taking into account for a theory to become knowledge. The book of reference is Nola & Sankey, 2007. The book presents a detailed introduction to the scientific method.
what procedures were used, and any other information that is relevant for an accurate replication. It must also be falsifiable, a hypothesis is falsifiable if we are able to imagine at least finding observations that will contradict our hypothesis. If we cannot imagine what such contradictory data would look like, well, then the hypothesis cannot be disproven. Finally, logical consistency, in order to become knowledge, there should not be any internal contradiction in a theory or model.

In other words, for any economic theory to constitute knowledge, this must be empirically testable, and the research study in itself must be in accordance with the mentioned principles.

The academic discussion: main divergences

The academic discussion on the effects of migration shocks on local workers’ wages, especially on the wages of low-skills workers, has developed because researchers in economics use the scientific method in order to support and evaluate scientific claims about how the world works. Economists essentially use econometrics to test the validity of economic theory. Econometrics models have therefore been at the core of the academic debate, especially those that have put the theory of labor supply and demand to the test. In this debate, the slope of the labor demand curve has been a sensitive topic.

The demand curve is downward sloping

The labor demand curve gives us the relationship between wages and the quantity of labor demanded by the firms. In the short run, it will tell us what happens with a firm’s employment as the wages change, holding capital (Borjas G. J., 2010) and other inputs constant. The presumption that the input demand curves are downward sloping had a singular persistence in the making of microeconomics of production and it has been formally and elegantly proven in Samuelson, 1947. In other words, more labor is demanded at lower wages. Card criticizes that the leap between Samuelson’s proof to the proposition that a positive labor shock reduces

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32 Econometrics is the science and art of using economic theory and statistical techniques to analyze economic data (Stock & Watson, 2015).
33 As in the Hicksian inputs demand curves, with an adjusting output, that were admittedly invalid in the case of constant return to scale; the Hicks-Allen curves of derived demand were prove to be downward sloping only under some regularity assumptions concerning output demand and in the case with two inputs; the Ferguson-Saving-Silberberg long –run input demand curves with an adjusting output price, etc (Steedman & Opocher, 2015).
34 This probe was developed on page 72 in Paul Samuelson’s book Foundations of economic analysis (Samuelson, 1947)
workers’ wages is too short and easy (Card, 2012). While for George Borjas there is no doubt about the answer to this question. One of his major contributions in the field of economics is a paper titled "The Labor Demand Curve is Downward Sloping: Reexamining the Impact of Immigration on the Labor Market" (Borjas G. , 2003) and from the very beginning he makes his standpoint clear, the elasticity of labor demand is negative.

On the other hand, David Card’s calculation in The Mariel Boatlift paper gives a constant elasticity of labor demand. The importance of this paper resides in the fact that it is the analysis of a natural experiment, something very valuable in socials science since it is difficult to have the opportunity to test the theory in reality. It has even been attributed to David Card to make the term natural experiment fashionable in economics (Morgan, 2013). Moreover, let us examine how the design of the researches affects their results.

**Differences in econometric research designs**

Econometric research design is essential in this debate because the discussion focuses on which econometric tools have been used and developed to test the validity of the model. There are essentially three methods used in order to test the effects of a migration shock: Instrumental variables, simulation based approaches or skill cell correlation approaches.

**Spatial correlation approach:** The historic settlement patterns are used in this case as the instrument. The approach amounts to regressing differences in regional economic outcomes on differences in immigrant/resident ratios, using past immigrant densities as an instrument for the latter. Examples of empirical research using this approach are Altonji and Card 1991, Hunt 1992, Card 2001, Card and Lewis 2005, Dustmann et al. 2003.

**Simulation based approaches:** It aims to avoid the identification of the effects of immigration from local labor market information only. The counterfactual – the labor market conditions in the absence of immigration – is constructed by simulation. An example of this research design can be found in Borjas, Freeman and Katz 1997.

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35 Mary Morgan’s paper attribute this popularity of the term to David Card due to his work on the investigation of minimum wage effects in David Card and Alan Krueger work in 1994 and 1995.
36 In this, I follow the classification done at Dustmann, Glitz, & Frattini, 2007.
In order to be able to conduct this kind of econometric model an important assumption for obtaining unbiased results is that natives and immigrants are perfect substitutes within each skill group.

The skill-cell correlation approach: Borjas suggests that an analysis based on the national level, and therefore robust to the problem of out-migration or, for that matter, other ways of adjustment of local labor markets, is better. He argues that the spatial correlation approach may lead to an underestimation of wage- and employment effects (Borjas G., 2003).

It is interesting to see that Borjas’s cell correlation approach is not dissimilar to the idea in Card (2001), who distinguishes between six skills groups, in that it creates additional variation that can be used for estimation. For a sufficiently large number of cells, and additional time variation, the estimation does not need to rely on variation obtained from spatial segregation.

Underlying the skill-cell correlation approach is the assumption that there is perfect substitutability between natives and immigrants within skill cells.

In most studies using this approach, the results tell us that immigrants are not perfect substitutes for natives even within narrowly defined skill groups, but partly complement them in their skills, in other words the effect on native wages is substantially small.

It is therefore that researchers, under the assumption that the mechanism behind the model of labor supply and demand is true, have tried to identify the mechanisms behind the absorption of immigrants by the receiving economies without lowering the wages of their native workers. The harder discussed mechanisms are out-migration, international trade and capital elasticity:

Out-migration: Borjas and others consider migration of native workers in the presence of migration as the reason that leads to a bias towards zero when estimating the effects using the spatial correlation approach. Refuters of Borjas call it the “skating-rink” model: whereby each immigrant who skates into an area knocks one native off the ice. As immigrants, enter the labor market of the receiving country, native workers with similar skills move out. Card and co-authors finds little to no evidence of this for U.S. data.

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38 Card and Di Nardo 2000, Card 2001
**International trade:** As in Lewis 2004 and others, the low skilled - labor-intensive industries absorb the inflow of less educated immigrants, allowing export of the negative impact. If there are comparative advantages in trade and trade takes place, these industries will benefit and the overall income for the receiving country will grow.

**Capital elasticity:** Whether we believe that the overall effects on wages of resident workers (i.e. the effect on the average native wage in our economy) is positive, zero, or negative, the magnitude of these effects depend on our views about the elasticity of capital supply. Firms are not statics and they respond to the increased supply of immigrant workers by adjusting capital for the US as in Ottavian & Peri, 2012. The intuition behind this is that the faster capital is able to adjust, the smaller will the effect on average wages in the economy be.

For the current knowledge of the author, other channels are being discussed in this moment in seminars, working papers, the news, and even in social media. The most anticipated research is Borjas new book that will be available in October 2016, titled “We wanted workers – unravelling the immigration narrative”.

The majority of the empirical research on natural experiments and on available data show, until today, no or minimal effect on migration on native wages, but the discussion is far from over\(^\text{39}\). With this in mind, it seems that the displacement theory: the idea that immigrants will “take” some jobs from the natives by reducing the markets wage and convincing them not to work has been invalidated.

The approaches presented are econometrical models that differ in design. The theory is also presented as a model. The word model appears many times in these pages, and this thesis tries to build two models, so it is necessary to define its meaning. The next chapter will do so.

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\(^{39}\) There are two literature reviews that focus on comparing the results of the studies, especially the elasticities of demand: One about 27 published empirical studies (Peri, Do immigrant workers depress the wages of native workers?, 2014), and other on 18 published empirical studies between 1982-2003 (Longhi & Poot, 2005), that support this statement.
5 All models are wrong

An economic model is normally defined as a simplified description of reality, designed to yield hypotheses about economic behavior that can be tested. An important feature is that a model is necessarily subjective in design (Ouliaris, 2011). In the following quote, we see how the statistician George Box articulated these model features:

*For such a model there is no need to ask the question “Is this model true?” If “truth” is to be the “whole truth” the answer must be “no”. The only question of interest is “Is the model illuminating and useful?”* George Box (Box, 1979)

Box tells us that all models are in essence wrong or imperfect, but more important is how useful they are to the scientific dialogue. The quality of the model will depend on its power to explain the reasons of the observed economic phenomena, to make precise common sense insights and to expose erroneous reasoning (Cowell, 2006).

One characteristic that gives power to a model is simplicity, and the simpler it is, the more attractive it turns out to be. One important measure of simplicity is the number of parameters that it contains. When this number is small it can be said that the model is parsimonious, and it is desirable because simplicity illuminates and complication obscures. Being the model rewarded with precision (Box, 1979).

The model of labor supply and demand is so powerful for this reason, for its simplicity. In a similar manner, there is a singular persistence in the assumption that the input demand curves are downward sloping in the making of microeconomics of production40. With this in mind,

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40 This idea that there is persistency in the literature in assuming that the input demand curves are downward sloping is based on the review of professor Arrigo Opocher and Ian Steedman, in their book “Full Industry Equilibrium: A theory of the Industrial Long Run”. In their conclusions (p.200), they wrote, “The presumption of downward-sloping input demand curves had a singular persistence in the making of the microeconomics of production. Many different versions were characterized by different *ceteri paribus* stipulations, each providing a different proof of the same property. Yet these proof were by no means all of the same strength: Samuelson’s conditional input demand curves are unassailable within their narrow limits; the Hicks–Allen curves of “derived demand” were proved to be downward-sloping only under some regularity assumptions concerning output demand and in the case with two inputs; the partial equilibrium Hicksian input demand curves with an adjusting output were admittedly invalid in the case of constant return to scale; the Ferguson–Saving–Silberberg long-run input demand curves with an adjusting output price were proven to be downward-sloping only when expressed in per unit of output terms. Other weaknesses characterized the many versions of a supply curve in the Marshallian tradition. The deep-rooted belief in the existence of general laws of demand and supply has been nurtured by an equally deep-rooted attitude to making a clear-cut distinction between partial equilibrium and general equilibrium methods, neglectful of Schumpeter’s plea for more nuanced views.” (Opocher & Steedman, 2015)
let us investigate the possibility of alternative frameworks to explain David Card’s research results.

5.1 An alternative theoretical framework

Models make us think more clearly, and they help us make decisions and design policy. There are many reasons for using models in social science and one of them is to understand patterns in the data (Page, 2016).

The two patterns found in the data by the empirical research presented in this master’s thesis as part of the described academic discussion are:

1. Increase in the supply of labor due to low-skill migration, reduction on wages of native workers (Borjas and others).

2. Increase in the supply of labor due to low skill migration, no impact in the wage of native workers (Card and others).

One of these patterns is not in accordance with the predictions of the model of labor supply and demand, so the question is whether a model with a different specification helps us understand the patterns in the data found by David Card’s research. If the answer is yes, it is mandatory to find out what kind of model we are going to use.

5.1.1 Partial equilibrium analysis

The supply and demand model is a partial equilibrium model, since the clearance of the input market is obtained independently from prices and quantities in other markets. A partial equilibrium model is one where all prices other than the price of the good being studied remain fixed (Varian, 1992).

It is therefore that in order to be able to compare the results, it is necessary that the model is also a partial equilibrium analysis. This is because its results must be comparable to the ones of the beautiful model of labor supply and demand. In the short–run, impact on native wages will depend on the assumption of immigrants and natives being perfect substitutes or not. My
point of start is to treat labor as consisting of two types: locals and foreign\textsuperscript{41}. This assumption is not without a problem, in Christian Dustmann’s words when referring to a model that does so: “However, it seems quite difficult to argue that two equally qualified workers, one a native, and the other one an immigrant, are not easily substitutable in production” (Dustmann, Glitz, & Frattini, 2007)\textsuperscript{42}. With this in mind, in section 7, I will set together arguments to support this decision.

Moreover, features that are not specified in the labor supply and demand model will be included, as discrimination, cultural frictions and management’s considerations.

In order to explore an alternative that includes features as discrimination, cultural frictions and management considerations, but that keep us in the world of partial equilibrium analysis, let us begin with a simple story to understand the logic behind the model.

### 5.1.2 The story of Aki

One useful way to explore the intuition behind a model is to use a story to illustrate the logic behind it. Let us imagine the following:

A small society has never experienced international migration. Everyone knows each other, speak the same language and have a skill set they have developed according to their needs and interests. They share the same cultural values and history, and there is no wage differentiation by gender, beauty or other reason, even that it is possible. People in working age are working at different firms performing tasks in order to produce goods and services. One day an immigrant arrives in this fictitious society; let us call this person Aki.\textsuperscript{43}

What will happen?

It does not matter the reason for Aki migrating. As long as he is in working age, he will enter the labor market in search for a job\textsuperscript{44}. In this society, every worker receives a certain income\textsuperscript{45}.

\textsuperscript{41} Some other models that start with similar assumption, see Grossman, 1982.
\textsuperscript{42} He actually refers to Grossman, 1982.
\textsuperscript{43} I talk about a person, Aki, to start humanizing the word worker, but it should have been more accurately to talk about a group of immigrants.
\textsuperscript{44} I am using the preposition he, just for simplicity. I apologize to the female or other gender reader, since we still do not have a gender-neutral personal pronoun to refer to people in the English language.
Aki has no friends, no family and no network in the local society. It was not so expensive to get a working visa. He has some knowledge of the local language, but he does not have much knowledge of the local culture. His culture and native language has no value in this society. All this combined are migration costs, direct costs like the cost of a visa or opportunity costs, as the work he could have had by using his cultural knowledge in the sender country. As the costs of migration sum up, it becomes mandatory for Aki to find a job.

Aki’s skills, including language, are equal to other workers in some firms in this society, so he will search for work in those firms. Discrimination is possible, but it is not performed because everybody knows each other. But no one knows Aki, and it is therefore that it is possible to discriminate against him; firms wishing to maximize profits will wage discriminate him.

Firms will think twice before hiring him because hiring him could mean an extraordinary management effort due to cultural frictions with other workers, and the firm will have to compensate the wage of the manager for that. Since firms can also see his current situation, they will understand that he will accept a low wage, a wage that can ensure survival. If there are tasks that do not require country specific skills, they could be performed by Aki. Firms will assign some of those tasks to Aki. It will liberate time from the other workers, time that they can use now to maximize the performance of the tasks that have been assigned to them. Gains to the firm will increase by hiring a new worker to a lower wage and by native workers maximizing the performance of their tasks.

A wage gap between Aki and the other workers will emerge. As the wage gap gets bigger, the lower will be Aki’s possibilities to compensate for the costs of migration and to invest in a new skill-set. Cultural frictions are expected to appear since there is cultural distance between him and other workers. If he stays, he will get a lower wage than the wages of other members of this society, natives’ wages will be kept constant and production will increase.

Now let us formalize this fictitious situation in economics terms.

The framework that follows will concentrate only in presenting possible mechanisms behind the effects of a positive increase in the stock of workers due to migration, especially low-skilled workers. The story of Aki implies that wages are not only a function of productivity,

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45 I am not using the word wage in order to make clear that the wage is not the only form of payment.
and that workers use their skills to perform tasks in the production process. Not all the consequences of this assumption are developed in this master’s thesis.\(^{46\text{,}47}\)

\(^{46}\) It must be clear that the author have no intention to present a general theory of labor or migration. It is just an attempt to find if other mechanisms could explain David Card’s results.

\(^{47}\) The name “Aki” has intentionally been used to remember the importance of country specific skills, and include the idea that interpretation will depend of the cultural-glass we are using to read. The name Aki is a feminine name in Japanese, masculine name in Finland and Nigeria, and gender neutral in most Asian countries. Moreover, the sounds Aki means completely different things in different languages: past of “to move” from old Norse, “here” in Spanish, “country” in Proto-Algonquian, “who” in Hungarian, and “second in rank” in Japanese. The most common meanings of the sound, in Asian languages, are “bright”, “clear”, “fall” (noun) and “to get bored” (verb), coming from the same route of old Chinese meaning “empty space” (空), as an example “to get bored” is to get “an empty space in the mind”.

6 Models

Now let us build a framework in accordance with the story of Aki. I will present two stylized task-based models based on the principles behind the Ricardian Skill model to illustrate how the wages will be set in the labor market in the presence of foreign labor, and how wages will be affected if foreign labor increases. I follow Professor David Autor in defining task-based models: “Task-based models make a distinction between skills and tasks. A skill is a worker’s endowment of capabilities for performing various tasks. This endowment is a stock, and it may be exogenously assigned or, more generally, acquired through schooling, etc. A task is a unit of work activity that produces output. Workers apply their skill endowments to tasks in exchange for wages. Thus, skills are applied to tasks to produce output; skills do not directly produce output” (Massachusetts Institute of Technology, 2012). I assume that the labor supply curve of foreign workers is less elastic than the one of natives, and that firms have the possibility to discriminate between the two kinds of labor.

In order to do so, a simplification of the labor market is set up to analyze how migration affects the wage of local workers in the short-run. Where a before and after migration scenario is presented, local labor, capital and technology are kept constant. The economic environment is an imperfect market where firms can influence input prices.

There are two types of labor: local \( n_L \) and foreign \( n_F \), and workers perform tasks by means of skills. There are three types of skills: general skills \( s \), that are classified as 1 and 2. Skill 1 is low education, less than 12 years of education, and skill 2 for higher education, more than 12 years of education (college or university education). And a country specific skill, \( h \), that represents cultural knowledge related to the receiving country. Below I will define each assumption.

In the ensuing sections, I will firstly present some motivating evidence for the main assumption of both models. Secondly, I will introduce model I, its technology and the economic environment. I call it the basic model because it is a very simple version of models

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48 At my current knowledge, The Ricardian Skill model is not studied in either ECON3730 Lønnsfastsettelse og arbeidsmarked or ECON4715 Labour Economics, or other course at the Department of Economics at the University of Oslo. For explanation and development of the Ricardian Skill model the lecture notes Labor Economics II Spring 2012 at MIT of professor David Autor are available here.
of tasks. It is a model with only two tasks. Moreover, this model is a two-step process. Firstly, given that labor market is imperfect in the sense that firms can influence input prices, firms will set the wages according to a wage-setting equation in the presence of migration. Secondly, they will maximize the benefit from the use of the available inputs; in other words, profit maximization will take place. In section 6.2, I will introduce model II, it is an extension of a more advance model of tasks that have been developed by professors Daron Acemoglu and Pascual Restrepo from The Massachusetts Institute of Technology (MIT). Finally, the results of both models will be discussed in section 7.

6.1 Motivating Evidence

The models are in line with the results of Aslan Zorlu and Joop Hartog, in their paper called “Employment Assimilation of Immigrants in the Netherlands: Catching Up and the Irrelevance of Education” (Zorlu and Hartog, 2012), an empirical research on employment assimilation of immigrants in the Netherlands. They observed marked differences between immigrants by source country. Non-western immigrants never reach parity with native Dutch, but Caribbean immigrants, who share a colonial history with the Dutch, assimilate relatively quick compared to other non-western immigrants. The study also documents that the quality of jobs is significantly lower for immigrants, especially for those who are at larger cultural distance to Dutch society. Job quality of immigrants increases with the duration of stay but again, does not reach parity with natives. The western immigrants seem to face no considerable difficulties in the Dutch labor market. The most remarkable conclusion is the irrelevance of education for socio-economic position of immigrants once the country of origin has been controlled for.

The models that I will present are in line with the results of the mentioned paper because they have an essential assumption: Low-educated immigrants in the short-run do not have country specific skill related to the culture of the receiving country. In the very short run, it is expected that immigrants will be assigned tasks that do not require that skill, tasks being considered of “lower-quality”. It will depend on the cultural distance of the immigrant from the receiving country, that in the case of models I and II is represented by the skill $h$.

[^49]: This is not the only study that motivates the assumption that $h$ plays a major role in economic outcomes of immigrants’ workers. Especial mention must be given to Professor Albrecht Glitz paper “Ethnic Segregation in Germany”, where he found out that: “Segregation had been stable over the last 30 years. Ethnic minority workers
6.1.1 Model I: A model of two tasks

In macroeconomics, aggregate output is defined as a composite measure of all final goods and services produced in an economy during a given period (McEachern, 2014). The aggregate production function describes how total real gross domestic product (real GDP) in an economy depends on available inputs. We group the inputs other than labor, physical, and human capital together, and call them technology (Cooper & Andrew John, 2016).

We can express it, in a general form, using \( Y \) to represent real GDP, \( K \) to represent the physical capital stock, \( N \) to represent labor, \( H \) represents human capital and \( A \) to represent technology, then we can write:

\[
Y = F(N, K, H, A) \quad (a.1)
\]

In this model, I follow the task approach, in the sense that aggregate output, \( Y \), is giving by the tasks been performed in the economy. In order to do it as simple as possible, I say that all labor (\( N \)) in the economy is performing only two tasks, \( x \) and \( z \). Moreover, labor (\( N \)) is performing these two tasks by using its skills, in other words labor is using its human capital (\( H \)) to perform tasks. Human capital (\( H \)) does not produce output directly, but it is applied to tasks to produce output, and that is the reason why, in this model, I associate human capital (\( H \)) to Labor (\( N \)), and I re-write expression (a.1) as follows:

\[
Y = F(N_{Hx}, N_{Hz}, K_x, K_z, A_x, A_z) \quad (a.1')
\]

Moreover, I will analyze only the short run, keeping capital and technology constant. In this model, I am looking to get an expression for the effects on the wages of local workers due to a migration shock of low-educated people.

Let us start by defining each block that builds this model, because we will move into defining an index of aggregate production as a function of the production of tasks \( x \) and \( z \), in order to find the effects on wages of a migration shock. I will not solve for the complete equilibrium of the model given the limits of this master’s thesis and I am only interested in getting the expressions that represents the effects of migration on the wages of local workers.

---

are segregated not only from native workers but also from workers of other ethnic groups, but less so if they share a common language. From a dynamic perspective, for given cohorts of workers, the results show a clear pattern of assimilation, reminiscent of typical earnings assimilation profiles, with immigrants being increasingly less likely to work in segregated workplaces with time spent in the host country” (Glitz, 2014)
6.1.2 Capital

Capital is defined as units of capital that serve in the production of tasks, \( k_x \) for task \( x \), and \( k_z \) for task \( z \). Capital for all the economy is constant in the short run (\( K \)). Given that I am assuming no effect from capital in the short run, I will go further with the simplification, and I will let the capital associated with the performance of each tasks as follows: \( k_z = k_x = 0 \). It is therefore a model without capital.

6.1.3 Technology

Production requires technology, \( A \), which is kept constant in the short run. In other words, labor producing each task, \( x \) and \( z \), requires its own factor augmenting technology, \( a_x \) and \( a_z \). For simplicity, it is constant and equal to 1 for both, \( a_x \) in the performance of task \( x \), and \( a_z \) in the performance of task \( z \).

6.1.4 Labor

The labor force (\( N \)) is all the people in working age in the country, and it is defined as follows:

\[
\begin{align*}
\text{Before migration} & \quad \text{After migration} \\
N &= n_L^v \quad (a.2) & N &= n_F^v + n_L^v \quad (a.2')
\end{align*}
\]

Where:

\( N \) = Total labor force
\( n_F^v \) = Immigrant labor, with human capital \( v \).
\( n_L^v \) = Total local labor force with human capital \( v \).
\( v \) is the worker’s human capital. For a worker \( i \), it is defined as the sum of the workers general skills (\( s \)) and country specific skills (\( h \)).

Labor will perform tasks by using their skill, and tasks will produce output. This is the reason why human capital is associated to each labor unit. In the ensuing section, I will develop further the definition of human capital, given that this assumption is essential to this model.

---

50 I talk about production of tasks meaning that labor perform tasks by means of their skills in order to produce output.
51 Notation is as follow, \( N \) = Total labor force. Types of workers \( i \) = F or L. F for foreign and L for local. In addition, \( v \) for human capital, \( v = (s, h) \).
6.1.5 Human capital

Before continuing, it is important to define human capital clearly. Every worker has a set of skills that we call human capital. When the labor force was defined the letter v was used to represent the human capital of the worker i. v is the worker’s human capital, and for a worker i, it is defined as the sum of the workers general skills (s) and country specific skills (h).

\[ V_i(s,h) := v_i = s_is + h_i \]  \hspace{1cm} (a.3)

We assume that there are three types of skills in the economy as following: There are only two types of general skills (s):

\[ s = 1 \] for low educated workers or manual workers.

\[ s = 2 \] for high educated or intellectual workers\(^{52}\).

And skill h, that is defined as follows:

\[ h := \text{It is a vector of knowledge of skills that are specific to one country or region, as Norwegian languages for Norway and Southern Quechua for the Tawantinsuyu}^{53}. \]

In the short-run skills are given. In the long run workers can increase their general and country specific skills, but we expect a foreign worker to never reach the maximum level of h for the receiving society\(^{54}\).

6.1.6 The model

We can give a specific mathematical form to the production function, and for tractability I assume and aggregate, constant return to scale Cobb-Douglas function that measure y as a function of the two tasks that are being performed by labor, and it is defined by:

\[ y = Bx^\alpha z^{1-\alpha}, \alpha \in (0,1), \text{ and } B > 0. \]  \hspace{1cm} (a.4)

\(^{52}\) In choosing two types of general skill, I try to follow, as simple as possible, the logic at Dupuy, 2008 that developed a tasks assignment model with two types of workers and heterogeneity of workers within types and, general distributional form of tasks.

\(^{53}\) A large portion of western South America centered on the Andean mountain range, including parts of modern Ecuador, Peru, south central Bolivia, northwest Argentina, north and central Chile (Inca Empire, 2016).

\(^{54}\) This assumption means that “not” all culture can be learned. In this I am completely against the opinion of Paul Collier who in his book “Exodus: How migration is changing our world” argued that “any culture can be learned” (Collier, 2013).
The components of this function are:

\( y := \) An index for the level of output.

\( x := \) It is a task that can performed by workers with skill 1 and we assume that, task productivity of workers endowed with skill \( h \) is higher. Before migration every workers is endowment with the same amount of \( h \). I use a constant \( u \) in front of the inputs that are not endowed with \( h \) to signalize that their productivity is less than the one of local workers in the production of task \( x \). \( u \in [0, 1] \), it is 1 when the foreign worker can perform the task as a local worker, without having \( h \), and zero when he cannot perform the task at all. I assume it is positive, but not one.

\( z := \) It is a task that can be performed by workers that have both, skill \( h \) and 2. Firms will not hire foreign workers in the production of \( z \), because we assume that in the short run there are not foreign workers with country specific human capital, \( h_F = 0 \).

Given the previous definitions, the production of tasks \( x \) and \( z \) can be defined as performed by labor with different skill sets, as given by the following relationships\(^{55}\):

<table>
<thead>
<tr>
<th>Task production before migration</th>
<th>Task production after migration</th>
</tr>
</thead>
<tbody>
<tr>
<td>( x = n_{L}^{1,h} ) (a.5)</td>
<td>( x = n_{L}^{1,h} + u n_{F}^{1} ) (a.5')</td>
</tr>
<tr>
<td>( z = n_{L}^{2,h} ) (a.6)</td>
<td>( z = n_{L}^{2,h} ) (a.6')</td>
</tr>
</tbody>
</table>

Where:

\( n_{L}^{1,h} = \) local labor with skill \( h \) and 1; \( n_{L}^{2,h} = \) local labor with skill \( h \) and 2; \( n_{F}^{1} = \) Foreign labor with skill 1, and the term \( u \in [0, 1] \). This term represents the lower productivity of the foreign worker given the lack of \( h \), as closer \( u \) is to 1, the productivity of the local worker is higher in relation with the productivity of the local worker, but I will never be 1. I assume that a foreign worker will never reach the same level of country specific skill of a native.

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\(^{55}\) I use indifferently the words “performing tasks” and “producing tasks”.
6.1.7 The economic environment

We assume that we operate in a labor market where the firms have market power. Firms acquire market power with migration because the supply curve of immigrants is less elastic than the one for natives\textsuperscript{56}. There is monopsony power, but not in the sense of there being a single buyer of labor, but monopsony in the sense of the supply of labor to an individual firm not being infinitely elastic (Manning, 2003)\textsuperscript{57}.

For a specific type of labor with a given human capital needed to perform a task, firms in the labor market will act as a \textit{wage setter}. In this case, the wage setter will set the real wages according to the skills of workers\((s, h)\), and the discriminatory possibilities of the firm \((\Omega)\).

It is not literally that they set the “real wages”, since the real wage is a measure of the purchasing power of wage earners and it is therefore the wage setter can only set the money wage for a worker.

The motivation to do so is cost minimization. The firms will try to reduce their cost as much as possible in order to maximize profits. Profits, \(\Pi\), been be defined as follows:

\[
\Pi = \text{Total Revenues} - \text{Total Costs} \quad \text{or} \quad \Pi = p_y y - w N
\]

**Total revenue (TR)**

\[
\text{TR} = p_x x + p_z z
\]

**Total cost function (TC)**

\[
\text{TC} = w_x n_x + w_z n_z
\]

The total revenues are the total value of production of tasks \(x\) and \(z\), and the total cost is the total unit cost of performing tasks \(x\) and \(z\). Then profits can be defined by the equation:

\[
\Pi := p_y y - w_x n_x + w_z n_z \quad (a.7)
\]

6.1.8 Step I: The wage setting process

The wage setting process is the first step in the model. First, firms will set the wages for workers, foreign and local, as a function of the \textit{value} they give to the human capital of

\textsuperscript{56} There is empirical evidence on immigrants’ labor supply been less elastic than the one for local workers, at Dahle-Olsen, Reed and Schone 2014 (for Norway), Hisch and Jahn 2015 (for Germany) and Naidu, Nyarko and Wang 2015 (for the United Arab Emirates).

\textsuperscript{57} “The assumption that employers set wages then tells us that employers exercise this market power. But, with these two assumptions, it is monopsony, not perfect competition, that is the best simple model to describe the decision problem facing an individual employer” (Manning, 2003)
workers \((v_i)\) in the production of tasks \(x\) and \(z\), and the firm’s possibilities of discrimination \((\Omega_i)\). The function that represents how the wages will be set is the following:

\[
w_i = f(v_i, \Omega_i) := v_i(s, h) - \omega_i(-\varphi_i, \mu) \tag{a.8}
\]

Now, let us define each argument in function \((a.8)\).

The value given to a worker’s human capital, \(v_i(s, h)\).

The value given to a worker’s human capital, \(v_i(s, h)\), in the production of tasks \(x\) and \(z\), is defined as the productivity of those skills in the production of the tasks. Given that workers need different skills to perform tasks \(x\) and \(z\), and the productivity of the workers performing \(x\) and \(z\) depends on their skill set, different wages per skill set can be set in the production of each task.

We have previously defined human capital in section 6.1.5, and we can rewrite it as follows:

For local workers is: \(v_L = s_L + h_L\).

For foreign workers is: \(v_F = s_F + h_F\), and assuming that in the short-run \(h_F = 0\), we have that: \(v_F = s_F\), for \(s = 1\) or \(2\)

The discriminatory possibilities of the firms, \(\Omega_i\)

Discrimination was not practiced before migration because “everybody knows each other”. I imagine a small receiving country in terms of “labor stock” and firm’s reputation between local workers matters for hiring the best workers. Migration makes discrimination possible because the elasticity of their labor supply curve is less elastic than the one of natives.

I assume that local workers are not being discriminated, \(\Omega_L = 0\).

For foreign workers, \(\Omega_F\), it is defined as follows:

\[
\Omega_F = \omega_F(-\varphi_F, \mu) \tag{a.9}
\]

It is a function of \(\mu\), other factors that make discrimination possible, and the elasticity of the labor supply curve of the foreign worker, \(\varphi_F\). The negative sign is important given the definition of \(\varphi_F\), as it will be explained later on.
The possibilities of discrimination are an increasing function of $\mu$. $\mu$ increases when there is weak employment protection legislation (EPL), high unemployment in the receiving country, a weak legal enforcement of labor legislation in the receiving country, social acceptance of discrimination in the receiving society, cultural preferences for certain ethnic groups, etc. In other words, the function $\omega_F$ is positive and increasing in $\mu$.

For example, if legislation in the receiving country gives firms the possibility to discriminate, they will set a lower wage for foreign workers. The intuition is as follows, if the laws do not have sanctions or believable sanctions for discriminating foreign from native workers, then a lower wage will be offered to the former. As long as, the sanctions are zero, unbelievable, or having a small economic impact, firms will not see the sanctions as an incentive to not discriminate.

The elasticity of the labor supply curve of the foreign workers, $\varphi_F$ plays a major role in defining if there will be wage discrimination. The possibilities for discrimination increases the lower the elasticity of supply of foreign workers. The firms will have the possibility of offering a lower wage to the foreign workers, if and only if, the labor supply curve of these workers is less elastic than the elasticity of the labor supply curve of local workers. Firms cannot discriminate workers that will not accept lower wages. Let us explain this carefully:

The value of $\omega_F$ increases if the elasticity of the supply of the foreign worker is lower than the one for natives, in other words, as the foreign workers’ supply is less sensitive to a change in the offered wages, firms will offer a lower wage. The elasticity is the sensitivity of the worker to a change in the wages, and for foreign workers it is assume to be:

$$\varphi_F = \left| \frac{\text{change in the number of foreign workers}}{\text{change in the wage} (w_F)} \right| < \left| \frac{\text{change in the number of local workers}}{\text{change in the wage} (w_L)} \right|$$

In the extreme case when a foreign worker is desperate to have an income, we can have a perfect inelastic labor supply curve, $\varphi_F = 0$. For a foreign worker, it will normally be between 0 and 1. It will never be equal to one because it means that they have a perfect elastic labor supply curve, $\varphi_F \neq 1$.

I use the negative sign ($-$) in front of $\varphi_F$, in order to ensure that as closer it get to zero, higher the possibilities to discriminate are.

The first order derivatives of $\omega_F$ are:
\[ \frac{\partial \omega_F}{\partial -\varphi_F} > 0 \] and \[ \frac{\partial \omega_F}{\partial \mu} > 0 \]

The logic is as follows, given that the costs of migration are very high, the necessity to have a job becomes an imperative for the foreign worker. The worker becomes less sensitive to lower wages, and a wage lower than the one for natives will be accepted. In the extreme case of a perfect inelastic labor supply curve, the firm will be able to offer the lowest wage possible to the worker and the worker will accept it as long as it permits survival, it is there we can say that there is a minimum survival wage, \( w_{min_F} \). Figure 5, at the end of this section shows this situation.

Summing up, the firms will set the wage of the foreign workers according to equation (a.8) as follows:

\[ w_F = v_F(s, h) - \omega_F(-\varphi_F, \mu) \]

The first order derivatives of this function are:

\[ \frac{\partial w_F}{\partial \omega_F} < 0 \] and \[ \frac{\partial w_F}{\partial v_F} > 0 \]

Firstly, \( \frac{\partial w_F}{\partial \omega_F} < 0 \), it means that higher the possibilities of discrimination of the firms, lower the wage offered to the foreign worker will be.

Secondly, \( \frac{\partial w_F}{\partial v_F} > 0 \), means that higher the human capital of the worker, higher the wage offered by the firms.

It is important to be careful when checking the behavior of \( v(s, h) \) because, in the wage setting process, a different wage will be set in the production of tasks \( x \) and \( z \). The reason behind it is that skills have a different productivity in the production tasks \( x \) and \( z \).

For task \( z \), the productivity is positive if the workers have skills 2 and \( h \). It is zero for workers without \( h \).

In the short run, foreign workers have \( h = 0 \). It means that they cannot perform task \( z \), even if they have skill 2, and no wage in the production of this task will be offered to them.

Summing up, for the production of task \( z \) we have that:

\[ w_{Lz} > 0, \] and \( w_{Fz} = 0. \]
$w_z$ is defined as the unit cost of producing task $z$, and given the previous assumptions it can be written as follows:

$$w_z = w_L^{2,h} (a.10)$$

The wage offered to a local workers in the production of task $z$ is positive, and it is zero for foreign workers. The unit cost of the production of $z$ is $w_z$ that is equal to the wage given to high-educated local workers, $w_L^{2,h}$, since they are the ones performing task $z$.

For task $x$, the productivity is positive if the workers have skills 1 and/or $h$. A worker with $h = 0$ can perform task $x$, but the productivity of that worker is lower than the productivity of a worker endowed with skill $h$.

In the production of task $x$, foreign workers that have skill 2 will be valued equally that workers with skill 1, as long as the firms cannot observe differences in efficiency before hiring them. If we assume that intellectuals can clean a room as well as manual workers, but if they do not understand the local language, they will not be able to report to their boss, we have that for foreign workers:

$$w_F^1 = w_F^2.$$

This is not important for this model, given that the migration shock is just of low-educated workers. The production of task $x$ is more efficient if the workers have skill $h$.

According to the definition of task $x$, the wages of foreign workers are set lower than the wages of local workers in the production of $x$, because their productivity is different. It is therefore that the following relation holds:

$$w_L^{1,h} > w_F^1$$

$w_x$ is the unit cost of producing task $x$. In this model, we have foreign workers, $n_F^1$, and low-educated local workers, $n_L^{1,h}$, performing task $x$, and that is the reason why I can define $w_x$ as:

$$w_x = w_L^{1,h} + w_F^1 (a.11)$$

**Assumption 1:** There is one wage for each skill set. The wages are assigned to workers according to their skills, as follows:

$$w_L^1 = v_F(1) - \omega_F(\varphi_F, \mu) (a.12)$$

$$w_L^{1,h} = v_L(1, h) (a.13)$$

$$w_L^{2,h} = v_L(2, h) (a.14)$$

All workers endowed with the same skill set will be assigned the same wage.
Assumption 2: The unit cost of each task is the aggregate cost of all the inputs used to perform that task. Represented for task x and z by the following equations:

\[ w_z = w_z^{2h} \text{ (a.10)} \]  
\[ w_x = w_x^{1h} + w_x^f \text{ (a.11)} \]

In figure 4, we can see a representation of the aggregate wage-setting curve in the production of task x. This figure helps us to see graphically the wage gap between local and foreign workers. The case of full discrimination for a full inelastic labor supply curve, is represented by the blue line, workers are getting the minimum wage that they will accept in order to survey. The green line shows the case without discrimination, when all foreign workers are getting the same wage given that they have the same skill, 1 and not h. As we can see both the green and the blue line stop at the point where the production of tasks can not continue without h.

Figure 4: An aggregate wage-setting curve in the production. Each point in the line is the sum of all the wages offered to each type of worker at a given skill set (s, h). The blue line shows the extreme case of foreign workers accepting a minimum survival wage, \( w_{\text{min}F} \), when they have only skill 1.
6.1.9 Step II: Profit maximization

This is the second step of the model. The equations needed in this step are (a.4), (a.5'), (a.6'), (a.7) and (a.8).

\[
y = Bx^\alpha z^{1-\alpha} , B > 0 \text{ and } \alpha \in [0, 1]
\] (a.4) Aggregate production function

\[
x = n_L^{1,h} + u n_F^1, \in [0, 1]
\] (a.5') Production of task x

\[
z = n_L^{2,h}
\] (a.6') Production of task y

\[
\Pi := y - w_x n_x + w_z n_z
\] (a.7) Total Profits of the production of y

\[
w_t = v_t(s, h) - \omega_t(\varphi_t, \mu)
\] (a.8) Wage-setting equation

In step I, the firms in the labor market set the wages by using equation (a.8) because they have market power. They set the wages as low as possible in order to minimize costs. That is the reason why in step II, the wages are considered as fixed variables.

The price of \( y \) is set equal to one, as the price assigned to each task, so \( p_x = p_z = p_y = 1 \).

The resource constraint is the total available labor in the economy and it can be written by using (a.2'):

\[
N = n_F^1 + n_L^{1,h} + n_L^{2,h} \quad (a.2')
\]

I will rewrite equation (a.7), defining \( n_x \) and \( n_z \), by using equations (a.2'), (a.10) and (a.11), as follows:

\[
n_x = n_L^{1,h} + n_F^1 \quad (a.15), \text{ and the same for } n_z: \quad n_z = n_L^{2,h} \quad (a.16).
\]

\( n_x \) is the labor allocated to the production of task \( x \), and \( n_z \) is the labor allocated to the production of task \( z \).

Now, I insert for \( n_x \) and \( n_z \) using (a.5'), (a.6'), (a.15) and (a.16). I also insert for unit cost of tasks \( x \) and \( z \) using (a.10) and (a.11):

\[
\Pi := y - w_t^x n_F^1 + w_L^{1,h} n_L^{1,h} + w_L^{2,h} n_L^{2,h}
\] (a.7')
In step II, firms will seek to maximize profits by maximizing the use of the available inputs, \( n^1_L, n^{1,h}_L \) and \( n^{2,h}_L \).

The optimization problem is as follow:

\[
\max_{n^1_L, n^{1,h}_L, n^{2,h}_L} \Pi := y - w^1_F n^1_F + w^{1,h}_L n^{1,h}_L + w^{2,h}_L n^{2,h}_L, \textrm{ given } N = n^1_F + n^{1,h}_L + n^{2,h}_L.
\]

First, I insert (1*), (2*), (3*) into (4*) we get:

\[
\Pi := B(n^{1,h}_L + u n^1_F)^{1-\alpha} (n^{2,h}_L)^{1-\alpha} - w^1_F n^1_F + w^{1,h}_L n^{1,h}_L + w^{2,h}_L n^{2,h}_L
\]  

(a.7*)

The first order conditions are given by:

\[
\frac{\partial \Pi}{\partial n^1_F} = B\alpha (n^{1,h}_L + u n^1_F)^{\alpha-1} u (n^{2,h}_L)^{1-\alpha} - w^1_F = 0 \tag{a.17}
\]

\[
\frac{\partial \Pi}{\partial n^{1,h}_L} = B\alpha (n^{1,h}_L + u n^1_F)^{\alpha-1} (n^{2,h}_L)^{1-\alpha} - w^{1,h}_L = 0 \tag{a.18}
\]

\[
\frac{\partial \Pi}{\partial n^{2,h}_L} = B(n^{1,h}_L + u n^1_F)^{\alpha} (1 - \alpha)(n^{2,h}_L)^{-\alpha} - w^{2,h}_L = 0 \tag{a.19}
\]

These are the necessary conditions for finding the optimal values of \( n^1_F, n^{1,h}_L \) and \( n^{2,h}_L \) that will maximize profits. Now by re-arranging equations (a.17), (a.18) and (a.19), we get:

\[
B\alpha (n^{1,h}_L + u n^1_F)^{\alpha-1} u (n^{2,h}_L)^{1-\alpha} = w^1_F \tag{a.17'}
\]

\[
B\alpha (n^{1,h}_L + u n^1_F)^{\alpha-1} (n^{2,h}_L)^{1-\alpha} = w^{1,h}_L \tag{a.18'}
\]

\[
B(n^{1,h}_L + u n^1_F)^{\alpha} (1 - \alpha)(n^{2,h}_L)^{-\alpha} = w^{2,h}_L \tag{a.19'}
\]

Equations (a.17'), (a.18') and (a.19') give us the expressions of wages in terms of labor. By inserting equations (a.12), (a.13) and (a.14) from step I, we get the following expressions:

\[
B\alpha (n^{1,h}_L + u n^1_F)^{\alpha-1} u (n^{2,h}_L)^{1-\alpha} = \varphi_F(1) - \omega_F(\varphi_F, \mu) \tag{a.17'\prime}
\]

\[
B\alpha (n^{1,h}_L + u n^1_F)^{\alpha-1} (n^{2,h}_L)^{1-\alpha} = \varphi_L(1, h) \tag{a.18'\prime}
\]

\[
B(n^{1,h}_L + u n^1_F)^{\alpha} (1 - \alpha)(n^{2,h}_L)^{-\alpha} = \varphi_L(2, h) \tag{a.19'\prime}
\]
Expressions (a.17’’), (a.18’’) and (a.19’’) tell us that, the productivity of labor endowed with different skills in the production of tasks x and z, is equal to the value that the firms give to the skills of workers. If the firms can discriminate a type of worker, they will do so, in order to reduce their cost and increase their profits. In this case, firms are discriminating foreign workers and their wages do not represent their productivities.

**Assumption 3.** In order to have an equilibrium all workers endowed only with skill 1, \( n^1_F \), will get paid the same wage, and similarly for workers with skill sets (1, h) and (2,h). In other words, the law of one price for skills holds for this model.

The law of one price for skills is essential to have equilibrium in the Ricardian Skill model. This model is based on the principle behind that model. Equations (a.17’’), (a.18’’), (a.19’’), (a.17’’’), (a.18’’’) and (a.19’’’) are in accordance with that law.

**Assumption 4.** For an equilibrium to exist, workers should be assigned to tasks they have a relative advantage in production. Given the definition of tasks x and z, high-educated workers could be performing task x, but they are relative more productive performing task z. That is the reason why they will be assigned to its production. If there are productivity differences between workers, they will be allocated to the production of the task that they can produce relative more efficiently than others. Low-educated workers have a comparative advantage in production of task x, and high-educated workers have a comparative advantage in the production of task x, so:

\[
n^1_F = n^{(1h)}_L = 0 \text{ for task } z, \text{ and } n^{(2h)}_L = 0, \text{ for task } x.
\]

**Assumption 5.** The Cobb-Douglas production function implies “equal task shares” between task x and z. So there is an equal division of labor between workers that have skill 1 and those who have skill 2.

There are three equilibrium conditions in the Ricardian Skill model: The law of one price for skills, no arbitrage between tasks, and equal division of labor among task with a skill group. The three conditions for having equilibrium are met, but I am not interesting in solving for the equilibrium. In step I, we have seen how the wages were set in the labor market when we passed from a state without migration to a state with migration. Now, I am interesting on getting to know, what will happen if migration continues increasing. Increasing migration in a new period of time, period II, in the model without capital and technology.
changes: Will this change the wages of local workers? Are the wages in each task, x and z, been affected? In order to differentiate between both migration shocks, I talk about period I, when I refer to the pass from a state without migration to a state with migration, and about period II, when migration increases.

Period II

I assume that there is a marginal increase of low-educated foreign workers. I differentiate the wages with respect to foreign labor using equations (a.17'), (a.18') and (a.19'), inserting (a.5') and (a.6') for x and z respectively. The effect of a marginal increase of \( n_F \) on \( w^F_1, w^L_{1,h} \) and \( w^L_{2,h} \), and correspondently for \( w_x \) and \( w_z \) are:

\[
\frac{dw^F_1}{dn_F} \quad \text{when} \quad w^F_1 = B\alpha(n^L_{1,h} + un^F_1)^{\alpha-1}u(n^{2,h}_L)^{1-\alpha}
\]

\[
\frac{dw^L_1}{dn_F} = B(\alpha^2 - \alpha)(n^L_{1,h} + un^F_1)^{\alpha-2}u^2(n^{2,h}_L)^{1-\alpha} < 0
\]

\[
\frac{dw^L_{1,h}}{dn_F} \quad \text{when} \quad w^L_{1,h} = B\alpha(n^L_{1,h} + un^F_1)^{\alpha-1}(n^{2,h}_L)^{1-\alpha}
\]

\[
\frac{dw^L_{2,h}}{dn_F} = B(\alpha^2 - \alpha)(n^L_{1,h} + un^F_1)^{\alpha-2}u(n^{2,h}_L)^{1-\alpha} < 0
\]

\[
\frac{dw^L_{2,h}}{dn_F} = B\alpha(n^L_{1,h} + un^F_1)^{\alpha}(1-\alpha)(n^{2,h}_L)^{-\alpha}
\]

\[
\frac{dw^L_{2,h}}{dn_F} = B\alpha(n^L_{1,h} + un^F_1)^{\alpha}u(1-\alpha)(n^{2,h}_L)^{-\alpha} > 0
\]

\[
\left| \frac{dw^F_1}{dn_F} \right| < 0, \left| \frac{dw^L_{1,h}}{dn_F} \right| < 0, \text{ and } \left| \frac{dw^L_{2,h}}{dn_F} \right| > 0
\]

From equations (8) and (9) from Step I, we have that \( w_x = w^F_1 + w^L_{1,h} \), and \( w_z = w^L_{2,h} \), so we can rewrite for the effect on the unit cost of task x and z, as follows:

\[
\frac{dw_x}{dn_F} = \left[ B(\alpha^2 - \alpha)(n^L_{1,h} + un^F_1)^{\alpha-2}u^2(n^{2,h}_L)^{1-\alpha} + B(\alpha^2 - \alpha)(n^L_{1,h} + un^F_1)^{\alpha-2}u(n^{2,h}_L)^{1-\alpha} \right] < 0
\]

And,
\[
\frac{dw_z}{dn^z} = B \alpha (n_1^{1, h} + un_1^1)^\times u(1 - \alpha)(n_2^{2, h})^{1-\alpha} > 0
\]

The result is that increasing migration without capital and technology changes will reduce the unit cost of the production of tasks \(x\), and increase the unit cost of the production of task \(z\). In other words, the wages of local workers will increase for workers performing task \(z\), and will go down for workers performing task \(x\). The term \(u\), the difference of productivity between foreign and local low-educated workers, is the force behind the size of the effect. As smaller \(u\) is, smaller will be the negative effect for foreign workers if migration increases.

The main result is that increasing migration in **period II**, is a force that will create a bigger wage gap between workers performing different tasks.

Moreover, given the law of one price for skills, if the newcomers have a less elastic labor supply curve than the immigrant that arrived in **period I**, and firms can discriminate, they will drive the wages for all foreign workers further down. Discrimination will reinforce the polarization of wages, and it is a distortion for the real productivity of foreign workers in the production of task \(x\). All this forces together create a polarization of wages and tasks. If firms are free to discriminate, they could create a vicious circle, a poverty circle, driving foreign workers to task segregation, low wages and poverty\(^{58}\).

Summing up, in **step I**, the model sets, in an imperfect labor market, the dynamics behind the assignation of wages to workers according to their skills. In **step II**, firms optimize the use of the available inputs. I check the outcomes in the case of marginal increase of migration in a second period of time, **period II**, after optimization takes place. I do not solve for the equilibrium of the model given that my only interest is to get the expressions for the wages, and outcomes for increasing migration.

The mechanism behind this result is the following: In the production of task \(x\), the first shock of migration will not reduce the wages of local workers, as long as immigrants are performing activities that do not require country specific skill \(h\) in the production of task \(x\). A new shock, without capital and technology changes, can only reduce the wages of workers producing \(x\), and it increases the productivity of local workers producing \(z\).

---

\(^{58}\) For an example of occupation segregation, see Glitz, 2014.
An example that represents the situation in the first period is task “hotel services”, by hiring a foreign worker that clean the reception area, the desk and keep security; the receptionist can increase its productivity by selling more rooms and using his time in customer service. The foreign worker cannot perform customer service. By hiring more foreign workers that clean the rooms, and cut food in the kitchen, we can free time for local workers. Now local workers can for example manage the cleaning activities, or administrate the kitchen activities increasing their productivity.

There are low wages for foreign workers, due to their lack of $h$, and wages will be lower if firms have positive possibilities of discrimination. It is undesirable to have discrimination because it will give the impression that foreign workers are less productive of what they really are. Wages for local workers are higher in the short run, both in the production of tasks $x$ and $z$ due to specialization. In the long run, if the labor market is flexible, workers with $h$ can increase their general skills and move from the production of $x$ to the production of $z$, increasing overall production. If the labor market is not flexible, and migration increases, but there is no capital and/or technology changes, there will be lower wages for both native and foreign workers that perform $x$.

6.2 Model II: An extension of the Ricardian Skill Model

As it was mentioned in the introduction and in the beginning of section 6, a more advanced model than my basic model is introduced in this section. The equilibrium will not be fully developed given the limits of time and pages of this master’s thesis. This model is a task-based static model where I make a clear distinction between tasks and skills, and it is static because I am just analyzing the very short run. It is inspired on the work of David Autor, Daron Acemoglu and others. It is an extension of the model developed by professors Daron Acemoglu and Pascual Restrepo in their paper “The Race Between Man and Machine: Implications on Technology for Growth, Factor Shares and Employment” (Acemoglu & Restrepo, 2015). The analysis is only about a migration shock of low-educated workers, keeping capital and technology constants. This will explained in the ensuing sub-sections.

59 I am using as reference the lecture notes on Labor Economics II, spring 2012, of Professors David Autor and Daron Acemoglu at MIT (Massachusetts Institute of Technology, 2012). Some definitions belong only to lectures of Daron Acemoglu at the course Labor Economics I, autumn 2014, MIT (Massachusetts Institute of Technology , 2014). I am using the logic behind is inspired in the following papers Autor, 2013, Rosen, 1974
6.2.1 Environment

As in model I, it is an imperfect labor market where firms have monopsony power, and there are positive possibilities of discrimination. Discrimination was not practiced before migration because “everybody knows each other”; I imagine a small receiving country in terms “labor stock” and firm’s reputation between local workers matters for hiring the best workers. Migration makes possible discrimination because the elasticity of their labor supply curve is less elastic than the one of natives, as it was assumed in model I. The main reason behind this assumption is the higher cost of migration, especially in terms of opportunity costs, and the lack of supportive networks in the receiving country. I am also assuming a Labor supply curve derived from the Labor-Leisure choice model, I could have used a “quasi-labor supply” as Acemoglu and Restrepo do in their paper, but I want to keep this assumption equal to the one in the basic model.

The analysis goes from a scenario without migration, to a new scenario with migration, assuming the immigrants are low educated. As in the basic model, there is local and foreign labor, \( n_L \) and \( n_F \). They are endowed with a set of skills.

Skills are a worker’s stock of capabilities for performing various tasks, and workers apply their skills to tasks in exchange for wages (Autor, 2013). There are 3 types of skills: general skill type 1 for low education, general skill type 2, and country-specific skill, \( h \). The notation is: 1, 2 and \( h \). For simplicity, I assume that all local workers have equal endowment of \( h \).

The aggregate output, \( Y \), is giving by all the tasks \( i \) been performed in the economy. There are two types of tasks been performed, tasks that requires human country-specific skill \( h \) and tasks that do not. The production of one task \( i \) is defined as \( y(i) \). We can define the aggregate output as:

\[
Y = \left( \int_{N-1}^{N} y(i) \frac{\sigma-1}{\sigma} di \right)^{\frac{\sigma}{\sigma-1}} \text{ The elasticity of substitution } \sigma \in (0, \infty). 
\]

\(^{60}\) For graphical reasons 1, 2 and \( h \) are measured in years. 1 is 12 or less years of education, 2 are more than 12 years of education. \( h \) is also in years, but years living in the receiving country, scoring higher \( h \) for those persons who had been born in the receiving country. In order words, second generations of immigrants have equal \( h \) than locals.
A task, \( i \), one unit, that produces output. The assignment of factors to tasks is determined by comparative advantages, this assumption will be explained in detail when dealing with assignation.

In the production of each task, in the very short run, I will keep capital \( (\overline{K}) \) and technology constant \( (\overline{A}) \), but in order to avoid any distortion related to capital and technology in the practice, I do not include capital in the analysis \( k = 0 \), and let \( \overline{A} = 1 \).

### 6.2.2 The model

In this model the economy contains a unique final good, \( Y \). It is produced with a continuum of tasks, \( y(i) \), on the unit interval \([N - 1, N]\):

\[
Y = \left( \int_{N-1}^{N} y(i)^{\frac{\sigma - 1}{\sigma}} \, di \right)^{\frac{\sigma}{\sigma - 1}} \quad \text{The elasticity of substitution } \sigma \in (0, \infty). \quad (b.1)
\]

In the very short run capital and technology are kept constant, so there are no new tasks been created due to technology advance. For simplicity, I will ignore capital, \( k \), in the production of tasks. This implies that there are no machines that can substitute for labor in the production of specific tasks.

**Assumption 1: Specialization**, workers that are assigned fewer tasks are more productive because it implies task specialization. Variety is costly in the Smithian sense in that forgoes the gains from specialization.

**Before migration**

In this model, before migration takes place, skills 1 and 2 are the only important skills in the assignation of tasks to a worker given that all workers have the same endowment of skill \( h \).

Before migration, we can say that the task assignation is in equilibrium. When migration takes place firms will assign tasks to the foreign workers if, and only if, they can increase profits by using the new available input, and the task assignation equilibrium will change. The higher indexed tasks in the economy need skills \( h \) to be performed, and its production is increasing with skill 2. In the basic model this was represented with task type \( z \).
**Assumption 2:** For any set of skills in the production of tasks, each skill-set will have a unique productivity. With this in mind, a task productivity schedule for each type of worker, with a specific set of skills, is represented by the parameter, $\gamma_{\text{skills}}$. For simplicity, I will use s when I refer to a set of skills, so notation is $\gamma_s$.

Just as an example, we can say that, $\gamma_1(i)$ is the productivity of a low-educated worker with only skill 1, a foreign worker, in the production of a task $i$, and that $\gamma_{2,h}(i)$ is the productivity of a high-educated local worker in the production of a task $i$.

Before migration, there was some task threshold, $T$, such that $i \leq T$ were performed by low-educated local workers and $i > T$ were performed by high-educated workers.

The production of tasks $i$, for $i \leq T$, before migration was given by:

$$y(i) = \left[ (1 - \tau) \left( \gamma_1 n_1(i) + \gamma_h n_h(i) \right) \right]^{\frac{\zeta-1}{\zeta}} + \tau \left[ \gamma_{1,h} n_{1,h}(i) \right]^{\frac{\zeta-1}{\zeta}} (b.2)$$

$\tau \in [0,1]$ and $\zeta \in (0,\infty)$. $\zeta$ is the elasticity of substitution between types of tasks. The assumption is that they are gross complements, so $\zeta < 1$, but we could also be in the special case of $\zeta \to 0$, when the substitution is Leontief. Why? It is because tasks are not competing with each other.

The first argument tells us that some of the tasks $(1 - \tau)$, can be performed either by workers that have skill 1 or h, they are substitutes of each other performing this type of tasks. The second argument tells us that some of the tasks $\tau$, need workers with both skills 1 and h in order to be performed. This is irrelevant for the assignation of tasks before migration, given that all low-educated local workers had h, but it will be relevant with migration.

The production of tasks $i$, for $i > T$, before migration is given by:

$$y(i) = \left[ (1 - \tau) \left( \gamma_2 n_2(i) + \gamma_h n_h(i) \right) \right]^{\frac{\zeta-1}{\zeta}} + \tau \left[ \gamma_{2,h} n_{2,h}(i) \right]^{\frac{\zeta-1}{\zeta}} (b.3)$$

The first argument tells us that some of the tasks $(1 - \tau)$, can be performed either by workers that have skill 2 or h, they are substitutes in the production of this type of tasks. The second argument tells us that some of the tasks $\tau$, need workers with both 2 and h in order to be performed. This is irrelevant for the assignation of tasks before migration, given that all high-
educated local workers have \( h \), but it will be relevant with migration when task may be reassigned.

**After migration**

In the presence of migration, tasks that do not require skill \( h \) will be assigned to foreign workers, as long as it minimize costs. By doing this, firms will assign fewer tasks per worker, increasing their productivity. For example, in a coffee shop, owners will assign tasks to foreign workers, as cleaning tables and making coffee, while local workers will sell the coffee to the customers; or in the kitchen of a restaurant, the head chef will assign to the foreign workers to cut vegetables, to clean or to make dishes from their home-countries.

I assume that the immigrants that arrives to this society are low educated and at working age. It is reasonable to think that given the high costs of migration, as it was explained earlier in this master’s thesis, we can assume that:

\[
 n_{L}^{1,h} > n_{F}^{1}
\]

Now tasks can be reassigned between local and foreign workers according to new threshold as follow, for workers with skill 1 according to a threshold \( T^{1,h} \), so for \( i \leq T^{1,h} \) we have that:

\[
y(i) = \left( (\gamma_{1} n_{F}^{1,h}(i) + \gamma_{1,h} n_{L}^{1,h}(i))^{\frac{c}{c-1}} \right)^{\frac{c}{c-1}} (b.4)
\]

In the production of these tasks, low-educated foreign workers are perfect substitutes of low educated native workers, and firms will hire them if they can minimize the costs.

For tasks \( T^{1,h} < i \leq T^{2,h} \), we will have the following production function:

\[
y(i) = \left( (1 - \tau) \left( \gamma_{1,h} n_{L}^{1,h}(i) \right)^{\frac{c}{c-1}} + \tau \left( \gamma_{2} n_{F}^{2}(i) + \gamma_{h} n_{L}^{h}(i) \right)^{\frac{c}{c-1}} \right)^{\frac{c}{c-1}} (b.5)
\]

\( \tau \in [0,1] \) and \( \zeta \in (0, \infty) \). \( \zeta \) is the elasticity of substitution between types of tasks. The assumption is that they are gross complements, so \( \zeta < 1 \), but we could also be in the special case of \( \zeta \to 0 \), when the substitution is Leontief.

The first argument tells us that some of the tasks \( \tau \), need workers with both 2 and \( h \) in order to be performed. The second argument tell us that some of the tasks \( (1 - \tau) \), can be performed either by workers that have skill 2 or \( h \), they are substitutes. It means that if we
have local workers with skills set \((1, h)\) and its cost in producing \(i\) is less than the costs of local workers with skills \((2, h)\) they will be reassigned those tasks.

For \(i > T^{2,h}\), we will have the following production function:

\[
y(i) = \left[ \gamma_{2,h} n_{L}^{2,h}(i) \right]^{\frac{\gamma - 1}{\gamma - 2}} \tag{b.6}
\]

**Assumption 3:** Local and foreign workers with different skills set can perform tasks, but the comparative advantage of skills groups differ across tasks. This is captured by the term \(\gamma_s\).

Following the idea that higher indexed tasks require \(h\) in order to be performed, we impose the following assumption on the structure of comparative advantage:

**For tasks:**

\[\gamma_{1,h} / \gamma_{2,h} \text{ and } \gamma_{1} / \gamma_{1,h}\] are continuously differentiable and strictly decreasing.

It means that higher-educated local workers are better than lower-educated local workers and both high and low educated foreign workers in performing higher indexed tasks.

Given that skills groups differ in efficiency at each tasks, and respectively bundles of tasks, it is possible to state that before migration the factor clearing required for bundles of tasks was:

\[
\int_{N-1}^{T} n_{L}^{(2,h)}(i) \, di \leq N_{L}^{(2,h)} \text{ and } \int_{T}^{N} n_{L}^{(1,h)}(i) \, di \leq N_{L}^{(1,h)}
\]

In a perfect equilibrium model with migration, the new factor market clearing will also require:

\[
\int_{N-1}^{T^{1,h}} n_{L}^{1,h}(i) \, di \leq N_{F}, \int_{T^{1,h}}^{T^{2,h}} n_{L}^{1,h}(i) \, di \leq N_{L}^{(1,h)} \text{ and } \int_{T^{2,h}}^{N} n_{L}^{(2,h)}(i) \, di \leq N_{L}^{(2,h)}
\]

### 6.2.3 Allocation of skills to tasks

I have mentioned that tasks are assigned according to a (some) threshold(s), \(T\). Now I will formalize that assumption.

**Lemma 1:** For any equilibrium, there is a (some) threshold \((T)\) that acts as a rule to the allocation of tasks.

Before migration, we have an equilibrium such that, \(T \in [N - 1, N]\), and for any \(i < T\), \(n_{L}^{(2,h)} = 0\), and for any \(i > T\), \(n_{L}^{(1,h)} = 0\).
Migration changes the threshold for the assignation of tasks. Two new thresholds are established as follow: There exists $T_{2,h}$ and $T_{1,h}$ such that tasks are assigned to workers, and for any $i < T_{1,h}$, $n_L^{(1,h)} = n_L^{(2,h)} = 0$, for any $i \in (T_{1,h}, T_{2,h})$, $n_F^1 = n_L^{(2,h)} = 0$, and for any $i > T_{2,h}$, $n_F^1 = n_L^{(1,h)} = 0$.

This lemma is similar to the one in Autor & Acemoglu, 2011, in an environment where there are two types of workers and three different skills sets.

![Figure 5: “The task space” before migration.](image)

Figure 5 shows us the “the task space”: how tasks are been assigned in this space to workers according to the threshold $T$ before migration takes place. The firms assign tasks to the workers according to the principle of comparative advantages, and lower educated have a comparative advantage in the production of tasks that requires skill 1.

Figure 6 represents “the task space after migration”: Tasks are been re-assigned among foreign and local workers according to the principle of comparative advantages; tasks that do not require $h$ to be performed are assigned to foreign workers. Local workers with skills $(1,h)$ will be performed more advanced tasks, they are assigned tasks that were performed earlier by higher educated workers.

![Figure 6: “The task space” after migration](image)
6.2.4 No arbitrage across skills

The threshold tasks, $T_{1,h}$ and $T_{2,h}$, decides the equilibrium in the model. The assumption of no arbitrage across skills is essential to secure equilibrium in the Ricardian Skill model, and it applies to this model. This assumption states that a type of “no arbitrage” condition, equalizing the cost of producing these threshold’s tasks using different skills, will determine the thresholds.

The threshold task $T_{1,h}$, must be such that it can be profitably produced using either foreign workers with skill type 1 or local workers with skill set $(1, h)$, and the threshold task $T_{2,h}$, must be such that it can be profitably produced using either low-educated local workers or high-educated local workers.

6.2.5 The wages and inequality

Once the threshold tasks, $T_{1,h}$ and $T_{2,h}$, are determined, wages and earnings differences across skill groups can be found in a very straightforward manner. Firms in this labor market have market power, as in the basic model, given that foreign workers will accept lower wages than local workers. The wages are set as the value of the marginal products of different types of skills, but in the case of foreign workers firms will discriminate if they can do so. Firms have market power because foreign workers have a more inelastic labor supply curve than local workers. This is the same assumption that was explained in the basic model. There is a wage setting equation for a worker $i$ with a skill set $s$ that can be written as follow:

$$W_s^p = p(i) \gamma_s - \omega_f(\varphi_f, \mu) \quad (b.7)$$

I assume local worker are not been discriminated, as in the basic model, $\omega_L(\varphi_L, \mu) = 0$. Now we can write the wage setting function for workers of each skill-set as:

$$w_1^F = p(i) \gamma_1 - \omega_f(\varphi_F, \mu) \quad (b.8)$$

$$w_{1,h}^L = p(i) \gamma_{1,h} \quad (b.9)$$

$$w_{2,h}^L = p(i) \gamma_{2,h} \quad (b.10)$$
This is a simplification, because it could be the case that some groups of local workers are been discriminated. As long as firms can discriminate, they will offer a lower wage to foreigners than the one they should have offered in equilibrium.

Productivity is increasing in \( h \) and \( 2 \), and wages are different between workers with different skill sets, and it is therefore it is possible to say that:

\[
\begin{align*}
    w_{2h}^L &> w_{1h}^L > w_F
\end{align*}
\]

Discrimination of foreign workers reinforces the inequality between the wages of foreign and local workers.

The wage ratios are more important than the levels because they inform us about the wage structure and inequality. An example is the following:

\[
\frac{w_{2h}^L}{w_{1h}^L} = \frac{p(i)}{p(i)} r_{2h} / r_{1h} \tag{b.11}
\]

Equation (b.11) let us evaluate the wages of high-educated local workers respect to the wages of the low educated local workers. By using equation (b.8), (b.9) and (b.10) and given the principle of specialization, it is possible to compare the wages of local workers before and after migration in order to see if they have changed, and we assume that as fewer tasks are assigned to local workers they will become more specialized, hence more productive.

The intuition is as follow: There will be a re-assignation of tasks among workers, low indexed tasks, if possible, will be assigned to low-educated foreign workers. Given that foreign workers lack of country-specific skills firms can increase productivity by assigning to them low-indexed tasks that do not require \( h \) to be performed, and paying lower wages to them. At the same time, given that their supply curve is less elastic than the one of natives; firms will see an opportunity to minimize costs, offering a lower wage than the equilibrium wage.

### 6.2.6 Equilibrium in the Static Model

I will not characterize completely the equilibrium, but I will introduce its main characteristics. As noted above, tasks are priced \( p(i) \) and there are strict comparative advantage. This ensures

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61 Examples are aborigine groups in the Americas, and descendants of Africans in countries like the US and the Dominican Republic. This have been well documented in the literature in the Social Sciences, many studies have evidence of these groups been discriminated.
that there exist two thresholds \( T_{1,h} \) and \( T_{2,h} \). Below \( T_{1,h} \), all the tasks are produced by foreign workers, between \( T_{1,h} \) and \( T_{2,h} \) are all the tasks performed by low-educated local workers, and above \( T_{2,h} \), all the tasks are performed by high-educated local labor.

**Proposition 1** There is a unique equilibrium summarized by \( (T_{1,h}, T_{2,h}, P_1(i), P_{1,h}(i), P_{2,h}(i), W_1, W_{1,h}, W_{2,h}) \) given by equations that represents:

1. Prices of tasks per skill set as a function of the thresholds
2. Relative Wages as a function of the thresholds
3. The demand for tasks

**Prices of tasks per skill set as a function of the thresholds.**

I proceed by characterizing the unit cost \( c_u \) of producing tasks as a function of factor prices with migration represented by the two thresholds \( T_{1,h} \) and \( T_{2,h} \). Thus:

\[
\begin{align*}
    c_u\left(\min\left(\frac{w_1^f + \omega_F}{y_1}, \frac{w_1^{1,h}}{y_{1,h}}\right)\right) & \equiv \min\left(\frac{w_1^f + \omega_F}{y_1}, \frac{w_1^{1,h}}{y_{1,h}}\right) \quad \text{If } i \leq T_{1,h} \\
    c_u\left(\min\left(\frac{w_{1,h}^f, w_{2,h}}{y_{1,h}, y_h}\right)\right) & \equiv \left(1 - \tau\right)\frac{w_{1,h}^{1,h}}{y_{1,h}} + \tau \min\left(\frac{w_{1,h}^{1,h}, w_{2,h}^{1,h}}{y_{1,h}, y_h}\right) \quad \text{If } T_{1,h} < i \leq T_{2,h} \\
    c_u\left(\min\left(\frac{w_{2,h}}{y_{2,h}}\right)\right) & \equiv \left(1 - \tau\right)\frac{w_{2,h}}{y_{2,h}} \quad \text{If } i > T_{2,h}
\end{align*}
\]

We call this set of equations for equation (b.12).

\( c_u \) is derived from the production function of task \( i \), derived from equations (b.4), (b.5) and (b.6). The unit cost in the case of \( i \leq T_{1,h} \) also depends of the possibilities of discrimination of the firms. We still assume, as in the basic model that only foreign workers can be discriminated in a first period with migration. The reason to write the unit costs for tasks \( i \leq T_{1,h} \) as \( c_u\left(\min\left(\frac{w_1^f + \omega_F}{y_1}, \frac{w_1^{1,h}}{y_{1,h}}\right)\right) \), is because given perfect substitution between foreign workers and local workers with low education in those tasks, firms will choose whichever factor has a lower effective cost. The effective costs of a foreign workers is \( \frac{w_1^f + \omega_F}{y_1} \) since the productivity of task is \( y_1 \).
Relative Wages as a function of the thresholds

I will follow Acemoglu and Restrepo, 2015, in using the final good as the numeraire $Y$. From (1) we get the demand for task $i$: \[ y(i) = Yp(i)^{-\sigma} \] (b.13)

By using equation (11a) and (12a) we get the set of equations (13a):

\[
y(i) = \begin{cases} 
  Yc^{\mu} \left( \min \left( \frac{w_{1}^{F} + \omega_{F}}{\gamma_{1}}, \frac{w_{1,h}^{F}}{\gamma_{1,h}} \right) \right)^{-\sigma} & \text{if } i \leq T_{1,h}^{1} \\
  Yc^{\mu} \left( \min \left( \frac{w_{1,h}^{F}}{\gamma_{1,h}}, \frac{w_{2,h}^{F}}{\gamma_{h}} \right) \right)^{-\sigma} & \text{if } T_{1,h}^{1} < i \leq T_{2,h}^{1} \\
  Yc^{\mu} \left( \min \left( \frac{w_{2,h}^{F}}{\gamma_{2,h}} \right) \right)^{-\sigma} & \text{if } i > T_{2,h}^{1} 
\end{cases}
\]

For an equilibrium to exist the assumption of non-arbitrage across skills must hold, as explained earlier. (b.14) gives us the mathematical relationship by the one this assumption holds in this model. At $T_{1,h}^{1}$ firms will be indifferent between using foreign workers or low-educated local workers. The same happened at $T_{2,h}^{1}$, where firms are indifferent between using a low-educated local worker or high-educated local worker.

It gives us, at thresholds the following two relations:

\[
\frac{w_{1,h}^{F}}{w_{1}^{F} + \omega_{F}} = \gamma(T_{1,h}^{1}) \quad \text{and} \quad \frac{w_{2,h}^{F}}{w_{1,h}^{F}} = \gamma(T_{2,h}^{1})
\]

These conditions determine the cost-minimization allocation of tasks between foreign workers and local worker of different skills set.

**The demand for tasks**

The quantities of task production of each input as a function of the two equilibrium thresholds by using equations (b.4), (b.5), (b.6) and (b.13), are the only equations missing to characterize the full equilibrium, and define the equilibrium in the static model.

Summing up, even that I have not fully characterized the equilibrium I have got the dynamic of task allocation, the expressions for wages and the impact of a migration shock of low-educated workers in the short run. The results are as in model I, foreign workers will get a
different wage than local workers because their lack of skill and they will be allocated in “lower-quality jobs” represented by “low indexed tasks” in this model.

In the ensuing section, I will discuss the results of model I and model II, specifically on how a migration shock of low-skilled worker affect the wages of local workers.
7 Discussion

I started this master’s thesis trying to understand the main result of David Card’s paper “The Impact of the Mariel Boatlift on the Miami Labor Market”: A migration shock has no effect on the wages or unemployment rate of less-skilled native workers. The research question of this master’s thesis is: Are there alternative mechanisms for David Card’s results? My answer is yes, if we take into account two assumptions: 1) Migration is a complex process because it is about people, but in economics, we study people as labor input, in other words as a mere quantity, a direct input in a production function. 2) Labor markets are imperfect, in the sense that firms can affect input prices.

I have formalized the answer to that question by presenting two task-based frameworks. Before doing so, in section 3 and 4, I set restrictions to the definitions of migration, labor migration and labor. These definitions apply to both models, and they are important because when talking about migration, or any social phenomena, we have to clearly set definitions as to not open up for different interpretations of the models.

Using the task approach to the production function can be a useful tool because it opens the possibility to include questions on input frictions, organization and management in the production process. The reason for this is that neoclassical production theory assumes the existence of production processes and its supervision as given, ignoring organizational and management related questions that are essential in production.

One main feature of task-based frameworks is that we can include in the long run the creation of new tasks due to changes in the input mix, as for example management of foreign labor, tasks related to intercultural communication, etc. As we could also include the management of entropic process, given it is performed by humans beings, and novel task creation as higher technological achievement we have\(^62\). This is an important topic because, the management of workers is essential to production, and it requires high country specific human capital, since the management of people depends in essence on cultural understanding.

**Model I** is a simple model of two tasks. **Model II**, is an extension to Daron Acemoglu and Pascual Restrepo’s model. This allows us to check for the dynamics on how the process of

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\(^62\) Novel tasks are those demanded by new products, techniques, or services. This is the definition used by David Autor on page 2 in “The “Task Approach” to Labor Markets: An overview” (Autor, 2013).
assigning tasks between local and foreign workers takes place. We moved from a world of two tasks to a world with a continuum of tasks.

*Labor inputs complement each other in the production of tasks.* This is an important assumption in both models. **In model I,** the form of the production function gives complementarity between tasks, since it is a Cobb-Douglas function with constant returns to scale. **In model II,** this is given by the elasticity of substitution between types of tasks, \( \zeta \). This complementarity is in contradiction to the model of supply and demand of labor that assumes that migrants are the same as local workers, and thus, their arrival increases the supply of labor and predicts that the wages of all workers go down, as the market for labor becomes saturated in the short-run\(^63\). The reason behind this assumption is that most empirical studies find no harm to wages of low-skilled local workers; most estimates are small and, on average, essentially zero. There is evidence in many studies that low-skilled workers act as complements or imperfect substitutes of local workers increasing productivity\(^64\). **In model I,** if a new migration shock take place without capital and/or technology changes there will be negative outcomes for all the workers performing task \( x \). Some studies that have found negative effects for natives with migration, lower wages, have also assumed no capital or technology change\(^65\).

*The lack of country specific skill, \( h \), is a driven force in both models.* Foreign workers have no skills related to the culture of the receiving country in the short run. In **Model I,** it means they will only be able to work in the production of task \( x \). In **Model II,** it means that they will be assigned lower-indexed tasks, in other words, jobs of lower quality. It is clear that the skills of workers, especially \( h \) are at the center of the results and it is the reason why I treat foreign and local labor as two different inputs. This assumption has earlier been criticized as was mentioned in section 5.1.1, but I can answer that critique by arguing that the cultural

\(^{63}\) Complementarity defined as “workers who need to work together in certain proportions to accomplish a task and thus who do not compete with each other for positions” (Constant, 2014).

\(^{64}\) The literature is rich on research on complementarity and imperfect substitution. I can cite as examples; Gang & Rivera-Batiz, 1994, by using the 190 US Census of Population and Euro-barometer data found that education is complementarity with unskilled labor and experienced labor in production, for a 1% increase in the endowment of unskilled labor aises the returns of education by close to 3/4%. Peri & Sparber, 2009, by using individual data on the task intensity of occupations across US states from 1960-2000, they demonstrate that foreign-born workers specialize in occupations that do not harm the economic outcomes of local workers. Theoretical they use a task approach with imperfect substitution between natives and immigrants with similar education levels; Moreover, Giovanni Peri has developed research that had shown positive effects of migration on U.S.-born workers both in the short run and the long run (Peri & Gianmarco, 2012).

\(^{65}\) For example, George Borjas in his paper “The labor demand curve is Downward Sloping: Re-examining the Impact of Immigrants on the Labor Market” (Borjas G., 2003)
closeness to the receiving country play a major role in the assignation of tasks in the labor market, ergo workers with completely different endowment of \( h \) are treated as different inputs.

Moreover, in some studies, as for example, Rienzo 2014, it is found that wage dispersion between immigrants is not fully explained by variables linked to the standard human capital model as education and experience, and perhaps \( h \) could be an explanation. The motivating evidence presented in section 6.1 is in line with the results, because that research tells us that immigrants’ cultural distance from the receiving country play a role in the economic outcomes of immigrants.

There are three common features in the assignation of tasks for both models, the principle of comparative advantages, the law of one price for skills and the principle of specialization.

The principle of comparative advantages tells us that tasks will be assigned to the inputs that are relatively more productive in its production. If firms have access to new inputs, firms are given the opportunity to reassign tasks between workers, increasing productivity.

The law of one price for skills is a driving force behind the re-assignation of inputs to task, given that the same wage will be given to inputs with equal skills, in other words, inputs that are equally productive.

The principle of specialization tells us that local workers will become more productive, in other words, if a worker performs fewer tasks then productivity will increase. This has been suggested since Adam Smith’s description of a pin factory (Smith, 1776). In recent years, some studies have criticized this principle, especially with reference to the fact that in the modern world companies are moving from Tayloristic organizations toward holistic organizations and the idea that multitasking increase productivity\(^{66}\).

\(^{66}\) Many authors have criticized this idea in the past years. Lindbeck & Snower, 2000 and 1996, wrote, “Firms are moving from Tayloristic organizations toward holistic organizations, where the former are characterized by a strong degree of tasks specialization and the latter by multitasking of workers”. Borghans & Weel, 2006: They wrote that in Becker & Murphy 1992, it was suggested that lower communication costs, e.g. due to computers, would make specialization more likely, but that in recent years multitasking has increased and, hence, there is a lower degree of specialization. They argued in their paper that computers have made workers more productive in many tasks, so the relative gains from learning by doing for a specialized task have decreased. In the same spirit, the paper of Dessein & Santos 2006, highlighted that multitasking is a good outcome because it implies higher flexibility, and that the cost of “ unbundling” tasks that are complementary to each other reduce productivity, and in Görlich 2010, where he argues that productivity increases when a worker is performing complementarity tasks, ergo multitasking increases productivity.
In reply to these critiques, I can just answer that recent studies have proven that multitasking due to the use of new technology had become a cause of brain damage and illness among workers all over the world.\(^6\) This is the reason why I keep myself closer to the spirit of Adam Smith and Gary Becker, and the results of the model imply that higher task specialization increases productivity.

For both models, the principle of specialization is a driving force in the assignment of tasks, together with the principle of comparative advantages, and the law of one price for skills. Model II gives a better specification of the process, it makes it very clear that there is no arbitrage among skills and this set the rules, the thresholds that determine the assignment of tasks.

The forces that explain the assignment of tasks in model II, also explain the polarization of wages and tasks. On the one hand, in the lowest index we find low quality occupations with very low wages and on the other hand, in the highest index, we find highly specialized and productive occupations with very high wages for highly educated local workers. This polarization of wages is reinforced if firms can discriminate foreign workers, since they will get a lower wage than the one they could get in a competitive equilibrium.

The models presented in this master’s thesis rule out negative outcomes for natives in the very short run. Even in the case of firms not having discriminatory possibilities, and it actually does not rule out negative outcomes in the long run if capital and technologies are driven to increase labor-intensive techniques by making production intensive in tasks that can be performed with very low-country specific skill. It is a question about what kind of society we wish to live in. Since the major conclusion of this model is that in the presence of possibilities of discrimination, a poverty circle will be created, and inequality should never be an economic desirable outcome, works efforts should move towards demonstrating the negative impacts that inequality has in the societies and how discrimination can be eliminated.

\(^6\) The literature on research about brain damage and productivity loss due to multitasking is extent, the main conclusion is that it not only causes damage, but there are losses of productivity up to 40% in some cases, some well-known examples of research are: Mayr & Kliegl, R., 2000, Meuter, R. F. I & Allport, A., 1999, Meyer, D. E & Kiers, D. E, 1997a, Meyer, D. E & Kiers, D. E, 1997b, Rubinstein, J., Evans, J, & Meyer, D. E, 1994 and Yeung, N. & Monsell, S., 2003For the US, an independent report in 2005 calculated a cost of interruptions due to multitasking for U.S. companies up to $588 billion per annum (Spira & Feintuch, 2005). Given it is an independent report I have my doubts on the results, but coming from Mr. Spira, who has achieved respect in organizational management in some circles in the US, it is worth the reading.
8 Conclusion

An academic debate on the effects of migration provided inspiration for the development of this master’s thesis. Academic debates are healthy because they drive researchers to develop further tools of analysis and theory. Debates give room for imagination and progress; therefore, there is hope that the Borjas versus Card debate will move the field forward in the next years.

This debate drove me to modeling migration from the start point of an imperfect market full of frictions and using the task approach to the production function, making it no longer an “anthropomorphic function”, but a “humanized function” in the sense that can help us to understand management and organization issues. The results of the models presented in this master’s thesis fit the results of David Card’s research. The use of task-based frameworks could open to the possibility for further development, especially with respect to the fundamentals of a task approach to production. There is a need for development of the task approach, not for the sake of research, but for sake of education.

It is not an exaggeration to say that the economic profession has an extremely important task in education of people about economics because their models have a big impact on shaping society. Tertiary education is still not the normal rule in the world, since the average gross enrollment ratio for tertiary education has been approximate 30%68. Gross enrollment ratios at all levels of education have risen globally, but wide variations remain between rich and poor countries. In other words, access to tertiary education is still limited in poor countries, being mainly the most economically advantaged groups that access it.

The advantaged groups existing within our global society in order to protect the most disadvantaged segments, aiming to eradicate discrimination, must implement adaptive measures, and particularly solidarity, judiciously. Otherwise, it will be more of a “humanitarian issue” rather than a “labor challenge”.

The challenge is to move away from a debate on how migration can have negative effects on labor outcomes of local workers, to how we can diminish the frictions due to

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68 World Development indicators published on April 15th, 2016.
cultural differences. Perhaps by doing so developing policy tools to maximize production, reduce income inequality, the reduction of the discrimination’s possibilities of the firms, and how firms could assign tasks in production in order to get the best of the skill-set of immigrants.

The good news is that many researchers are concentrating their efforts in this direction, so perhaps we will have a future where governments will ask for people and will get people to maximize their production functions.
Bibliography


